PROCEEDINGS of

7th AGRICULTURAL GRADUATE STUDENTS CONFERENCE AGSC 2021

Food, Farmers and Future:
Envisioning Amassment of Regenerating and Nourishing Food

Editors : **J.S. Kennedy** *et al.*

School of Post Graduate Studies
Tamil Nadu Agricultural University
Coimbatore 641 003

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SCHOOL OF POST GRADUATE STUDIES

TAMIL NADU AGRICULTURAL UNIVERSITY, COIMBATORE, INDIA

CITATION

Proceedings of the 7th Agricultural Graduate Students Conference (AGSC) 2021 on "Food, Farmers and Future: Envisioning Amassment of Regenerating and Nourishing Food" held at the School of Post Graduate Studies, Tamil Nadu Agricultural University, Coimbatore on September 07 & 08, 2021, TNAU Publications, Coimbatore – 641 003, India.

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ISBN: 978-93-91845-00-1

9 789391 845001

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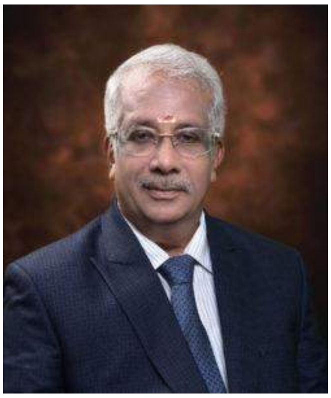
Published by Thannambikkai Publications, No. 10, Shastri Street Number 1, P.N. Pudur, Coimbatore 641 041, India on behalf of the Dean, School of Post Graduate Studies, Tamil Nadu Agricultural University, Coimbatore and 7th Agricultural Graduate Students Committee, Tamil Nadu Agricultural University, Coimbatore, India.

PRINTED BY

Printed @ TNAU Offset Printing Press,
Directorate of Extension Education,
Tamil Nadu Agricultural University,
Coimbatore - 641 003, India.

FOREWORD



Food - we all need it and we can't live without it. As the world's population grows every minute, there are more and more mouths to feed. In fact, there are so many mouths to feed that 'overpopulation' is now a big concern for our planet's future. In 2050, there are expected to be an extra 2.5 billion people on earth. Therefore, the case for urgent action in the global food system is now compelling.

We are at a unique moment in history as diverse factors converge to affect the demand, production and distribution of food over the next 20 to 40 years. The needs of a growing world population will need to be satisfied as critical resources such as water, energy and land become increasingly scarce. The food system must become sustainable, whilst adapting to climate change and substantially contributing to climate change mitigation. There is also a need to redouble efforts to address hunger, which continues to affect so many. Deciding how to balance the competing pressures and demands on the global food system is a major task facing policy makers, and is the impetus for this Agricultural Graduate Students Conference 2021.

The conference has aimed to add value though the breadth of its approach which places Food and Farmers within the context of wider policy agendas. It argues for decisive action and collaborative decision making across multiple areas, including development, investment, science and trade, to tackle the major challenges that lie ahead. The conference has brought together evidence and expertise from a wide range of disciplines across the natural, engineering and social sciences to identify choices, and to assess what might enable or inhibit future change. Building upon existing work, it has also drawn upon over 250 reviewed evidence papers that have been commissioned. I am delighted that the findings of all of this work are now published in Journals of Good Standing which will be available to all. I hope that this will help policy makers and other communities of interest to think creatively and decisively about how to address the challenges ahead in a way that is pragmatic and resilient to future uncertainties.

I hope the 7th Agricultural Graduate Student Conference (AGSC 2021) will stimulate young minds be more significant and committed in their objectives. I appreciate the efforts taken by Dr. J.S. Kennedy, Dean, School of Post Graduate Studies and his team of Scientists for motivating the Postgraduate Students to think objectively about Food, Farmers and Future: Envisioning Amassment of Regenerating and Nourishing Food. I congratulate all the Postgraduate Students, who have contributed to their research outputs in this conference.

I wish the 7th edition of Agricultural Graduate Students Conference (AGSC) 2021, a grand Success.

Date: 26.08.2021

Place: Coimbatore

Office of the Vice-Chancellor
Coimbatore
26 AUG 2021
641 003
Tamil Nadu Agricultural University

26.8.21.

Prof. N. Kumar, Ph.D., F.H.S.I.,
Vice-Chancellor
TNAU, Coimbatore

PREFACE

As globalization has greatly broadened the mirror through which we view anthropoid activities, the critical role of agriculture in this larger tableau and of the farmer in particular, has long-drawn-out as well. All of the seemingly intractable global challenges we face exploding population growth, hunger, poor nutrition, lack of food security and safety, a growing middle class, and changing diets are falling heavily on the world's farmers.

So it's a good thing they're not alone in facing these challenges. Think of the farmer as the hub of our global food development and supply chain ecosystem, and the input suppliers, food companies, regulators, advocates, consumers and academia as the spokes. Every single one of these players has a stake in making sure there is enough safe food for people around the world and, thus, in increasing both yield and farm sustainability. This makes them natural collaborators with farmers in the effort to address the changes and improvements needed to satisfy the increasing global demand for food.

The complexity of food system and ecosystem approaches is being addressed today by an emerging discipline, or rather trans-discipline, of agricultural, ecological, economic and health knowledge. Pathways to holistic and multifactorial approaches have been increasingly conceptualized and elaborated. As a result, a new food system narrative has been firmly established over the past decade. This new narrative is distinctly different from the post-war industrial and chemical narrative whose fame and glory culminated in the Green Revolution and which still dominates mainstream farming. It also goes well beyond concepts of sustainable intensification merely trying to improve the resource efficiency of productivism.

Integrating previously segregated sectors of production, processing, trade, consumption, environmental assessment and health, as well as knowledge systems into the concept of food systems substantially extends the scope and complexity of the approaches that are needed. Together with the recognition of social inclusion as critical systemic factors in any sustainability equation this systems approach has gained weight enormously over the past decade. The new paradigm of agri-food systems also integrates the implementation and cost of public and personal health as part of the economy of food and agricultural production. Threats to the resilience of ecosystems and sustainable use of natural resources and critical material cycles have increased over the past decade.

All planetary boundaries, except the ozone layer, are being stressed harder today than ten years ago. Loss of biodiversity, mounting greenhouse gas emissions, degradation of soil fertility, deforestation, and detrimental nutrient and chemical emissions continue to rise at unacceptable levels. In many regions of the world 'mainstream' chemical agriculture continues on a pathway of self-destruction. Despite progress on the part of some countries, chronic undernourishment and hidden hunger, as well as obesity and other food related diseases have actually increased over the past decade. The destructive impact of industrial food systems and agricultural practices on our ecosystems and the social and cultural wellbeing of communities and nations has probably never been higher than today.

Keeping these in view, the School of Post Graduate Studies, Tamil Nadu Agricultural University is organizing the 7th edition of Agricultural Graduate Students Conference (AGSC) during September 7-8, 2021 under the broad theme "Food, Farmers and Future: Envisioning Amassment of Regenerating and Nourishing Food". Thus AGSC 2021 offers a stimulating venue for Student Research Exchange and gives Students a platform to broaden their scientific and social network. The scientific program of this conference includes variety of Student Research Outcome under sub-themes such as 1. Designing Nourishing Food for Future: Perspectives in Crop Improvement, 2. New Vistas in Resilient Farming: Trends and Challenges in Crop Management, 3. Emerging Paradigms in Crop Protection, 4. Enhancing Sustainable Use of Natural Resources for Enhancing Food Production, 5. Horticulture for Unswerving and Optimized Food Production, 6. Trends in Agricultural Engineering for the Changing Landscape, 7. Perspectives in Nutrition and Dietetics, 8. Forest Management Scenarios in a Changing Climate, 9. Approaches in Bio Nanotechnology for Enhancing Agricultural Productivity, and 10. Environmental, Economic and Social Dimensions of Farm Sustainability. The articles are presented as poster, oral or plenary forms to International and Professional audience both online and offline. This compendium of Student Research Articles would certainly enlighten the young minds for better tomorrow in Indian Agriculture.

Date: *26.08.2021*

Place: *Coimbatore*

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Dr. J.S. Kennedy, D.Sc.,
Dean
School of Post Graduate Studies
TNAU, Coimbatore

THEME 1

Designing Nourishing Food for Future: Perspectives in Crop Improvement

THEME 2

New Vistas in Resilient Farming: Trends and Challenges in Crop Management

THEME 3

Emerging Paradigms in Crop Protection

THEME 4

Enhancing Sustainable Use of Natural Resources for Enhancing Food Production

THEME 5

Horticulture for Unswerving and Optimized Food Production

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Trends in Agricultural Engineering for the Changing Landscape

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Forest Management Scenarios in a Changing Climate

THEME 9

Approaches in Bio Nanotechnology for Enhancing Agricultural Productivity

THEME 10

Environmental, Economic and Social Dimensions of Farm Sustainability

AGRICULTURAL GRADUATE STUDENTS CONFERENCE
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2021

THEME 01

Designing Nourishing Food For Future: Perspectives in Crop Improvement

Assessement of Storability of Bioprimed Maize Seeds by the Accelerated Ageing Method

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Keywords: *Maize, Biopriming, Germination, Vigour, and Storage*

Introduction

Maize is one of the important cereal crop next to rice and wheat in India. Maize cultivation is limited by disease which causes a grain losses. For biological control of diseases, biopriming of seeds is recommended. We need to determine storability of bioprimed seeds based on speed of emergence, germination and seedling traits of bioprimed seeds.

Methodology

Seeds are bioprimed with different bioinoculants, 5% Bacillus amyloliquefaciens, 5% *Bacillus licheniformis*, 10% *Brachybacterium paraconglomeratum*, 1% *Trichoderma asperellum*, 1% *Trichoderma koningiopsis*. Storability of bioprimed seed were carried out by accelerated ageing test (Panayotov,2014). For accelerated ageing test, bioprimed seeds along with control seed are packed in small size butter paper with equal number of holes and placed in desiccator at 100% RH and 40 ± 1 °C for 10 days. After 10 days of accelerated ageing, aged seeds were tested for seed quality parameters such as speed of germination, germination percentage, seedling characters and seed vigour. The data of the study was analysed by ANOVA and the mean are compared by LSD using SPSS Software.

Results and Discussion

The results of present study revealed that, bioprimed seeds can maintain the vigourous status of the seed. Seed vigour of bioprimed seeds can maintain the vigourous status of seed upto 6 days of accelerated ageing. Different bioinoculants are used to assess the storability of bioprimed seed. Among the bioinoculants, 1% *Trichoderma koningiopsis* maintain the germination percentage above Indian Minimum Certification Standard upto 5 days of accelerated ageing. The results of the present study revealed that storage of bioprimed seed will not reduce the vigourous status of seed. Current study concludes that storage of bioprimed seed can be practice.

Reference

Panayotov, N. 2014. Assessment of vitality potential and storability of pepper seeds by the method of accelerated ageing. *Bulgarian Journal of Agricultural Science*, 20 (1): 133-139.

Ananthi, M., Sasthri, G., Srimathi, P. and Malarkodi, K. 2015. Prediction of storability of greengram seeds through accelerated ageing test. *International Journal of Farm Sciences*, 5(4):326-331.

Table 1. Effect of bioprimed seed on storage based on seed vigour

	1AA	2AA	3AA	4AA	5AA	6AA	7AA	8AA	9AA	10AA
T0	3486	3844	3463	3245	3868	3276	428	343	419	-
T1	4418	2681	4147	4356	3382	3666	199	694	35	-
T2	4418	3146	3370	4174	3682	3619	621	700	427	8
T3	4351	4223	3344	3448	3115	3405	271	300	132	11
T4	3368	4194	4324	3572	4410	4034	1331	778	1503	62
T5	4077	4653	3873	4374	4133	3302	1552	1284	742	89

	SED	CD (0.05)
Treatment	85.84740	169.39719
Days	110.82852	218.69083
Treatment X Days	271.47332	535.68095

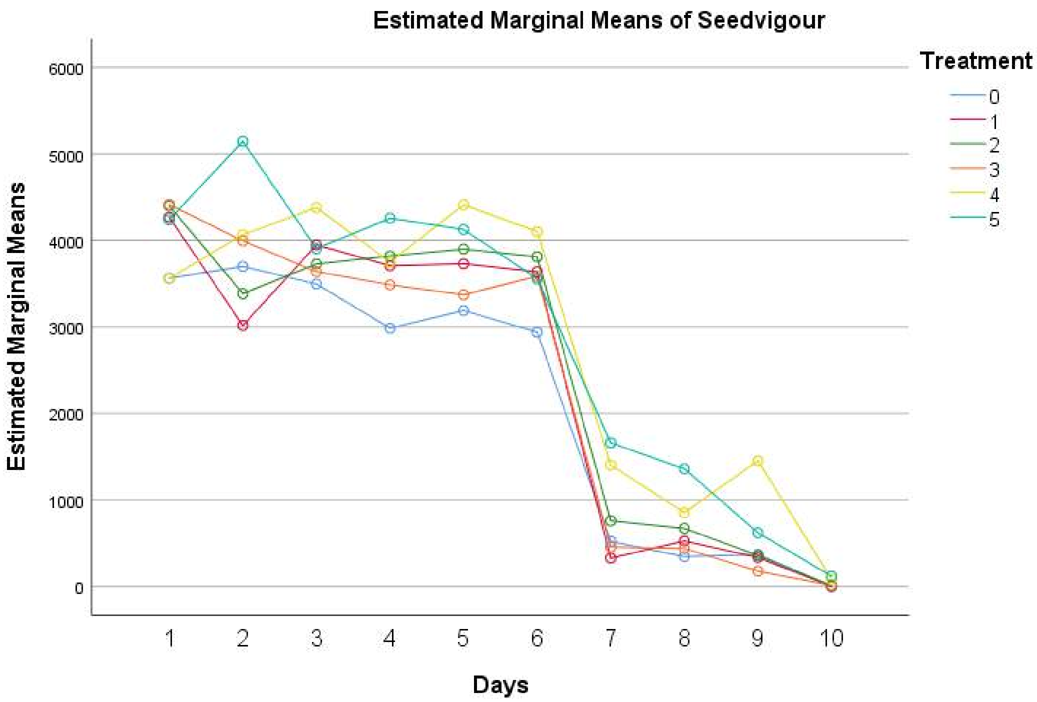

Figure 1. Effect of bioprimed seed on storage based on seed vigour

T_0 – Control ; T_1 – 5% *Bacillus amyloliquefaciens* ; T_2 – 5% *Bacillus licheniformis*

T_3 – 10% *Brachybacterium paraconglomeratum* ; T_4 – 1% *Trichoderma asperellum*

T_5 – 1% *Trichoderma koningiopsis*

Association Analysis for Seed Yield and Component Traits in Segregating Populations of Blackgram (*Vigna mungo* (L.) Hepper)

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Keywords: *Blackgram, F_2 population, correlation analysis, path analysis, seed yield*

Introduction

Blackgram (*Vigna mungo* (L.) Hepper, 2n = 22) is an important legume crop occupying peculiar position in Indian agriculture. Association studies gives information about the contribution of different characters towards seed yield. The study on inter-relationship between the component traits and seed yield will formulate an effective and viable breeding programme for improvement of seed yield in a short time.

Methodology

The present research work was carried out at the National Pulses Research Centre, Vamban during the *kharif* 2017. F2 generation of VBN (Bg) 4 x Mash 114 and their parents formed the basic genetic material for the present study. Observation were recorded on 9 yield contributing traits. The TNAUSTAT software (Manivannan, 2014) was used to analyze the, correlation and path coefficients.

Results and Discussion

The simple correlation coefficient between seed yield and yield component characters in F2 generation was presented in Table 1. The results revealed that, the seed yield per plant had significant and positive correlation with number of branches per plant, number of clusters per plant, number of pods per cluster, total number of pods, pod length, number of seed per pod and 100 - seed weight. Plant height had non significant association with seed yield. These results are in close agreement with findings of Singh *et al*. (2016). The direct and indirect effect of yield components on seed yield per plant was presented in Table 2. In the present study, number of pods per plant and 100-seed weight had high and positive direct effect on seed yield. Number of clusters per plant had low and positive direct effect on seed yield. The results are in accordance with Reni *et al*. (2013) and Bharti *et al*. (2013). Hence , based on the results of correlation and path analysis, it may be concluded that the traits, number of pods per plant, 100-seed weight and number of pods per cluster, can be considered as selection indices for seed yield improvement programme in blackgram.

Reference

Bharti, B., Kumar, R., Bind, H.N., Kumar, A. and Sharma, V. 2014. Correlation and path analysis for yield and yield components in black gram [*Vigna mungo* (L.) Hepper]. *Internat. J. Plant Sci*., **9:** 410-413.

Manivannan, N. 2014. TNAUSTAT - Statistical package. Retrived from http://sites.google.com/site/tnaustat. On 11.03.2017

Reni, Y.P., Rao, Y.K., Satish, Y. and Babu,S. J. 2013. Estimates of genetic parameters and path analysis in blackgram [*Vigna mungo* (L.) Hepper]. *Internat. J. Plant, Animal and Environ Sci*., **4:** 231-234.

Singh. M., Swarup, M. I., Billore, and Chaudhari, P.R.2016. Association analysis of seed yield and its attributing traits in black gram [*Vigna mungo* (L.) Hepper]. *Agric. Sci. Digest*., 36 (2): 83-87.

Table 1. Simple correlation coefficient among yield attributes in F2 generation of VBN(Bg) 4 x Mash 114 cross combination

Character	PH	NPB	NCPP	NPPC	NPPP	PL	NSPP	HSW	SYPP
Plant height (PH) (cm)	1.00								
Number of branches per plant(NPB)	0.37**	1.00							
Number of cluster per plant(NCPP)	0.32**	0.62**	1.00						
Number of pods per cluster(NPPC)	0.12*	0.31**	0.22**	1.00					
Number of pods per plant(NPPP)	0.29**	0.65**	0.85**	0.53**	1.00				
Pod length (PL) (cm)	0.16**	0.14**	0.18**	-0.01	0.16**	1.00			
Number of seeds per pod (NSPP)	0.20**	0.32**	0.30**	0.24**	0.36**	0.38**	1.00		
100 - seed weight (HSW) (g)	-0.11*	0.04	0.13*	0.09	0.14**	0.11*	0.04	1.00	
Seed yield per plant (SYPP) (g)	0.09	0.46**	0.69**	0.32**	0.75**	0.15**	0.30**	0.40**	1.00

***,** Significant at 5 % and 1 % level of probability, respectively.**

Table 2. Direct and Indirect effect of yield components on seed yield per plant in F2 generation of the cross VBN(Bg) 4 x Mash 114

Character	PH	NPB	NCPP	NPPC	NPPP	PL	NSPP	HSW	SYPP
Plant height (PH) (cm)	**-0.100**	-0.009	0.049	-0.009	0.185	-0.004	0.013	- 0.031	0.094
Number of branches per plant(NPB)	-0.037	**-0.025**	0.095	-0.024	0.417	-0.003	0.022	0.011	0.456**
Number of cluster per plant(NCPP)	-0.032	-0.016	**0.153**	-0.017	0.546	-0.004	0.020	0.039	0.688**
Number of pods per cluster(NPPC)	-0.012	-0.008	0.034	**-0.078**	0.338	0.000	0.016	0.026	0.317**
Number of pods per plant(NPPP)	-0.029	-0.016	0.130	-0.041	**0.643**	-0.004	0.024	0.040	0.746**
Pod length (PL) (cm)	-0.016	-0.004	0.027	0.001	0.103	**-0.023**	0.026	0.032	0.146**
Number of seeds per pod (NSPP)	-0.020	-0.008	0.046	-0.019	0.232	-0.009	**0.067**	0.010	0.300**
100 - seed weight (HSW) (g)	0.011	-0.001	0.021	-0.007	0.088	-0.003	0.002	**0.291**	0.402**

Residue= 0.572. * bold figures denote direct effects

Association Analysis in *Kabuli* Chickpea (*Cicer arietinum* L.)

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Keywords: *Correlation, Germplasm, Kabuli Chickpea, Association analysis*

Introduction

The king of pulses, chickpea is a cool season legume cultivated and consumed widely throughout the world because of its protein rich constitution, taste and nitrogen fixing ability. But its per capita availability is far below its requirement urging for development of new varieties with better production along with climate resilience. For selection process to be more accurate and precise, association studies of different characters with yield paves a way showing the positive and negative correlation and suggesting the base characters to be chosen for selection.

Methodology

Fifty five *kabuli* chickpea genotypes including four check varieties have been grown in *rabi*, 2018 and biometrical observations are recorded for twelve quantitative characters. Correlation coefficients have been calculated from the covariance values; the positive and negative association of the various characters along with yield was deduced.

Results and Discussion

The magnitude of genotypic correlations was higher as compared to the corresponding phenotypic correlations indicating that there was an inherent association between the characters at genotypic level (Table1.). Thus, selection could be practiced for improvement of one character which will automatically result in the improvement of other though direct selection. Thus above traits could be used for direct selection of yield per plant. Economically important trait seed yield per plant showed positive and highly significant correlation with primary branches per plant, height at first pod set, pods per plant and 100-seed weight. On the basis of the present investigation of interrelationship, it can be presumed that for improving seed yield in chickpea an ideal plant type should have traits like early maturity, high 100-seed weight, more pods per plant and primary branches. Hence, these characters could be utilized as selection criteria for improving seed yield in chickpea.

Reference

Panse, V. G. and Sukhatme, P. V. (1978). "Statistical method for agricultural workers".

Naveed, M. T., Ali, Q., Ahsan, M. and Hussain, B. (2012). Correlation and Path Coefficient Analysis for Various Quantitative Traits in Chickpea (*Cicer arietinum* L.). *International Journal for Agro Veterinary and Medical Sciences*, **6**(2): 97-106.

Parhe, S. D., Harer, P. N., Kute, N. S. and Chandra, K. (2014). Association among grain yield and morphological traits of chickpea genotypes. *Biolife*, **2**(3): 997-1001.

Table 1. Genotypic (r_g) and phenotypic (r_p) correlation coefficients among twelve characters in *kabuli* chickpea

Characters		Days to 50 % flowering	Days to maturity	Primary branches per plant	Secondary branches per plant	Height at first pod set (cm)	Plant height (cm)	Pods per plants	100 Seed weight	Seed volume/weight	Harvest index %	Protein content
Days to 50% flowering	r_g	1.000										
	r_p	1.000										
Days to maturity	r_g	0.970**	1.000									
	r_p	0.881**	1.000									
Primary branches per plant	r_g	0.085	-0.067	1.000								
	r_p	0.076	0.041	1.000								
Secondary branches per plant	r_g	-0.007	-0.162*	1.784**	1.000							
	r_p	-0.078	-0.139	0.283**	1.000							
Height at first pod set (cm)	r_g	0.179*	0.220**	-0.003	-0.046	1.000						
	r_p	0.146	0.140	0.070	0.064	1.000						
Plant height(cm)	r_g	0.213**	0.196*	-0.225**	0.037	0.523**	1.000					
	r_p	0.150	0.085	0.007	0.079	0.404**	1.000					
Pods per plants	r_g	-0.344**	-0.463**	0.972**	0.656**	-0.180*	-0.024	1.000				
	r_p	-0.292**	-0.367**	0.268**	0.461**	-0.074	0.004	1.000				
100 Seed weight	r_g	0.218**	0.253**	-0.265**	-0.277**	0.342**	0.432**	-0.332**	1.000			
	r_p	0.206**	0.201**	-0.016	-0.163*	0.296**	0.400**	-0.304**	1.000			
Seed volume/weigh	r_g	0.148	0.236**	-0.163*	-0.046	0.024	-0.207**	-0.081	-0.355**	1.000		
	r_p	0.120	0.174*	-0.001	0.023	0.035	-0.133	-0.082	-0.320**	1.000		
Harvest index %	r_g	0.059	0.001	0.523**	0.264**	-0.261**	0.146	0.141	0.014	0.055	1.000	
	r_p	0.055	-0.001	0.095	0.187*	-0.163*	0.139	0.131	0.023	0.032	1.000	
Protein content	r_g	0.229**	0.239**	-0.121	-0.179*	-0.037	0.262**	-0.296**	0.109	0.022	0.074	1.000
	r_p	0.192*	0.179*	-0.006	-0.118	-0.025	0.240**	-0.272**	0.105	0.027	0.062	1.000
Seed yield per plant (g)	r_g	-0.085	-0.044	0.585**	0.142	0.253**	0.172*	0.250**	0.247**	-0.355**	0.039	-0.259**
	r_p	-0.067	-0.042	0.071	0.018	0.186*	0.083	0.223**	0.213**	-0.337**	0.022	-0.249

***, ** at 5% and 1% significance level respectively**

Biofortification of Zinc in Rice Under Sodic Environment

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Keywords: *Sodic soil, Zinc uptake, Zinc sulphate, Rice*

Introduction

Sodic soil, due to high pH, Zn gets precipitated as $Zn(OH)_2$ and hence it is unavailable to crops. Rice is moderately resistant to soil sodicity, it is sensitive to Zn deficiency among other micronutrient, which may appear during early growth stages. Application of different amendments and zinc sulphate enhance the soil properties, zinc availability and uptake. Hence, this study was undertaken to investigate the influence of amendments and zinc sulphate application on biofortification of zinc in sodic environment

Methodology

Field experiment was laid out in split plot design with rice (var. CO 52) as a test crop. The amendments gypsum @ 50% GR (6.8 t ha-1) + GM @ 6.25 t ha-1, GLM @ 12.5 t ha-1 and press mud @ 10 t ha-1 were used as main-plot treatments for the reclamation of sodic soil. Different levels of zinc sulphate viz., 50, 100 and 150 per cent of recommended dose of zinc sulphate as basal with and without foliar spray of ZnSO4 @ 0.5 per cent at panicle initiation and heading stages were imposed as sub-plot treatments.

Results and Discussion

Amendments application decreased the pH, ESP and enhanced the availability and uptake of Zn. The highest zinc uptake and desirable reduction of pH, ESP being noticed in gypsum+ GM treated plots followed by GLM and press mud. Grain yield and DTPA- Zn was significantly increased by both amendments and zinc sulphate application. Among the amendments gypsum+ GM treated plots showed highest followed by GLM and press mud.

The reduction in pH and ESP on application of gypsum+ GM was attributed to the displacement of exchangeable Na by the calcium ions of gypsum. Application of amendments decreased the pH, which in turn might have decreased the Zn precipitation as $Zn(OH)_2$ and hence increasing the availability and uptake of Zn. In zinc sulphate applied treatments, the highest uptake of zinc was noticed in the treatment which received 150 per cent RD of zinc sulphate as basal+ foliar spray. The increase in the zinc content in grain might be due to the presence of increased amount of zinc in soil solution by the application of zinc sulphate.

Table 1. Effect of amendments and zinc sulphate on pH, EC and ESP of post-harvest soil

	Control	Gypsum+ GM	GLM	Pressmud	S Ed	CD(0.05)
pH	9.95	8.45	8.95	9.13	0.10	0.25
ESP (%)	29.7	14.8	25.2	26.2	0.36	0.91

Table 2.Effect of amendments and zinc sulphate on Zn uptake (g kg-1) of rice at harvest stage

M/S	Levels of $ZnSO_4$ (%)				Levels of $ZnSO_4$ (%)+ Foliar spray			Mean
	0	50	100	150	50+ FS	100+ FS	150+FS	
Control	95.0	118	142	163	145	178	207	150
Gypsum+GM	246	305	341	384	360	415	433	355
GLM	218	269	301	333	325	372	380	314
Pressmud	208	255	299	334	313	393	367	310
Mean	192	237	271	303	286	340	347	282
	M	S	M x S	S x M				
SE d	4.4	4.9	10.3	10.1				
CD (0.05)	11	10	22	20				

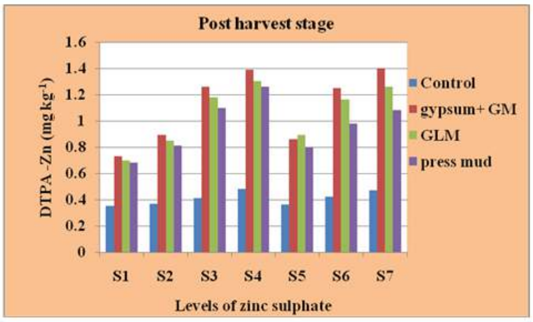

Fig.1 Influence of amendments and ZnSO4 on DTPA-Zn content of soil at post harvest stage

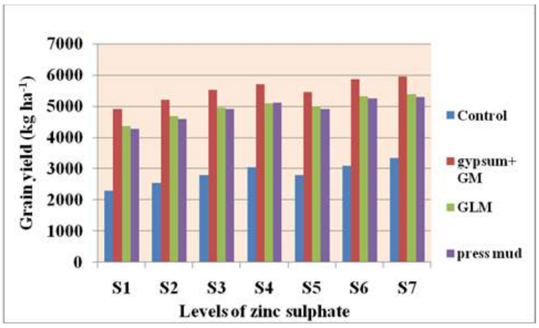

Fig.2 Influence of amendments and ZnSO4 on grain yield (kg ha-1) of rice

Reference

Fageria N K, Dos Santos A B, and Cobucci T (2011) Zinc nutrition of lowland rice. *Communications in soil science and plant analysis* 42(14): 1719-1727.

Kumawat S R and Yadav B L (2013) Sodicity tolerance of Fenugreek as influenced by application of zinc and vermicompost. *Legume Research* 36: 312-317.

Gayathri, P., K. Surya, C. Selvaraj, M.Ramya and L. Chitra. 2015. Evaluation of distillery spent wash and other organic amendments on soil physico-chemical properties and exchangeable sodium content in sodic soil. In: *National seminar on soil resilience*, 21-22 January 2015, AC &RI, Madurai, Tamil Nadu, pp. 273-27

Calcium on Growth Attributes Of Tomato (*Solanum Lycopersicum*)

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Keywords: *Calcium nutrition, Hybrid Tomato, Growth attributes*

Introduction

Calcium is the fifth most abundant element in the earth crust which is considered as a multifunctional nutrient in the physiology of crops. It enhances the cell wall integrity, cell division, cell growth, nitrogen assimilation and act as cofactor for many enzymes (Sajid *et al*. 2019). It is one of the macronutrient, important for the growth, development and production of tomatoes. Calcium in tomato at establishment and vegetative stage, boosts root and leaf growth, thus it maintains vigorous plant growth. Plant tissues lacking sufficient Ca susceptible for hypo-osmotic shock, therefore leads to physiological disorders, such as 'cracking' in tomato fruits, which is due to structural weaknesses in cell walls. Hence, calcium supplementation helps to alleviate its deficiency and improves growth of tomato plants.

Methodology

A field experiment was conducted in the farmer's field with hybrid tomato Shivam using different sources and levels of calcium (Ca) for improving the growth attributes. The treatment structure comprised of six calcium sources viz., calcium sulphate, calcium nitrate, calcium silicate, calcium EDTA, poultry manure and press mud applied at five different levels (0, 20, 40, 60, 80 kg Ca ha-1).The treatment were replicated thrice in a FRBD. The plant growth parameters such as plant height, root length, lateral root length and root volume were measured at different growth stages of tomato viz., vegetative, flowering, fruit setting and harvesting stages. The results obtained were discussed in this paper.

Results and Discussion

Application of various calcium sources and levels had significant effect on the growth parameters of hybrid tomato which varies with growth stages. All the growth attributes of hybrid tomato increases with the advancement of crop growth period. The growth attributes such as plant height, root length, lateral root length and root volume varies from 52.8 cm to 88.5 cm, 10.3 cm to 17.1cm, 7.5 to 14.2 cm and 3.80 cm to 7.80 cm respectively. Increasing levels of calcium improves all the growth attributes of hybrid tomato, irrespective of various sources. Application of Calcium EDTA at 60 kg Ca ha-1 recorded the highest mean plant height (77.3cm) and root length (15.1cm) which was shown in Table 1. However the highest mean lateral root length (10.4 cm) and highest root volume (5.10 cm) was observed with the application of poultry manure as at 80 kg Ca ha-1(Table 1). This might be due to the important role of calcium in plant life cycle as it influences the intake of other nutrients viz., nitrogen and boron, helps in promoting early root formation and growth. It also influences the apical growth of shoot or root (Sajid *et al*., 2020). The lowest growth attributes were observed with the application of calcium sulphate applied at various levels. The poor growth response to the application of calcium sulphate might be due to lesser solubility and supply of calcium for the growth of hybrid tomato. The results of the present study concluded that, application of Ca EDTA at 60 kg Ca ha^{-1} and poultry manure at 80 kg Ca ha^{-1} were found effective in improving the growth attributes of hybrid tomato.

Table 1. Effect of various sources of calcium on the growth attributes of hybrid tomato

Ca Sources	Plant Height (cm)	Root Length (cm)	Lateral Root Length (cm)	Root Volume (cm)
Calcium sulphate	68.2	12.4	9.67	5.16
Calcium Nitrate	71.7	14.0	9.51	4.83
Calcium Silicate	72.5	14.0	10.4	4.90
Calcium EDTA	77.3	15.1	9.80	5.37
Poultry manure	72.9	14.3	10.3	5.51
Press mud	72.5	14.0	9.90	5.15
Mean	73.4	14.3	10.0	5.15
SEd	2.19	1.47	0.33	0.12
CD (P=0.05)	4.31	2.89	0.65	0.24

Mean of three replicates; SEd-Standard error of difference; CD-Critical difference

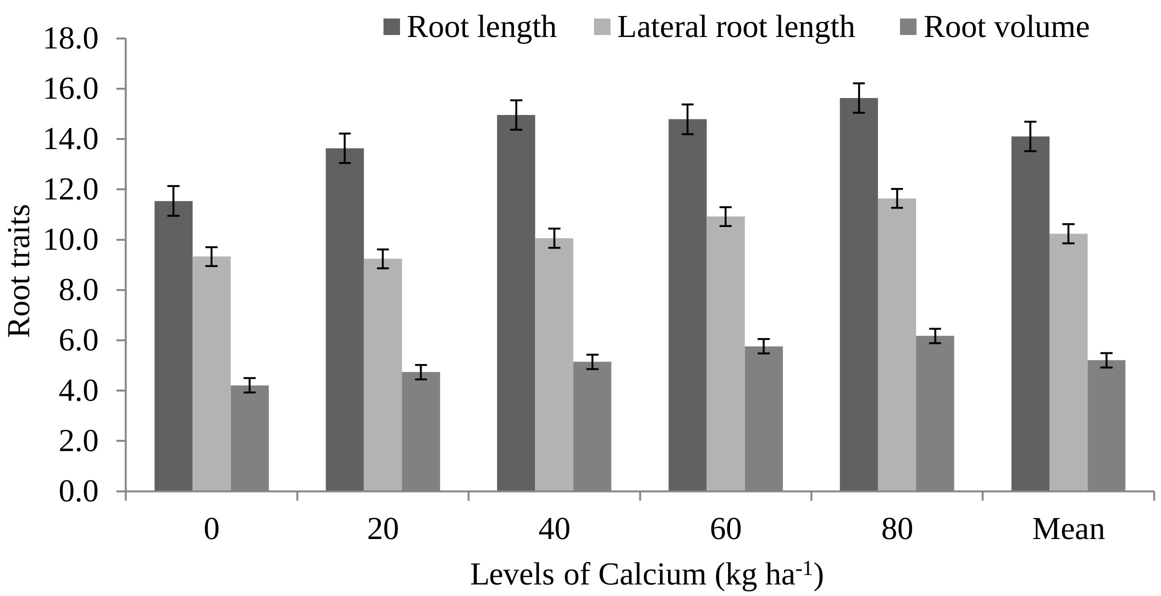

Figure 1. Effect of various calcium levels on the root attributes of hybrid tomato

Reference

Ewulo, B. S., Eleduma, A. F., & Sanni, K. O. (2016). Effects of urea and poultry manure on growth and yield attributes of tomatoes (*Lycopersicon esculentum* mill) and soil chemical composition. International Journal of Innovative Research and Advanced Studies (IJIRAS), 3(3), 5-9.

Sajid, M., Basit, A., Ullah, I., Tareen, J., Asif, M., Khan, S., ... & Nawaz, M. K. (2019). 13. Efficiency of calcium chloride (CaCl2) treatment on post-harvest performance of pear (*Pyrus communis* L.). Pure and Applied Biology (PAB), 8(2), 1111-1125.

Murillo-Amador, B., Jones, H. G., Kaya, C., Aguilar, R. L., García-Hernández, J. L., Troyo-Diéguez, E., ... & Rueda-Puente, E. (2006). Effects of foliar application of calcium nitrate on growth and physiological attributes of cowpea (*Vigna unguiculata* L. Walp.) grown under salt stress. Environmental and Experimental Botany, 58(1-3), 188-196.

Correlation of Radicle Emergence Test to Predict Seed Vigour and Field Emergence in Blackgram (*Vigna mungo* L.) Seed Lots

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Keywords: *Blackgram, Radicle emergence, Germination, Vigour and Field emergence*

Introduction

Blackgram (*Vigna mungo* L.) is one of the important pulse crop grown throughout India. According to Indian Minimum Seed Certification Standards (IMSCS), blackgram seedlings evaluated on 7th day for its germination percentage. During these long days of evaluation period was time consuming. We need advance technology which would give a precise result in short period.

Methodology

Radicle emergence test was conducted through Top of paper method (Matthews and Powell, 2012). The first appearance of radicle, which is termed as Mean Just Germination Time (MJGT) and the Mean Germination Time (MGT), which is the 2mm length of radicle emergence was calculated using the formula proposed by Ellis and Roberts (1980) and expressed in hours. Significance of correlation was tested by Pearson correlation method by using SPSS 16.0 software.

Results and Discussion

The results of present study clearly revealed that, the field emergence (0.972**), vigour index (0.956**) and germination (0.952**) had highly significant positive correlation. Whereas, electrical conductivity (-0.974**) and mean germination time (-0.933**) had highly significant negative correlation with the percentage of radicle emergence with 2mm length at 28th hour followed by 20, 26, 22, 24 and 18 hours (Table 1). The current findings are in accordance with the results of Matthews and Powell (2012). The study concluded that mean germination time with 2mm radicle emergence at 28th hour count could be used for quick indicator of seed vigour in terms of field emergence in blackgram seed lots.

Reference

Ellis, R.H. and Roberts, E.H. 1980. The influence of temperature and moisture on seed viability period in barley (*Hordeum distichum* L.). *Annals of Botany*, **45(1):** 31-37.

Matthews, S. and Powell, A. 2012. Towards automated single counts of radicle emergence to predict seed and seedling vigour. *Seed Testing International (ISTA Bulletin)*, **142:** 44-48.

Table 1. Correlation between seed vigour parameters and radicle emergence with 2mm length (%) in blackgram seed lots

	SOG	GER	DMP	VI	MJGT	MGT	EC	DA	HSW	FE	RE18h	RE20h	RE22h	RE24h	RE26h	RE28h
SOG	1															
GER	.922**	1														
DMP	.948**	.985**	1													
VI	.932**	.991**	.973**	1												
MJGT	-.851**	-.952**	-.945**	-.953**	1											
MGT	-.828**	-.897**	-.921**	-.891**	.973**	1										
EC	-.908**	-.923**	-.957**	-.920**	.915**	.900**	1									
DA	.913**	.874**	.886**	.912**	-.875**	-.853**	-.917**	1								
HSW	.930**	.870**	.899**	.884**	-.893**	-.904**	-.872**	.883**	1							
FE	.930**	.996**	.984**	.989**	-.953**	-.910**	-.923**	.895**	.887**	1						
RE18h	.850**	.798**	.810**	.809**	-.809**	-.828**	-.717*	.803**	.873**	.832**	1					
RE20h	.876**	.964**	.967**	.963**	-.962**	-.925**	-.970**	.910**	.839**	.961**	.728*	1				
RE22h	.723*	.905**	.867**	.898**	-.896**	-.853**	-.797**	.772**	.714*	.908**	.633*	.848**	1			
RE24h	.615	.852**	.796**	.841**	-.881**	-.826**	-.737*	.706*	.629	.850**	.578	.789**	.973**	1		
RE26h	.833**	.958**	.933**	.962**	-.950**	-.892**	-.885**	.861**	.783**	.950**	.716*	.894**	.942**	.927**	1	
RE28h	.931**	.952**	.952**	.956**	-.967**	-.933**	-.974**	.928**	.938**	.972**	.917**	.924**	.906**	.868**	.964**	1

**** Significant at 0.01 level** *** Significant at 0.05 level**

SOG – Speed of germination

GER – Germination (%)

DMP – Dry matter production (g/ 10 seedling)

VI – Vigour index

MJGT – Mean just germination time (h)

MGT – Mean germination time (h)

EC – Electrical conductivity of seed leachate (dsm^{-1})

DA – Dehydrogenase activity (OD value)

HSW – Hundred seed weight (g)

FE – Field emergence (%)

RE – Radicle emergence (%)

Creation of Variability for Powdery Mildew Resistance in Blackgram Using Different Breeding Approaches

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Keywords: *Blackgram, powdery mildew, resistant, variability, yield*

Introduction

Among the pulses, blackgram is the third important pulse crop due to its nutritional quality and suitability to different cropping systems. Although India holds the first position in area (56.02 lakh hectare) and production (30.59 lakh. tonnes), productivity is low (546 kg/ha) (Anonymous, 2020). The major drawbacks against realizing higher yield in blackgram can be attributed to lack of wider variability at a genetic level, indeterminate growth habit, canopy architecture, poor harvest index, cultivation in marginal lands and susceptibility to pests and diseases. Among the biotic stresses, powdery mildew, caused by *Erysiphe polygoni* is a major disease which causes both qualitative and quantitative loss. Disease management through host plant resistance has been the best and cheapest method in all the crops. Breeding for resistant varieties is the simplest, effective, and economical method as they provide durable resistance in controlling the disease. In the present study, different breeding strategies viz., screening of wild accessions, hybridization, and mutation breeding were employed to identify and characterize powdery mildew disease resistance in blackgram.

Methodology

Screening of wild relatives of blackgram

Twenty-four *Vigna mungo* var *silvestris* accessions along with check varieties LBG 17 (resistant) and CO 6 (susceptible) were collected from Department of Pulses, Tamil Nadu Agricultural University and screened artificially under glasshouse conditions for powdery mildew disease reaction.

Hybridization

The powdery mildew resistant and susceptible varieties namely LBG 17 and CO 6 identified in the artificial screening were selected and effected for crossing. The true F1's (hybrid) was forwarded to F2 generation to identify the segregants for powdery mildew disease resistant.

Mutation breeding

The blackgram variety CO 6 was selected for mutagenesis. Based on earlier reports on lethal dose 50 (LD 50), seeds were treated with three doses of 60Co (Cobalt-60) gamma rays viz., 200, 300 and 400 Gy at Bhabha Atomic Research Institute, Mumbai. 60Co treated seeds were sown in M1 generation and all the individual M1 plants were forwarded to raise M2 generation for screening of powdery mildew disease in MBS&NA Farm, Tamil Nadu Agricultural University, Coimbatore during Rabi 2019, is an ideal season for powdery mildew screening. The disease incidence was recorded at 45 and 55 days after sowing (DAS) using AICRP, (2013) scale. Percent disease index (PDI) was calculated using the following formula (Wheeler, 1969).

$$PDI = \frac{\text{Sum of all the rating of infected leaves on plant}}{\text{Number of leaves observed X Maximum disease score}} X\ 100$$

Results and Discussion

Among the 24 accessions of *Vigna mungo* var *silvestris* along with check varieties, LBG 17 and CO 6 screened for powdery mildew disease, *Vigna mungo* var *silvestris* /20 and LBG 17 were found to be observed as powdery mildew resistant genotypes (Table 1). These genotypes can be used as donors for development of powdery mildew resistant lines through recombination breeding. Mutation breeding also offers great scope for inducing variability to broaden the genetic base in blackgram (Yildirim *et al*., 2013). Among 20, 371 M2 screened for powdery mildew disease, eleven mutants were identified as powdery mildew resistant mutants and the remaining populations exhibited the susceptible reactions (Table 1).

Regarding hybridization, out of the 150 F2 population of the cross LBG 17 × CO 6 screened for powdery mildew, fifteen segregants were found to be resistant and others showed a varying level of response to powdery mildew (Table 1). It is concluded that hybridization and mutation were effective, however, hybridization utilizes the existing variability and produces resistant progeny through recombination processes. While mutations were effective in creating new variability for powdery mildew resistance. In addition, a wide variability for powdery mildew disease resistance has been recorded in the M2 and F2 generation, which could be confirmed further under artificial screening.

Table 1: Screening for powdery mildew resistant using different breeding approaches

S.No.	Breeding techniques	Number of entries screened	Number of resistant lines
1.	Screening of wild relatives of blackgram	26	Two
2.	Mutation	20, 371	Eleven
3.	Hybridization	150	Fifteen

Reference

All India Coordinated Research Project on MULLaRP. 2013. Proceedings and Recommendations Indian Institute of Pulses Research, Kanpur.

Anonymous, Indian Statistical Data Base, 2020. Retrieved from www.indiastat.com/agriculture-data/2/pulses/17213/urad-blackgram/19573/stats.aspx.

Yildirim, T., H. Canci, N. Inci, F. Baloglu, C. Ikten, and C. Toker. 2013. "Inheritance of female sterility in induced Cicer species." Turkish *J. Field Crop*., 18 (1):78-81.

Wheeler, B. E. J. 1969. "An introduction to plant diseases." John Willey & Sons Ltd., London. https://www.cabdirect.org/cabdirect/abstract/19700305235.

DNA Fingerprinting for the Identification of Apple Cultivar KKL1 Specific RAPD marker

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Keywords: *DNA fingerprinting, KKL1, RAPD, PCR*

Introduction

DNA fingerprinting for varietal identification has become a major tool in plant breeding. Among the different classes of molecular markers, Randomly Amplified Polymorphic DNA (RAPD) markers has been widely employed in DNA fingerprinting technique due to its quick and easy protocol and it requires no prior sequence information (Bardakci, 2001). Though RAPD markers have already been used in genetic diversity analysis of apple cultivars (Landry *et al*. 1994; Nybom and Schall, 1990), its applicability in identifying specific varieties has been scarcely shown. The present study reports a specific RAPD marker to identify apple cultivar KKL1, which has been released by TNAU, from other apple cultivars (such as Gold Spur and Tropical beauty) that are widely cultivated in Kodaikanal regions.

Methodology

Plant Material and Genomic DNA isolation

Leaf samples of apple cultivars viz., KKL1, Gold Spur and Tropical Beauty were collected from the Horticultural Research Station, Kodaikanal and DNA was isolated using the CTAB (Cetyl Trimethyl Ammonium Bromide) protocol (Clarke, 2009). Quantification of the DNA was done by electrophoresis on a 0.8% agarose gel as well as by measuring absorbance at 260 nm.

PCR amplification with RAPD primers

A total of 20 RAPD primers (viz., OPA03, OPD03, OPA04, OPD04, OPA06, OPD05, OPB03, OPE02, OPB04, OPE03, OPB05, OPE04, OPC04, OPE05, OPC05, OPF02, OPC06, OPF03, OPD02 and OPF04) were used in this study. The polymerase chain reactions (PCR) were performed using those RAPD primers in 12 µl of reaction volume containing 8 µl of 1x master mix, 1 µl of primer, 1 µl of sterilized water and about 100 ng (2µl) of template DNA. DNA was amplified in a thermal cycler that was programmed as follows: initial denaturation for 6 min at 95°C; 36 cycles of 1 min at 95°C (denaturation), 45 sec at 37°C (annealing) and 1 min at 72°C (extension), and a final extension at 72°C for 10 min that was followed by cooling to 4°C. The amplified products were resolved on 1.5% agarose gel electrophoresis for further analysis.

Band Scoring and data analysis

The DNA fragments that were amplified by a given primer were scored as presence (1) or absence (0). Only intense and clearly resolved and unambiguous PCR products were considered for further analysis. The results were analysed using the UPGMA clustering available in NTSYS-2.02i (Rohlf, 1997) and a dendrogram was constructed for the investigated three apple cultivars.

Results and Discussion

The Ultimate aim of this study is to identify a molecular marker specific to the KKL1, an apple variety released from HRS, Kodaikanal (which is a clonal selection derived from Parlin's beauty). Though there are enough differences among the fruits of the other widely cultivated varieties such as Gold Spur and Tropical beauty, it has been found to be difficult to differentiate these varieties when they are grown in nursery. Further, identification of molecular marker would be useful to notify the given variety and the genetic diversity captured using the molecular markers will enable further utilization in breeding program.

The genetic similarity coefficients among the three apple cultivars estimated from the RAPD data were varied from 0.59 to 0.74 (Fig 1). The resultant dendrogram generated from the investigated RAPD primers have clearly grouped the two cultivars Gold Spur and Tropical beauty into one cluster, KKL1 genotypes on a separate cluster. It was noticed that KKL1 had 59% similarity with other two apple cultivars; however, 74% similarity were observed between Gold Spur and Tropical beauty.

It has been unambiguously established that the RAPD primers OPC04 and OPE03 has produced a polymorphic bands that differentiated KKL1 from Gold Spur and Tropical beauty (Fig 2). The use of RAPD analysis in the genetic diversity analysis of apple cultivars would be of considerable help to breeding.

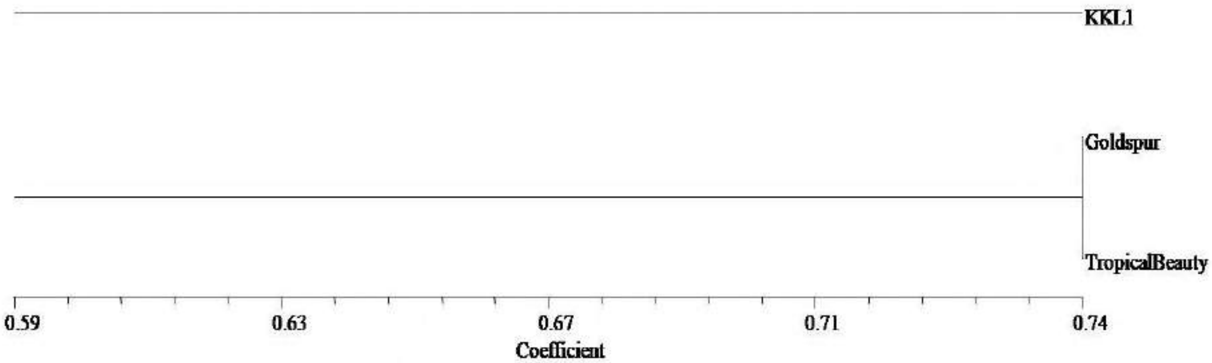

Fig 1. Dendrogram of genetic relationships of apple cultivars based on RAPD analysis

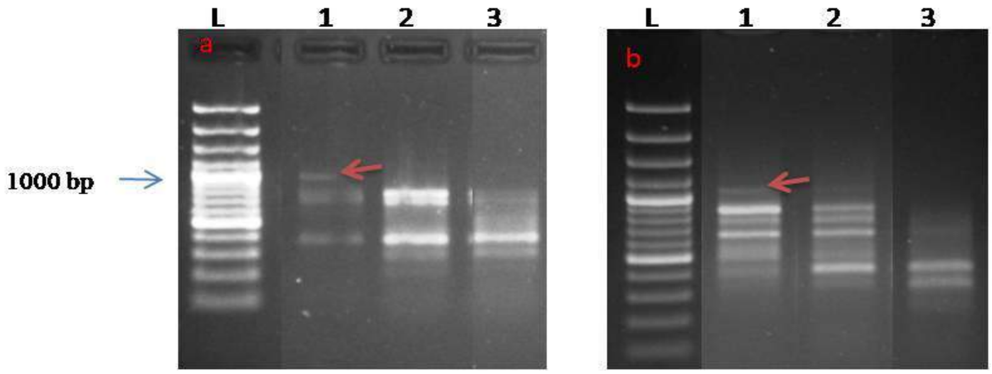

Fig 2. DNA fingerprinting of Apple cultivars using RAPD primers
a. PCR with OPC04 primer; b. PCR with OPE03 primer
Lane L – 100 bp ladder; 1 – KKL1; 2 – Gold Spur; 3 – Tropical Beauty

Reference

Bardakci, F. 2001. Random Amplified Polymorphic DNA (RAPD) Markers. *Turk. J. Biol.*, 25: 185-196.

Clarke, J.D., 2009. Cetyltrimethyl Ammonium Bromide (CTAB) DNA Miniprep for Plant DNA Isolation. *Cold Spring Harb. Protoc.,* 4(3): 1-2. doi: 10.1101/pdb.prot5177

Landry, B. S., Li, R. Q., Cheung, W.Y. and R. L. Granger. 1994. Phylogeny analysis of 25 apple rootstocks using RAPD markers and tactical gene tagging *Theor. Appl. Genet.*, 89: 847-852.

Nybom, H. and B. A. Schaal. 1990. DNA "fingerprints" applied to paternity analysis in apples *(Malus x domestica) Theor. Appl. Genet.*, 79: 763-768.

Rohlf, F.J. 1997. NTSYS-pc Version. 2.02: Numerical Taxonomy and Multivariate Analysis System. Applied Biostatistics Inc., Exeter Software. Setauket, New York.

Effect of Agronomic Biofortification of Iron on Amino Acid Profile of Barnyard Millet (*Echinochloa frumantacea*) Grain

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Keywords: *Biofortification, Iron Fertilization, Amino acid profile*

Introduction

All the nutrients that humans consume are derived from the soil –plant system. Micronutrient malnutrition is one of the attention drawing problems in the developing world. The WHO has projected that over 3 billion people in the world suffer from micronutrient under nourishment and that about 2 billion of these have Fe deficiency. Thus, enhancing the concentration of the prime microelements like Fe and Zn in crop produce has become an vital task (Zhao and McGrath, 2009). Mineral fertilization is generally resorted to achieve immediate benefits, while breeding and transgenic approaches are of long term interest (White and Broadley, 2009). We are unaware of the direct impact of agronomic biofortification on dietary intake of micronutrients on human health.

Methodology

The present study attempts to identify the most appropriate ecofriendly technology for biofortifying the barnyard grain with most deficient micronutrient with iron. A field experiment was conducted in farmers's field at lalapuram village, Kallikudi block, Madurai District Tamilnadu with test crop of barnyard millet during the Kharif season in the year 2018-19 in Typic Haplustalf soil of Peelamedu soil series of Alfisol order to study the impact of NPK levels and iron fertilization on growth and yield attributes of barnyard millet cultivars. The cultivars were screened based on the grain iron content and the affinity to iron. Twenty four treatment combinations were tested in factorial randomised design with two replications. Grain sample was well ground and 0.5 g of sample was taken and digested with triple acid mixture. Digested sample were filtered and volume was made upto 100 ml and grain Fe content was estimated by ICP-OES at 259.9 wavelength (Humphries, 1956). The amino acids viz., cysteine, Isoleucine, lysine, leucine, methionine, phenylalanine, tyrosine, valine, tryptophan, threonine were analysed in the grains of barnyard millet in the FT-NIR spectroscopy (BRUKER company) Williams (1996) and the spectrum of amino acids profile of each samples were obtained.

Results and Discussion

Amino acid profile

The spectrum of amino acids profile of each samples were obtained (Fig.1) and analysed result were tabulated (Table.1).

From the results it was found that the Cysteine content of barnyard millet grain ranged from 172.2 to 180.5 mg g^{-1}, Isoleucine content from 285.93 to 289.63 mg g^{-1}, Lysine from 104.18 to 108.29 mg g^{-1}, Leucine from 722.54 to 727.69mg g^{-1}, Methionine from 133.13 to 135.1 mg g^{-1}, Phenylalanine from 360.76 to 365.33 mg g^{-1}, Threonine from 230.16 to 234.87 mg g^{-1} and Tryptophan from 61.79 to 66.04 mg g^{-1}.

The result of aminoacid profile indicated that the biofortification of barnyard millet grain with iron registered significant increase in the limited aminoacids viz, lysine and tryptophan. The phenylalanine content recorded negligible reduction due to iron biofortification.

Table 1. Amino acid profile of barnyard millet grains

	Cystine [mg]	Iso-leucine [mg]	Leucine [mg]	Lysine [mg]	Methio-nine [mg]	Phenyl-alanine [mg]	Threonine [mg]	Trypto-phan [mg]	Tyrosine [mg]	Valine [mg]
Max	180.6	289.6	727.7	108.3	135.1	365.3	234.9	66.0	154.2	394.1
Min	172.2	285.9	722.5	104.2	133.1	360.8	230.2	61.8	148.3	383.4
Mean	175.6	287.3	724.5	106.0	134.2	363.2	233.0	63.8	151.6	388.0

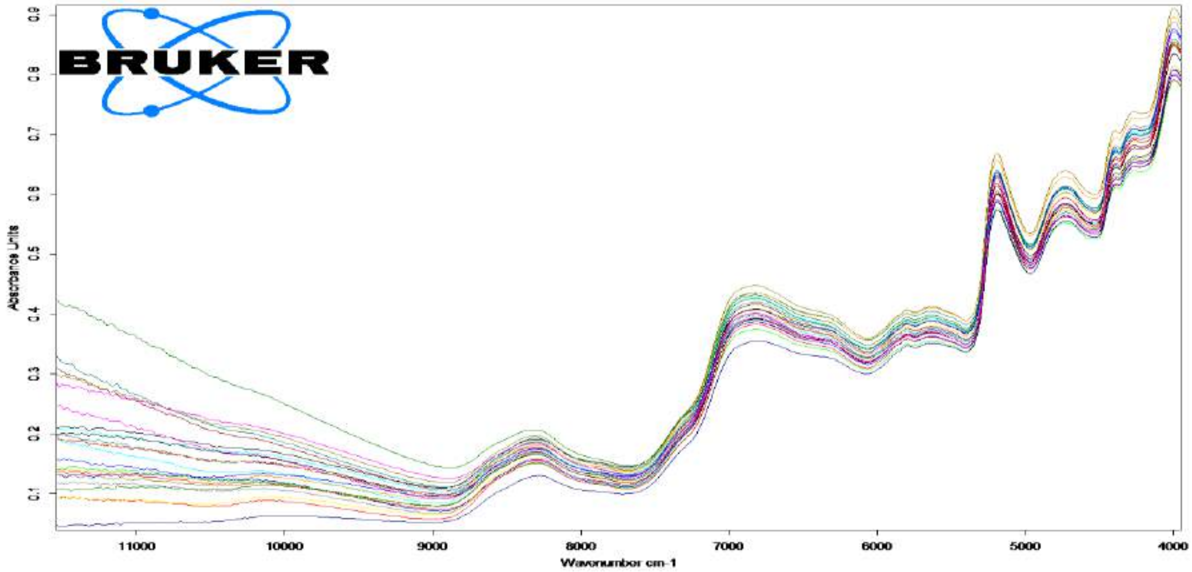

Fig. 1. Aminoacid spectrum of barnyard millet grains

Reference

Humphries, EC. 1956. "Mineral components and ash analysis." In Moderne Methoden der Pflanzenanalyse/Modern Methods of Plant Analysis, 468-502. Springer.

Williams, PC E Sobering D. 1996. How do we do it: a brief summary of the methods we use in developing near infrared calibrations En "Near Infrared Spectroscopy: The Future Waves". Eds. Davies, AMC e Williams. PC NIR Publications. Chichester. UK.

Zhao, Fang-Jie, and Steve P McGrath. 2009. "Biofortification and phytoremediation." *Current opinion in plant biology* 12 (3):373-380.

Effect of Phytohormones on Seed Quality Traits of Maize Under Different Temperature Regimes

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Keywords: *Maize, Seed priming, Phytohormones, Germination and vigour*

Introduction

Maize is one of the most important crops being cultivated as a cereal grain in India. High temperature stress influences the yield of crop by disrupting the gametophytes which results in the loss of pollen viability and germination leading to poor seed set. Phytohormones play an important role in alleviating the heat stress. The exogenous application of these hormones at optimum concentration can help plants to manage heat stress.

Methodology

The maize seeds were primed with various phytohormones *viz.*, salicylic acid 75 ppm, brassinolides 0.5 ppm and sodium nitroprusside 50 micro M for 9 hours duration. The germination test was conducted for the primed seeds along with the control using the roll towel method and tested under the different temperature regimes at 40°C and 42°C in the plant growth chamber with 65% relative humidity and ambient temperature (25°C) with 95% relative humidity. The seed quality parameters like germination (%), root length (cm), shoot length (cm), dry matter production (g/10 seedlings) and vigour index were recorded.

Results and Discussion

The present study revealed that the seeds primed with phytohormones performed well under the heat stress conditions. The phytohormones plays an important role in the high temperature tolerance and protects the plants from heat stress. Various phytohormones were used to assess the performance of the seedlings under stress condition. Among the priming treatments, the maize seeds primed with sodium nitroprusside 50 micro M for 9 hours soaking duration outperformed the other treatments by recording the maximum seed quality parameters *viz.*,germination and vigour under different temperature regimes. The study clearly indicated that the suitable phytohormone with optimum concentration can be recommended for mitigating the heat stress.

Reference

Fahad et al.,(2017) Crop Production under Drought and Heat Stress: Plant Responses and Management Options. *Front. Plant Sci*.

Sita et al., (2017) Food Legumes and Rising Temperatures: Effects, Adaptive Functional Mechanisms Specific to Reproductive Growth Stage and Strategies to Improve Heat Tolerance. *Front. Plant Sci*.

Table 1: Effect of phytohormones under plant growth chamber

Treatments	Seed quality parameters at 25^{0}C					Seed quality parameters at 40^{0}C					Seed quality parameters at 42^{0}C				
	G (%)	RL	SL	DMP (g 10 seedlings^{1})	VI	G (%)	RL	SL	DMP (g 10 seedlings^{-1})	VI	G (%)	RL	SL	DMP (g 10 seedlings^{-1})	VI
Control	88 (69.73)	24.55	17.71	0.9	2981	88 (69.73)	23.72	15.95	2.1	3600	84 (66.42)	20.78	13.56	0.6	2867
Hydropriming	92 (74.46)	25.81	19.46	1.0	3316	90 (71.59)	24.50	17.90	2.1	3846	86 (68.03)	21.92	14.02	0.7	2951
Salicylic acid 75 ppm	96 (88.61)	27.87	20.26	1.3	3719	94 (75.82)	27.85	19.46	2.8	4464	93 (75.52)	25.25	15.76	2.5	3803
Brassinolides 0.5 ppm	95 (77.08)	26.61	18.13	1.2	3456	94 (75.82)	27.06	18.32	2.6	4261	92 (74.47)	24.93	14.74	2.2	3676
Sodium nitroprusside 50 micro M	96 (88.61)	29.16	21.43	1.5	4062	96 (88.62)	28.81	20.96	2.9	4706	94 (75.82)	26.20	15.66	2.7	3916
SEd	0.48	0.83	0.52	0.18	76	0.53	0.41	0.49	0.26	97	0.63	0.96	0.29	0.33	108
CD (P=0.05)	1.00	1.77	1.11	0.37	155	1.04	0.87	0.05	0.53	202	1.31	2.06	0.62	0.65	232

G – Germination percentage
RL - root Length
SL – Shoot Length
DMP – Dry Matter Production
VI – Vigour Index

Effect of Zinc Fortification on Yield Attributes and Yield of Babycorn

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Keywords: *Zinc Fortification, Babycorn, G-5414, Detasseling, Cob weight, Green cob yield*

Introduction

Babycorn is typically a maize ear produced from regular corn plants which are harvested earlier, particularly when the silks have the size of 1-3 cm. India is emerging as the potential producer of babycorn due to high demand with less cost of production. It has a high nutritive value and its nutritional quality is superior to some of the high priced vegetables such as tomato, cucumber, cabbage and cauliflower (Yodpet, 1979).Maize and babycorn are highly susceptible to zinc and then maize occupy the third rank in zinc demand after rice and wheat (Meena *et al.*, 2013). The fundamental agronomic zinc fortification is keeping adequate quantity of available zinc in the soil by soil application and leaf tissues by foliar spray.

Methodology

A field experiment was conducted at Eastern Block Farm, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore during late *Kharif* (September- November) of 2019. The experiment was laid out in randomised block design with three replications. Babycorn hybrid G-5414 was used for the experimentation and adopted plant spacing of 45 cm x 25 cm. The treatments comprised of T1: No zinc (control), T2: ZnSO4 at 25 kg/ha as soil application, T3: ZnSO4 at 37.5 kg/ha as soil application, T4: Foliar spray at 0.5% on 20 and40 DAS, T5: Foliar spray at 1.0% on 20 and 40 DAS, T6: T2+T4, T7:T2+ T5, T8:T3+ T4, T9: T3+ T5.De-tasseling, a most important practice in babycorn cultivation was done immediately after the emergence of the tassel before anthesis mainly to avoid pollination and fertilization. Numbers of cobs per plant was calculated from the five tagged plants in each treatment plot, the total number of cobs harvested in each picking were counted, expressed as average number of cobs per plant. Cob weight was taken as by weight of the green cobs from each treatment was measured and mean weight of these cobs were expressed as g/cob. Corn weight was taken as by green cobs weight without husk was taken and the mean was calculated as weight of babycorn and expressed in g/babycorn. Green cob yield was calculated from five pickings of freshly harvested cobs and weighed.

Results and Discussion

Effect of zinc fertilization on yield attributes and yield of babycorn

The number of cobs per plant ranged from 3.1 to 4.0 irrespective of the treatments imposed. Among the treatments, application of zinc sulphate through soil @ 37.5 kg/ha with foliar spray @ (0.5% and 1.0%) at 20 and 40 DAS (T8 and T9) recorded the maximum cob number (4.0 Nos.) per plant. It was observed that all the treatments that were supplied with zinc nutrition (T9, T8, T7, T6, T5, T4, T3 and T2) were statistically on par with each other, but significantly superior over control (T1) which recorded the lowest number of cobs (3.1 Nos.) per plant.

In the present investigation, soil application of zinc sulphate @ 37.5 kg/ha with foliar spray of 0.5% on 20 and 40 DAS resulted in producing positive improvement in cob weight and corn weight as 19.5 per cent and 24.1 per cent respectively, over control.

Yield is the cumulative behaviour of all the yield attributes. Zinc fertilization had a significant effect on green cob yield. Application of zinc sulphate in soil @ 37.5

kg/ha with 0.5% foliar spray recorded higher green cob yield. The increased yield might be due to the beneficial effect of Zn in the plant system.

Table 1. Effect of zinc fortification on yield attributes and yield of babycorn

Treatments	Number of cobs per plant (Nos. /plant)	Cob weight (g)	Corn weight (g)	Green cob yield (kg/ha)
T_1: Control (No Zinc)	3.1	44.6	14.9	14378
T_2: $ZnSO_4$ @ 25 kg/ha as soil application	3.5	48.1	15.1	16115
T_3: $ZnSO_4$ @ 37.5 kg/ha as soil application	3.6	48.6	15.6	16328
T_4: Foliar spray of $ZnSO_4$ @ 0.5 % on 20 and 40 DAS	3.6	48.9	16.4	16425
T_5: Foliar spray of $ZnSO_4$ @ 1.0 % on 20 and 40 DAS	3.6	49.3	16.5	16571
T_6: $T_2$and T_4	3.7	51.9	17.2	17189
T_7: $T_2$and T_5	3.8	52.1	17.9	17476
T_8:$T_3$and T_4	4.0	53.3	18.5	17837
T_9: $T_3$and T_5	4.0	52.1	18.4	17916
SEd	0.2	1.8	0.8	787
CD (P=0.05)	0.5	3.8	1.6	1669

Reference

Meena, SK, SL Mundra, and P Singh. 2013. Response of maize (*Zea mays)* to nitrogen and zinc fertilization. *Indian Journal of Agronomy*., 58 (1):127-128.

Yodpet, C. 1979. Studies on sweet corn as potential young cob corn (*Zea mays, L*).*University of the Philippines, Los Banos*.

Effects of Foliar Application of Nutrients and Plant Growth Regulators on Quality of Guava Cv.Lucknow-49

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Keywords: *Guava, Zinc sulphate, Borax, Urea, GA3, Yield, Quality*

Introduction

Guava (*Psidium guajava* L.) is one of the important fruit crops in tropical and sub-tropical parts of India grown for its delicious and nutritious fruits. An increasing trend in guava production is observed recently because of its acceptance in a wide range of value-added products. The adequate supply of nutrients in guava has been largely neglected among farmers. Enhanced production of good quality fruits needs adoption of proper cultural practices especially fertilization. In the present study, quality of the guava fruits are observed under foliar application of different nutrients and plant growth regulators.

Methodology

The experiment was conducted on four years old guava cultivar Lucknow-49, planted at 3 x 3 m spacing during the year 2018-19. For experimental trial, forty five guava plants (3 plants under each treatment) of uniform size and vigor were selected. The experiment was laid out in Randomized Complete Block Design with three replications and fifteen treatments using the chemicals such as Zinc sulphate, Borax, Urea, GA3 and *Pseudomonas fluorescens* at different doses. Two foliar sprays were given before onset of flowering and after the fruit set, in July and August respectively and the flowering and fruiting were observed. Three fruits of uniform maturity from each treatment were selected randomly from each tree and were analysed for different parameters. The TSS of the fruit juice was estimated with the help of hand refractometer and expressed in 0 Brix. Vitamin C content and Acidity Percentage was estimated by the method suggested by Ranganna (1996). Sugar in fruit juice was estimated by the method as suggested by Nelson (1944). The statistical analysis of the results was performed using WASP software developed by ICAR.

$$\text{Ascorbic acid (mg100g-1)} = \frac{\text{Titer value} \times \text{dye factor} \times \text{volume made up} \times 100}{\text{Aliquot extract taken for estimation} \times \text{weight of sample}}$$

$$\text{Acidity (\%)} = \frac{\text{Titer value} \times \text{Normality of NaOH} \times \text{Equivalent weight of acid} \times \text{Volume made up} \times 100}{\text{Aliquot taken for estimation} \times \text{Weight of sample} \times 1000}$$

$$\text{Reducing sugar (\%)} = \frac{0.25 \times 100}{\text{Burette reading}}$$

$$\text{Total sugar (\%)} = \frac{1.5 \times 100}{\text{Burette reading}}$$

Non reducing sugar % = Total sugar % – Reducing sugar %

Results and Discussion

Effect of nutrients and plant growth regulators on biochemical parameters of guava

Application of different plant growth promoting substances exerted significant effect on the quality of fruits. The highest TSS (12.63) and vitamin content (220.17) was recorded in T3 (ZnSO4-0.8%). Whereas the lowest TSS (7.68) and vitamin C content (162.81) was recorded in T15 (Control). Zinc is credited with definite role in the hydrolysis of complex polysaccharides into simple sugars, synthesis of metabolites and rapid translocation of photosynthetic products and minerals from other parts of the plant to developing fruits which results in increased TSS of fruit which is supported by Dhakar *et al.* (2017). The minimum acidity percentage (0.34) was observed in T9 (Urea-1.5%) and the maximum acidity percentage (0.54) was observed in T15

(Control). Lower acidity in fruits results due to higher accumulation of sugars, better translocation of sugars into fruit tissues and conversion of organic acids into sugars. These findings supported previously by Singh *et al*. (2018). The highest amount of total sugar (9.36), reducing sugar (5.29) and non- reducing sugar (3.61) were noted in T3.The lowest amount of total sugar (6.82) reducing sugar (2.95) and non- reducing sugar (1.31) found in T15 (Control). An association of zinc with synthesis of auxins in plants played a vital role along with the increase in enzymatic activities. It also acts as a catalyst in oxidation-reduction processes in plants. This leads the biochemical reactions including conversion of complex food material into simple ones, which enhances the metabolic activity in fruits and it results in increased total sugar of fruit. Present results are in conformity with Baranwal *et al*. (2017).

Table1. Effect of plant growth promoting substances on TSS and Vitamin C of Guava

Treatments	TSS (^{0} Brix)	Vitamin C (mg $100g^{-1}$)
T1--ZnSO4 (0.4%)	11.05	197.40
T2-ZnSO4 (0.6%)	12.24	218.44
T3-ZnSO4 (0.8%)	12.63	220.17
T4-Borax (0.2%)	9.56	197.42
T5-Borax (0.4%)	11.02	217.05
T6-Borax (0.6%)	11.84	217.69
T7-Urea (0.5%)	9.28	174.66
T8-Urea (1%)	11.36	177.25
T9-Urea (1.5%)	11.96	177.59
T10-GA3(50 ppm)	9.99	183.63
T11-GA3(75 ppm)	10.05	205.68
T12-GA3 (100 ppm)	10.56	210.60
T13-Pf (30 ml/plant)	8.74	173.62
T14-Pf (60 ml/plant)	8.93	183.77
T15-Control	7.68	162.81
S. Em.±	0.402	13.559
CD at 5% level	1.166	39.281

Reference

Baranwal D, Tomar S, Singh JP and Maurya JK. 2017. Effect of Foliar Application of Zinc and Boron on Fruit Growth, Yield and Quality of Winter Season Guava (*Psidiumguajava*L.). *International Journal of Current Microbiology and Applied Sciences*, 6(9): 1525-1529.

Dhakar D, Barholia AK and Jatav R.2017.Effect of Phosphorus and Zinc Sulphate on Yield Attributes and Quality of Guava (*Psidium guajava* L.) cv. Gwalior 27. *International Journal of Current Microbiology and Applied Sciences*, (4):16-24.

Nelson N.1944. A photometric adaptation of the Somogyi method for the determination of glucose. ***Journal of*** *Biology and Chemistry*, 153: 375-80.

Ranganna S. 1986. Handbook of Analysis and Quality Control for Fruits and Vegetable Products. Tata McGraw Hill Publishing, New Delhi. P 102.

Singh B, Singh RB, Singh KV and Barholia AK. 2018. Influence of Foliar Application of Urea, Potassium sulphate and Borax on the Fruit Quality of Guava. *International Journal of Current Microbiology and Applied Sciences*, 6: 2791-2796.

Elucidating Differentially Expressed Water Stress Responsive Genes Among Minor Millet and Major Cereal, Rice (*Oryza sativa* L.)

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Keywords: *Abiotic stress, Expression analysis, Semi quantitative RT-PCR, Water stress*

Introduction

Abiotic stresses like water stress, one of the most common environmental stress, activates a series of changes in plants by affecting growth and productivity negatively. Various morphological mechanisms functioning under water stress has also been identified. Water stress occurs severely in major producing areas of the world. India is the largest grower of minor millets. Millets - Lower in economic competitiveness. Known for their great level of tolerance against water stress and salinity. Grains of small millets are extremely resistant to pest. Healthy food, mainly due to the lack of gluten in their grain. "Orphan crop","food for the poor " (Sharma and Khurana, 2014). Rice has High Drought Sensitivity Index (Karl, 1983).Necessitates to dissect the transcriptome information toprovide valuable information on molecular mechanism and dynamics underlying their water stress tolerance potential.

Methodology

Growth-Conditions

This study is based on secondary data Planted in pots and maintained in green house condition at 28 ± 2ºC in Department of Plant Molecular Biology and Biotechnology, Indira Gandhi Agricultural University, Raipur, Chhattisgarh, India. Pots were watered normally until plant attain 21 day periods. Water was withdrawn from pots on 21 up to 29 days.

Setting up of experiment under STRESS and CONTROL condition

Stress imposition at vegetative stage (After 21 DAS) before panicle initiation.

Harvested samples after stress imposition are stored immediately in liquid Nitrogen for RNA extraction followed by cDNA synthesis.
RNA extraction from leaf tissues at vegetative stage - Trizol+Himedia protocol.
RT-PCR analysis was performed to analyze expression among the genotypes under control and stress conditions for different genes (using designed expression primers).
Actin gene primer was used for Internal control followed by cDNA synthesis (Bio RAD iSCRIPTcDNA synthesis kit).The floroscence data of Semi- quantitative RT-PCR gels were digitalised to numerical values using *Gel quant NET software.*
NOTE: Protocols were standardized for Millets and Rice genotypes.

Results and Discussion

Expression pattern of water stress responsive genes using semi-quantitative RT-PCR

Among twelveminor millet genotypes under water stress

Among the seven genes under study, Gene OsNAC29 showed highest up-regulation. RLM-37 showed a positive significant up-regulation in the expression analysis among Little millet genotypes, followed by OsNAC29 (MM-23)(Figure 1). Similarly, Gene SiNAC29L showed high up-regulation. MELGHAT-3 showed a highest level of positive significant up regulation in the expression analysis among Barnyard millet genotypes, followed by SiNAC29L (MELGHAT-1) (Figure 2).

Among three rice genotypes under water stress

Among the seven genes, Gene TaNAC 4 showed highest up-regulation. R-RF-127 showed a positive significant up-regulation in the expression analysis among Rice genotypes, followed by SiNAC 29L (R-RF-127) (Figure 3).

Expression analysis using gene specific primers of millet and rice genotypes

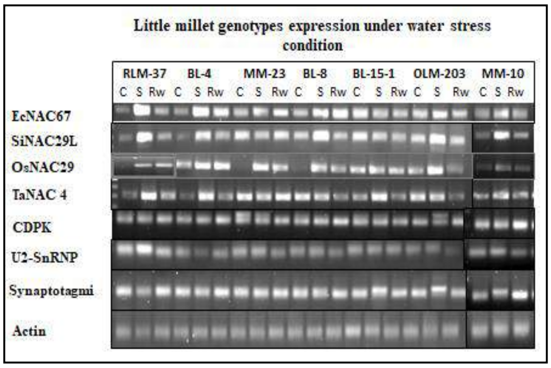

Figure 1.Little millet expression

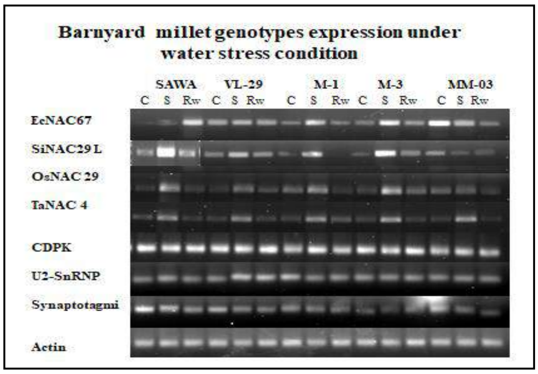

Figure 2. Barnyard millet expression

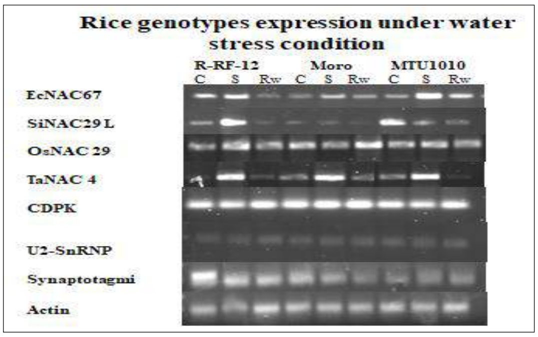

Figure 3.Rice expression

Among the three crops, highest expression- Little millet genotype, RLM-37, for gene OsNAC 29.Little millet genotype RLM-37 was showing tolerance characteristics, this can be taken as a base for water stress tolerance response of the crop to select the gene and genotype for the ortholog gene isolation, which may be useful for further validation studies of genes for water stress tolerance in millet and other crop plants.

Reference

Karl, T.R., 1986. The sensitivity of the Palmer Drought Severity Index and Palmer's Z-index to their calibration coefficients including potential evapotranspiration. Journal of Climate and Applied Meteorology, 25(1), pp.77-86

Sharma M and Paul KhuranaSM. (2014).Alternative Healthy Food Crops **J** NutrFood Sci,4:4.

Evaluation of Chemical Properties, Total Carotenoid Content, and Total Polyphenol Content of Carrot out-Grades and Encapsulated Carrot Powder

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Keywords: *Spray drying, carrot out grades, encapsulation, encapsulated carrot powder, total carotenoid content*

Introduction

Carrot is the important root of the family Apiaceae. They are highly nutritious and contain a good source of natural antioxidants, such as carotenoids and phenolic compounds. However, face high loss during post-harvesting operations. Most of the time carrots are rejected at the time of gradin based on their shape and size. However, such carrot out-grades are an edible, nutritious, and good source of carotenoids. Hence, the study was undertaken to utilize the non-commercial carrots out-grades, which includes encapsulation so that prepared encapsulated carrot powder (ECP) can retain more nutrients and can be used in the food industry

Methodology

Carrot out-grades were cleaned, washed, peeled, and sliced. Carrot pieces were blanched at 80 °C for 7 min in 2 parts (1:2) of boiling acidified water (0.2 % of citric acid). Carrots were pulped by a domestic grinder then a press cloth was used to extract the juice. Enzymatic extraction of carrot juice was followed using pectinase and cellulase enzymes (0.02%) according to Stoll et al. (2003) with modification. Carrot coagulum thus obtained was used for spray drying (Lab spray dryer, LSD-48, JISL, Mumbai). About 15 grams of maltodextrin DE 20 was added and mixed thoroughly. Encapsulation was carried out at a constant aspirator rate of 90%, feed pump 12% and at pressure 1.5-2.0 kg cm-2. Spray dryer operated at inlet temperature 170°C and outlet temperature 86 ±5 °C. The final powder was collected and packed in aluminum pouches and stored in an airtight container. Carrot out grades and ECP were analyzed for pH (pH meter) and titratable acidity (TA) by titration method. Total sugars were measured calorimetrically at 630 nm using an anthrone reagent. Reducing sugars were determined by the 3, 5-dinitrosalicylic acid method whereas non-reducing sugar was estimated using the formula.

% Non-reducing sugars = % total sugars – % reducing sugars

Total carotenoid content (TCC) (mg/100g) was analyzed and optical density was recorded at 452 nm (Ranganna, 1986). Total polyphenol content (TPC) was measured at 650 nm using Folin-ciocalteau reagent (Singleton et al., 1999). The data were analyzed statistically using SPSS software. Data are the mean values with a standard deviation of three replicates.

Results and Discussion

The data shows that the pH of carrot out-grades was high 6.03. TA was 0.18g/100ml. Other chemical attributes were total soluble solids (5.10°Brix), reducing sugars (1.12%), non-reducing sugars (3.35%), total sugars (4.47%), and TPC (1.17±0.32 mg GAE/100g). Selvakumar and Tiwari (2018) reported, TSS 8.73 °Brix, TA 0.16 percent, reducing sugars 1.79 percent, non-reducing sugars 4.20 percent, and total sugars 5.99 percent in fresh carrots. TCC of carrot out-grades used in the study (12.77 mg/100g) was higher compared to fresh carrots 10.77mg/100g by Haque et al. (2020) and carrot out-grades TCC was 10.04 mg/100g reported by Darshan (2015) respectively. Though carrots were rejected due to aesthetic reasons, they still contain an appreciable amount of nutrients.

ECP was further analysed and had pH (4.50), TA (0.16%), water activity (0.21), TSS (19.13 °Brix), total sugars (37.99%), reducing sugars

(19.43%), non-reducing sugars (18.51%), TCC (9.93 mg/100g), and TPC (2.24 mg GAE/100g). The addition of citric acid decreased the pH value. The addition of maltodextrin increases the total sugars in encapsulated carrot powder as it is a starch derivative. The results obtained during the present investigation indicate that good quality encapsulated powder with less moisture and water activity and good retention of TCC can be produced by spray drying, which demonstrates the great potential for use of such powders in the food industry. It was concluded that carrot out-grades contain an appreciable amount of carotenoids and can be utilized for further enzyme extraction and encapsulation.

Table 1: Chemical properties, Total Carotenoid Content and Total Polyphenol Content of carrot out-grades and encapsulated carrot powder

Chemical Properties	Carrot out-grades	Encapsulated carrot powder
Ph	6.03±0.05	4.50±0.02
Titratable acidity (g/100 ml)	0.18±0.05	0.16±0.02
Total soluble solids (°Brix)	5.10±0.25	19.13±0.35
Reducing sugars (%)	1.12±0.09	19.43±0.72
Non-reducing sugars (%)	3.35 ±0.09	18.51±0.61
Total sugars (%)	4.47±0.16	37.95±0.54
Total carotenoid content -(mg/100 g)	12.35±0.45	9.93±0.05
Total polyphenol content (mg GAE/100 g)	1.17±0.32	2.24±0.070

*Mean± standard deviation

Reference

Darshan, M. B. 2015. Encapsulation of β-carotene with natural polysaccharides using spray freeze drying technique. Ph.D Thesis, PHT, ICAR-IARI, New Delhi.

Haque, O, M., Zohora, F., Jilhaz, M., Hasan, M., Enan, M. E. and Islam, S. N. 2020. Estimation and comparison of total carotenoid contents in ethnic vegetables, fruits and some common non leafy vegetables of Bangladesh. *Int. J. Pharmacognosy and Life Sci.*,1(1): 05-09.

Ranganna, S. Handbook of analysis and quality control for fruits and vegetable products. 2nd ed. Tata Mc Graw-Hill Pub. Co. Ltd., New Delhi. 1986.

Selvakumar, R. and Tiwari, R. B. 2018. Physico-chemical changes in osmotically dehydrated carrot slices during storage. *Int. J. Chemical Studies., 6(5):* 1685-169.

Singleton, V. L., Orthofer, R., Lamuela-Raventos, R. M. 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folincio calteu reagent. *Methods. Enzymol.*, 299: 152-178.

Stoll, T., Schweiggert, U., Schieber, A. and Carle, R. 2003. Process for the recovery of a carotene-rich functional food ingredient from carrot pomace by enzymatic liquefaction. *Inn. Food Sc. and Emerging Tech.*, 4: 415-423.

Evaluation of G×E Interaction Under Sodic and Normal Soil Conditions in Short Duration Genotypes of Rice (*Oryza sativa* L.)

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Keywords: *Stability, G×E interaction, AMMI, sodicity*

Introduction

Rice is regarded as one of the important food crops serving almost half of the world's population (Kong *et al.*, 2015). The development of high yielding rice varieties that are stable across different environments is one of the major objectives of a plant breeding programme. Hence, a study was undertaken to identify genotypes with stable performance across sodic and normal conditions.

Methodology

The experiment was carried out using 66 short duration rice genotypes evaluated in three environments viz., ADAC&RI, Trichy-2019 (E1), SRS, Sirugamani-2019 (E2) and ADAC&RI, Trichy-2020 (E3) [pH-9.2, 8.03 and 9.1; EC- 0.35, 0.23 and 0.32 respectively]. The seeds were sown in a raised nursery bed and transplanted to main field after 25 days with a spacing of 20×10 cm. The experiment was laid out in Randomized Block Design with two replications. All recommended package of practices were followed for maintaining a healthy crop. Data was subjected to AMMI and GGE biplot analysis for the detection of Genotype × Environment interaction using Plant Breeding Tools version 1.4 (IRRI 2013). AMMI stability value was calculated using the following formula

$$ASV = \sqrt{\left(\frac{PC1SS}{PC2SS}\right) \times PC1^2 + PC2^2}$$

Results and Discussion

Yield response of rice genotypes

The mean yield of genotypes across all the evaluated environments ranged from 4.77g (G45) to 28.98g (G20). Similarly, the yield potential of environments were also evaluated which ranged from 10.7g (E3) to 21.91g (E2).

AMMI analysis of variance

The AMMI analysis of variance (Table 1) in 66 rice genotypes tested over three seasons showed that 36.9 per cent of the total sum of squares (SS) was attributed to the genotypes, 45.7 per cent to the environment and 17.4 per cent to the Genotype × Environment interaction. It was found that only first interaction component was significant. Previous reports also reported similar result that only first interaction component was significant in their study (Hagos and Abay, 2013).

AMMI-1 biplot display

The AMMI-1 biplot (Figure 1) displays the main effect means on the x-axis and PC1 values of genotypes as well as environments on the y-axis. The genotypes 17, 20, 23, 39, 61 and 66 show higher abscissa component indicating highest mean yield, while the genotypes 38, 45, 55, 56 and 62 show lower abscissa component indicating lowest mean yield. Similarly, the genotypes 22, 24, 25, 26, 27, 47, 48 and 49 exhibited higher ordinate component indicating highest interaction in both directions with the environment, while the genotypes 13, 59 and 60 recorded almost zero interaction effects. Similarly, the environments, E1 and E3 exhibit similar interaction effects.

Table 1: Analysis of variance for AMMI model

SOURCE	D.F.	S.S.	M.S.	F	FPROB	% contribution to total SS
GENOTYPES	2	10254.5	5127.3	670.5	0	36.9
ENVIRONMENTS	65	12678.5	195.1	25.5	0	45.7
G × E	130	4837.4	37.2	4.9	0	17.4
AMMI COMPONENT 1	66	4707.0	71.3	9.3	0	97.3% of total interaction
AMMI COMPONENT 2	64	130.5	2.0	0.3	1	2.7% of total interaction
Residual	198	1514.2	7.6	NA	NA	0

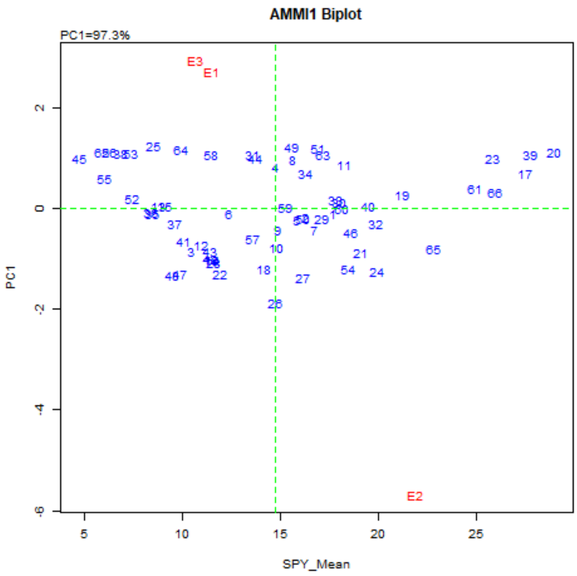

Figure 1: AMMI1 biplot using PC1 and grain yield of 66 genotypes in three environments

Reference

Hagos, Hintsa G, and Fetien Abay. 2013. "AMMI and GGE biplot analysis of bread wheat genotypes in the northern part of Ethiopia." *Journal of Plant Breeding and Genetics* 1 (1):12-18.

IRRI. 2013. "Plant Breeding Tools (PBTools), version 1.4." International Rice Research Institute. Manila, Philippines. http://bbi.irri.org/products.

Kong, Xiangli, Stefan Kasapis, and Jinsong Bao. 2015. "Viscoelastic properties of starches and flours from two novel rice mutants induced by gamma irradiation." LWT-*Food Science and Technology* 60 (1):578-582.

Field Evaluation for Identification of Sodicity Tolerant Barnyard Millet [*Echinochloa frumentacea* (Roxb.) Link] Germplasms

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Keywords: *Barnyard millet, Echinochloa, Sodicity*

Introduction

Barnyard millet is a multipurpose crop grown for both food and fodder. Being a millet crop, it is known for its adaptation to various growing conditions. It is herbaceous annual crop having chromosome number 2n=4x=36, and is self pollinated. The grain is yellow or white in colour and a small single seeded dry (Caryopsis) fruit (Arya *et al*., 2017). It is grown as a multipurpose crop for food and fodder. Barnyard millet has also been used for the reclamation of sodicity, arsenic and cadmium affected soils (Sherif and Ali., 2007). In coastal areas, sodicity is one of the major abiotic-stress which affects the barnyard millet crop yield. Hence, a study was carried out to identify sodicity tolerant barnyard millet from 44 germplasm accessions.

Methodology

The field study was carried out under sodic soil condition at Anbil Dharmalingam Agricultural College and Research Institute, Trichy, Tamil Nadu during January 2018. The experiment was laid out in randomized block design with two replications involving 44 germplasm lines including two check varieties viz., MDU1 and CO (KV) 2 in a naturally sodic soil (pH - 9.07, EC- 0.95dS/m, ESP-43.69%) condition. Each genotype was sown in one row per replication with spacing of 25 x 10 cm. The crop was raised under protective irrigation and all the recommended agronomic practices and crop protection measures were followed during the crop growth period. The EC and pH of the irrigated water are 4.9dS/m and 7.6 respectively. The observations were recorded on eight quantitative traits *viz*., days to 50% flowering, plant height (cm), number productive tillers, inflorescence length (cm), inflorescence width (cm), lower raceme length (cm), thousand grain weight (g) and grain yield per plant (g). The statistical analysis was carried out using TNAUSTAT software.

Results and Discussion

The ANOVA for the eight characters revealed significant differences among genotypes for all the characters under sodic soil condition. Correlation studies with yields and its components provide the information about association of traits which is favourable for improve the yield. Phenotypic correlation between two characters indicates both hereditary and the environmental influence whereas the genotypic association provides real correlation between two characters and is highly useful in selection.

Grain yield per plant expressed significant and positive genotypic association with thousand grain weight (0.728), days to fifty percent flowering (0.561) and inflorescence width (0.348). For this trait, significant and positive phenotypic association was observed with thousand grain weight (0.518) and days to fifty percent flowering (0.457). That indicated that an increase in these traits would result in a corresponding increase in grain yield of barnyard millet (Table 1). Similar results were recorded by Arunachalam and Vanniarajan (2012) and Sood *et al*. (2016) in barnyard millet.

Preliminary evaluation revealed that the accessions BAR 242 and BAR 252 were superior under sodic soil condition in terms of grain yield. These will be further evaluated in advanced trials for confirmation. Character association studies revealed that test weight was positively correlated with grain yield thus, the trait, thousand grain weight can be used as selection criteria to select superior barnyard millet genotypes under sodicity.

Table 1. Estimation of phenotypic and genotypic correlation coefficient among yield and yield components in barnyard millet genotypes.

Characters	Days to fifty per cent flowering	Plant height	Inflores-cence length	Inflores-cence width	Lower raceme length	Number of productive tillers per plant	Thousand grain weight	Grain yield per plant
Days to fifty per cent flowering	1.000	0.702**	0.641**	0.831**	0.548**	0.273	0.488**	0.561**
Plant height	0.535**	1.000	0.900**	0.627**	0.687**	0.167	0.307**	0.255
Inflorescence length	0.446**	0.820**	1.000	0.525**	0.696*	0.006	0.258	0.192
Inflorescence width	0.578**	0.562**	0.489**	1.000	0.609**	0.213	0.435**	0.348*
Lower raceme length	0.427**	0.585**	0.571**	0.571**	1.000	0.256	0.344**	0.197
Number of productive tillers per plant	-0.008	0.140	0.064	0.157	0.095	1.000	0.111	0.001
Thousand grain weight	0.325**	0.224	0.276	0.255	0.268	0.027	1.000	0.728**
Grain yield per plant	0.457**	0.247	0.182	0.289	0.173	0.021	0.518**	1.000

Values above diagonal indicate genotypic correlation and values below indicates phenotypic correlation coefficients.

Reference

Arya, Rinkey, Arun Bhatt, Vineet Kumar, and Divya Prakash Singh. 2017. "Correlation analysis of some growth, yield and quality parameters of barnyard millet (Echinochloa frumentacea (Roxb.) Link) Germplasm." *Journal of Pharmacognosy Phytochemistry* 6 (5):1426-1429.

Sherif, Al, and Emad Ali. 2007. "Echinochloa colona (L.) Link., A Promising species to cultivate Salt Affected Soils in Arid lands." *American-EuroAsian J. Agric. Environ. Sci,* 2 (6).

Arunachalam, P , and C Vanniarajan. 2012. "Genetic Parameters and Quantitative Traits Association In Barnyard Millet (*Echinochloa Frumentacea*)." *Plant Archives* 12 (2):691-694.

Sood, S, RK Khulbe, and L Kant. 2016. "Optimal Yield Related Attributes for High Grain Yield using Ontogeny Based Sequential Path Analysis in Barnyard Millet (Echinochloa spp.)." *Journal of Agricultural Science Technology* 18 (20):1933-1944.

Genetic Analysis in Early Duration Pigeonpea (*Cajanus Cajan* (L.) Millsp.)

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Keywords: *Early duration pigeonpea, genetic advance as per cent mean. genetic variability, heritability*

Introduction

Pigeonpea (*Cajanus cajan* L. MillSp.) is an important pulse crop grown in the tropical and subtropical regions (Sarkar *et al.*,2020). It is a versatile food legume, helping in resource-free cultivation by poor farmers (Chandavenkata *et al.*, 2019). The early duration pigeonpea are photo-insensitive types with compact plant stature suitable for intercropping. The present study was formulated to study the genetic variability present in the early duration pigeonpea germplasm and to utilize for the development of early duration pigeonpea varieties or hybrids.

Methodology

The study was conducted at the Department of Pulses, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India during rabi 2019-2020 and rabi 2020-2021. The experimental material includes 67 early duration pigeonpea genotypes and a local check variety Co(Rg)7. The experimental design employed was randomized complete block design (RCBD) with two replications. The genotypes were evaluated for genetic variability based on twelve quantitative traits.

Results and Discussion

The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) show cast supremacy in representing the variability present among the genotypes (Table 1). The phenotypic coefficient of variation is higher in magnitude than the genotypic coefficient of variation. The GCV and PCV was higher for traits viz., plant height (20.2, 20.77 %), pod bearing length (22.14, 23.44 %), clusters per plant (23.03, 25.06 %), pods per plant (21.21, 23.64 %) and the single plant yield (23.61, 34.89 %). The presence of high GCV and PCV indicates high variability for the traits and aids in the selection of genotypes based on these traits. The traits viz., days to fifty per cent flowering (5.84, 5.91 %), days to maturity (3.85, 3.96 %), pod length (7.71, 8.35 %), seeds per pod (5.85, 6.99 %) and shelling percentage (6.70, 9.34 %) possessed low GCV and PCV. Pushpavalli et al. (2018) and Hemavathy et al. (2019) recorded less difference between GCV and PCV for various traits in pigeonpea.

Heritability was high for traits viz., days to fifty per cent flowering (97.85 %), days to maturity (94.74 %), plant height (94.77%), number of branches per plant (78.20 %), pod bearing length (89.18 %), clusters per plant (84.49%), pods per plant (80.51%), seeds per pod (70.03 %) and 100 seed weight (94.37 %). The highest genetic advance as per cent mean was recorded for clusters per plant (43.61%) followed by pod bearing length (43.07%), plant height (40.54%), pods per plant (39.20%), single plant yield (32.92 %) and number of branches per plant (31.04%). The traits viz., plant height (94.77, 40.54 %), number of branches per plant (78.20, 31.04 %), pod bearing length (89.18, 43.07 %), number of clusters per plant (84.49, 43.61 %), number pods per plant (80.51, 39.20 %) and 100 seed weight (94.37, 29.56 %) existed high heritability combined with high genetic advance as per cent of mean. The high heritability with high genetic advance implies additive gene action and selection for these traits leads to crop improvement. Ajay *et al.* (2014) observed similar results.

The significant variation present for each quantitative trait summarize the posssiblity for improvement of yield and other yield related traits. The high heritability and genetic advance as per cent mean for traits viz., number of clusters per plant, number of pods per plant and 100 seed weight represents selection for these traits is feasible thereby improving the yield in pigeonpea. The genotypes identified in the present study for various traits could be used in the breeding program to develop early duration and photo insensitive varieties in pigeonpea.

Table.1. Genetic variability, heritability and genetic advance as per cent mean for the quantitative traits

Characters	GCV (%)	PCV (%)	Heritability (%)	Genetic advance	Genetic advance as per cent of mean
Days to fifty per cent flowering	5.84	5.91	97.85	8.31	11.90
Days to maturity	3.85	3.96	94.74	9.21	7.72
Plant height	20.22	20.77	94.77	54.57	40.54
Number of branches per plant	17.04	19.27	78.20	2.91	31.04
Pod bearing length	22.14	23.44	89.18	33.66	43.07
Number of clusters per plant	23.03	25.06	84.49	37.66	43.61
Number of pods per plant	21.21	23.64	80.51	61.98	39.20
Pod length	7.71	8.35	85.29	0.83	14.68
Number of seeds per pod	5.85	6.99	70.03	0.40	10.09
Shelling percentage	6.70	9.34	51.44	6.44	9.90
100 seed weight	14.77	15.21	94.37	2.85	29.56
Single plant yield	23.61	34.89	45.80	12.82	32.92

Reference

Ajay, B. C., Byregowda, M., Prashanth Babu, H., Veera Kumar, G. N. and Reena, M. 2014. Variability and transgressive segregation for yield and yield contributing traits in pigeonpea crosses. *Electronic Journal of Plant Breeding*, 5(4) : 786-791.

Chandavenkata, S. K., Nadigatla Veera Prabha Rama, G. R., Saxena, R. K., Saxena, K., Upadhyaya, H. D., Siambi, M., Silim, S. N., Sharma, S., Lyimo, S. D., Ubwe, R., Makenge, M., Gas, K., Kimurto, P. K., Amane, M., Kanenga, K., Obong, Y., Monyo, E., Ojiewo, C., Mallela Venkata, N. K., Rao, J. K., Lakkireddy, P., Chourat, S., Singh, I., Sajja, S., Beliappa, S. H. and Varshney, R. K. 2019. Pigeonpea improvement: An amalgam of breeding and genomic research. *Plant Breeding*, 138(4): 445-454.

Hemavathy, A. T., Bapu, J. R. and Priyadharshini, M. 2019. Genetic variability and character association in pigeonpea [*Cajanus cajan* (L.) Millsp.] core collection. *Indian J. Agric. Res.*, 53(3) : 362-365.

Sarkar, S., Panda, S., Yadav, K. K. and Kandasamy, P. 2020. Pigeon pea (*Cajanus cajan*) an important food legume in Indian scenario-A review. *Legume Research-An International Journal*, 43(5): 601-610.

Pushpavalli, SNCVL., Yamini, K. N., Anuradha, R., Kumar, G., Rani, C. S., Sudhakar, C., Saxena, R. K, Varshney, R. K. and Kumar, C. S. 2018. Genetic variability and correlation in pigeonpea genotypes. *Electronic Journal of Plant Breeding*, 9(1) : 343-349.

Genetic Variability for Quantitative Traits in M4 Generation of Soybean Mutant Lines (*Glycine max* (L.) Merrill.)

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Keywords: *Soybean, mutation, quantitative trait, gene action, variability, heritability*

Introduction

Soybean plays a very important role in changing the scenario of industrial sector. Hence, development of high yielding varieties specific to particular eco-geographic situation is of paramount importance. Choice of parents is the primary criterion for developing high yielding varieties or hybrids through any breeding programme. Studies on variability for yield and its related characters are the pre – requisites for choice of parents. Since the variability is highly influenced by the environment, it does not give a real picture of the potential genotypic variability. Hence, knowledge about heritability and genetic advance on yield and yield contributing characters are necessary for the crop improvement through selection. The present investigation was therefore planned to estimate and evaluate different genetic parameters in 283 mutants for 11 characters.

Methodology

The promising soybean varieties namely Co (Soy) 3 and JS 335 were subjected to mutagenic treatment utilizing Gamma and EMS. In M3, 283 mutants were selected and raised as M4 generation to estimate yield and yield related traits. These 283 mutants along with their parents were raised in Randomized Block Design (RBD) with two replications at Department of Pulses, TNAU, Coimbatore. Recommended cultural practices were adopted to raise good crop. Five plants in parents and mutant lines were randomly selected in each replication and observations were recorded for days to 50 per cent flowering, days to maturity, plant height (cm), number of branches per plant, number of clusters per plant, number of pods per plant, number of seeds per pod, 100-seed weight (g), seed yield per plant (g), harvest index (%) and phytate content (mg/g). The mean values of five plants were utilized for estimation of various genetic parameters like Phenotypic Coefficient of Variance (PCV), Genotypic Coefficient of Variance (GCV), heritability and genetic advance as per cent mean were calculated by adopting the formulae given by Johnson *et al*. (1955).

Results and Discussion

Phenotypic and genotypic coefficient of variation

The estimates of genotypic coefficient of variation were lesser than the estimates of phenotypic coefficient of variation indicating the environmental influence over the characters studied (Table 1). The characters plant height, number of clusters per plant, number of pods per plant, seed yield per plant and phytate content showed higher values of PCV and GCV. Similar findings were reported by Amrita *et al*. (2014). The results indicate a greater scope for selection to improve these characters. On the other hand, moderate values of PCV and GCV were noticed for characters *viz*., days to 50 per cent flowering, number of branches per plant, hundred seed weight and harvest index. This indicates selection for such traits may be rewarding.The characters *viz*., days to maturity and number of seeds per pod showed lower values of PCV and GCV. This indicates selection for such traits may be undesirable.

Heritability and genetic advance as per cent of mean

The results indicated that estimates of heritability were high for all the characters except for number of branches per plant (Table 1).Similar observations were made by Sujata *et al*. (2011).In the present study, high heritability coupled with high genetic advance as per cent of mean was observed for days to 50 per cent flowering, plant height, number of clusters per plant, number of pods per plant, hundred seed weight, seed yield per plant, harvest index and phytate content. This indicates the lesser influence of environment in expression of these characters and prevalence of additive gene action in their inheritance. Hence, these traits are amenable for simple selection. On the other hand, high heritability accompanied with moderate genetic advance as per cent of mean was recorded for days to maturity and number of seeds per pod. The results indicate that these characters were governed by additive gene action and selection for such traits may be rewarding. Similar results were obtained by Khan and Tyagi (2010).

From the above discussions, it can be concluded that high genotypic coefficient of variability and phenotypic coefficient of variability coupled with high heritability were observed for plant height, number of clusters per plant, number of pods per plant, seed yield per plant and phytate content. This indicates that there is a lesser influence of environment in the expression of these characters which is amenable for selection. The character *viz*., days to 50 per cent flowering, number of branches per plant, hundred seed weight and harvest index showed high heritability but moderate level of variability. Hence, these characters are also amenable for selection by minimizing the environment influence. The character *viz*., days to maturity and number of seeds per pod showed high heritability but low level of variability. Hence, these characters are not amenable for selection.

Table 1. Estimates of variability parameters in M4 generation

Character	Mean	SE	Min.	Max.	PCV (%)	GCV (%)	h^2 (%)	GAM (%)
Days to 50 % flowering	31.24	0.24	27.00	41.00	13.06	12.34	89.19	24.00
Days to maturity	80.43	0.33	75.00	91.00	6.81	6.40	88.49	12.41
Plant height (cm)	33.87	0.75	11.00	74.00	37.14	36.11	94.55	72.34
No. of branches/plant	5.54	0.08	2.80	10.20	23.09	13.49	34.13	16.23
No. of clusters/plant	20.62	0.56	3.60	56.80	45.85	43.27	89.07	84.13
No. of pods/plant	67.51	1.80	13.40	182.64	44.74	43.03	92.50	85.26
No. of seeds/pod	2.35	0.01	2.00	2.60	8.24	7.06	73.41	12.47
100 seed weight (g)	11.34	0.12	3.94	15.80	17.29	16.15	87.22	31.07
Seed yield/plant (g)	19.58	0.57	3.40	53.84	49.33	44.20	80.25	81.56
Harvest index	0.59	0.54	0.18	0.75	15.60	12.98	69.27	22.26
Phytate (mg/g)	4.84	0.09	1.76	9.10	29.99	29.34	95.72	59.14

Reference

Amrita, B., A.N. Shrivastava, B. Rajani and M. Stuti. 2014. Genetic variability, association and path analyses in advanced generation fixed lines of soybean [*Glycine max* (L.) Merrill]. *Soybean Res.*, 12(1**)**: 20-27.

Johnson, H.W., H.F. Robinson and R.E. Comstock. 1955. Estimates of genetic and environmental variability in soybeans. *Agron. J.*,47: 314-318.

Khan, M.H. and S.D. Tyagi. 2010. Induced polygenic variability in Soybean [*Glycine max* (L.) Merrill]. *Res. J. Agric. Sci.*, 1(2): 93-101.

Sujata, B.and G.T. Basavaraja. 2011. Genetic variability and correlation studies in segregating generation of soybean. [*Glycine Max* (L.) Merril].*Crop Impro.,38(1):* 77-87.

Identification of Promising Donors from Collection of *Oryza nivara* Accessions for Resistance to Sheath Blight

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Keywords: *O.nivara, Rhizoctonia solani, sheath blight resistance, relative lesion length, potential donors*

Introduction

Sheath blight of rice caused by *Rhizoctonia solani* Ku¨hn, occurs in all rice production areas worldwide. This disease has become severe during recent years mainly due to excessive use of nitrogenous fertilizers, high planting density and adoption of high-yielding cultivars, with estimated yield losses of 5–10% at global level which can reach upto 50% depending upon severity of the disease. To date, absolute resistance to *R. solani* has not been identified. Resistant sources with varying levels of tolerance to sheath blight have been reported. However continuous efforts are required to identify potential donors for resistance to sheath blight. Rice wild species germplasm is a valuable resource for improving present rice cultivars in terms of resistance and tolerance to biotic and abiotic stresses.(Khush *et al*.,1990; Kishor *et al*., 2018) Wild species of rice, a pool of valuable genes for important traits proved as savior from time to time. Therefore there is an urgent need to unfold the underutilized wild rice germplasm to identify the suitable resistant donors with sheath blight resistance to develop sheath blight resistant varieties.

Methodology

The present experiment was conducted for identification of superior and promising donors to resistant sheath blight from the set of 423 *O. nivara* accessions along with susceptible check (PR114). All the accessions including check were screened using artificial inoculation conditions during *Kharif* season of 2018, 2019 and 2020 at Punjab Agricultural University, Ludhiana. Two plants of each accession were inoculated with pathogen inoculums at maximum tillering stage and the spread of sheath blight (lesion length) along with plant height was recorded after 15 days of inoculation. Relative lesion length (RLL) in percentage was evaluated with reference to plant height (cm). Based on the disease severity scale and relative lesion length, accessions were scored as 1 as resistance, 3 as Moderately resistance, 5 as Moderately susceptible, 7 as Susceptible and 9 as highly susceptible.

Results and Discussion

A range of variation was observed in *O. nivara* accessions for resistance to sheath blight based on Relative Lesion Length (RLL) showing quantitative nature of the trait. RLL varied from 25-82 % in all the *O. nivara* accessions. Based on RLL, *O. nivara* accessions were categorized as moderate resistant (21-30%), moderate susceptible (31-45%), susceptible (46-65%) and highly susceptible (66-100%). None of accession showed high resistance to sheath blight. Based on three years evaluation, out of 423 *O. nivara* accessions, 25 accessions were moderately resistant and among them, four accessions namely IRGC104473, IRGC104725A, IRGC81941A and CR100008E were found as the promising donors which showed consistent results. These promising donors can also be used for mapping of QTLs for resistance to sheath blight and developing sheath blight resistant cultivars.

Reference

Khush GS, Balacangco E and Ogawa T (1990) A new gene for resistance to bacterial blight from *Oryza longistaminata*. *Rice Genetics Newsletter* 7: 121–122.

Kishor K, Sarao PS, Bhatia D, Neelam K, Kaur A, Mangat GS, Brar DS and Singh K (2018) High-resolution genetic mapping of a novel brown planthopper resistance locus, Bph34 in *Oryza sativa* L. X *Oryza nivara* (Sharma & Shastry) derived interspecific F2 population. *Theoretical and Applied Genetics* 131: 1163–1171.

Impact of Different Levels of Iron on Mitigation of Iron Chlorosis in Varagu

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Keywords: *Varagu, chlorosis, FeSO4, iron deficiency*

Introduction

Varagu (*Paspalum scrobiculatum*), one of the important minor millets. Varagu, also called as Kodo millet, is having high micronutrient content, particularly calcium and iron, high dietary fibre, higher amount of essential amino acids and low glycemic index and thus plays an important role in the food and nutritional security of the poor. Iron deficiency in crops, characterised by interveinal chlorosis, is a worldwide problem. Varagu crop plants are more susceptible in the early stage of growth and therefore, the plants become stunted in early seedling stages. The present study was carried out for different levels iron on mitigation of chlorosis in varagu under calcareous soil.

Methodology

The study was conducted under field condition in the Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore. The varagu variety CO3 taken for this study. The experiment was laid out in Randomized Block Design (RBD) and ten treatments consisted with three replications, As per the treatment schedule, potassium in the form of Muriate of potash and ferrous sulphate were applied in the soil on 30th and 50th day after sowing (DAS). Foliar spray of ferrous sulphate was given on 30th and 50th DAS coinciding with tillering and vegetative stage of the crop respectively.

Results and Discussion

The present investigation iron nutrition in addition to recommended dose of fertilizers showed significant enhancement in plant growth and the treatment soil application of 50 kg FeSO4 ha-1 along with NPK (44:22:30 kg ha-1) was the most effective in enhancing the plant height (102 cm) to the highest level. The leaf chlorophyll content is of the prime importance, which is directly associated with the increase in PSII photochemistry, photosynthate production and dry matter accumulation. Hence, measurement of chlorophylls indirectly explains the efficiency of the photosynthesis and photosynthates production. The present study also revealed that soil application of FeSO4 50 kg ha-1 with 0.5% foliar spray of FeSO4 enhanced the pigment (0.768 mg g-1)composition by double fold over control (0.392 mg g-1) at panicle initiation stage. Similar result was observed by (Eskandari, 2011). The study concluded that for alleviating iron chlorosis, application of FeSO4 @ 50 kg ha-1 through soil at 30 and 50 days after sowing combined with foliar spray of 0.5% FeSO4 at 30 and 50 days after sowing was effectively alleviate iron chlorosis in varagu.

Table.1 Effect of application of iron on growth parameters at grain maturation stage of varagu

Treat ments	PH (cm)	RL (cm)	NT	LN/plant	LA (cm^2)	LAI	LAD days	SLW (mg cm^{-2})	TC (mg g^{-1})
T1	98.8	10.5	3.6	10.3	94.9	0.422	9.2	13.83	0.392
T2	101.5	12.3	3.8	10.3	102.9	0.457	10.31	15.92	0.441
T3	97.2	12.0	3.6	10.2	114.7	0.510	11.21	14.17	0.496
T4	95.9	13.8	3.6	10.9	101.2	0.540	12.11	16.08	0.546
T5	101.8	14.6	3.8	11.8	117.4	0.698	12.53	18.71	0.652
T6	101.6	14.0	4.2	10.9	104.6	0.687	13.12	16.41	0.643
T7	100.9	14.7	4.2	11.3	112.3	0.712	13.21	17.60	0.613
T8	103.8	14.9	3.8	11.4	105.1	0.667	13.52	18.49	0.682
T9	97.4	15.4	4.0	11.7	120.5	0.764	15.82	17.51	0.738
T10	102.0	15.6	4.6	11.9	116.4	0.862	17.40	19.62	0.768
Mean	101.72	13.72	3.90	11.03	107.45	0.6274	17.130	17.37	0.5971
S.Ed	1.49	0.22	0.08	0.20	2.77	0.0101	0.330	0.396	0.0198
CD (P=0.05)	3.14	0.47	0.18	0.43	5.83	0.0211	0.694	0.832	0.0385

*Significant at 0.05 level

PH- Plant height

RT-Root Length

NT-Number of Tillers

LN-Leaf Number

LA-leaf Area

LAI-Leaf Area Index

LAD-Leaf Area Duration

SLW-Specific Leaf Weight

TC- Total chlorophyll

Reference

Abbas, G., M. Q. Khan, M. J. Khan, F. Hussain and I. Hussain. 2009. Effect of iron on the growth and yield contributing parameters of wheat (*Triticum aestivum* L.). *J. Anim. Plant Sci*. 19(3): 135-139.

Bameri, M., R. Abdolshahi, G. Mohammadi-Nejad, K. Yousefi and S. M. Tabatabaie. 2012. Effect of different microelement treatment on wheat (*Triticum aestivum* L) growth and yield. Intl. *Res. J. Appl. Basic. Sci*. 3(1): 219-223

In Vitro Propagation of Moringa (*Moringa oleifera*) to Ensure High-throughput Production of Genetically Uniform Planting Materials

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Keywords: *Tissue culture moringa, PKM1, Nodal culture*

Introduction

Moringa (*Moringa oleifera*), a commercially cultivated fast growing tree, is recognized for its high nutritional value owing to its rich content of essential amino acids, vitamins, minerals, antioxidants and other medicinally important phytochemicals. Though it has employed globally as an important plant food to alleviate malnutrition and as raw materials in medicinal industry, availability of Moringa raw products to meet the global demands is scarce due to the limited supply of uniform planting material for commercial cultivation. Propagation of plants/trees through tissue culture method using different explants has long been practiced for producing quality planting materials through micropropagation, conservation of plants including endangered species and enhancing selection efficiency of desirable traits (Heidary *et al.* 2018; Pandey *et al*. 2019).This report focused on large scale multiplication of genetically uniform Moringa planting materials using in vitro propagation methods for the cultivar PKM1, a widely adapted and productive variety..

Methodology

The seeds of Moringa cultivar PKM 1 were sown in pots. Two weeks later, when the seedlings growing from the seeds had reached a height of about 20 cm, the nodal segments were collected and used as explants for the present investigation. The collected nodal segments were trimmed to 1-2 cm length and treated with Tween 20 for 20 minutes followed by tap water washing. Finally the explants were sterilized with 0.1 % HgCl2 for 3 minute, and thoroughly washed with sterile distilled water under laminar air flow chamber.

Shoot initiation

Surface sterilized nodal segments (1-2 cm) were cultured on MS medium fortified with 3% sucrose (w/v), BAP (2.0 mg /L) and 8.0 g/L agar which were added after adjusting the pH to 5.8 before autoclaving. The explants were cultured both in jam bottles (10 × 7.5 cm) and test tubes, which were filled with 50 and 20 ml medium, respectively. All the aseptically inoculated explants were maintained under white fluorescent light with 16 hour's photoperiod at 25±2°C temperature. Number of explants that were regenerated were periodically recorded and subcultured for multiple shoot induction or root initiation

Results and Discussion

New auxiliary shoots were observed from tenth day after initiation and it was found that each explant can able to produce two to three axillary shoots (Figure 1). The axillary shoots were divided and taken for subculturing along with the calli like base. More number of regenerations was found in MS media supplemented with BAP @ 2.0 mg /l and it was in congruence with our earlier study (Harshitha *et al*., 2020). Further works on multiple shoot initiation and rooting of the regenerated plants besides testing the genetic fidelity of the PKM1 micropropagated plants using in house generated novel and unique simple sequence repeat markers are in progress and it will be discussed during the presentation.

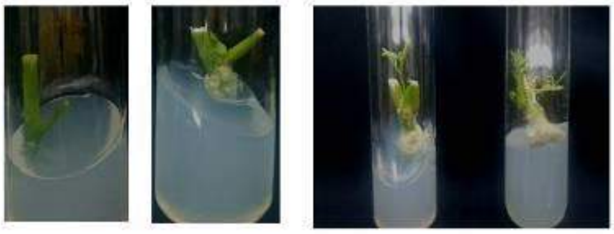

Figure 1. Different stages of Micropropagation in Moringa

Reference

Harshitha J.D., Santhanakrishnan V.P., Meenakshisundaram P., Hemaprabha K., Manikanda Boopathi N., Raveendran M and Gnanam R. 2020. Micropropagation in *Moringa oleifera* Lam for high-throughput multiplication. *Electronic Journal of Plant Breeding*. Vol 11(4):1205-1210

Heidari P., Etminan A., Azizinezhad Reza and Khosroshahli M. 2018. In vitro-examination of genetic parameters and estimation of seedling physiological traits under drought and normal conditions in durum wheat. *Indian J. Genet*., 78(2): 217-227. DOI: 10.5958/ 0975-6906.2018.00028.7.

Pandey A., Verma O. and Chand S. 2019. In vitro propagation of *Boerhaavia diffusa* L.: An important medicinal plant of family Nyctagimaceae. *Indian J. Genet*., 79(1): 89-95. DOI: https://doi.org/10.31742/ IJGPB.79.1.12

Interaction of Copper with Total NPK Content of Rice (*Oryza sativa*.L) in TypicHaplustalf

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Keywords: *Rice, Copper, Total macronutrients, different plant parts*

Introduction

Among the micronutrients, copper is required only in small quantities for normal plant growth, but its role in maximizing yield is very impressive (Emami 2005). When Cu is supplied with below the requirement of crop there may be a drop in the crop yield. Reports are additionally accessible on induced deficiency of different mineral substance under copper toxicity. Henceforth endeavours have been made to build up the toxicity level of copper on rice plants in the present investigation (Mocquot *et al*., 1996).

Methodology

The effect of soil application of different levels of copper (0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0 kg Cu ha^{-1}) and foliar application (0.25% $CuSO_4$ at tillering stage, 0.25% $CuSO_4$ at tillering and flowering stage, 0.5% $CuSO_4$ at tillering stage and 0.5% $CuSO_4$ at tillering and flowering stage) on total nutrient content of rice was examined by leading field trail in Typic Haplustalfs of AC &RI, Madurai.Leaf samples were collected at flowering stage and grain and straw samples were collected at post-harvest stages and shade dried followed by oven drying at 65^0C, ground in Willey mill and analyzed for total N, P& K.

Results and Discussion

Total Nitrogen and Total Potassium (Figure1&3)

Nitrogen & Potassium content of rice showed progressive decline with increase in copper level. The N & K content in leaves at flowering stage and in grain and straw at harvest stage significantly reduced by higher levels of copper. Ureta *et al*., (2005) noticed that decrease in nitrogen content of green gram leaf due to higher dose of copper and it lead to poor nodule development, diminished nitrogen fixation and reduced N uptake from soil. The decrease in K content of rice due to the toxic effect of copper on plant growth or competition by other ions which in turn exercised a regulatory control on K uptake (Manivasagaperumal *et al*., 2011).

Total Phosphorus (Figure 2)

Application of Cu more than 1.5 kg ha-1resulted in bringing down of P content in leaves, grain and straw and demonstrated negative relation between phosphorus and copper. High convergence of Cu stifles P metabolism by decreasing the substance of inorganic phosphorus in plants. This led to the belief that there may be a negative correlation between Cu and P and this was also revealed by Wallace and Cha (1989) and Mateos-Naranjo *et al*., (2008).

Application of Cu in excess amounts (2.0 to 3.0 kg ha-1) exhibited antagonist interaction on all total nutrients and adversely affected the growth, dry matter and nutrient content. Application of Cu in excess amount may induce the deficiency of other macro micronutrients and adversely affect the yield. Hence, judicious and adequate amendment of Cu can contribute to a great deal in enhancing the yield of rice crop especially in Cu responsive soils.

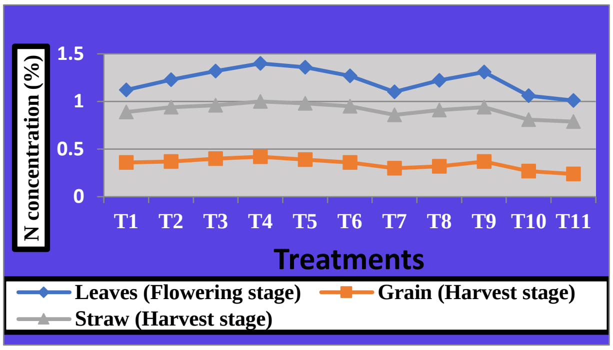

Figure 1. Effect of Cu on total N conc (%) on different plant parts of rice

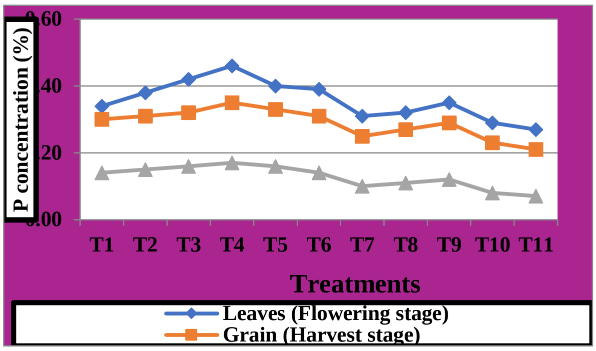

Figure 2. Effect of Cu on total Pconc (%) on different plant parts of rice

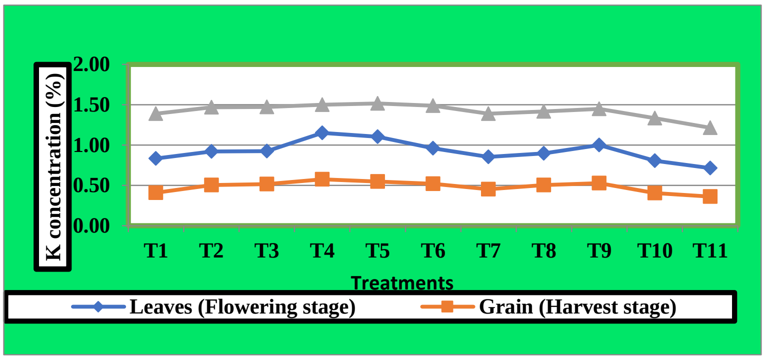

Figure 3. Effect of Cu on total Kconc (%) on different plant parts of rice

Reference

Emami, A. 2005. "The effect of foliar absorption of macro and microelements on growth and yield of potato." M. Sc. thesis. Agriculture Faculty. Khorasgan branch of Islamic Azad ….

Jackson, ML. 1973. "Methods of chemical analysis." *Prentic Hall., EngleWood Cliffs, NTJ.*

Lidon, FC, and FS Henriques. 1992. "Copper toxicity in rice; a diagnostic criteria and its effect on Mn and Fe contents." *Soil Sci* 154 (2):130-135.

Wallace, Arthur, and Jong Whan Cha. 1989. "Interactions involving copper toxicity and phosphorus deficiency in bush bean plants grown in solutions of low and high pH." *Soil Science* 147 (6):430-431.

Ureta, Ana-Claudia, Juan Imperial, Tomás Ruiz-Argüeso, and Jose M Palacios. 2005. "Rhizobium leguminosarum biovar viciae symbiotic hydrogenase activity and processing are limited by the level of nickel in agricultural soils." *Appl. Environ. Microbiol.* 71 (11):7603-7606.

Relationship and Association Analysis in the Cultivated and Wild Species of Sesame

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Keywords: *Sesame, correlation coefficient, path analysis, number of capsules*

Introduction

Sesame is entitled to be the "Queen of oilseeds" which is nutritionally rich due to the energy being stockpiled in its seed that is cultivated all throughout the year. Globally, Sesame is being cultivated on a sizeable area with an unappreciable productivity The eventual pronouncement of yield in crop plants are harnessed by the action and relationship among a number of characters. Correlation analysis assists to extract the strength of estimating the critical components of complex trait like yield. Inevitably, the path coefficient analysis promotes in splitting up the contribution of component characters with regard to yield into direct and indirect effect through other characters with the purpose of disclosing the cause and effect relationship (Wright, 1921)

Methodology

The experimental materials for the present study included nine varieties of *Sesamum indicum* and three wild species namely *Sesamun alatum*, *Sesamum malabaricum* and *Sesamum radiatum*. The seeds of experimental materials were obtained from Department of Oilseeds, Tamil Nadu Agricultural University, Coimbatore was conducted in Wild species garden and Oilseeds farm at TNAU, Coimbatore during Rabi season of 2021. All the recommended package of practices were followed regularly. Data were recorded from the plants on days to first flowering, plant height, the number of branches per plant, the number of capsules per plant, the number of seeds per capsule, capsule length ,1000 seed weight and seed yield per plant. Correlation coefficients were calculated according to the formula recommended by Goulden (1952). Path coefficients were estimated as per the methods given by Dewey and Lu (1959). The estimates of correlation coefficient and path coefficient analysis were calculated by analyzing data using TNAUSTAT statistical package.

Results and Discussion

Relationship among cultivated and wild species

The relationship among the cultivated and wild species can be concluded by heat map which explains that cultivated varieties of *Sesamum indicum* falls under three clusters and wild species into two clusters depicting significant difference among the cultivated and wild species. (Figure 1)

Genotypic and phenotypic correlation coefficients

From the genotypic and phenotypic correlation analysis it was observed that seed yield per plant emphasizes positive and high significant correlation with number of capsules per plant and thousand seed weight followed by inter correlation among number of capsules, number of seeds per capsule, capsule length, thousand seed weight, number of branches and days to fifty percent flowering. Hence these traits should be given paramount importance during selection for crop improvement in Sesame. (Table 1).

Path analysis

Path analysis revealed that the trait number of capsules per plant had high positive direct effect on yield followed by low positive direct effect on thousand seed weight and number of branches. As far as indirect effects are considered, thousand seed weight has high positive indirect effect on seed yield per plant via number of capsules per plant. The residue in path analysis discloses that extrinsic characters apart from the yield contributing traits taken for current study are involved in association with the yield of the crop (Table 2).

Table 1. Phenotypic (upper) and genotypic (lower) correlation co efficient for yield and yield related traits in Sesame species

Traits	PH	NB	DFF	NCP	NSC	CL	TSW	SY
PH	1	0.6446*	0.3893	0.0234	0.6107*	0.4732	-0.328	0.0026
		0.6507*	0.4038	0.0154	0.6171	0.4678	-0.3388	-0.0108
NB		1	0.6078*	0.3091	0.1799	-0.186	0.2182	0.3443
			0.6606*	0.3059	0.1439	-0.2281	0.2111	0.3353
DFF			1	-0.3662	-0.1879	-0.1404	-0.3051	-0.3483
				-0.3663	-0.1855	-0.1314	-0.3041	-0.3467
NCP				1	0.23	-0.2844	0.798**	0.974**
					0.2214	-0.3006	0.7979**	0.9803**
NSC					1	0.7628**	-0.3419	0.1313
						0.7762**	-0.3647	0.1201
CL						1	-0.7343**	-0.3699
							-0.7581**	-0.4027
TSW							1	0.8543**
								0.8574**
SY								1

* Correlation is significant at the 0.05 level, **Correlation is significant at the 0.01 level

Table 2. Path coefficient analysis of yield and yield related traits in Sesame species (Bold values are direct effect)

Traits	PH	NB	DFF	NCP	NSC	CL	TSW	Correlation with SYP
PH	**0.0397**	0.0663	-0.0434	0.0117	-0.0045	-0.0227	-0.0578	-0.0108
NB	0.0259	**0.1018**	-0.071	0.2325	-0.0011	0.0111	0.036	0.3353
DFF	0.0161	0.0673	**-0.1075**	-0.2784	0.0014	0.0064	-0.0519	-0.3467
NCP	0.0006	0.0312	0.0394	**0.7601**	-0.0016	0.0146	0.1362	0.9803**
NSC	0.0245	0.0147	0.0199	0.1683	**-0.0074**	-0.0377	-0.0622	0.1201
CL	0.0186	-0.0232	0.0141	-0.2285	-0.0057	**-0.0486**	-0.1294	-0.4027
TSW	-0.0135	0.0215	0.0327	0.6065	0.0027	0.0369	**0.1706**	0.8574**

Residual effect: 0.137

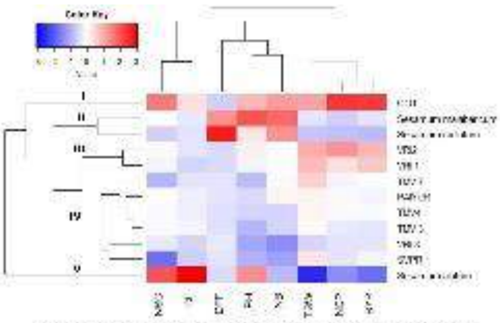

Fig 1. Heat map shows the relationship between cultivated and wild species of sesame

Reference

Goulden, H.C. 1952. Methods Of Statistical Analysis. Asia Publishing House; Bombay.

Joshi, A.B., 1961, Sesamum. Indian Central Oilseeds Committee, Hyderabad, India, pp.62-77.

Wright, S. 1921. "Correlation and causation." J. *of agric. res.* 20 (7):557-585.

Role of Chelated Micronutrients in Relation to Uptake of Nitrogen in Rice

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Keywords: *Nitrogen, Chelate, Iron, Zinc, Amino acid, Rice*

Introduction

Rice (*Oryza sativa* L.), is the staple food for nearly half the world population. To produce high grain yield levels of rice, modern rice cultivars require more amount of essential nutrients. Intensive rice production and future rice demands will require knowledge-intensive strategies for the efficient use of all inputs, including fertilizer nutrients. Micronutrients like Hence usage of chelated micronutrients could supply micronutrient requirements like Fe and Zn to the plants which has become major deficiencies in Indian soils. As irrigated and rainfed lowland rice system accounts for about 80 % of the worldwide harvested rice area and 92 % of total rice production Abid *et al.* (2002), the discussion in this chapter will be focused more towards the usage of chelated micronutrients as a fertilizer to the plants.

Methodology

The lab experiment was carried out to study the synthesis and characterization of new chelated iron fertilizer (Iron methionate). The field experiment was carried out to evaluate the effect of chelated micronutrients in enhancing the yield of rice at Aruppukottai block during the Rabi season of 2018-19. The Ferrous sulphate was hydrolyzed using excess alkali to produce ferrous hydroxide at stabilized pH between 9.0-9.5. The precipitated ferrous hydroxide has been separated by centrifugation process, washed using alcohol and mixed with methionine. The fine powder form of iron methionate chelate was grained, sieved and packed it in air tight container. Before the formation of above mentioned chelate, many attempts were given with more than three different procedures using different salts and different amino acids in different formulations.

Results and Discussion

Effect of chelated Fe and Zn on Nitrogen uptake (kg ha-1) at different growth stages of rice

The results of the experiment (Table 1) found clear support for the need of micronutrient mixture for rice crop. Among the treatments, (T13) application of recommended dose of fertilizers along with chelated micronutrient mixture (12.5 kg ha-1) significantly recorded the maximum N uptake of 31.0, 48.5, 62.0, 70.2 (grain) and 28.3 (straw) kg ha-1 followed by this, the treatment T12[28.8, 45.5, 61.3, 67.9 (grain) and 27.9 (straw) kg ha-1] which received 10.0 kg ha-1 of chelated micronutrient mixture along with RDF as soil application was found be the best performing over other treatments. As Fe plays a role in ascorbic acid synthesis, assimilation and uptake of N is affected by the application of amino acid chelated Fe in the soil. Similar results were also reported by (Abbas *et al.*, 2012). Applications of Zn source resulted in increased availability of Zn which in turn influenced DNA and protein synthesis leading to increased nitrogen uptake.

Table 1. Effect of chelated Fe and Zn on Nitrogen uptake (kg ha-1) at different growth stages of rice

Treatments	Palavanatham village - Nitrogen uptake (kg ha^{-1})				
	Active Tillering	Panicle Initiation	Heading	Post-Harvest	
				Grain	Straw
T_1	13.1	20.5	26.3	29.0	12.1
T_2	23.3	37.5	52.5	55.8	26.3
T_3	23.8	38.4	54.0	58.2	26.1
T_4	24.1	38.8	54.3	58.3	26.5
T_5	25.7	39.7	55.1	59.0	27.0
T_6	25.2	40.6	56.0	60.2	27.4
T_7	26.3	42.2	57.2	62.3	27.1
T_8	25.8	41.4	55.9	60.4	26.9
T_9	26.5	42.6	57.8	63.1	27.2
T_{10}	27.0	43.4	59.4	65.2	27.6
T_{11}	27.1	43.5	59.5	65.3	27.7
T_{12}	28.8	45.5	61.3	67.9	27.9
T_{13}	31.0	48.5	62.0	70.2	28.3
T_{14}	28.7	45.3	61.2	67.7	27.8
SEd	**0.868**	**0.89**	**0.97**	**1.2**	**0.1**
CD(P=0.05)	**1.78**	**1.84**	**2.00**	**2.4**	**0.3**

Reference

Abid, Muhammad, Niaz Ahmad, Maqsood Jahangir, and Iftikhar Ahmad. 2002. "Effect of zinc, iron and manganese on growth and yield of rice (Oryza sativa L.)." *Pakistan Journal of Agricultural Sciences* 39:177-180.

Abbas, Ghulam, Fida Hussain, Zubair Anwar, Jabar Zaman Khan Khattak, and Muhammad Ishaque. 2012. "Effects of Iron on the Wheat Crop (Triticum aestivum L.) by Uptake of nitrogen, phosphorus and potassium." *Asian Journal of Agricultural Sciences* 4 (3):229-235.

Sampling the Moringa Germplasm Accessions with Novel Genomic and Genic SSRs and Diversity Analysis with Different Algorithms Ensured Both Conservation and Divergence in Their Genetic Content

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Keywords: *Moringa, SSR markers, Genetic diversity algorithms, Parents for hybridization*

Introduction

Though Moringa (*Moringa oliefera* Lam.,) is recognized as superfood and low-input responsive crop (Trigo et al., 2021), non-availability of leafy Moringa cultivar is the major problem faced by the farmers, as there is huge demand for Moringa leaves in the market. Breeding for better Moringa cultivars with improved biomass production require to sample the available genetic diversity for the leaf characteristics. Molecular markers have successfully shown to be useful in this direction and especially the simple sequence repeat (SSR) markers were widely used for sampling the genetic diversity in crop plants (Boopathi, 2013). However, only twenty SSRs are available in Moringa (Wu *et al.*, 2010). Hence, additional set of Moringa SSRs were identified, synthesized and validated at this laboratory and in order to ensure accurate and unbiased estimates of genetic diversity different genetic diversity algorithms that enable robust way of identifying intraspecific diversity.

Methodology

Totally 55 Moringa germplasm accessions (serially numbered from 1 to 55) were utilized in this study that were collected from different parts of South India. The genotyping data collected from 75 genomic and 41 genic SSR markers that were surveyed on the 55 Moringa germplasm accessions were used in this study. The raw SSR marker data were processed into different formats as instructed in the manuals of DARwin 6.0 (available at http://darwin.cirad.fr/darwin; dissimilarity coefficient was estimated by the Jaccard index and dendrogram was constructed by employing the unweighted pair group with mean average (UPGMA) with Bootstrapping over loci with 1000 replications), TASSEL 4.0 (Bradbury et al. 2007; using General Linear Model) and NTSYSpc 2.2 (Rohlf, 1999; with Dice's similarity coefficient using UPGMA that followed sequential agglomerative hierarchical non-overlapping (SAHN) clustering techniques.

Results and Discussion

All the three algorithms used in this study has resulted three major clusters- I, II and III (Table 1; Figure 1), even though each one of the clusters was constituted with different germplasm accessions. Though it was not a perfect match, a more similar kind of clustering pattern was observed between the Darwin 6.0 and TASSEL 4.0, results. However, all the three analyses have helped to identify the extremely diverged. Moringa germplasm lines that may be used as parental combinations to evolve novel segregating progenies with greater genetic variability. Further, the polymorphic markers found between the selected parental lines would be used as in marker assisted selection to introgress the desirable genomic segments from diverse germplasm in to the elite Moringa line (upon validating its association with the target traits).

Thus, this study has helped to identify the extremely diverse Moringa germplasm accessions such as serial number 54 (Karumbumurungai) and serial number 4 (KappalpattiMurungai), which were found to be genetically different. Hence, use of these two lines in hybridization program will lead to generate maximum number of recombinants that may have desirable leafy phenotypes.

Table 1. Genetic diversity analysis of Moringa germplasm accessions by different algorithms generated three different clusters. Numbers in each column matcheswith serial number of corresponding germplasm accession. Numbers in bold and within parenthesis denotes numbers of germplasm line present in the given cluster.

Cluster	Cluster generated by Darwin 6.0	Cluster generated by TASSEL 4.0	Cluster generated by NTSYSpc 2.2
I	25,26,27,28,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55 **(30)**	1,3,8,11,19,21,26,27,28,30,31,32,33,34,35,36,37,38,40,41,42,43,44,45,46,47,48,49,50,52,53,54,55 **(33)**	**(A)**12,13,14,15,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,37,38,39,40,41,42,43,44,45,46,47,48 **(44)** **(B)** 5,11,16 **(3)**
II	1,2,3,5,6,7,8,9,10,11,12,13,14,15,18,19,20,21,24 **(19)**	2,5,6,7,9,10,12,14,15,18,20 **(11)**	36,49,50,51,52,53,54,55 **(8)**
III	4,16,17,22,23,29 **(6)**	4,13,16,17,22,23,24,25,29,39,51 **(11)**	

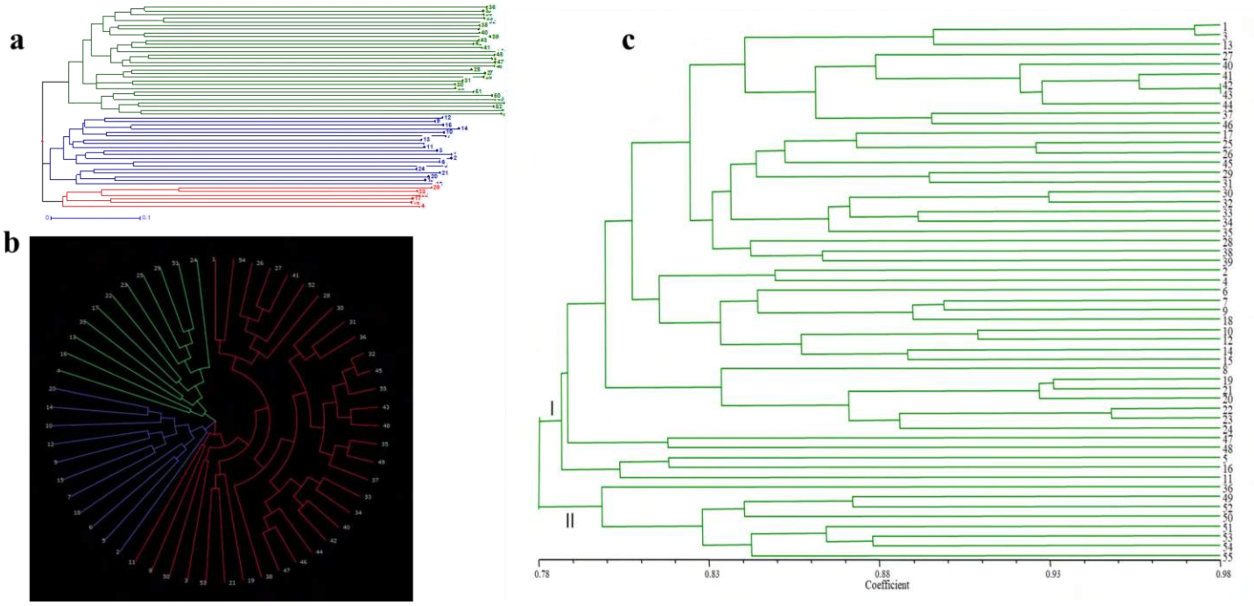

Figure 1. Dendrograms generated by three different algorithms a) Darwin 6.0 b) TASSEL 4.0 and c) NTSYSpc 2.0 that show different clustering patterns

Reference

Boopathi, N. M. 2013. Marker-assisted selection. In Genetic mapping and marker assisted selection (pp. 173-186). Springer, India.

Wu, J. C., Yang, J., Gu, Z. J., and Zhang, Y. P. 2010. Isolation and characterization of twenty polymorphic microsatellite loci for *Moringa oleifera* (Moringaceae). ***HortScience***, 45(4), 690-692.

Screening of Finger Millet Genotypes for Sodicity Tolerance Using Na^+/K^+ Ratio as a Major Physiological Triat

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Keywords: *Sodicity, Na+/K+ ratio, grain yield, finger millet*

Introduction

Finger millet (*Eleusine coracana* (L.) Gaertn.) is a drought hardy crop majorly cultivated and consumed by resource poor farmers in the developing countries of Asia and Africa. Sodic soils are characterized by extravagantly higher concentration of Sodium (Na) in their cation exchange capacity. These soils tend to have poor physical and chemical properties leading to soil instability, which can have a significant impact in the plant growth than under saline soils (Tran *et al*., 2015).

Methodology

120 finger millet genotypes were screened for their tolerance/susceptibility to sodicity under sodic soil condition along with sodicity tolerant check variety TRY 1. The experimental field soil condition was sandy clay loam with pH 8.9, electrical conductivity (EC) 0.94 dSm-1 and exchangeable sodium percentage (ESP) 21.5. Estimation of sodium and potassium were done according to the procedure of Jackson (1973) using flame photometer.

Results and Discussion

A significantly higher grain yield per plant than the sodicity tolerant check variety TRY 1 was observed in 30 finger millet genotypes viz., FIN 3045, FIN 2875, FIN 3077, FIN 3015, FIN 3063, FIN 2861, FIN 3028, FIN 2867, FIN 2854, FIN 2860, FIN 2872, FIN 2896, FIN 4268, FIN 3034, FIN 3928, FIN 3104, FIN 3965, FIN 3091, FIN 2960, FIN 3994, FIN 4198, FIN 3174, FIN 3078, FIN 4288, FIN 4202, FIN 4238, FIN 3089, FIN 4205, FIN 3966 and FIN 3182.

The analysis of sodium and potassium revealed that these 30 finger millet genotypes also recorded a significantly lower Na+/K+ ratio which is comparatively lower than the sodicity tolerant check variety TRY 1.Similarly, the low yielding genotypes such as FIN 3071 and FIN 2881 seemed to contain higher levels of Na+/K+ ratio. Figure 1. clearly depicts the relationship between grain yield per plant and Na+/K+ ratio. These results were in accordance with Vijayalakshmi *et al*. (2014).

The genotypes which recorded higher grain yield per plant and lower Na+/K+ ratio can be considered as sodicity tolerant as the Na+/K+ ratio has a significant negative correlation with grain yield (Keerthana *et al*., 2019). These tolerant genotypes have the ability to maintain the level of K and lower Na accumulation in their shoot (Sharma *et al*., 1986).

From the study it can be concluded that sodium and potassium levels in plant sample contribute majorly to the sodicity tolerance in finger millet. The selected 30 finger millet genotypes with high grain yield per plant and low Na+/K+ ratio could be utilized in stress breeding program in developing sodicity tolerant finger millet variety.

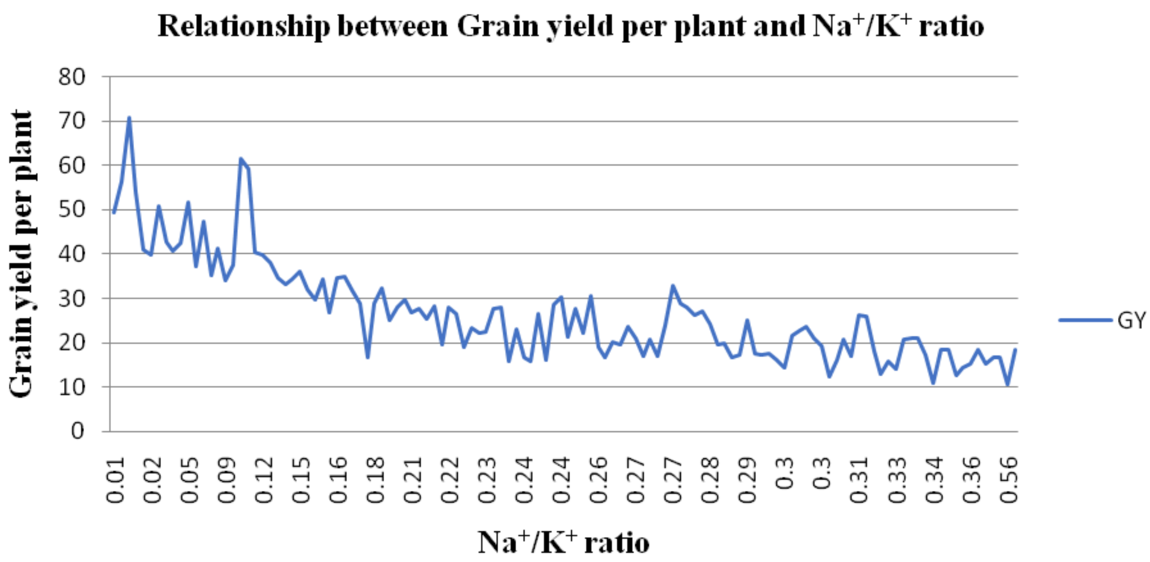

Figure 1. Relationship between Grain yield per plant and Na+/K+ ratio

Reference

Jackson, M. L. (1973). Soil chemical analysis, pentice hall of India Pvt. *Ltd., New Delhi, India*, *498*, 151-154.

Keerthana, K., Chitra, S., Subramanian, A. & Elangovan, M. (2019). Character association and path coefficient analysis in finger millet [Eleusine coracana (L.) Gaertn] genotypes under sodic conditions. *The Pharma Innovation Journal*, *8*(6), 556-559.

Sharma, S. K. (1986). Mechanism of tolerance in rice varieties differing in sodicity tolerance. *Plant and Soil*, *93*(1), 141-145.

Tran, D. B., Hoang, T. V., & Dargusch, P. (2015). An assessment of the carbon stocks and sodicity tolerance of disturbed Melaleuca forests in Southern Vietnam. *Carbon balance and management*, *10*(1), 1-14.

Vijayalakshmi, D., Ashok, S. K., & Raveendran, M. (2014). Screening for salinity stress tolerance in rice and finger millet genotypes using shoot Na+/K+ ratio and leaf carbohydrate contents as key physiological traits. *Indian Journal of Plant Physiology*, *19*(2), 156-160.

Selection of Diversed Parents in Pigeonpea [*Cajanus cajan* (L.) Millsp.] and Breeding for Nutritional Security

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Keywords: *genetic diversity,PCA, quantitative traits, selection*

Introduction

Being an often cross pollinated crop, Pigeonpea acts as a potent reservoir of genetic variability. The second most important pulse crop of India after chickpea is bestowed with rich source of proteins (20 - 21 %) and is an important soil ameliorant crop (Tharageshwari and Hemavathy, 2020). In spite of its hardy, drought tolerant nature, the crop is challenged by various biotic and abiotic stresses. Therefore, there is an urge to increase the production of pigeonpea, which could be done by opting suitable breeding methods to develop high yielding, multiple stress tolerant, stable genotypes. Principal Component Analysis (PCA) can be used to uncover similarities between variable and classify the genotypes, while cluster analysis on the other hand is concerned with classifying previously unclassified materials (Leonard and Peter).

Methodology

Fifteen genotypes (including checks) of Pigeonpea were studied during kharif, 2018 at Dept. of Pulses, Tamil Nadu Agricultural University. The experimental trial was laid out in randomized complete block design with five replications under irrigated conditions. Data on the basis of five randomly selected competitive plants were recorded. The hierarchial clustering was performed with DARwin 6.0 Software (Perrier et al., 2006). The Principal Component Analysis was performed using GENRES 7.01 and Minitab 19 Statistical Software

Results and Discussion

Genetic variability serves as a source of noble alleles responsible for key agronomic and quality traits, which ultimately form basis for identification and selection of promising parents for breeding programs. The UPGMA cluster grouped the 15 pigeonpea genotypes into two genetic clusters, which were further grouped into different sub-clusters (Figure 1). The analysis revealed that the genotype CO 8 forms a unique sub-cluster leaving the other genotypes viz., IC 525413, IC 525411, Maruti and CO 6 in an alternate sub-cluster. This indicates that the genotype CO 8 might have a distinct ancestral lineage (APK 1 x LRG 41) (Bapuet al., 2017).The remaining genotypes forms another cluster with two sub-clusters viz., IC 525527, ICPL 11023, BWR 133, IC 525521, IC 525456 belonging to first sub-cluster and IC 525403, ICPL 10967, BSMR 846, Gulyal red, IC 525424 belonging to second sub-cluster respectively. The result of the PCA explained the genetic diversity of the pigeonpea collection. Eigen vectors, principal components for quantitative traits in pigeonpea germplasm were given in Table 1 along with the scree plot graph (Figure 2). The scree plot graph is constructed with the help of eigenvalue and the component number. In general, plant breeder is interested in keeping only those principal components whose eigenvalues are greater than 1. Components with an eigenvalue of less than 1 account for less variance and so are of little use. PCA identified four principal components (PC 1 to PC 4) with eigen values more than one which contributed 70.9 per cent of the cumulative variance. The first Principal Component (PC1) contributed maximum towards variability (27%) was correlated with plant height, pod bearing length, number of primary branches per plant, pod length and hundred seed weight. These traits had the largest participation in the divergence and carried the largest portion of its variability. Similar findings with regard to number of pods per plant and plant height was reported by Rekhaet al., 2013 in pigeonpea. The second Principal Component (PC2) accounted 21.8 per cent of total variance and it reflected positive loading of racemes per plant, clusters per plant, total number of pods, single plant yield and pods per cluster, number of primary branches per plant, pod bearing length, dry matter weight, plant height contributing to the third Principal Component (PC3). The fourth PC (PC4) was correlated with hundred seed weight, pods per cluster, days to 50 per cent flowering, plant height, pod bearing length. These findings states that the genotypes under different clusters or with maximum genetic distance are to be taken for hybridization programs, since they are genetically distinct and diverse with less ancestral sharing properties.

Table 1: Eigen vectors, principal components for quantitative traits

Traits	PC1	PC2	PC3	PC4
Days to 50 per cent flowering	-0.04	-0.03	-0.67	0.23
Number of primary branches	0.28	0.21	0.33	-0.47
Racemes per plant	0.03	0.56	-0.18	-0.09
Pod length (cm)	0.23	-0.02	-0.30	-0.24
Plant height (cm)	0.49	0.14	0.13	0.19
Number of clusters per plant	-0.31	0.46	-0.01	0.03
Number of pods per cluster	-0.29	-0.09	0.45	0.28
Total number of pods per plant	-0.35	0.44	0.04	-0.02
Pod bearing length (cm)	0.45	0.16	0.23	0.19
Hundred seed weight (g)	0.15	0.08	0.04	0.70
Dry matter weight (g)	-0.28	0.08	0.21	0.08
Single plant yield (g)	0.15	0.42	-0.12	0.14
Eigenvalue	**3.24**	**2.61**	**1.41**	**1.24**
Proportion %	**27**	**21.8**	**11.7**	**10.3**
Cumulative %	**27**	**48.8**	**60.5**	**70.9**

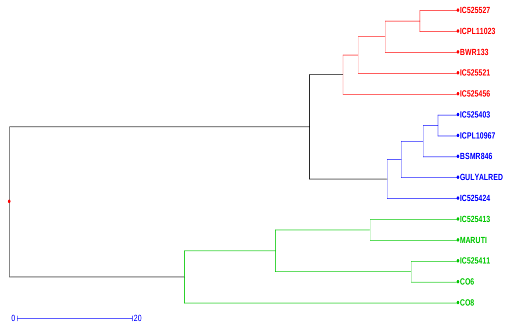

Figure 1: Hierarchial cluster analysis

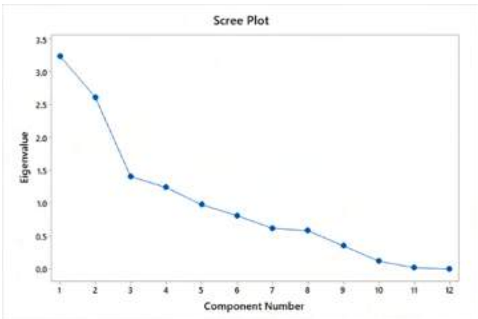

Figure 2: Scree plot graph

Reference

Bapu, J. R. K., ThangaHemavathy, A., Nadarajan, N., Muthiah, A. R., Packiaraj, D., Malarvizhi, D., Ganesamurthy, K., Rajeswari, E. and Rajabaskar, D. (2017). CO 8 : A high yielding long duration new red gram variety suitable for Tamil Nadu. *Electronic Journal of Plant Breeding*., 8(4): 1053-1058.

Perrier, X. and Jacquemoud-Collet, J.P. (2006) DARwin Software.Version 6.0.

Rekha, R., M. Prasanthi, ReddiSekhar and M. Shanti priya. (2013). Principal component and cluster analyses in pigeonpea [Cajanuscajan (l.) Millsp].Int. *J. Applied Biology and Pharmaceutical Technol*., 4(4): 424-430.

Tharageshwari, L. M. and ThangaHemavathy, A. (2020). Correlation and Path Analysis in Pigeonpea [Cajanuscajan (L.) Millsp.]. *Int.J.Curr.Microbiol.App.Sci*., 9(1): 80-86

Studies on Foliar Spray of Pulse Wonder Using Drone on Yield Attributes and Yield of Green Gram

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Keywords: *Drone, Green gram, foliar spray, pulse wonder, spray fluid*

Introduction

Green gram is a short-term pulse crop that contains 24% protein, 1.5% fat, 60% carbohydrates, vitamins and amino acids (Chandrasekhar, 2003). It is being a short duration crop response well to foliar application of nutrients. Pulse wonder a foliar nutrition product developed by Department of Plant Physiology, TNAU Coimbatore is recommended to spray at peak flowering stage to increase the yield (CPG, 2020). The existing conventional method of manual spraying of foliar nutrient is associated with high input and labour cost. Drone technology is a phenomenal innovation that continues to have far-reaching effects across today's society. Hence, use of drones for foliar spray of pulse wonder in green gram has been studied.

Methodology

A field experiment was carried out at ADAC&RI, Trichy during *summer*, 2021 to study the effect of foliar spray of pulse wonder using drone in green gram. Green gram variety VBN Gg(4) was used. The experiment was laid out in randomized block design replicated thrice with 7 treatments. The treatments consisted of two levels of pulse wonder (1% and 2%), two levels of spray fluid (30 and 50 litres ha-1) compared with manual spray (1% & 2%) with spray fluid of 500 litres ha-1 and control. Pulse wonder was sprayed at peak flowering stage by using knapsack sprayer and drone. Quadcopter is the type of agriculture drone used for spraying. Observations on yield attributing characters *viz*., number of pods plant-1, number of seeds pod-1 and grain yield of green gram were recorded.

Results and Discussion

Drone spray of 2% TNAU pulse wonder with spray fluid of 50 litres ha-1 (T4) recorded significantly more number of pods plant-1 (39.2), number of seeds pod-1(11.0) and grain yield (679 kg ha-1) than manual spray as well as control. However, it was on par with drone spray of 2% TNAU pulse wonder with spray fluid of 30 litres ha-1 (T3) and drone spray of 1% TNAU pulse wonder with spray fluid of 50 litres ha-1 (T3), the lowest number of pods plant-1 (21.3), number of seeds pod-1 (7.0) and grain yield (521 kg ha-1) were recorded in control. Foliar spray of pulse wonder at peak flowering stage increased photosynthetic efficiency of green gram resulted in more number of pods plant-1 and higher grain yield. These findings are in accordance with Mir *et al*. (2010).

Thus, foliar spray of 2% pulse wonder with spray fluid of 50 litres ha-1 using quadcopter type of drone once at peak flowering stage found to increase the grain yield when compared to manual spray. Hence, drone could be used for foliar spray of nutrients in green gram.

Table1: Effect of foliar spray of pulse wonder using drone on yield attributes and yield of green gram

Treatments	Number of pods plant-1	Number of seeds pod-1	Grain yield (kg ha-1)
T_1 - Drone spray of 1% TNAU Pulse Wonder with spray fluid of 30 litres ha^{-1}	29.1	9.2	607
T_2 - Drone spray of 1% TNAU Pulse Wonder with spray fluid of 50 litres ha^{-1}	37.2	10.2	636
T_3 - Drone spray of 2% TNAU Pulse Wonder with spray fluid of 30 litres s ha^{-1}	38.1	10.5	657
T_4 - Drone spray of 2% TNAU Pulse Wonder with spray fluid of 50 litres ha^{-1}	39.2	11.0	679
T_5 - Manual spray of 1% TNAU Pulse Wonder with spray fluid of 500 litres ha^{-1}	28.5	9.0	602
T_6 - Manual spray of 2% TNAU Pulse Wonder with spray fluid of 500 litres ha^{-1}	30.2	9.3	615
T_{7}- Control	21.3	8.0	521
SEd	1.3	0.68	25
CD (P=0.05)	2.8	1.49	55

Reference

Chandrasekhar, C. N. 2003. Maximizing the yield of mung bean by foliar application of growth regulating chemicals and nutrients. *Madras Agricultural Journal.*, 90 (1/3):142-145.

Crop Production Guide (CPG) – Agriculture 2020. Tamil Nadu Agricultural University, Coimbatore. 137.

Mir, M. R., M. Mobin, N. A. Khan, M. A. Bhat, N. A. Lone, K. A. Bhat, S. M. Razvi, S. A. Wani, Nowsheeba Wani, and Sabina Akhter. 2010. "Crop responses to interaction between plant growth regulators and nutrients. *Journal of Phytology.*, 2 (10).

Studies on the Effect of Organic and Inorganic Sources on the Dry Matter and Plant Nutrient Content of Cowpea in Sodic Soil

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Keywords: *Biochar, Marine Gypsum, Rhizobium, PGPR, Cowpea*

Introduction

Legumes such as Cowpea (*Vigna unguiculata* L.) has been known long for its unique ability to enrich the soil through biological nitrogen fixing system in symbiotic association with rhizobial strains. Cowpea is medium sensitive to sodicity. It is known as wonder crop and has smothering effect. Sodicity is important abiotic stress that adversely affects the growth and productivity of plants, also degrades the soil productivity in arable croplands worldwide. To reclaim these soils, gypsum is the most commonly used as a source of calcium to replace the exchangeable sodium, to reduce alkalinity and improve soil permeability Murtaza *et al*. 2009.

Methodology

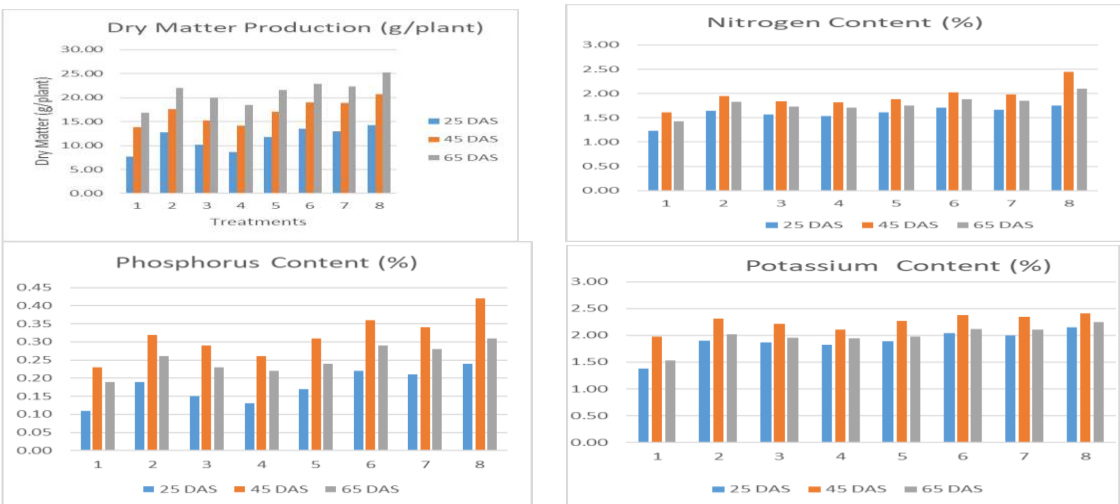
Field experiment was conducted at Anbil Dharmalingam Agricultural College and Research Institute, Trichy during summer, 2021. Cowpea variety Co (CP) 7 was taken as test plant with spacing 40x15cm. The experiment was conducted in Randomized Block Design and the treatments were: T1 (Control), T2 (50% Gypsum Reclamation GR), T3 (Biochar), T4 (PGPR), T5 (Biochar + PGPR), T6 (GR + Biochar), T7 (GR + PGPR) and T8 (GR + Biochar + PGPR). Blanket recommendation of 25 kg N + 50 kg P2O5 + 25 kg K2O applied as basal. Regular crop management practices are followed as per TNAU crop production guide. 5 plants were selected from each plot for recording dry matter production. For estimation of nutrient content, the samples were ground to fine powder in wiley mill.

Results and Discussion

Experimental results shown that T8 resulted in significantly higher dry matter production at 25, 45 and 65 DAS in cowpea. Similar results were reported by Meena et al., 2016 for increase in dry matter production by combined application of Biochar, FYM and PGPR in mungbean. Similarly, higher NPK content at 25, 45 and 65 DAS was found in T8 treatment compared to control. Similar studies were reported by Singh et al., 2016 for increase of NPK content in rice by combined application of biochar along with PGPR.

Table 1: Effect of organic and inorganic sources on the dry matter and plant nutrient content of cowpea under sodic soil (Pepper) `

Treatments	DMP (g/plant)			Plant Nutrient Content (%)								
				Nitrogen			Phosphorus			Potassium		
	25 D.A.S	45 D.A.S	65 D.A.S	25 D.A.S	45 D.A.S	65 D.A.S	25 D.A.S	45 D.A.S	65 D.A.S	25 D.A.S	45 D.A.S	65 D.A.S
T1 - Control	7.65	13.82	16.85	1.23	1.61	1.43	0.11	0.23	0.19	1.38	1.98	1.53
T2 - 50 % Gypsum	12.72	17.63	22.00	1.64	1.95	1.83	0.19	0.32	0.26	1.90	2.31	2.02
T3 - Biochar	10.20	15.20	20.00	1.57	1.84	1.73	0.15	0.29	0.23	1.87	2.21	1.96
T4 - Rhizobium + Pgpr	8.67	14.09	18.42	1.54	1.82	1.71	0.13	0.26	0.22	1.82	2.11	1.94
T5 - Biochar + Rhizobium + Pgpr	11.80	17.00	21.60	1.61	1.88	1.76	0.17	0.31	0.24	1.89	2.27	1.98
T6 - 50 %Gypsum + Biochar	13.50	19.00	22.80	1.71	2.02	1.88	0.22	0.36	0.29	2.04	2.38	2.12
T7 - 50 % Gypsum + Rhizobium + Pgpr	13.00	18.90	22.30	1.67	1.98	1.85	0.21	0.34	0.28	2.00	2.35	2.11
T8 - 50 %Gypsum + Biochar + Rhizobium + Pgpr	14.20	20.70	25.20	1.75	2.45	2.10	0.24	0.42	0.31	2.15	2.41	2.25
CD (0.05)	0.49	0.61	0.79	0.05	0.09	0.07	0.02	0.04	0.02	0.07	0.11	0.08



Figures showing the Dry matter production and Nutrient content (%) in T1 to T8.

Reference

Meena, S.S., Yadav, J., Singhal, D.K., Jat, L.K. and Meena, R.K., 2016. The assessment of rice husk biochar, carpet waste, FYM and PGPR on growth and yield of Mungbean (Vigna radiata L.). *Journal of Pure and Applied Microbiology*, 10(3): 2427-2431.

Murtaza, G., Ghafoor, A., Kahlon, U.Z., Bhatti, A.S. and Sabir, M., 2009. Evaluation of rice and wheat cultivars for tolerance to salinity and sodicity in soil. *Communications in soil science and plant analysis*, 40(7-8), pp.1268-1281.

Singh, A., Singh, A.P., Singh, S.K., Rai, S. and Kumar, D., 2016. Impact of addition of biochar along with PGPR on rice yield, availability of nutrients and their uptake in alluvial soil. *J Pure Appl Microbiol*, 10(3): 2181-8.

Trend Analysis of Rice Production Performance in India

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Keywords: *Trend analysis, NFSM impact, Compound Growth Rate, Structural break*

Introduction

Rice is the most important staple and primary food for the world, directly feeding nearly half of world's population. It helps in reduction of poverty and hunger to achieve the Millennium Development Goal. During 2004, International year of Rice was announced mainly focusing on one crop (rice) which was the first time in the history of international year concentrated on a particular crop. Among India gross cropped area of about 199 million hectares, more than 21 per cent of the area is under rice. NFSM started in 2007 and presently under implementation in 482 Districts of 19 States of the country with a view to enhance the production of Rice, Wheat and Pulses, among that rice had major attention. NFSM had a major role in enhancing the major crops production performance through area expansion and productivity enhancement; restoring soil fertility and productivity; creating employment opportunities; and enhancing farm level economy to restore confidence of farmers. It is necessary to know the trend in rice production to learn about whether increasing or decreasing growth and it helps the policy makers to come out with new strategies to promote and export our rice production to meet up the food requirements for geometrically increasing population.

Methodology

The objective of this paper is to identify the implication of post-NFSM period along with previous phases in growth pattern by analysing the growth trend of rice production performance using Compound Growth Rate (CGR) model. This paper analyses 50 years of data (1966-67 to 2017-18) on area, production and yield under paddy helps us to understand the question of implication of National Food Security Mission (NFSM) rice on the production performance rice before and after the implementation of the programme in India along with previous growth pattern. Based on the structural break observed the time period is divided into 3 phases namely I. Green revolution period (1966-67 to 1990-91), II. Post Economic reform period (1991-92 to 2006-07), III. Post NFSM period (2007-08 to 2017-18). Government of India invested Rs 163105 Cr for agricultural and allied activities in eleventh five-year plan to boost up the economy. Based on the production share of 2018-19 crop report, the selected states (West Bengal, Uttar Pradesh, Punjab, Andhra Pradesh, Orissa, Bihar, Tamil Nadu, Assam, Haryana, Madhya Pradesh, Karnataka, Maharashtra and other states) accounted with major share of 96.00 per cent of rice production to the India production, the remaining states with minor share were put together as others holding only 4 per cent share to the India production.

Results and Discussion

Based on the estimated CGR value (Figure 1), NFSM implementation has not shown much increase in area under rice due to the change in cropping pattern, increasing demand for agricultural land for industrialization, urbanization, housing and infrastructure, which is forcing conversion of agricultural land to non – agricultural uses. But there has been a significant increase in production which made our nation as a self-sufficient to meet the demand and became a significant potential exporter of rice to other nations. Even though the yield of rice was increasing over a period of time, still the yield is low when compared to the major rice producing countries namely Thailand and China. Research efforts are needed to strengthen the crop breading programs using new efficient technologies. Further, developing and establishing the bio-technology programs should be intensified to develop high yield varieties of the crops suitable to agro-climate conditions of the regions.

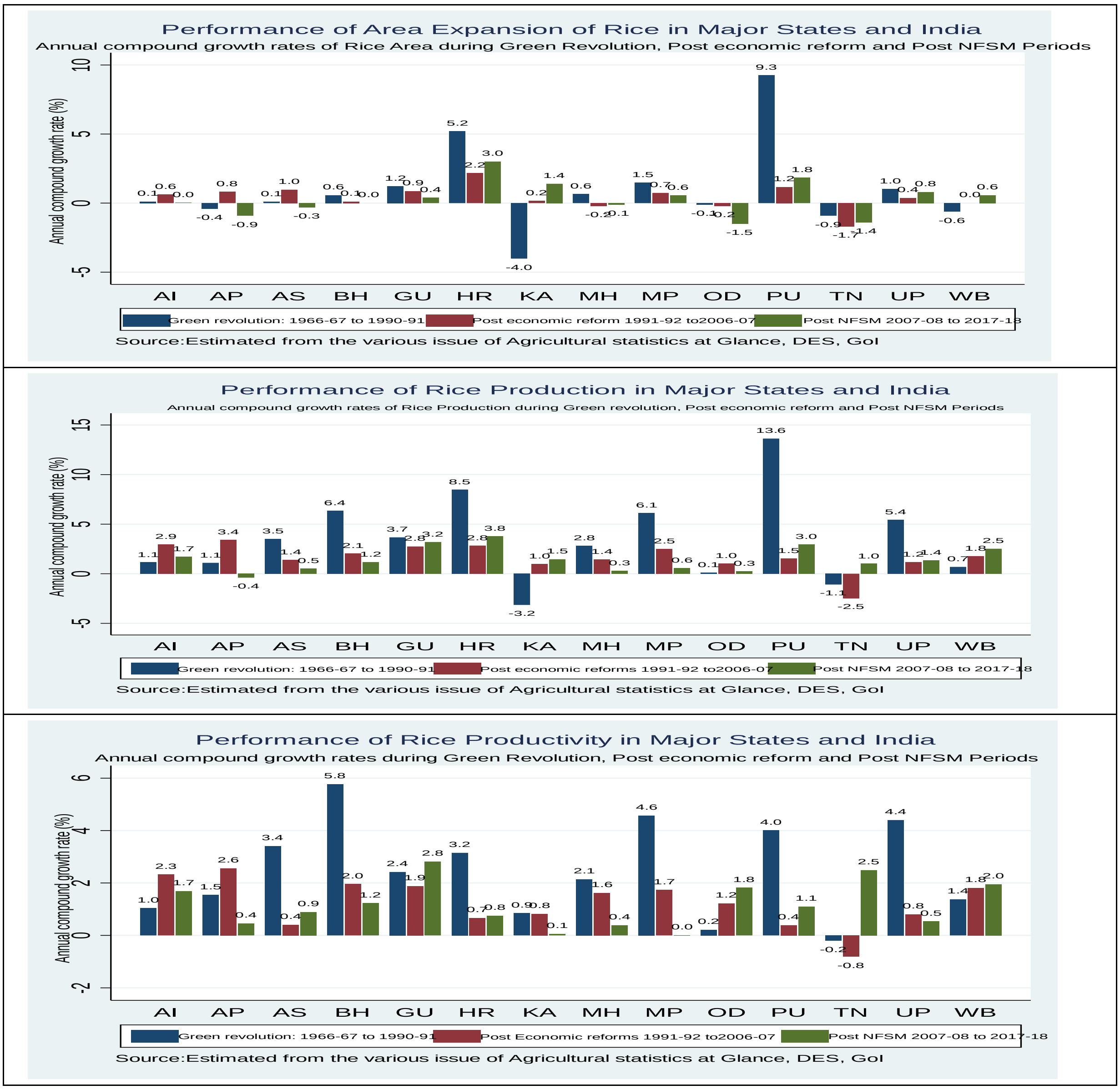

Figure 1. Compound Growth Rate (per cent) of area, production and yield in rice with three periods compared from (1966-67 to 2017-18) in India.

Reference

Jain, A., 2018. Analysis of growth and instability in area, production, yield and price of rice in India. *Social Change and Development*, *15*(2), pp.46-66.

Thanh, N.C. and Singh, B., 2006. Trend in rice production and export in Vietnam. *Omonrice*, *14*, pp.111-123.

Yield Gap Analysis of Chickpea in Major Producing States in India

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Keywords: *Yield gap, Productivity, Potential yield, Demonstration yield, Farmer yield*

Introduction

Chickpea (Gram) is the most dominant pulse crop which is having a share of around 49.3 percentage in total pulse production (25.58 million tonnes (mt)) during the year 2020-2021. It also ensures nutritional security to the largely vegetarian population of the country. Several programs were initiated by the Government to boost up the production and productivity of pulses such as National Food Security Mission (NFSM) - Pulses, Technology Mission on Oilseeds and Pulses (TMOP) and Integrated Scheme of Oilseeds, Pulses, Oil Palm and Maize (ISOPOM). Thus increasing the productivity of chickpea can also be achieved by reducing the yield gap. This paper trace the impact of NFSM on chickpea production by major producers in the country.

Methodology

The objective of the present study is to analyse the performance of its growth before and after implementation of NFSM and to estimate the yield gap in major producing states of India. The actual average yields of the farmers' field were collected from the annual reports from Department of Economics and Statistics, Ministry of Agriculture. The potential yield and field demonstration yield were collected from published report of All India Coordinated Research Projects (AICRP). The data on area, production and productivity of chickpea were collected for the year 1966-1967 to 2016-2017. Yield Gap I is defined as the gap between potential yield (YP) of a variety and the yield in the demonstration field (Ydf). Yield Gap I (YG I) = (Yp – Ydf) /Yp × 100%. Similarly, Yield gap II is the difference between the yield of variety in the demonstration field (Ydf) and at farmers' field (Yff), Yield Gap II (YG II) = (Ydf – Yff)/ Yp × 100%.

Results and Discussion

The results indicate that India is losing its The state wise chickpea area and production analysis revealed that the area and production of chickpea was increased in Karnataka followed by Maharashtra and Rajasthan after the implementation of NFSM. But it had negative impact on Uttar Pradesh in both area and production. Similarly, the productivity of Chick pea is more in Rajasthan and Madhya Pradesh and had negative impact in Andhra Pradesh. The state which was higher in area and production had less productivity. It was observed from the yield gap analysis that the yield gap ranged from 13.14% (Rajasthan) to 25.82% (Madhya Pradesh) in major producing states of Chickpea and 10.82 % (Jammu Kashmir) to 15.52% (Jharkhand) in minor producing states of Chickpea. Similarly, the yield gap I was 24.07% (Andhra Pradesh), 21.86% (Madhya Pradesh), 30.67% (Maharashtra) and 5.67% (Rajasthan). (Table.1). The study result confirmed the further scope to increase the chickpea productivity by reducing the existing yield gap.

Table 1: Yield gap I and Yield gap II of chickpea in major and minor producing states of India

States	Yield gap 1 (%)	Yield gap II (%)
Andhra Pradesh	24.07	20.62
Madhya Pradesh	21.86	25.82
Maharashtra	3.67	14.74
Rajasthan	5.61	13.14
Chhattisgarh	44.02	14.95
Jammu Kashmir	52.32	10.82
Jharkhand	43.04	15.52

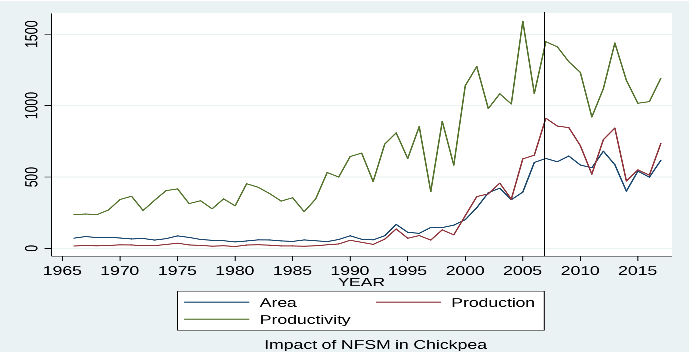

Fig. 1 Impact of NFSM on area, production and productivity of Chickpea

Reference

Kumar et al., (2015) "Yield gap analysis of Major Pulses in India", *Journal of the Institute of Agriculture and Animal Science*, 33-34: 213-219.

Michiel et al., (2017), "Disentangling agronomic and economic yield gaps: An integrated framework and application", *Agricultural Systems*. (154), 90-99.

Genetic Variability in F_2 Segregating population in Brinjal (*Solanum melongena* L.)

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Keywords: *Variability, F2 Segregating Population and Brinjal*

Introduction

Brinjal or eggplant (*Solanum melongena* L.) is an important solanaceous crop of sub-tropics and tropics. The low yield levels in India are due to the lack of sufficient crop genetic improvement. Greater the variability present in the initial material better should be the chances for evolving desired types. A clear understanding of variability of various quantitative characters of the breeding materials is an asset to the plant breeder for selecting superior genotypes on the basis of their phenotypic expression.

Methodology

The experiment was carried out at the College Orchard, Department of Vegetable Crops, HC & RI, TNAU, Cbe. Totally 250 F_2 brinjal plants derived from the cross Sevathampatti local x Seetipulam local were evaluated for high yield and yield contributing characters during the year 2018 – 2019. Genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability in broad sense (h^2) and genetic advance (GA) and genetic advance as percentage over mean were illustrated by Singh and Chaudhary (1997).

Results and Discussion

Variability plays an important role in crop breeding material ensures the better chance of producing desirable crop plant. The results of range, mean, GCV, PCV, heritability (h^2), GA % in F2 population of cross Sevathampatti local x Seetipulam local are shown in the **table 1**. Results showed that the genotypic coefficient of variation was observed highest for shoot infestation (56.39%), followed by number of branches per plant (22.73%) and plant height (20.93%), while moderate GCV was recorded in number of fruits per plant (19.18%) and yield per plant (17.42%). The highest phenotypic coefficient of variation was recorded for shoot infestation (57.24%), followed by number of branches per plant (23.42%) and yield per plant (22.32%), while moderate GCV was recorded in number of fruits per plant (19.65%) and fruit infestation (10.95%) Higher GCV and PCV were recorded for characters like shoot infestation followed by number of branches per plant indicating higher magnitude of variability for these characters. These findings were similar to Lokesh *et al.* (2013b) and Mili *et al.* (2014).

Highest value of heritability was noticed in plant height (98.36%), followed by shoot infestation (97.06%), number of fruits per plant (95.34%), number of branches per plant (94.19%) and fruit infestation (70.57%). The results confirmed the involvement of additive gene action in these traits with less environment influence. Lowest value of heritability was recorded by fruit girth (23.19%).

Genetic advance as percent of mean was highest in shoot infestation (114.45%), followed by number of branches per plant (45.44%), plant height (42.76%) and number of fruits per plant (38.58%). High estimates of heritability with high genetic advance as percent over mean were recorded for shoot infestation followed by number of branches per plant, number of fruits per plant and plant height. These findings are similar to Mili *et al.* (2014). It might be assigned to be under the control of additive genes and phenotypic selection for their improvement could be achieved by simple breeding methods.

In respect of fruit yield, which is the most important character in an improvement programme, high heritability coupled with high genetic advance was recorded. It indicates the chances for wide range for selection in F_2 population of the cross Sevathampatti local x Seetipulam local and the yield per plant was positively and significantly correlated with plant height, number of branches per plant, individual fruit weight and number of fruits per plant. Hence, these traits can further be exploited by direct selection for genetic improvement in brinjal to bring about the improvement in yield.

Table 1. Mean, Range and genetic parameters in F_2 population of the brinjal hybrid

Characters	Mean	Range		PCV	GCV	h^2	GA as %mean
		Minimum	Maximum				
Plant height	88.91	56.17	146.9	21.10	20.93	98.36	42.76
Days to first flowering	48.01	38.00	56.00	6.93	4.62	44.48	6.35
No. of branches per plant	8.12	4.00	14.00	23.42	22.73	94.19	45.44
No. of fruits per plant	42.94	23.00	73.00	19.65	19.18	95.34	38.58
Fruit length	7.01	4.92	8.86	12.03	8.57	50.80	12.59
Fruit girth	12.68	10.10	15.28	6.55	3.16	23.19	3.13
Single fruit weight	50.31	36.00	59.46	8.02	5.58	48.40	8.00
Shoot infestation	14.90	5.94	52.37	57.24	56.39	97.06	114.45
Fruit infestation	20.00	15.93	25.38	10.95	9.20	70.57	15.91
Yield per plant	2.15	0.67	3.43	22.32	17.42	60.92	28.02

Reference

Johnson, Herbert W, HF Robinson, and R Ev Comstock. 1955. "Genotypic and phenotypic correlations in soybeans and their implications in selection 1." *Agronomy Journal* 47 (10):477-483.

Lokesh, Balaji, P Suryanarayana Reddy, RVSK Reddy, and N Sivaraj. 2013b. "Research Note Variability, heritability and genetic advance studies in Brinjal (*Solanum melongena* L.)." *Electronic Journal of Plant Breeding* 4 (1):1097-1100.

Mili, C, GC Bora, BJ Das, and SK Paul. 2014. "Studies on variability, heritability and genetic advance in *Solanum melongena* L.(Brinjal) genotypes." *Direct Research Journal of Agricultural and Food Science* 2:192-194.

Singh, P.K. and R.D. Choudhary. 1977. Biometrical methods. In: Quantitative Genetic Analysis, Kalyani publishers, New Delhi. 178 -185.

Tiwari, Devesh, GC Yadav, Vipin Kumar Maurya, and Aman Kumar. 2019. "Correlation coefficient and path analysis for yield and its component traits in Brinjal (*Solanum melongena* L.)." *Journal of Pharmacognosy and Phytochemistry* 8 (1):291-294.

Studies on Distribution Pattern of Yield Attributing Traits in Segregating Generation of Red Sorghum (*Sorghum bicolor* (L.) Moench)

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Keywords: *3-deoxyanthocyanin, Food colorant, Nutritious cereal, descriptive statistics*

Introduction

Sorghum is a pre-eminent crop grown for its variegated uses like food, feed, and fuel. It's serving as the staple food for the majority of the arid and semi-arid tropics of the world. Its also said to be the 'nutritious grain' for its well-occupied nutritional profile (Aruna *et al.*, 2020). Cereals are gluten-rich compounds with higher consumption results in celiac disease (CD), it was reported 1 in every 300 individuals worldwide (Gujral *et al.*, 2004). So, sorghum is a perfect substitute for wheat as it was free from gluten. It's also a good supplement of feed for poultry and cattle can substitute soybean and maize. Retracing the sorghum pathways back to the food system eliminates many modern chronic diseases. The present study was conducted to predict the basic genetics and idea of the breeding material to provide effective selection during further generations.

Methodology

The genetic material comprises of the seeds developed from the selfing of F_1 evolved from the cross Paiyur 2 (variety released from RRS, Paiyur) X Kottathur local 5 (local collection from Trichy district) during the *summer*, 2020. The selfed seeds were space planted i.e., F_2, and evaluated for nine quantitative characters at Breeding experimental farm (09˚ 96′ 75.04″ North latitude and 78˚ 20′ 71.66″ East longitude), Agriculture College and Research Institute, Tamil Nadu Agriculture University, Madurai during *Kharif*, 2020. A total of 250 plants were evaluated and recorded data at appropriate stages of plant growth. The nine quantitative characters i.e., days to fifty percent flowering (DFF), days to maturity (DM), Plant height (PH), Number of leaves (NL), leaf length (LL), leaf width (LW), stem diameter (SD), test weight (TW), single plant yield (SPY). Descriptive statistics were carried out by using the TNAUSTAT tool. Skewness and Kurtosis were calculated adopting the frequency distribution (Kapur, 1980) of the characters above mentioned. While the kurtosis was splitted into leptokurtic when the coefficient was greater than 3 and platykurtic when the coefficient was less than 3 (Robson, 1956).

Results and Discussion

The nature of genetic control and the number of genes underlying the particular character in F_2 population of red sorghum were framed in Table 1. The traits such as plant height (PH), leaf width (LW), and stem diameter (SD) are significant and negatively skewed with platykurtic ($k<3$). This reveals that the traits were controlled by a large number of genes with duplicate gene action. While the traits namely number of leaves (NL) and leaf length (LL) were shown significantly negative skewness with leptokurtic ($k>3$) it indicates that the characters were controlled by fewer dominant genes with duplicate genes interaction. Vemanna *et al.* (2013) reported similar results for plant height and stem diameter and dissimilar for remaining traits. These characters can be improved through mild selection to achieve faster gain for these traits (Roy, 2000). The characters like days to fifty percent flowering (DFF), days to maturity (DM), and test weight (TW) was shown non-significant coefficients for skewness and kurtosis which deliberates that there is no gene interaction involved and they follow the normal distribution. The trait single plant yield (SPY) shown significantly positive skewness which reveals that the trait was under the complementary gene action and can be improved through intense selection (Roy, 2000). Similar, results were obtained by Jayachandran *et al.* (2010) in the mutant population of the sorghum. The further conclusion for improvement of the yield that the majority of the traits shown the negative skewness with kurtosis the population improvement can be achieved through mild to intense selection.

Table 1: Estimates of descriptive statistics and coefficients of skewness and kurtosis in F2 generation of cross PYR 2 X Kottathur local 5

Character	Mean	Sd	Variance	Skewness	Kurtosis	Kurtosis type	CV%	S.E
DFF	62.73	6.15	37.86	-0.31	0.06	P	9.81	0.42
DM	105.37	6.88	47.34	-0.14	-0.46	P	6.53	0.47
PH	225.10	45.74	2092.49	-0.90*	2.55*	P	20.32	3.13
NL	10.81	0.77	0.59	-4.71*	26.10*	L	7.13	0.05
LL	61.82	7.25	52.55	-3.99*	27.77*	L	11.73	0.50
LW	7.08	0.53	0.28	-0.64*	1.09*	P	7.53	0.04
SD	2.02	0.28	0.08	-0.35*	0.66*	P	14.03	0.02
TW	19.84	0.28	18.91	-0.19	-0.59	P	21.92	0.30
SPY	17.06	7.58	57.42	0.59*	0.07	P	44.42	0.52

Reference

Aruna, C. R., Ratnavathi, C. V., Suguna, M., Ranga, B., Praveen Kumar, P., Annapurna, A., and Toapi, V. A. (2020). Genetic variability and GxE interactions for total polyphenol content and antioxidant activity in white and red sorghums (*Sorghum bicolor*). *Plant Breeding*, *139*(1), 119-130.

Gujral, H.S.; Haros, M.; and Rosell, C.M. (2004). Improving the texture and delaying staling in rice flour chapati with hydrocolloids and [alpha]-amylase. Journal of Food Engineering 2004, 65 (1), 89–94.

Jayaramachandran, M., Kumaravadivel, N., Eapen, S., & Kandasamy, G. (2010). Gene action for yield attributing characters in segregating generation (M2) of sorghum (*Sorghum bicolor* L.). *Electronic Journal of Plant Breeding*, *1*(4), 802-805.

Kapur S K. 1980. Elements of practical statistics. Oxford and IBH Publishing Co., New Delhi. pp 148-154.

Kimbeng, C. A., & Bingham, E. T. (1998). Population improvement in lucerne (*Medicago sativa* L.): components of inbreeding depression are different in original and improved populations. *Australian journal of experimental agriculture*, *38*(8), 831-836.

Robson, D. S. (1956). Applications of the k 4 Statistic to Genetic Variance Component Analyses. *Biometrics*, *12*(4), 433-444.

Roy, D. (2000). *Plant breeding: Analysis and exploitation of variation*. Alpha Science Int'l Ltd. New Delhi, India, p. 300-304.

Response of Small Onion to Fertigation of TNAU Water Soluble Fertilizers (TNAU-WSF)

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Keywords: *Nutrient uptake, Small Onion, TNAU-WSF*

Introduction

In Tamil Nadu Agricultural University, Coimbatore, at the Department of Soil Science & Agricultural Chemistry, Water Soluble Fertilizers (WSF) @ 19:19:19 % of N, P, K is produced. It is attempted to assess the efficacy of TNAU-WSF on varieties of agricultural and horticultural crops. In the present study, the influence of TNAU-WSF on small onion is taken up. India is the second largest producer of onion next to China. The productivity of onion in India is 18.10 tha^{-1} which is low compared to world average. In the present study TNAU-WSF is used to validate the response on fertigation schedule to increase the growth, yield and Quality of small onion *(Allium cepa var. aggregatum).*

Methodology

A field experiment was conducted at farmer's field with aggregatum onion var. CO4 in a Randomized Block Design with eight treatments replicated thrice. The soil of the experimental site was sandy loam with pH of 7.18, EC of 0.05 dSm^{-1}, medium in organic carbon (5.3g kg^{-1}), low in available nitrogen (155kg ha^{-1}), high in available phosphorus (39 kg ha^{-1}), medium in available potassium (210 kg ha^{-1}), moderate in available sulphur (14ppm). Treatment details: T_1: Recommended dose of fertilizer @ 100% as TNAU-WSF and T_2, T_3, T_4 were Soil Test Based Application of TNAU-WSF @ 75%, 100%, 125% NPK, respectively. T_5, T_6, T_7 were T_2 + Sulphur (S) @ 40 kg ha^{-1} + Foliar Spray (FS) of TNAU Liquid Multi Micronutrient (LMM) @ 1%, T_3 + S @ 40 kg ha^{-1} + FS of TNAU LMM @ 1%, T_4 + S @ 40 kg ha^{-1} + FS of TNAU LMM @ 1%, respectively. TNAU-WSF was applied through fertigation. The small onion was harvested at full maturity stage and samples were taken for analysis of total (bulb + leaf) N, P, K and estimated through Kjeldahl method, vanadomolybdate yellow colour method (Jackson 1973), flame photometer, respectively. The data were statistically analyzed with AGRES software.

Results and Discussion

Total N uptake at harvest stage ranged from 21.5 to 62.9 kg ha^{-1}. Maximum N uptake was recorded with T_7: Soil Test based application of 125% NPK as TNAU-WSF with S + TNAU LMM@1% (62.9 kg ha^{-1}) (FS) which was on par with 125% NPK as TNAU-WSF (60.5 kg ha^{-1}) (T_4). Minimum N uptake was recorded in the absolute control plot (21.5 kg ha^{-1}) (T_8). The uptake was high due to high N availability to plants. The enhanced uptake may be due to synergistic effect between N and S. Singh *et al.*, (1995) and Nasreen *et al.*, (2007) observed similar results.

Total P uptake ranged from 5.2 kg ha^{-1} to 15.5 kg ha^{-1}. Application of Soil Test based application of 125% NPK as TNAU-WSF with Sulphur + TNAU LMM@1% (FS) (T_7) recorded maximum total P uptake of 15.5 kg ha^{-1} and was on par with application of 125% NPK (13.5 kg ha^{-1}) (T_4). Minimum uptake was recorded in absolute control (5.2 kg ha^{-1}) (T_8). The increase in P uptake was due to higher bulb production and high P availability. Singh and Singh (2003) reported the similar findings. Total K uptake ranged from 26.1 kg ha^{-1} to 69.8 kg ha^{-1}. Total S uptake ranged from 8.32 kg ha^{-1} to 16.5 kg ha^{-1}. Maximum K and S uptake was recorded in Soil Test based application of 125% NPK with Sulphur + TNAU LMM@1% (FS) (T_7) which was on par with (T_4) 125% NPK and minimum in absolute control plot (26.1 kg ha^{-1}) (T_8). Sawale *et al.*, (2018) observed that application of 100 kg ha^{-1} recorded high K uptake (97.68 kg ha^{-1}).

Agronomic Nutrient Use Efficiency of N, P and K was calculated and tabulated. Soil Test based application of 125% NPK as TNAU-WSF with S @40 kg ha^{-1} + TNAU LMM@1% (FS) (T_7) recorded maximum Nitrogen use efficiency (60.3 kg kg^{-1}), Phosphorus use efficiency (165.2 kg kg^{-1}), Potassium use efficiency (111.7 kg kg^{-1}).

Table 1. Total Uptake and Nutrient use efficiency (NUE) of N, P, K, S

Trt. No.	Treatment Details	Total Uptake (kg ha^{-1})				NUE (kg of bulb kg^{-1} of nutrient)		
		N	P	K	S	N	P	K
T_1	RDF @100% NPK as TNAU-WSF*	36.5	9.8	46.9	8.8	48.3	48.3	96.6
T_2	Soil Test based application of 75% NPK as TNAU-WSF	41.5	11.1	53.4	9.9	50.8	137.8	94.1
T_3	Soil Test based application of 100% NPK as TNAU-WSF	51	12.8	60.2	11.5	54.7	149.4	102.4
T_4	Soil Test based application of 125% NPK as TNAU-WSF	60.5	14.9	66.4	12.8	57.2	156.7	106.0
T_5	Soil Test based application of 75% NPK as TNAU-WSF + S @40 kg ha^{-1} + TNAU LMM @1% (FS)	45.3	11.8	55.2	15.1	53.5	145.3	99.2
T_6	Soil Test based application of 100% NPK as TNAU-WSF + S @40 kg ha^{-1} + TNAU LMM @1% (FS)	53.7	13.5	63.4	16.0	56.5	154.3	105.7
T_7	Soil Test based application of 125% NPK as TNAU-WSF + S @40 kg ha^{-1} + TNAU LMM@1% (FS)	62.9	15.5	69.8	16.5	60.3	165.2	111.7
T_8	Absolute Control	21.5	5.2	26.1	8.32	-	-	-
	CD (5%)	4.17	1.06	5.0	1.33	-		
	S.Ed	1.94	0.49	2.33	0.62			

*RDF; 60:60:30 kg $N:P_2O_5:K_2O$ ha^{-1} S – Sulphur, LMM – Liquid Multi Micronutrient

Reference

Sawale, D.D. B.D. Tamboli, Vedshree Patil, A.B. Jadhav, A.L. Pharande and S.K. Bansal.2018. Effect of sources, levels and methods of potash fertilization on yield, nutrient uptake, soil chemical properties and quality of rabi onion in an inceptisol. *Agropedology.*, 28(01): 22-30.

Nasreen, S., Haq, S.M.I., Hossain, M.A. and Farid, A.2007. Nutrient uptake and yield of onion as influenced by nitrogen and sulphur fertilization. *Bangaladesh J. Aric. Res.*, 32(3): 413-420.

Studies on Gene Action in Rice (*Oryza sativa* L.) under Coastal Saline Condition

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Keywords: *Genetic diversity, Gene action, combining ability*

Introduction

Rice is tolerant to most of the stresses, but under coastal salinity the productivity of rice is reduced. Hence, it is obvious to develop saline tolerant high yielding rice varieties. The combining ability analysis gives an indication of the variance due to GCA and SCA which represents a relative measure of additive and non-additive gene actions, respectively. Breeders use these variance components to measure the gene action and to assess the genetic potentialities of parent in hybrid combinations.

Methodology

Combining ability analysis was carried out with 10 parents which are the best genotypes selected from the genetic divergence study. The parents were crossed in a line x tester mating design and to provide a maximum of 21 cross combinations. Ten genotypes, based on genetic diversity analysis were selected as parents for hybridization programme. These parents were crossed in line x tester mating design out of which seven varieties were taken as lines (ADT 43, ASD 16, ADT 48, MTU 1010, IR 20, CO 51 and CO 49) and three well adopted varieties as testers (TRY 3, ADT 36 and CO 43).

Results and Discussion

Based on the *per se* performance of different traits of the parents, ADT 48, ADT 43, CO 51 and CO 49 among the lines and among the testers, ADT 36 and TRY 3 were found to be the best performers for grain yield and its component traits. The estimation of combining ability variances revealed that SCA was highly significant than the GCA, as observed the ratio of GCA/SCA for grain yield per panicle and its component traits indicated the preponderance of non-additive gene action. The hybrids namely, CO 49 x TRY 3, ADT 48 x TRY 3, CO 51 x ADT 36 and ADT 43 x TRY 3 were rated as superior crosses since they possessed high *per se* performance for most of the economic traits studied with earliness and short plant. Based on *sca* effects, the hybrids CO 49 x TRY 3 and ADT 48 x TRY 3 adjudged as the best since they were found to be highly significant for grain yield per plant and its component traits which indicated the predominance of non-additive gene action. The other two hybrids, CO 51 x ADT 36 and ADT 43 x TRY 3 were also recorded better performance. (Table 1).

Reference

Akter, A., M.J.Hasan, H. Begum, M.U. Kulsum and M.K. Hossain. 2010. Combining ability analysis in rice*(Oryza sativa L.)*. *Bangladesh J. Pl. Breed. Genet*., 23(2): 07-13.

AsadurRahaman Md. 2016. Study of nature and magnitude of gene action in hybrid rice (*Oryza sativa* L.) through experiment of line x tester mating design.*International Journal of Applied Research*, 2(2): 405-410.

Bineeta Devi and G. M. Lal 2015 Combining ability analysis for yield & yield components in rice (*Oryza sativa* L.) *Elec J. of Plant Breed*,6(2): 360-365.

Dadilakshmi and A. Upendra. 2014. Combining ability analysis for quality and nutritional fraits in rice. International Journal of farm Sciences 4(2): 15-23.

Gopikannan, M and S. K. Ganesh. 2013. Investigation on combining ability and heterosis for sodicity tolerance in rice (*Oryza sativa* L.) *African J. Agric. Res.*, 8(32): 4326-4333.

Table. 1 *SCA* effects for various characters in rice

Cross	Days to 50% flowering (days)	Plant height (cm)	Number of tillers per plant	Number of productive tillers per plant	Length of the panicle (cm)	Number of filled grains per panicle	Kernel Length (mm)	Kernel Breadth (mm)	Kernel L/B ratio	Hundred grain weight (g)	Grain yield per plant (g)
$L_1 \times T_1$	-2.23	-2.35	2.34	2.66	1.28	1.28	0.06	0.02	0.02	0.01	1.90
$L_1 \times T_2$	-3.49*	-10.80*	1.44	4.30*	3.15*	-0.71	0.14*	0.00	-0.00	0.04*	3.15*
$L_1 \times T_3$	5.72*	8.45*	-3.78*	-6.96*	-3.14*	-0.57	-0.20*	-0.03*	-0.05*	-0.04*	-5.06*
$L_2 \times T_1$	3.79*	6.39*	-3.71*	-0.27	0.44	-9.76*	-0.02*	-0.04*	-0.04*	0.07*	-2.77*
$L_2 \times T_2$	0.65	1.57	-2.98*	-4.92*	-2.03	-7.45*	0.08*	-0.01	0.05*	-0.09*	-2.22
$L_2 \times T_3$	4.44*	-7.95*	6.70*	5.19*	1.60	17.21*	0.12*	0.05*	-0.01	0.07*	4.98*
$L_3 \times T_1$	-4.07*	-15.35*	2.81*	3.07*	3.28*	5.45*	0.24*	0.05*	0.04*	0.06*	3.23*
$L_3 \times T_2$	4.36*	6.80*	-1.69	-2.27	-1.55	-1.82	0.00	-0.01	0.06*	-0.02	3.98*
$L_3 \times T_3$	-0.29	8.55*	-1.11	-0.80	-1.73	-3.63*	-0.24*	-0.04*	-0.06*	-0.04*	-3.65*
$L_4 \times T_1$	1.91	5.05*	-0.71	-2.56	-3.82*	-6.46*	-0.02	0.00	-0.01	-0.01	-2.67*
$L_4 \times T_2$	-0.34	6.60*	0.04	-2.61	-5.00*	-1.72	-0.37*	-0.06*	-0.10*	-0.10*	-1.27
$L_4 \times T_3$	-1.57	-11.65*	0.67	5.17*	8.82*	8.18*	0.39*	0.05*	0.11*	0.11*	3.94*
$L_5 \times T_1$	0.29	6.10*	-2.03	-2.34	-0.18	0.52	-0.26*	-0.04*	-0.07*	-0.12*	-0.83
$L_5 \times T_2$	1.05	-12.35*	-1.63	-2.38	-1.09	2.19	-0.24*	-0.03*	-0.07*	0.09*	0.00
$L_5 \times T_3$	-1.34	6.25*	3.65*	4.73*	-0.01	-2.72*	0.51*	0.08*	0.13*	0.03	0.83
$L_6 \times T_1$	0.89	8.46*	-0.93	-2.56	-0.59	5.50*	0.21*	0.05*	0.00	-0.00	-3.48*
$L_6 \times T_2$	-1.25	1.17	2.04	0.37	0.88	1.33	-0.02	-0.01	0.02	0.02	0.41
$L_6 \times T_3$	0.36	-4.98*	-1.85	-3.83*	-2.55	-13.69*	-0.19*	-0.05*	-0.03	-0.07*	-0.50
$L_7 \times T_1$	-3.10*	-9.78*	2.24*	6.39*	3.39*	5.31*	0.13*	0.03*	0.07*	0.04*	3.36*
$L_7 \times T_2$	-2.24	3.81*	2.77*	3.13*	3.14*	8.19*	0.26*	0.04*	0.02	-0.03*	-2.81*
$L_7 \times T_3$	5.34*	1.32	-4.28*	-3.50*	-4.27*	-6.64*	-0.39*	-0.06*	-0.10*	-0.01	-0.55

Sulphur Nutrition of Cabbage (*Brassica oleracea Var. capitata* L.) for Improving the Growth Attributes

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Keywords: *Sulphur, Hybrid Cabbage, Growth attributes*

Introduction

Sulphur is one of the essential element required for normal growth of plants and concentrations of S in plants are lesser than N and similar to P (Jamal et al., 2009). Sulphur fertilization is important to enhance the productivity and quality of cabbage (Bhat *et al*., 2017). Sandy soils of low organic matter present in upper- to mid-slope are prone to S deficiency having the symptoms of cupping of leaves and around the stem, chlorosis of young leaves with necrotic tips during vegetative stage of the crop. Cabbage (*Brassica oleracea var. capitata* L.) is one of the most important cole crop originated from Europe (NHB, 2018). India ranks second with 8,755,000 tonnes yearly production with an area of 388 lakh ha. This study was proposed to know the impact of sulphur nutrition on improving the growth attributes of cabbage.

Methodology

A field experiment was conducted on a sulphur deficient soil of the farmers field with Cabbage hybrid SAINT. Totally twenty treatment combinations were tested and replicated thrice in a factorial randomized block design using different sulphur sources *viz*., Elemental sulphur, Potassium sulphate, Gypsum and SSP with the levels of 0, 20, 40, 60, 80 kg S ha^{-1} respectively. Sulphur through different sources and levels as per treatment was applied as basal dose except elemental sulphur which was applied 15 days prior to transplanting of seedling. Growth attributes were measured at different stages *viz*.10, 30, 60, 90 days after planting and discussed below.

Results and Discussion

Cabbage growth attributes like canopy spread, leaf length and leaf breadth were recorded by adding different sulphur sources during different crop growth period of 10, 30, 60 & 90 DAT. The mean values of canopy spread, leaf length and leaf breadth by application of different sources and levels was shown in Table.1 and Figure.1 respectively.

The leaf length, leaf breadth and canopy spread ranged from 15.4 to 16.8 cm, 14.2 to 15.6 cm and 30.0 to 32.0 cm respectively. In all the measured growth attributes, the highest values were recorded in gypsum applied plot and the lowest were observed in elemental sulphur applied plot. Tandon (1989) found that sulphur in the sulphate form like gypsum is readily available to the plants than the elemental sulphur.

In case of levels, all the growth attributes increased with increase in levels of sulphur upto 60 kg ha^{-1}, after which there was a slight decline at 80 kg ha^{-1}. The lowest values of growth attributes were recorded in control when compared to sulphur applied plots. This might be attributed due to the fact that, sulphur involves in chlorophyll and protein synthesis in the plants and thereby increased the plant establishment and growth attributes. Similar results shows with the application of supplements through water dissolvable fertilizers at diverse crop stages makes a difference in dietary prerequisites which leads to better development in higher light interception and photosynthates translocation from source to sink for the upgraded growth attributes (Shinde *et al*., 2006).

The present investigation was conducted to know the effect of sulphur fertilization on growth attributes of cabbage. On comparing different sources of S, gypsum was found to be sulphur efficient fertilizer than SSP, potassium sulphate and elemental S. It was found that the application of sulphur level at 60 kg ha^{-1} of gypsum as a sulphur source showed an increased growth attributes like canopy spread, leaf length and leaf breadth of cabbage at different stages.

Table.1 Effect of sulphur sources on growth attributes of cabbage

Sources	Leaf length (cm)	Leaf breadth (cm)	Canopy spread (cm)
Elemental sulphur	15.4	14.2	30.0
Potassium sulphate	15.6	14.5	30.3
Gypsum	16.8	15.6	32.0
Super phosphate	16.0	14.9	31.1
Mean	15.9	14.8	30.9
SEd	**0.16**	**0.12**	**0.23**
CD (P=0.05)	**0.32**	**0.26**	**0.47**

* Mean of three replicates; SEd - Standard error of difference; CD - Critical difference

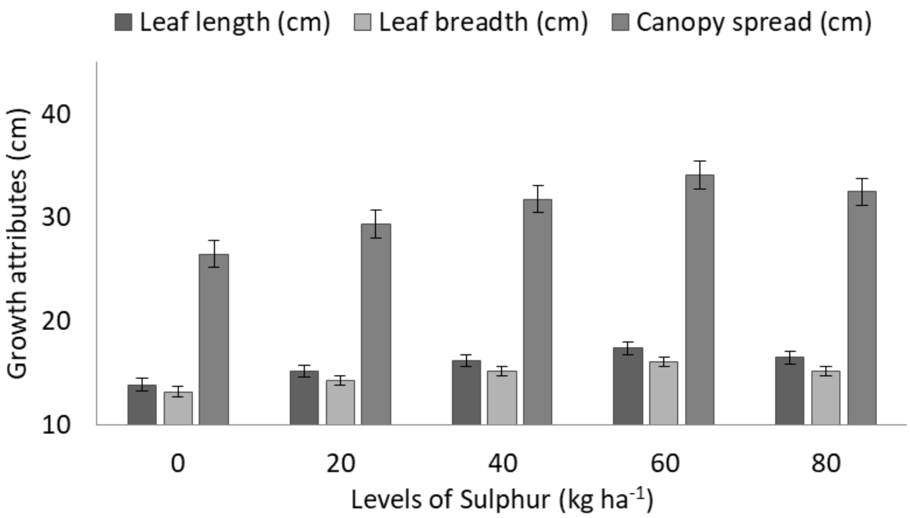

Figure 1 Effect of Sulphur levels on growth attributes of cabbage

Reference

Bhat, R., Shahid B. Dar and Zahida, R. 2017. Yield Performance and Economic Studies of Cabbage (Brassica oleracea var. capitata) as Influenced by Different Sources and Levels of Sulphur. *Int.J.Curr.Microbiol.App.Sci.* 6(10): 322-328.

Tetsopgang, S., & Fonyuy, F. (2019). Enhancing growth quality and yield of cabbage (Brassica oleracea) while increasing soil pH, chemicals and organic carbon with the application of fines from volcanic pyroclastic materials on a tropical soil in Wum, Northwest Cameroon, Africa. *Scientific African*, 6, e00199.

THEME 02

New Vistas in Resilient Farming: Trends and Challenges in Crop Management

Application of Remote Sensing and GIS to Capture Groundwater Potential Zone in Bhavani River Basin, Tamil Nadu

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Keywords: *Groundwater, potential zone, remote sensing and GIS, analytical hierarchical process*

Introduction

All living beings water is a most essential one. In India major part of the economy is governed by agriculture and water plays an important role in development (Saranya & Saravanan, 2020). The global renewable freshwater resource about 26 percent was groundwater contributes (FAO 2003). For human consumption, agriculture, industry, and many groundwater-dependent ecosystems, especially during droughts one of the major freshwater resources is groundwater (Rehman et al., 2019). Directly/indirectly different techniques are used to provide information about the groundwater potential occurrence. Earlier, the identification of groundwater potential zones (GWPZ) was carried out by ground surveys which were time-consuming and laborious (Saranya & Saravanan, 2020).

Methodology

The study of identification of groundwater potential zones of Bhavani River basin involves multi-technique approaches to find the appropriate zones. Remote sensing and conventional data sources played a significant role in groundwater management and planning. Combinations of satellite data and other collateral dataset were used to identify the problems of the regions based on the observation of thematic information. Thematic layers were incorporated into GIS environment for the purpose of performing different multicriteria analysis such as analytical hierarchical process (AHP). AHP method was used to generate the pairwise comparison matrix for the geosystem parameters and to examine the geometric mean and normalized weight of each parameter. Based on the multi- criteria decision analysis (MCDA), remote sensing and GIS served as a modern technique to approach the study of identifying groundwater potential zones for viable water resources planning and management.

Results and Discussion

The geographic information system forms an effective tool that enables us to derive results by spatial and visual interpretation. The tool is integrated with the analytical hierarchy process to obtain the ranks and weights for the parametric layers. Thus the application of this integrated tool was used to delineate the ground water potential zone for Bhvani river basin. The results obtained were grouped into five classes. Locations, such as Sathyamangalam, kavanadapadi, Mettupalayamr and few portions along the river course, were found to fall in very high potential category covering about 12.68% of the total area. Ooty, Coonoor, Anthiyur, Anaikatti have a high potential for groundwater covering about 49.82% of the total area. The moderate zones were about 28.79% of the area. Kovalam and Uthiramerur regions fall on low and very low category of the potential zone with an area covering very minimum of the total area. The geomorphology, drainage density, and rainfall were found to the predominant factors affecting the recharge in the study area. Artificial recharge techniques and participatory approach can be implemented in these regions with the moderate and low potentiality to increase the groundwater table and thereby preventing it from overexploitation.

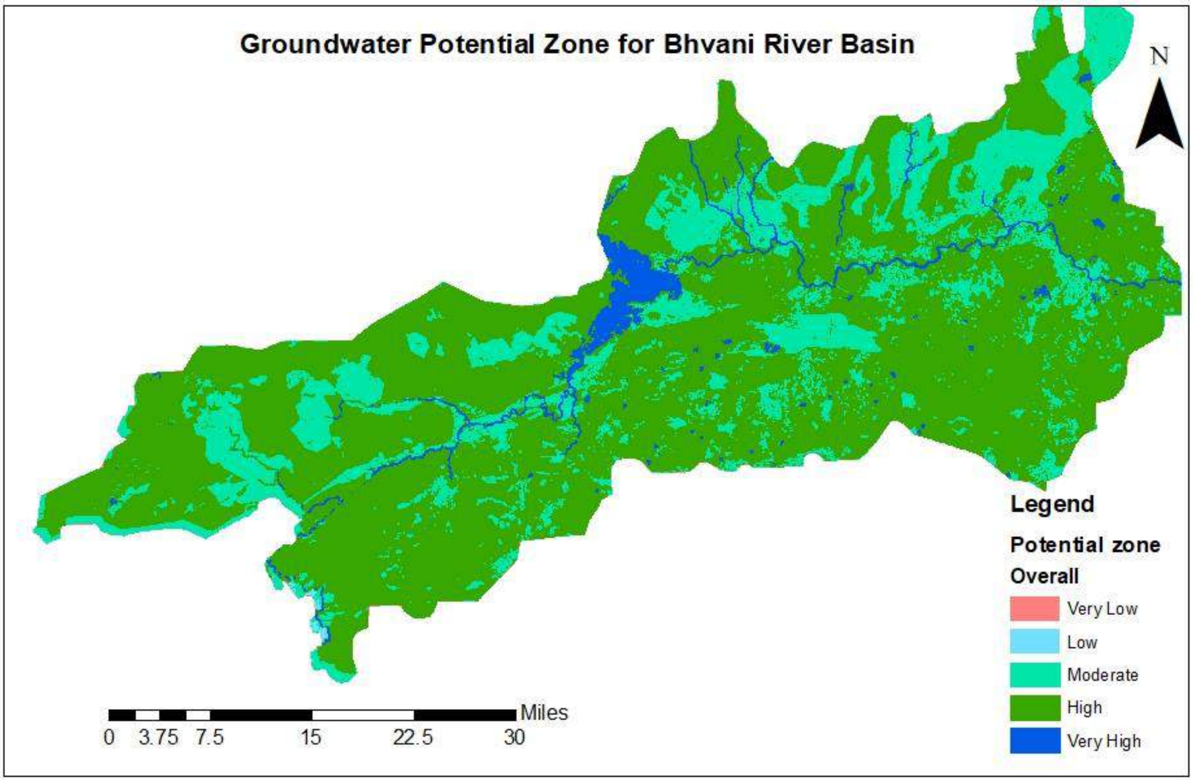

Fig. 1 Groundwater Potential Zone for Bhavani River Basin

Reference

Rehman, H. U., Ahmad, Z., Ashraf, A., & Ali, S. S. (2019). Predicting groundwater potential zones in Upper Thal Doab, Indus Basin through integrated use of RS and GIS techniques and groundwater flow modeling. *Arabian Journal of Geosciences*, *12*(20), 1–13. https://doi.org/10.1007/s12517-019-4783-4

Saranya, T., & Saravanan, S. (2020). Groundwater potential zone mapping using analytical hierarchy process (AHP) and GIS for Kancheepuram District, Tamilnadu, India. *Modeling Earth Systems and Environment*, *6*(2), 1105–1122. https://doi.org/10.1007/s40808-020-00744-7

Rehman, H. U., Ahmad, Z., Ashraf, A., & Ali, S. S. (2019). Predicting groundwater potential zones in Upper Thal Doab, Indus Basin through integrated use of RS and GIS techniques and groundwater flow modeling. *Arabian Journal of Geosciences*, *12*(20), 1–13. https://doi.org/10.1007/s12517-019-4783-4

Drought Assessment using Standardized Precipitation Index (SPI)

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Keywords: *Drought, Rainfall, SPI*

Introduction

Drought is a natural phenomenon that has significant impact on socio-economical, agricultural and environmental aspects. It is mostly related to the reduction for rainfall received over an extended period, such as a season or a year (Mishra and Singh, 2010). Drought affects both surface and groundwater resources and can lead to reduced water supply, crop failure, reduced range productivity, and diminished power generation, as well as affect economic and social activities (Manikandan *et al.*, 2015). The study was conducted with an objective to examine the drought using SPI.

Methodology

The study area is Mancadavu, which is located in Tiruppur district of Tamil Nadu at 10°40' 35" N latitude and 77°32'28" E longitude. The Standardized Precipitation Index (SPI) as a drought-monitoring tool was designed at Colorado State University, US to quantify the rainfall deficit on multiple time scales (McKee *et al.* 1993). The SPI is computed by fitting a probability density function to the frequency distribution of rainfall summed over the time scale of interest. This is performed separately for each month. Each probability density function is then transformed into the standardized normal distribution. A drought event occurs at the time when the value of SPI is continuously negative and the even ends when the SPI becomes positive (Edwards and McKee, 1997). Classifications of drought condition based on the SPI values are given in Table 1. The daily rainfall data was collected for over a period of 1971 to 2019 (48 years) from State Ground and Surface Water Resources Data Centre, Tharamani, Chennai. The daily rainfall data was then converted into monthly data and SPI was calculated.

Results and Discussion

Figure 1 shows the SPI for 12-month period of Mancadavu using the monthly rainfall record from 1971 to 2019. Based on the 48 years rainfall record in Mancadavu, more 77% (37 years) of the period were under the mild wet and mild drought condition. According to the SPI values, only 35% of the years comes under drought conditions which shows that the study does not experienced any serious drought situations. Figure 2 represents the probability of occurrence in percentage of different drought conditions.

From the results of the study, it could be understood that 65% of the years experienced wet situations. Therefore, there was less scope for occurrence of drought in the study area. Drought assessment is an intricate work and it is hard to analyze and predict it precisely.

Table 1. Classification of drought condition by SPI values (McKee *et al.* 1993)

SPI values	Classification
≥ 2.00	Extreme Wet (W4)
1.50 to 1.99	Severe Wet (W3)
1.00 to 1.49	Moderate Wet (W2)
0 to 0.99	Mild Wet (W1)

0 to -0.99	Mild Drought (D1)
-1.00 to -1.49	Moderate Drought (D2)
-1.50 to -1.99	Severe Drought (D3)
≤ -2.00	Extreme Drought (D4)

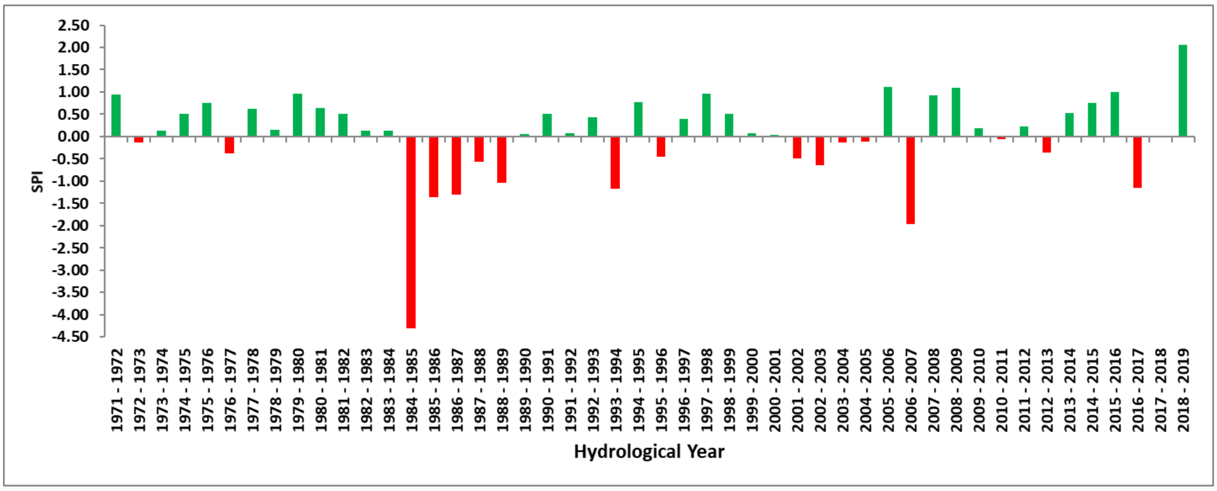

Figure 1. 12-month SPI values

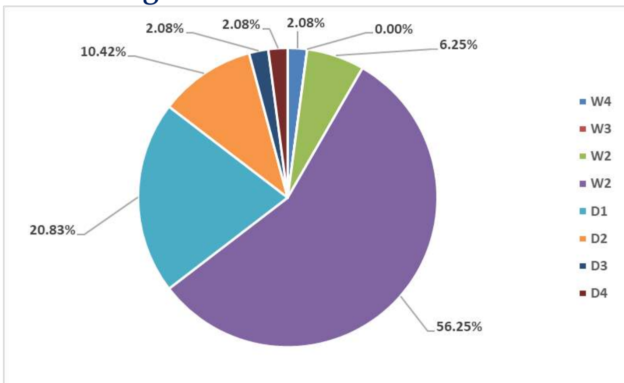

Figure 2. Probability of occurrence

Reference

Edwards, D.C. and T.B. McKee. 1997. Characteristics of 20th century drought in the United States at multiple scales, Atmospheric Science, Paper No. 634: 1-30.

Manikandan, M., D. Tamilmani, N. Anandaraj and G. Thiyagarajan. 2015. Evaluation of Meteorological Drought Parameters in the Parambikulam - Aliyar Basin, Tamil Nadu. ***Environment & Ecology,*** 33 (4): 1547-1552.

McKee, T.B., N.J. Doeskin and J. Kleist. 1993. The relationship of drought frequency and duration to time scales. **In:** proceedings of the 8th conference on applied climatology. Anaheim, CA, January 17–23, 1993. *American Meteorological Society, Boston,* pp 179–184.

Mishra, A.K. and V.P. Singh. 2010. A review of drought concepts. ***Journal of Hydrology,*** 391: 202—216.

Effect of Herbicide based Integrated Weed Management Practices on Irrigated Sesame (*Sesamum indicum* L.)

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Keywords: *Sesame, weed control, Pre-emergence, Early post-emergence*

Introduction

Sesame (*Sesamum indicum* L.) is the foremost conventional oilseed crop which cultivated in almost every tropical, subtropical, Asian and African nation (Iwo *et al.*, 2002). India ranks first in the sesame cultivation area (14.74 %) and second in production (12.78%). In India, 1.73 million ha area of sesame is grown with a production of 7.69 lakh tonnes per year and average productivity of sesame was 413 kg ha^{-1} (Anonymous, 2019). Weeds have competed for light, moisture and nutrients with crop. So, the field should be weed free during 2 to 6 weeks after sowing by using appropriate weed control method increased the seed yield in sesame up to 40% (Babiker *et al.*, 2014).

Methodology

The experiment was laid out in Randomized Complete Block design with eleven treatments and three replications. The treatments comprised of PE pendimethalin 30 EC @ 0.75 kg a.i.ha^{-1} + HW at 30 DAS, PE pendimethalin 38.7 CS @ 0.65 kg a.i. ha^{-1} + HW at 30 DAS, PE oxyfluorfen 23.5 EC @ 200 g a.i. ha^{-1} + HW at 30 DAS, EPoE quizalofop ethyl 5 EC @ 40 g a.i. ha^{-1} + HW at 40 DAS, EPoE imazethapyr 10 SL @ 75 g a.i. ha^{-1} + HW at 40 DAS, EPoE quizalofop ethyl 5 EC @ 40 g a.i. ha^{-1} + imazethapyr 10 SL @ 75 g a.i. ha^{-1}, EPoE imazythapyr 35 a.e. + imazamox 35 a.e. @ 30g a.i. ha^{-1}, EPoE quizalofop ethyl 5 EC @ 40 g a.i. ha^{-1} + imazethapyr 10 SL @ 75 g a.i. ha^{-1} + HW at 40 DAS, EPoE imazythapyr 35 a.e. + imazamox 35 a.e. @ 30 g a.i. ha^{-1} + HW at 40 DAS, Hand weeding at 20 and 40 DAS and Unweeded control. All the Pre-emergence herbicides were applied at 3 DAS, whereas early post-emergence at 14 DAS (3 leaf stage). Biometric observation of different weed parameters were documented at 30 DAS interval and seed yield also recorded.

Results and Discussion

Effect of weed management practices on total weed density (numbers m^{-2})

Hand weeding twice at 20 and 40 DAS recorded zero population of total weeds. It was narrowly followed by application of pendimethalin 30 EC @ 0.75 kg ha^{-1} as pre-emergence with one hand weeding at 30 DAS of total weed density m^{-2} (Table 1).

Effect of weed management practices on weed control efficiency (%) at 30 DAS

Hand weeding twice at 20 and 40 DAS registered 100% weed control efficiency. Successively, WCE of 94.7 % was obtained with application of pendimethalin 30% EC @ 75 kg a.i. kg ha^{-1} + one weeding (Figure 1).

Effect of weed management practices on seed yield

PE pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} + HW at 30 DAS recorded significantly higher seed yield which was on par with hand weeding twice at 20 and 40 DAS and PE application of pendimethalin 38.7 CS @ 0.65 kg a.i. ha^{-1} + HW at 30 DAS (Figure 2).

Table 1. Effect of weed management practices on total weed density (numbers m^{-2}) at 30, 60 DAS and harvest stage

Treatments	Total weed density (numbers m^{-2})		
	30 DAS	60 DAS	At harvest
T_1	3.06 (9)	3.21 (10)	3.38 (11)
T_2	6.26 (39)	4.51 (20)	5.69 (32)
T_3	6.52 (42)	7.95 (63)	5.33 (28)
T_4	10.27 (105)	4.93 (24)	10.50 (110)
T_5	9.66 (93)	5.87 (34)	7.09 (50)
T_6	8.03 (64)	15.57 (242)	9.45 (89)
T_7	8.97 (80)	15.91 (253)	9.51 (90)
T_8	7.51 (56)	5.96 (35)	6.66 (44)
T_9	9.44 (89)	3.37 (11)	7.96 (63)
T_{10}	0.71 (0)	6.19 (38)	9.24 (85)
T_{11}	11.81 (139)	15.28 (233)	8.57 (73)
SEd	0.360	0.369	0.350
CD (P=5%)	0.752	0.770	0.731

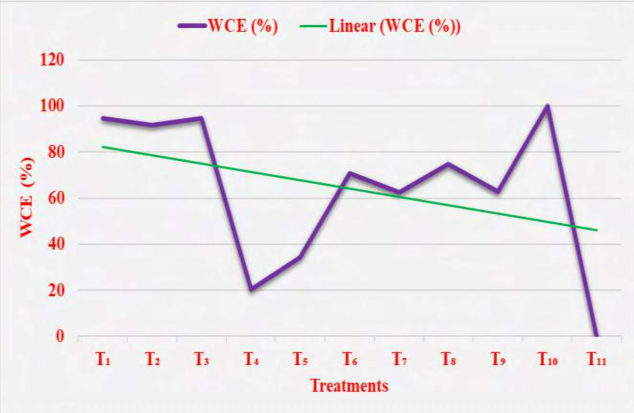

Fig. 1. Effect of weed management practices on WCE (%)

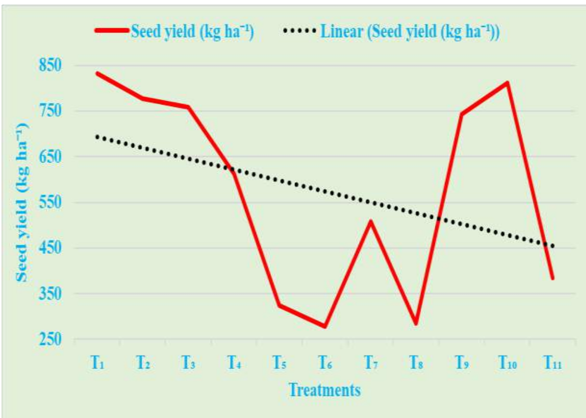

Fig. 2. Effect of weed management practices on seed yield (kg ha^{-1})

Reference

Anonymous, 2019. Agricultural Data INDIASTAT. Available online at: http://indiastat.org."

Babiker, MM, O Siraj, and AE Salah. 2014. "The Critical Period of Weed Control in Sesame (*Sesamum orientale* L.)." *Journal of Forest Products and Industries* 3(2): 66-70.

Iwo, GA, AA Idowo, and AA Ochigbo. 2002. "Evaluation of (*Sesamum indicum* L.) genotypes for yield stability and selection in Nigeria." *Nigeria Agricultural Journal* **33(1)**: 76-82.

Effect of Hexanal and Boric Acid on Shelf Life of Nerium (*nerium oleander* l.) Flowers

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Keywords: *Hexanal, boric acid, phospholipase, senescence and shelf life*

Introduction

Nerium is an emerging commercial loose flower among the flowers and it belongs to the family Apocyanaceae. It is widely grown in tropical and subtropical gardens, parks, avenues and is popular for its colour and fragrance. But, flowers are highly perishable lasting few hours to couple of days. The floral physiology is quite complex and often researches focus mainly on changes occurring during the senescence of petals (Desai *et al.*, 2012). Hexanal is a naturally occurring C_6 aldehyde and is a more efficient inhibitor of Phospholipase D activity (Paliyath and Subramanian 2008). Phospholipase D is responsible for the initiation of membrane deterioration during senescence. Boron is a micronutrient and it inhibits the ethylene synthesis and to reduce ethylene production through reducing the ACC synthase and ACC oxidase and delays senescence of flowers (Ezhilmathi *et al.*, 2007). Nerium is normally harvested in the evening hours. The major problem in nerium is that the flowers become shriveled and the quality is affected when the flowers reach the market in the next day morning. Hence, this study was carried out to study the effect of Hexanal and boric acid on shelf life of nerium flowers.

Methodology

The study was carried out at Horticultural College and Research Institute for Women, Trichy during 2015- 2016. Fresh unopened flowers were collected from market. The experimental design laid out was Completely Randomized Design (CRD) with six treatments along with control and three replications, each replication with 20 g of flowers of nerium cultivar Rasipuram local. Flowers selected for this study were ready to open in the next day morning and should be turgid, pink colour with single whorl. Treatments were T_0 (Control), T1 (Hexanal – 600 ppm), T_2 (Hexanal – 800 ppm), T_3 (Hexanal – 900 ppm), T_4 (Boric acid – 2 %), T_5 (Boric acid – 4 %) and T_6 (Boric acid – 5 %). Parameters recoded after treatment were Freshness Index, Flower Opening Index, Colour Retention Index and Shelf life. Data analysis was done by using the statistical software SPSS.

Results and Discussion

All the six treatments showed significant results for the recorded parameters. Among the six treatments, T_0 recorded the lowest freshness index of 81.91% followed by T_1 (91.92 %). T_6 recorded maximum freshness index value of 98.28 % followed by T_4 (97.99 %) for 5.5 hours at ambient conditions and were found to be highly significant. T_0 recorded the highest flower opening index value of 25.13 % followed by T_1 (20.69 %), but T_6 recorded the lowest of 3.32 % followed by T_5 (4.14 %). Among the treatments, colour retention index was higher in T_6 (53.24 % and 5.54 hours) followed by T_3 (51.55 and 5.41 hours) respectively, but T_0 recorded lower values with less period of shelf life (4 hours) (Table 1). Increased level of boric acid concentration from 2 to 5 % resulted in increased shelf life, this may be due to prevention of early rise of ethylene production and considerable improvement in life of flowers (Serrano *et al.*, 2001). Hexanal is responsible for 'Enhanced Freshness Formulation' (Tiwari and Paliyath, 2011). .

Table 1. Effect of hexanal and boric acid on physiological parameters and shelf life of nerium flowers

Treatments	Freshness Index (%)	Flower Opening Index (%)	Colour Retention Index (%)	Shelf life (hrs)
T_0	81.91	25.13	42.59	4.17
T_1	91.92	20.69	44.35	4.42
T_2	93.19	14.43	46.57	4.38
T_3	96.51	10.06	51.55	5.41
T_4	97.99	4.14	47.76	5.14
T_5	97.87	4.23	50.77	5.30
T_6	98.28	3.32	53.24	5.54
Mean	93.95	11.71	48.12	4.91
SEd	4.69	0.74	2.41	0.25
CD (p=0.05)	10.06	1.59	5.16	0.53

Reference

Desai, R., Patel, R. and Mankad, A., 2012. Petal senescence in cut *Tagetes erecta* L. flowers: Role of phenolics. *International Journal of Science, Environment and Technology*, *1*(5), 485-490.

Ezhilmathi, K., Singh, V.P., Arora, A. and Sairam, R.K., 2007. Effect of 5-sulfosalicylic acid on antioxidant activity in relation to vase life of Gladiolus cut flowers. *Plant Growth Regulation*, *51*(2), 99-108.

Paliyath, G. and Subramanian, J., 2008. Phospholipase D inhibition technology for enhancing shelf life and quality. *Postharvest biology and technology of fruits, vegetables, and flowers*, 240.

Serrano, M., Amorós, A., Pretel, M.T., Martínez-Madrid, M.C. and Romojaro, F., 2001. Preservative solutions containing boric acid delay senescence of carnation flowers. *Postharvest Biology and Technology*, *23*(2), 133-142.

Tiwari, K. and Paliyath, G., 2011. Microarray analysis of ripening-regulated gene expression and its modulation by 1-MCP and hexanal. *Plant Physiology and Biochemistry*, *49*(3), 329-340.

Effect of Intercropping and Double Row Planting on Growth Attributes, Yield of Sugarcane under Sustainable Sugarcane Initiative

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Keywords: *Sustainable Sugarcane Initiative, Inter cropping*

Introduction

Sustainable Sugarcane Initiative (SSI) is a vital and innovative technology to improve the productivity and quality of sugarcane when compared to conventional production system. System of Rice Intensification (SRI) which turned out as a major success in rice production has inspired in evolving of SSI. The SSI method of sugarcane cultivation includes raising of protray seedlings, wider row spacing of 5 feet, water saving through micro irrigation, intercropping and addition of organic inputs. Tillering potential in SSI is quite impressive and its full potential is yet to be harnessed (WWF-ICRISAT, 2009). Effective and efficient use of water and seed cane has made SSI, a viable technology among farmers for sustainable production. Intercropping is one of the sure ways of increasing the production without much increase in the application of inputs. Intercropping refers to growing of two or more crops simultaneously on the same piece of land. This system gives crop intensification in both time and space. Apart from its advantages like diversification, labour distribution, maintenance of soil fertility, suppression of weeds, two major advantages are higher productivity and greater stability through utilization of solar energy, moisture and nutrients. Hence, the present study has been proposed to find out the effect of intercropping and double row planting on growth attributes, yield of sugarcane under SSI

Methodology

Field experiment was laid out during *special* seasons of 2017-18 at Sugarcane Research Station, Sirugamani, located at Cauvery delta zone of Tamil Nadu. The geographical location of the experiment site is 10^0 56′N latitude and 78^0 26′E longitude with an altitude of 78.12 m above the MSL. The farm receives an average rainfall of 730.3 mm. The soil of the experimental site was well drained clay loam in texture with low in available nitrogen, medium in available phosphorus and high in available potassium. The soil analyzed 234, 15.8 and 467 kg/ha, respectively of $KMno_4$-N, Olsen P and NH_4OAc-K, respectively with EC 0.29 dsm^{-1}, pH 8.58 and organic carbon 0.58%. The experiments were laid out in strip plot design (SPD) with four treatments in main plot and four treatments in sub plot replicated thrice. The net plot size adopted was 27.0 m^2 (9.0 m X 3.0 m). Short duration pulses of greengram (ADT 3), blackgram (VBN5) and sunnhemp (CO1) maturing in 60-75 days were used for the study. The intercrops were raised in additive series *viz.*, 3 rows under a row spacing of 150 cm in sugarcane and 4 rows under 180 cm. The recommended schedule of surface drip fertigation for SSI was followed under surface drip irrigation system. The recommended dose followed was 300:100:200 kg/NPK/ha^{-1}. No additional fertilizers were applied to the intercrops. The growth parameter of plant height (240 and harvest) and Dry Matter Production at 300 and harvest were recorded. The yield attributes of cane equivalent yield at harvest was recorded.

Results and Discussion

Cane equivalent yield (t ha^{-1})

Among the different planting rows higher cane equivalent yield was recorded under 150 cm double row planting (M_2) (152.56 t ha^{-1}) in the plant crop, followed by 150 cm single row planting (M_1) (128.70 t ha^{-1}). With regard to intercropping systems, sugarcane with sunnhemp (S4) recorded higher cane equivalent yield (138.92 t ha^{-1}) and was on par with sugarcane with greengram (S_2) (132.55 t ha^{-1}). Lower cane equivalent yield was observed under sole crop of sugarcane (S_1) (101.04 t ha^{-1}). The interaction between planting rows and intercropping systems was significant on cane equivalent yield. The treatment combination, sugarcane planted at 150 cm in double rows (M_2S_4) and intercropped with sunnhemp recorded higher cane equivalent yield (170.46 t ha^{-1}) followed by sugarcane with blackgram (M_2S_3) (153.01 t ha^{-1}) and both were comparable. Lower cane equivalent yield was observed under 180 cm single row planting with sole crop of sugarcane (M_3S_1) (84.19 t ha^{-1}). The response of sugarcane to intercropping systems was much substantial. Sugarcane with sunnhemp (S_4) resulted in higher cane equivalent yield (139.04 t ha^{-1}) followed by sugarcane with blackgram (S_3), greengram (S_2) and both were comparable with each other. Sole crop of sugarcane recorded lower cane yield compared to other intercropping systems under SSI practices. Increased productivity by intercropping of onion as reflected by CEY confirm with report by Venkataraman (1977). Since the yield was not affected due to increased density of onion planting in wide row spacing of 120 and 150 cm, it would be advisable to go for an increased intercrop population of onion (1:4 ratio) while at normal row spacing of 90 cm, lower population (1:1 ratio) reported by Mahadevasamy (2001).

From the results of the experiment, it can be concluded that double row planting of sugarcane at 150 cm spacing with *insitu* incorporation of sunnhemp on 45th DAP can enhance the growth and yield attributes and cane equivalent yield of sugarcane.

Table 1. Effect of double row planting and intercropping systems on cane equivalent yield (t ha^{-1}) of sugarcane

Treatment	Plant crop II				
	M_1	M_2	M_3	M_4	Mean
S_1	109.97	132.23	84.19	77.77	101.04
S_2	140.13	154.55	116.75	118.78	132.55
S_3	128.18	153.01	111.01	115.69	126.97
S_4	136.50	170.46	119.96	129.25	139.04
Mean	128.70	152.56	107.97	110.37	
	M	S	M at S	S at M	
SEd	1.64	1.01	3.06	2.77	
CD (P=0.05)	4.02	2.48	6.73	5.95	

Reference

Mahadevaswamy, M. (2001). Studies on intercropping of aggregatum onion in wide spaced sugarcane. ***Ph.D. Thesis***, Tamil Nadu Agricultural University, Coimbatore.

Venkataraman, K. (1977). Studies on the effect of intercrops and nitrogen levels on sugarcane. ***M.Sc. (Agri.) Thesis***, Tamil Nadu Agricultural University, Coimbatore.

WWF-ICRISAT (2009). Improving Sugarcane Cultivation in India

Effect of Micro Irrigation and Establishment Methods on Water Use Studies

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Keywords: *Irrigation methods, Crop establishment, water use efficiency and productivity*

Introduction

Livestock plays a major role in Indian agriculture. But at present our country faces a net deficit of green and dry fodder. To meet green and dry fodder requirement of animals round the year, cultivation of perennial grasses (bajra napier hybrid grass) in forage based cropping sequences have become popular among dairy farmers. It is gaining importance as they provide year round supply of fodder to cattle. But issue with baja napier hybrid grass is the requirement of high planting material and water. This can be overcome by adopting single budded setts with sett treatment and micro irrigation systems (Varshini and Jayanthi, 2019). Hence, it was felt necessary to study the different crop establishment methods and irrigation methods in present investigation to maximize the water use efficiency and water productivity of bajra napier hybrid grass.

Methodology

A field experiment to study the Influence of crop establishment and irrigation methods on water use studies on bajra napier hybrid grass CO (BN) 5 was conducted during September, 2018 in Field No. 75 at the Eastern block of Department of Agronomy, Tamil Nadu Agricultural University – Coimbatore. The field was laid out in a strip plot design with three replications. Irrigation methods were imposed in main plot *viz.*, M_1 : Surface irrigation, M_2 : Surface drip irrigation, M_3 : Subsurface drip irrigation, M_4 : Micro sprinkler irrigation and crop establishment methods in sub plot *viz.*, S_1 : Vertical planting of setts with sett treatment, S_2 : Horizontal planting of setts with sett treatment, S_3 : Vertical planting of setts without sett treatment, S_4 : Horizontal planting of setts without sett treatment, S_5 : Vertical planting of two budded setts. Sett treatment adopted for the study was 12 hours water soaking followed by 24 hours incubation. The treatments S_1 to S_4 were adapted with single budded setts. For main plot, scheduling of irrigation for surface irrigation was done based on IW/CPE ratio 0.80 *i.e.,* cumulative pan evaporation. For micro irrigation systems irrigation was given in once in three days based on 100% pan evaporation. Observations on water use efficiency, water productivity (t/m^3) and economic water productivity were calculated based on the standard formula. The statistical analysis was done using the statistical method, strip plot design. Wherever the results were significant, the critical difference (CD) at 5 % level of significance was worked out as given by Gomez and Gomez (1984).

Results and Discussion

Significant variation was observed by both irrigation methods and crop establishment methods (Table 1). Among the irrigation methods, subsurface drip irrigation (M_3) resulted in significantly the highest WUE of 23.74 t/ha/mm. This might be due to uniform distribution of irrigation water, lower evaporation from the soil surface and easy availability of water and nutrients within the root zone (Sathiyaraj, 2017). In crop establishment methods, higher WUE of 21.47 t/ha/mm was observed with horizontal planting of setts with sett treatment (S_2). This might be due to early and synchronized field emergence, which resulted in more leaf area and early canopy development. Better ground cover reduced the evaporation from the soil by saving sufficient water for transpiration which resulted in higher water use efficiency. Interaction effect on water use efficiency (WUE) showed non-significant difference on water use efficiency. On water productivity and economic water productivity (Fig 1), subsurface drip irrigation (M_3) recorded higher water productivity (0.024 t/m^3) and economic water productivity (474.78 ₹ /ha/mm). Among the crop establishment methods, higher water productivity (0.021 t/m^3) and economic water productivity (429.43 ₹ /ha/mm) was observed with horizontal planting with sett treatment (S_2). Interaction between irrigation methods and crop establishment higher water productivity and economic water productivity was registered on subsurface drip irrigation with horizontal planting with sett treatment (M_3S_2).

From the study it can be concluded that, for achieving higher water use efficiency and water productivity subsurface drip irrigation and horizontal planting of single budded setts with sett treatment is recommended.

Table 1. Effect of micro irrigation and crop establishment methods on water use efficiency (t/ha/mm)

Treatments	S_1	S_2	S_3	S_4	S_5	Mean
M_1	15.00	16.67	13.50	14.39	15.96	15.10
M_2	21.57	24.14	20.00	20.37	22.75	21.77
M_3	23.87	26.52	20.51	22.49	25.31	23.74
M_4	16.76	18.56	15.52	15.93	17.68	16.89
Mean	19.30	21.47	17.38	18.29	20.43	
	M	S	M at S	S at M		
SEd	0.51	0.59	1.17	1.18		
CD (P = 0.05)	1.24	1.20	NS	NS		

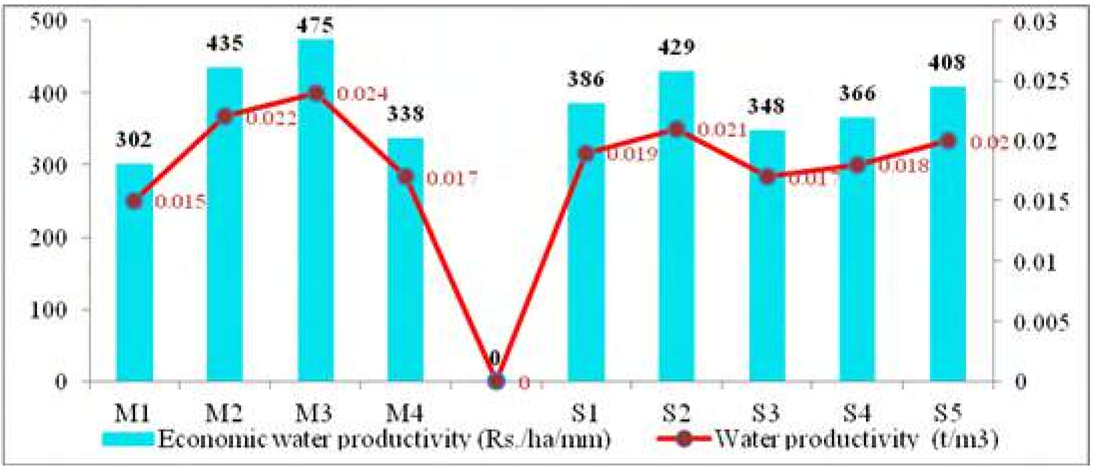

Fig 1. Effect of micro irrigation and crop establishment methods on water and economic water productivity

Reference

Gomez, KA, and AA Gomez. 1984. "Analysis of data from a series of experiments." *Statistical Procedures for Agricultural Research*. 2nd ed. New York: J. Wiley:316-356.

Sathiyaraj, M. 2017. "Irrigation regimes and fertigation levels on sugarcane under subsurfacedrip fertigation." *International Journal of Current Microbiology and Applied Sciences* 6 (11):3674-3684.

Varshini SV and Jayanthi C. 2019. "Effect of Crop Establishment on the Performance of Bajra Napier Hybrid Grass CO (BN) 5". *Madras Agricultural Journal* 106:590-593.

Effect of Moisture Stress and Stress Ameliorants on Phenology and Dry Matter Production in Pearlmillet (*Pennisetum Glaucum* L.,)

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Keywords: *Moisture stress, Salicylic acid, KCl, PPFM, Phenology, Dry matter production*

Introduction

Pearlmillet (*Pennisetum glaucum* L.,) is one of the major millets grown in arid and semi-arid regions. Among all abiotic stresses caused directly or indirectly by virtue of climate change, moisture stress due to non-availability of water is one of the foremost abiotic stresses. Water stress reduced the productivity in millets. An experiment was carried to study the effect of moisture stress and foliar application of stress ameliorants such as KCl, Salicylic acid and Pink pigmented facultative methylotrophs (PPFM) in increasing the photosynthetic pigments and relative water content of pearlmillet.

Methodology

The field experiment was laid out in Split-plot design The main plot factor M consisted of four levels *viz*., M_1: Skipping irrigation at active tillering stage; M_2: Skipping irrigation at flowering stage; M_3: Skipping irrigation at active tillering and flowering stages and M_4: Irrigation at all critical stages. The Subplot factor S comprised of six levels *viz*., S_1: Foliar spray at 1 % KCl on 20 and 40 DAS; S_2: Foliar spray of 100 ppm Salicylic acid (SA) on 20 & 40 DAS; S_3: Foliar spray of 2 % PPFM on 20 & 40 DAS; S_4: Foliar spray of 1 % Kcl on 20 DAS & 100 ppm SA on 40 DAS; S_5: Foliar spray of 1 % KCl on 20 DAS and 2 % PPFM on 40 DAS and S_6: Water spray on 20 and 40 DAS (as control).

Results and Discussion

Effect of moisture stress and stress ameliorants on phenology

Significantly lower number of days to attain 50 % flowering was obtained in well irrigated plants (50.9 days) which was on par with moisture stress imposed at active tillering (51.1 days) and higher number of days was observed in moisture stress imposed at both active tillering stage and flowering stage (53.6 days).The foliar spray of 1% KCl on 20 DAS and 2 % PPFM on 40 DAS significantly took lower number of days to attain 50% flowering (51.3 days).The interaction revealed that well irrigated plants combined with foliar spray of 1 % KCl on 20 DAS and 2 % PPFM on 40 DAS attained earlier physiological maturity (69.3 days).

Effect of moisture stress and stress ameliorants on dry matter production(kg ha^{-1})

At 15 DAS, no significant influence was observed among the moisture stress treatments and the stress ameliorants. However, at 30, 45 and 60 DAS, well irrigated plants (M_4) did produce the higher dry matter of 644 kg/ha, 7002 kg/ha and 9862 kg/ha, respectively. Significantly lower dry matter production was registered with M_3. At 30 DAS, foliar spray of PPFM twice at 20 & 40 DAS (S_3) did produce the highest dry matter of 641 kg/ha. At 45 and 60 DAS, foliar application of 1 % KCl on 20 DAS and 2 % PPFM on 40 DAS (S_5) significantly achieved higher dry matter production of 6819 kg/ha and 9381 kg/ha, respectively. The results confirmed that the moisture stress imposed at flowering stage caused severe reduction in dry matter production.

The experiment results concluded that the moisture stress imposed at flowering stage caused severe reduction in DM accumulation when compared to moisture stress imposed at other critical stages. Foliar spray of 1% KCl on 20 DAS & 2 % PPFM on 40 DAS resulted in greater amelioration of moisture stress imposed on critical growth stages and helped in achieving the higher dry matter production and earlier maturity in pearl millet.

Table 1. Effect of moisture stress and stress ameliorants on crop phenology and dry matter production in pearlmillet

Treatments	Days to 50 % flowering (days)	Days to Physiological maturity (days)	Dry matter production (kg ha^{-1})			
			15 DAS	30 DAS	45 DAS	60 DAS
M1	51.1	71.8	33	579	6724	9731
M2	52.9	74.0	40	640	6075	8441
M3	53.6	74.3	34	585	5962	7845
M4	50.9	70.1	40	644	7002	9862
SEd	**0.26**	**0.35**	**0.471**	**14.23**	**130.63**	**182.22**
CD (p=0.05)	**0.64**	**0.26**	**1.153**	**34.82**	**319.65**	**445.92**
S1	52.2	72.7	36	612	6195	8856
S2	52.2	72.3	38	614	6348	8960
S3	51.6	71.9	38	641	6746	9246
S4	52.3	72.5	37	603	6561	8947
S5	51.3	71.7	36	636	6819	9381
S6	53.2	74.3	36	567	5976	8427
SEd	**0.27**	**0.26**	**0.859**	**15.13**	**170.10**	**203.15**
CD (p=0.05)	**0.54**	**0.53**	**NS**	**30.59**	**343.79**	**410.58**

Reference

Bidinger, F. R., Mahalakshmi, V., Talukdar, B. S., & Alagarswamy, G. (1982). Improvement of drought resistance in pearl millet. *Drought resistance in crops with emphasis on rice*, 357-375.

Srivastava, A. K., Pasala, R., Minhas, P. S., & Suprasanna,P.(2016). Plant bioregulators for sustainable agriculture: integrating redox signaling as a possible unifying mechanism. *Advances in agronomy*, *137*, 237-278.

Effect of seed Biopriming with Biocontrol Agents using Protray Enhances Seedling Emergence of Brinjal (*Solanum melongena* L.) Cv. CO 2 Seeds

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Keywords: *Brinjal (Solanum melongena L.), Protray, Biocontrol agents, Seed biopriming*

Introduction

Bio-priming is a seed pre-treatment that integrates several biological and physiological aspects to enhance growth, improve disease control, and increase yields. It involves coating the seed with one of several biological agents, then incubating the seed under warm, moist conditions. Sustainable crop production requires the adoption of eco-friendly seed improvement techniques. One such treatment is seed bio-priming. Beneficial effects have been reported for bio-priming in several vegetable seeds (Balbinot and Lopes, 2006).

Methodology

T_1 - Control / unprimed

T_2 - Dry seed treatment with Metalaxyl @ 2g kg^{-1} of seeds.

T_3 - Dry seed treatment with *Pseudomonas fluorescens* @ 10g kg^{-1} of seed.

T_4 - Dry seed treatment with *Trichoderma viride* @ 4 g kg^{-1} of seed.

T_5 - Dry seed treatment with *Bacillus subtilis* @ 10 g kg^{-1} of seed.

T_6 - Seed biopriming with 15 % *Pseudomonas fluorescens* for 6h.

T_7 - Seed biopriming with 40 % *Trichoderma viride* for 6h.

T_8 - Seed biopriming with 8 % *Bacillus subtilis* for 6h.

Speed of germination

Four replicates of twenty five seeds each were used to test the speed of germination of seeds from different treatments. The seeds showing radicle protrusion were counted daily from second day after sowing until fourteenth day. From the number of seeds germinated on each day, the speed of germination was calculated using the following formula and the results were expressed in number (Maguire, 1962).

$$\text{Speed of germination} = \frac{X_1}{Y_1} + \frac{X_2 - X_1}{Y_2} + \dots\dots\dots + \frac{X_n - X_{n-1}}{Y_n}$$

Seedling emergence

Four replicates of 100 seeds from each treatment were sown in line on the raised beds separately using the spacing of 20 cm between the rows. Suitable care was taken to raise good and healthy seedlings. At 14 DAS, the number of seedlings emerged were counted and expressed in per cent.

Results and Discussion

In the present study, results revealed that speed of germination and germination per cent were statistically significant among the priming treatments. Higher speed of germination (23.5) and seedling emergence (94%) were observed in seed bioprimed with 15 % *Pseudomonas fluorescens* for 6h in protray nursery recorded higher speed of germination and seedling emergence when compared to raised bed nursery **(Table 1)**. The significant enhancement in speed of germination might be attributed to the activation of pre-germinative metabolic activities before the protrusion of radicle as reported by Bradford (1986) and McDonald (2000). The increase in speed of germination due to biopriming was also revealed by several previous reports. However, biopriming with biocontrol agents had a dual action such as control of disease causing pathogens during germination as well as enhancement of germination and vigour by integrating the biological and physiological changes during germination (Callan *et al.*, 1991); (Jahn *et al.*, 1998), (El-Mohamedy, 2004); El- Mohamedy *et al.*, 2006).

Table 1. Influence of dry seed treatment and seed biopriming with biocontrol agents Raised bed and portray nursery speed of germination and seedling emergence brinjal seed cv.CO 2

Treatment	Speed of germination			Seedling emergence (%)		
	Raised bed	Protray	Mean	Raised bed	Protray	Mean
T_1	17.1	19.2	18.2	80 (63.43)	84 (66.42)	82 (64.89)
T_2	17.3	20.3	18.8	84 (66.42)	87 (68.86)	86 (68.02)
T_3	17.5	20.8	19.2	85 (67.50)	88 (69.73)	87 (68.86)
T_4	17.3	19.8	18.6	83 (65.65)	86 (68.02)	85 (67.21)
T_5	17.4	20.1	18.8	86 (68.02)	89 (70.63)	88 (69.73)
T_6	19.8	23.5	21.7	91 (72.54)	94 (75.82)	93 (74.66)
T_7	18.5	21.5	20.0	88 (69.73)	90 (71.56)	89 (70.63)
T_8	19.2	22.7	21.0	90 (71.56)	89 (70.63)	91 (72.54)
Mean	**18.0**	**21.0**	**19.5**	**86 (68.02)**	**89 (70.63)**	**87 (68.86)**
Factor	**T**	**N**	**TXN**	**T**	**N**	**TXN**
SEd	0.28	0.14	0.39	1.46	0.73	2.07
CD (P=0.05)	0.57**	0.28**	0.80**	2.98**	1.49*	NS

(Figures in parentheses indicate arc sine values)

Reference

Basra, S.M.A., Farooq, M. and Tabassum, R. (2005) Physiological and biochemical aspects of seed vigour enhancement treatments in fine rice (*Oryza sativa* L.). *Seed Sci. & Technol.*, 33: 623-628.

Callan, N. W., Mathre, D. E., & Miller, J. B. (1991). Field performance of sweet corn seed bio-primed and coated with Pseudomonas fluorescens AB254. *HortScience*, *26*(9), 1163-1165..

Effect of Spacing and Nutrient levels on Nutrient Uptake of Pod Sown Groundnut

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Keywords: *Groundnut, pod sown, nutrient uptake*

Introduction

Groundnut (*Arachis hypogaea L.*) also identified as peanut and 'king of oilseeds' is a vital oilseed, food and fodder legume crop belonging to family Fabaceae. The seed cost accounts for about 31.40% of the mean total variable cost (Ani *et al*., 2013). The seed cost is increased mainly by the operation of shelling, which raises it upto 3 times. In view of reducing the seed cost, the practise of pod seeding technology in groundnut have been used. The nutrient that is recommended for groundnuts sown as kernel can't be used for pod sowing as pod sowing results in the emergence of two plants from a hill owing to the presence of two kernels in a pod. The study is hence conducted to fix the optimum nutrient requirement for pod sown groundnut.

Methodology

The field experiment was laid out in a factorial randomized block design with two factors and was replicated thrice. The field experiment comprises of twelve treatmental combinations. The four different spacing 30 × 10 cm (S_1), 20 × 20 cm (S_2), 25 × 15 cm (S_3) and 30 × 15 cm (S_4) were allocated as the first factor. The second factor comprised of three nutrient levels viz., N_1 – Soil Test based Crop Recommendation approach (22.54: 26.68: 51.2 kg N, P_2O_5, K_2O ha^{-1}), N_2 - 100% recommended dose of fertilizers (25: 50: 75 kg N, P_2O_5, K_2O ha^{-1}) and N_3 - 125% recommended dose of fertilizers (31.25: 62.5: 93.75 kg N, P_2O_5, K_2O ha^{-1}). The pods that were used for the above treatments were soaked in water for 24 hours. There were two controls i.e., Kernel sown and pod sown groundnut without soaking using 30 × 30 cm spacing.

Results and Discussion

Effect of spacing on nutrient uptake (kg ha^{-1}) of pod sown groundnut

At harvest, highest nitrogen, phosphorus and potassium uptake (124.4 kg ha^{-1}, 32.2 kg ha^{-1} and 79.2 kg ha^{-1} respectively) was found with the spacing of 30 cm × 15 cm (S4). This might be attributed to the less competition among plants which results in efficient utilization of all the nutrient resources. Closer spacing of 30 cm × 10 cm (S1) recorded the lowest nitrogen, phosphorus and potassium uptake (101.3 kg ha^{-1}, 27.1 kg ha^{-1} and 64.7 kg ha^{-1} respectively) due to the lesser haulm yield.

Effect of nutrient levels on nutrient uptake (kg ha^{-1}) of pod sown groundnut

Among the various nutrient levels tested, 125% recommended dose of fertilizers (N3) registered maximum nitrogen, phosphorus and potassium uptake (125.7 kg ha^{-1}, 37.2 kg ha^{-1} and 82.5 kg ha^{-1} respectively) in plants. The least nitrogen uptake (100.6 kg ha^{-1}, 23.9 kg ha^{-1} and 63.9 kg ha^{-1} respectively) was found in STCR approach (N1). The increase in nutrient uptake with increasing levels of fertilizers has also been evidenced by Rao and Narayanan (1990). Further, the higher uptake of nutrients might be possibly because of the greater translocation of nutrients to all plant parts and because of the nutrient rich environment in the rhizosphere created by the additional dose of fertilizers.

Table 1. Effect of spacing and nutrient levels on nutrient uptake (kg/ha) of pod sown groundnut at harvest

Treatment	Nitrogen uptake	Phosphorus uptake	Potassium uptake
Spacing			
S_1 - 30 cm × 10 cm	101.3	27.1	64.7
S_2 - 20 cm × 20 cm	114.4	29.8	73.4
S_3 - 25 cm × 15 cm	116.3	30.0	73.0
S_4 - 30 cm × 15 cm	124.4	32.2	79.2
SEd	**4.3**	**1.2**	**2.5**
CD	**8.9**	**2.4**	**5.1**
Nutrient levels			
N_1 - On STCR basis	100.6	23.9	63.9
N_2 - 100% RDF	116.1	28.4	71.4
N_3 - 125% RDF	125.7	37.2	82.5
SEd	**3.7**	**1.0**	**2.1**
CD	**7.7**	**2.1**	**4.4**
Kernel	154.1	35.2	81.7
Pod sown (Control)	116.8	24.6	40.2

Reference

Ani, D., J. Umeh, and E. Weye. 2013. "Profitability and Econimic Efficientcy of Groundnut Production in Benue State, Nigeria." *African journal of food, Agriculture, Nutrition and Development* 13 (4):8091-8105.

Rao, J., and A. Narayanan. 1990. "Physiological aspects of iron deficiency in groundnut (Arachis hypogaea L.) and blackgram (Vigna mungo L.)." *Madras Agricultural Journal* 77 (3-4):151-157.

Enhancement of Drought Tolerance Through Priming in Green Gram (*Vigna Radiata* L.)

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Keywords: *Green gram, PEG, priming, water stress, germination*

Introduction

Pulses are the second most important group of crops worldwide. Green gram (*Vigna radiata* L.) grows mainly in rain-fed conditions at high temperatures (27–30 °C), with low humidity and moderate rainfall. As a rainfed crop, drought at different developmental stages results in low productivity. Primed seeds performs well under drought stress conditions particularly at early stages of crop growth since primed seeds can retain the memory of previous stress and enable protection through earlier activation of the cellular defense mechanism, reduced imbibition time, upsurge of germination promoters, and osmotic regulation. Application of compatible solutes or osmoprotectants through seed priming can be an important approach to mitigate the adverse effects of water deficit conditions which enhance seedling emergence and growth. Hence the experiment was carried out to standardize the concentration of priming agents for green gram to enhance drought tolerance.

Methodology

Seed priming studies were carried out with green gram var. VBN 4 at Department of Seed Science and Technology, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai to standardize the concentration of priming agents to improve the water stress tolerance of green gram seeds. Drought stress was imposed using poly ethylene glycol (PEG) 6000 at -0.5 bar concentration. Seeds of green gram were primed with water and priming agents viz., glycine betaine and proline with different concentrations of 100, 200 and 300 ppm for 3hours. Unprimed seeds served as the absolute control. Seeds were evaluated for germination (ISTA 1999), shoot length (cm), root length (cm), dry matter production (g/10 seedling) and vigour index values (Abdul-Baki and Anderson 1973).

Results and Discussion

Germination test results revealed that priming with glycine betaine @ 200 ppm recorded the highest germination of 94 % with the longest root (17.60cm) and shoot length (21.20cm) (Table1). The dry matter production (0.171g) and vigour index values (3647) were also higher at this concentration. Glycine Beatine might have involved in stabilizing the quaternary structures of enzymes and complex proteins, lipids of photosynthetic apparatus as well as in maintaining the highly ordered state of membranes under desiccation stress (Papageogiou & Murata, 1995; Xing & Rajashekar, 1999). Whereas, performance of proline was at its best at 300ppm concentration. Primed seeds performed better than unprimed seeds with enhanced germination and vigour of the seedlings under water stress condition.

From the results it can be concluded that glycine betaine @ 200ppm concentration can be used to prime the seeds under water deficit conditions.

Table 1. Standardization of the concentration of osmoprotectants for priming the green gram seeds

Treatment	Germination %	Root Length (cm)	Shoot Length (cm)	DMP (gm)	Vigour Index I	Vigour Index II
T1-Control	70 (56.79)	11.50	12.60	0.115	1687	8.05
T2-Hydropriming	88 (69.73)	15.56	17.56	0.150	2913	13.20
T3-Glycine Betaine @ 100 ppm	90 (71.56)	16.00	19.30	0.155	3177	13.95
T4-Glycine Betaine @ 200 ppm	94 (75.82)	17.60	21.20	0.171	3647	16.07
T5-Glycine Betaine @ 300 ppm	92 (73.57)	16.50	19.80	0.166	3340	15.27
T6-Proline @ 100 ppm	86 (68.02)	15.35	17.80	0.152	2851	13.07
T7-Proline @ 200 ppm	90 (71.56)	15.85	18.80	0.156	3118	14.04
T8-Proline @ 300 ppm	92 (73.57)	17.00	20.60	0.170	3459	15.64
SEd	1.493	0.327	0.622	0.003	55.94	0.224
CD (P=0.05)	3.165	0.694	1.319	0.006	118.58	0.474

(*Values in parentheses indicate arc sine transformed values)

Reference

Bot, Pak & Mahmood, Tahir & Basra, Shahzad & Shahbaz, Muhammad. (2009). Does exogenous application of glycinebetaine as a pre-sowing seed treatment improve growth and regulate some key physiological attributes in wheat plants grown under water deficit conditions? *Pak J Bot. Pakistan Journal of Botany.* 41.

Xing,W. and C.B. Rajashekar. 1999. Alleviation of water stress in beans by exogenous glycinebetaine. *Plant Sci.*, 148(2):

Harnessing Halotolerant Bacteria from Different Rice Ecosystem for Salt Stress Mitigation in Rice

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Keywords: *Salinity, Isolation, Screening, Halotolerant bacteria*

Introduction

Soil salinity is considered as one of the major abiotic stresses that greatly affects plant growth (Sipayung *et al.,* 2021). Agricultural productivity of more than 20% of cultivated land worldwide is affected by high salinity (Mendpara *et al.,* 2013). Soil salinity negatively affects the growth and productivity of rice. However, it is considered that certain bacteria thriving in salt affected soils are able to alleviate the adverse effects of salinity and can promote growth and development of plants.

Methodology

Sample collection and isolation of halotolerant bacteria

Soil samples were collected from different rice ecosystems *i.e.,* conventional, SRI and aerobic planting system grown in salt affected areas of Tamil Nadu. Isolation of bacteria from 13 soil samples collected from three different districts (Vilupuram, Ramnad and Trichy) was carried out by adopting serial dilution technique using different growth media *i.e.,* Nutrient agar medium, Tryptic soya agar medium, Luria Bertani medium and R2A medium. Morphologically different colonies were selected.

Screening of halotolerant bacterial isolates against NaCl concentrations

Tryptic soya broth was prepared with different NaCl concentrations by adding (5, 10, 15, 20 and 25% w/v) NaCl. Isolated bacteria were inoculated in Tryptic soya broth containing different salt concentrations and incubated at 48°C for 48h. The growth was measured in terms of optical density values at 600 nm in spectrophotometer. The colonies which were able to proliferate under varying concentrations of NaCl in TSA medium were considered as halotolerant bacteria.

Results and Discussion

A total of 63 bacterial isolates were selected by isolation from different soil samples, purified and stored for further characterization. The selected 63 isolates were screened at different salt concentration up to 25% NaCl on TS broth (**Table 1**). Out of all the isolates, 41 isolates were able to grow at 5% NaCl concentration, 9 isolates showed growth in 10% NaCl concentration and only 5 isolates survived in 15% NaCl concentration. None of the isolates were able to survive in 20 and 25% NaCl concentrations. The isolates which were able to survive at salt concentration more than 5% NaCl were considered as efficient halotolerant bacteria which can be further characterized for plant growth promoting activities and can be used to impart salt tolerance to plants.

Thus, these selected halotolerant bacteria are capable of surviving in saline conditions and can be exploited in future for successful mitigation of salinity in rice and other crop plants.

Table 1. Growth of halotolerant bacterial isolates at various levels of NaCl concentrations

Sl. No	Bacterial Isolate No	Growth at various levels of NaCl concentrations (O.D value at 600 nm)					
		Control	0.86 M 5% NaCl	1.71 M 10% NaCl	2.57 M 15% NaCl	3.43 M 20% NaCl	4.31 M 25% NaCl
1	29	0.231	0.193	0.256	-	-	-
2	51	0.091	0.071	0.323	-	-	-
3	54	0.182	0.197	0.222	0.068	-	-
4	55	0.099	0.147	0.188	0.054	-	-
5	56	0.154	0.092	0.198	-	-	-
6	59	0.091	0.231	0.243	0.048	-	-
7	62	0.198	0.209	0.217	-	-	-
8	75	0.319	0.26	0.231	0.067	-	-
9	76	0.156	0.019	0.644	0.094	-	-

Reference

Mendpara, J., Parekh, V., Vaghela, S., Makasana, A., Kunjadia, P.D., Sanghvi, G., Vaishnav, D. and Dave, G.S., 2013. Isolation and characterization of high salt tolerant bacteria from agricultural soil. ***European Journal of Experimental Biology***, *3*(6), pp.351-358.

Sipayung, J., Tarno, H. and Chang, P., 2021, March. Isolation of halo-tolerant bacteria with plant growth-promoting traits. In ***IOP Conference Series: Earth and Environmental Science*** (Vol. 709, No. 1, p. 012078). IOP Publishing.

Herbicidal Weed Management in Barnyard Millet (*Echinochloa frumentacea*) under Irrigated Condition

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Keywords: *Barnyard millet, Weed density, Weed dry weight, Weed control efficiency*

Introduction

Weeds are a serious problem in barnyard millet, both in irrigated and in rainfed situations. Slow initial growth of barnyard millet is also favourable for high weed multiplication. The critical period for weed competition is 25-30 days after sowing and weed management at this time is crucial for increasing yields. Generally, weeds are controlled by conventional methods like hand weeding, hoeing etc. But due to labour scarcity along with higher wages, this traditional weed management is difficult nowadays. Application of herbicides is the best alternate solution in such situation. It is a quick, more effective, time and labour saving method. Studies on weed control in barnyard millet by herbicides were bare minimum. So, the present study aimed to identify a suitable herbicide for barnyard millet under irrigated condition.

Methodology

To assess the herbicidal weed management in barnyard millet, a field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore during *Summer* 2021. The experiment consisted of seven treatments replicated thrice in a randomized block design (RBD). The treatments tested were, T_1 : PE Pendimethalin 30 EC @ 500 g a.i. ha^{-1} on 3 DAS, T_2 : PE Bensulfuron methyl 0.6 G + Pretilachlor 6 G @ 660 g a.i. ha^{-1} (RM) on 3 DAS, T_3 : PE Oxyfluorfen 23.5 EC @ 80 g a.i. ha^{-1}on 3 DAS, T_4 : PE Pendimethalin 30 EC @ 500 g a.i. ha^{-1} on 3 DAS followed by EPOE Bispyribac sodium 10 SC @ 10g a.i. ha^{-1} on 15 DAS, T_5 : PE Bensulfuron methyl 0.6 G + Pretilachlor 6 G @ 660 g a. i. ha^{-1} (RM) on 3 DAS followed by EPOE Bispyribac sodium 10 SC @ 10 g a.i. ha^{-1} on 15 DAS, T_6 : PE Oxyfluorfen 23.5 EC @ 80 g a.i. ha^{-1} on 3 DAS followed by EPOE Bispyribac sodium 10 SC @ 10 g a.i. ha^{-1} on 15 DAS and T_7: Unweeded control. The data on weed density (No. m^{-2}) and weed dry weight (g m^{-2}) were transformed by using square root transformation $\sqrt{(X+0.05)}$. The transformed data were analyzed statistically.

Results and Discussion

A significant reduction in weed density and weed dry weight and higher weed control efficiency were recorded with PE Bensulfuron methyl 0.6 G + Pretilachlor 6 G @ 660 g a.i. ha^{-1} (RM) on 3 DAS followed by EPOE Bispyribac sodium 10 SC @ 10 g a.i. ha^{-1} on 15 DAS (6.41 No.m^{-2}, 4.75 g m^{-2} and 93.94%). This treatment was on par with PE Pendimethalin 30 EC @ 500 g a.i. ha^{-1} on 3 DAS followed by EPOE Bispyribac sodium 10 SC @ 10 g a.i. ha^{-1} (8.45 No.m^{-2}, 6.36 g m^{-2} and 88.05%). It is obvious that higher weed density and weed dry weight and lower weed control efficiency were observed in unweeded control than the other treatments (Table 1).

The application of different herbicides with varying doses and times had phytotoxic effects on irrigated barnyard millet. Among the herbicides, application of PE Bensulfuron methyl + Pretilachlor 660 g a.i. ha^{-1} showed moderate phytotoxicity on crop on 5 DAHS. The symptom persisted even upto 15 DAHS. However, the crop recovered on 30 DAHS. Other herbicides were found to be safe to the crop.

From this experiment, it is concluded that application of pre emergence Bensulfuron methyl 0.6 G + Pretilachlor 6 G @ 660 g a.i. /ha (RM) on 3 DAS followed by EPOE Bispyribac sodium 10 SC @ 10 g a.i. ha^{-1} on 15 DAS reduced the weed density and weed dry weight and shows higher weed control efficiency. Eventhough this treatment is effective in controlling weeds in barnyard millet, it showed phytotoxic symptoms. Hence this herbicide may be tried in lower doses for effective weed management without affecting the crop

Table 1: Effect of different herbicide applications on total weed density, total dry weight and weed control efficiency in irrigated barnyard millet

Treatments	Weed density (No.m^{-2})			Weeds dry weight (g m^{-2})			WCE (Percent)
	Grasses	Sedges	BLWs	Grasses	Sedges	BLWs	
T_1	2.80 (7.66)	2.47 (5.66)	6.08 (37)	2.23 (4.7)	1.80 (2.76)	5.37 (29)	66.48
T_2	2.00 (3.66)	2.33 (5)	4.90 (24)	1.56 (2)	1.72 (2.5)	3.81 (14.33)	82.69
T_3	3.38 (11)	2.59 (6.33)	8.52 (72.66)	2.77 (6.83)	1.83 (3.1)	7.62 (58.4)	37.19
T_4	2.46 (5.66)	2.25 (4.66)	3.74 (13.66)	1.88 (3.13)	1.68 (2.36)	2.80 (7.5)	88.05
T_5	1.76 (2.66)	1.93 (3.33)	2.72 (7)	1.32 (1.36)	1.39 (1.5)	2.04 (3.73)	93.94
T_6	3.17 (6.66)	2.38 (5.33)	7.02 (49.66)	2.00 (3.56)	1.79 (2.76)	6.13 (37.2)	59.99
T_7	3.89 (13.66)	2.78 (7.33)	13.45 (180.5)	2.93 (8.2)	2.04 (3.73)	9.86 (96.86)	0.00
SEd	0.2553	0.2077	0.6652	0.29	0.14	0.62	
CD (p=0.05)	0.556	0.4525	1.44	0.64	0.31	1.36	

Data within parentheses are original values; data analyzed using square root transformation PE: Pre emergence, DAS: Days after sowing, EPOE: Early post emergence, RM: Ready mix, BLWs: Broad leaved weeds

Reference

Priyanga, M., Ragavan, T., Durai Singh, R. and Prabhaharan, J. (2019). Effect of establishment methods and weed management practices on weed control in barnyard millet under irrigated condition. ***International Journal of Chemical Studies***. 7(3): 3201-3204.

Shamina, R., Annadurai, K., Hemalatha, M. and Suresh, S. (2019). Effect of Spacing and Weed Management Practices on Barnyard Millet (*Echinochloa frumentaceae*) under Rainfed Condition. ***International Journal of Current Microbiology and Applied Sciences***. *8*(6): 330-337.

Ice Nucleation Active Bacteria and Its Mitigation on Tomato

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Keywords: *Pseudomonas, ice nuclei, condensation*

Introduction

Pseudomonas bacteria that could stimulate biological ice nucleation are suspected to play an important role in ice nuclei and condensation process in clouds. These bacteria usually found on phylloshpere regions, soil and the atmosphere. Ice formation mainly influenced by the presence of ice nuclei, particles of a critical size and shape that allow formation of the ice lattice around them (Guna *et al*., 2019).

Methodology

In this study, *Pseudomonas aeruginosa* and PPFM (pink-pigmented facultative methylotrophs) isolated from phylloshpere and the soil. Further colonized and sprayed on the tomato plant with different irrigation levels (I1 – 0.6 IW /CPE ratio; I2 – 0.8 IW /CPE ratio; I3 – 1.0 IW /CPE ratio) to evaluate the ice nucleation activity. Photosynthetic rate were measured using Portable Photosynthesis System (PPS) (Model LI-6400 of LICOR inc., Lincoln, Nebraska, USA). Scanning Electron Microscope (SEM), a type of electron microscope that generates sample images by scanning the surface with a focused high-energy electron beam. The size and morphology of the leaf sample were investigated by a SEM (FEI Quanta 250, Netherlands). On the scanning sample stage, the sample stub was positioned. A tube nucleation test method was employed to determine the ice nucleation potential of the bacteria (Stopelli *et al*., 2014).

Results and Discussion

Photosynthetic rate

The microbial sprayed plants PPFM recorded higher value (40.7 µmol $CO_2/m^2/s$) followed by *P. aeruginosa* on 10 DAS. Among the microbial spraying PPFM has observed higher photosynthetic rate than *P. aeruginosa.* Microbial spray may increase the light saturated net CO_2 assimilation rate.

Scanning Electron Microscope

SEM performed in ESEM mode to discover the bacterial size, shape and phyllosphere population. The SEM clearly shows that *P. aeruginosa* has grown on upper leaf surface and PPFM has mostly presented in stomata region (Figure.1&2). The *P. aeruginosa* SEM image was confirmed with similar finding which already demonstrated by Morris *et al*. (2004). The PPFM SEM image furnished that colonies were induce the stomatal closure over lower surface of the leaves and it's already reported in rice by Kim *et al*. (2010).

Tube Nucleation Test

The ice nucleation potential tested for two bacteria's, of which *P. aeruginosa* was more efficient than PPFM. *P. aeruginosa* catalyzed the super-cooled buffer at – 2 to -10°C (Figure. 3), while PPFM was unable to catalyze the super cooled buffer even after 3 h. *Pseudomonas* species *P.aeruginosa* is well known to facilitate ice nucleation formation Michaud *et al*. (2004).
The presence of INA bacteria in phyllosphere regions of a plant that could mitigate the plant under scanty moisture conditions and also play an important role in nucleation process which is required for rainfall process.

Table 1. Impact of irrigation regimes and microbes on photosynthetic rate of tomato

Treatments	Photosynthetic Rate (µmol $CO_2/m^2/s$)											
	1 DAS			5 DAS			10 DAS			15 DAS		
	M1	M2	Mean	M1	M2	Mean	M1	M2	Mean	M1	M2	Mean
I1	30.1	30.6	30.3	32.9	31.1	32	40.1	36.5	38.3	34.8	31.0	32.9
I2	31.2	30.8	31.0	31.9	31.9	31.9	39.5	38.6	39.1	39.5	37.2	38.3
I3	30.6	32.7	31.6	32.9	35.8	34.35	36.6	47	41.8	32.7	31.2	31.9
Mean	30.6	31.6		32.5	32.9		38.7	40.7		35.6	33.1	
	M	I	M x I	M	I	M x I	M	I	M x I	M	I	M x I
SEd	0.23	0.28	0.40	0.24	0.3	0.42	0.29	0.36	0.51	0.25	0.3	0.43
CD (*P*=0.05)	0.50	0.61	0.87	0.52	0.64	0.91	0.63	0.77	1.1	0.53	0.65	0.92

Note: M1 – *P. aeruginosa;* M2 – PPFM; I1 – 0.6 IW /CPE ratio; I2 – 0.8 IW /CPE ratio; I3 – 1.0

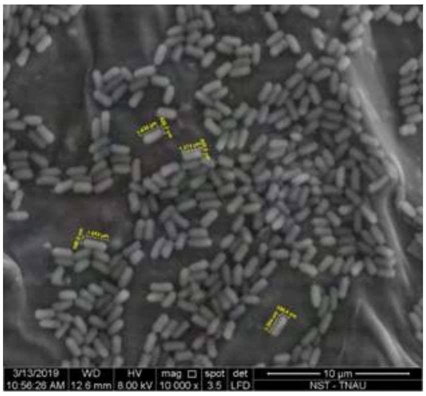

Figure 1. SEM image of upper leaf after inoculation of *Pseudomonas aeruginosa*

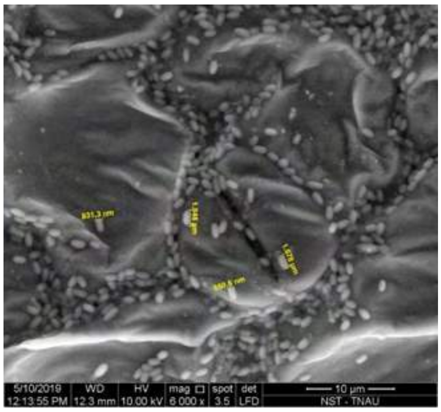

Figure 2. SEM image of lower leaf after inoculation of PPFM

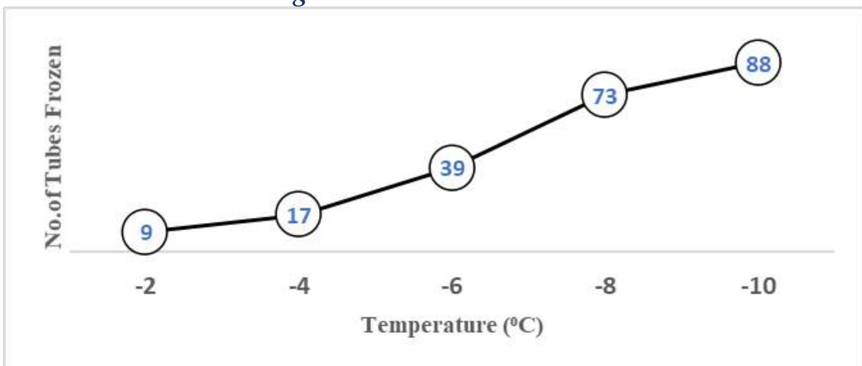

Fig 3. *P. aeruginosa* catalyzed the super-cooled buffer, while PPFM was unable to catalyze the super cooled buffer even after 3 h.

Reference

Guna, M., S. Panneerselvam, K. S. Subramanian, A. S. Krishnamoorthy, and A. Lakshmanan. 2019. "Role of phyllosphere microbes in Ice Nucleation Activity and Its impact on drought mitigation of tomato." *Madras Agricultural Journal*"106. doi:10.29321/MAJ 2019.000248

Stopelli, Emiliano, Franz Conen, Lukas Zimmermann, Christine Alewell, and Cindy E. Morris. 2014. "Freezing nucleation apparatus puts new slant on study of biological ice nucleators in precipitation." *Atmospheric measurement techniques* 7, no. 1: 129-134.

Influence of Plant Growth Regulators and Nutrients on Growth Parameters and Yield of Pigeonpea

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Keywords: *Foliar application, leaf area index, crop growth rate, seed yield*

Introduction

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is one of the major grain legume crops of the world. It is the second most important pulse crop after chickpea in India. In pigeon pea, vegetative and reproductive stage occurs side by side and hence always there is competition for available assimilates between vegetative and reproductive sinks. On the other hand, there is a limitation of source (leaves) particularly at flowering and pod development stages. The use of plant growth regulators has therefore been described as the most important tool of the agriculturist to increase crop yields.

Methodology

A field experiment was conducted with pigeonpea (CO Rg 7) under irrigated condition in Tamil Nadu Agricultural University, Coimbatore. The experiment was laid out in factorial randomized block design (FRBD) with three replication. The treatments consisted of growth retardants *viz.*, mepiquat chloride and chlormequat chloride, each 500 ppm sprayed at vegetative stage and different PGRs (Salicylic acid @ 100 ppm, Brassinosteroid @ 0.1 ppm, NAA @ 40 ppm), Nutrients ($ZnSO_4$ @ 0.5 % + Boric acid @ 0.3%, MAP @ 2%, TNAU Pulse Wonder @ 1%) and two Nutrient consortia mixture sprayed at flower initiation and 15 days thereafter. Leaf area index was calculated by employing the formula of Williams (1946). Specific leaf weight was calculated as per Pearce *et al.* (1968) and the values were expressed in mg cm^{-2}. The crop growth rate was estimated by using the formula of Watson (1956) and expressed in g m^{-2} day^{-1}. Seed yield per hectare was calculated from the mean plot yield and expressed in kg ha^{-1}.

Results and Discussion

Leaf area index (LAI)

Leaf area index was found significantly influenced with the application of growth regulators and nutrients at different growth stages **(Figure 1).** The data showed that Leaf area index was higher with the application of M_3 followed by M_2 when compared to M1. Among the treatments (T_1-T_9), T_8 recorded highest Leaf area index followed by T_9- Nutrient consortia-2 and T_7- TNAU Pulse wonder (1%). With respect to the interactions between the treatments M_3T_8 showed the maximum Leaf area index (1.358, 1.561) at flowering and pod filling stages.

Specific Leaf Weight (SLW; mg cm^{-2})

The effect of growth regulators and nutrients on Specific leaf weight was found significantly influenced in pigeonpea at different growth stages (**Figure 2**). The higher Specific leaf weight was recorded in M_3 treated plants compared to M_2 and M_1. Among the treatments, T_8 registered higher Specific leaf weight followed by T_9- Nutrient consortia-2 and T_7- TNAU Pulse wonder (1%).The interactions between the treatments M_3T_8 showed highest Specific leaf weight (7.29, 10.34 mg cm^{-2}) compared to control at both stages.

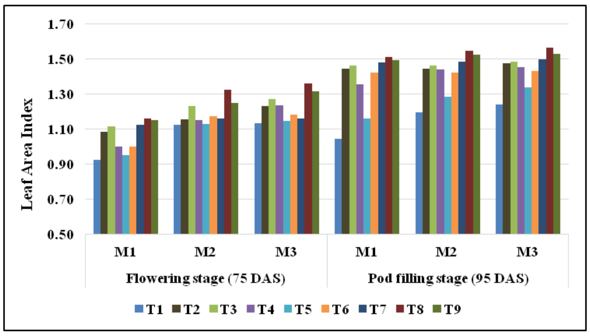
Crop Growth Rate (CGR; g cm^{-2} day^{-1})

Crop growth rate was found significantly influenced with the application of growth regulators and nutrients at different growth stages **(Figure 3).** Among the treatments (T_1-T_9), T_8 recorded highest crop growth rate followed by T_9- Nutrient consortia-2 and T_7- TNAU Pulse wonder (1%). With respect to the interactions between the treatments M_3T_9 showed the maximum crop growth rate (7.95 g cm^{-2} day^{-1}) at flowering and pod filling stages.

Seed yield per hectare (kg ha^{-1})

The effects of growth retardants and PGRs or nutrients spray at different growth stages of pigeonpea on seed yield per hectare is presented in Figure 4. Overall, the foliar application of Chlormequat chloride (500 ppm) at vegetative stage has significantly increased the grain yield per hectare (1133 kg ha^{-1}) compared to unsprayed control.

It is concluded from the present study that, application of combined formulation of hormones and nutrients present in the nutrient consortia at flowering and pod formation stage have influenced the growth attributes and resulted in higher seed yield.



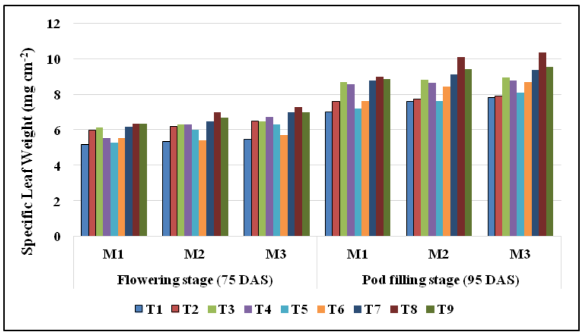
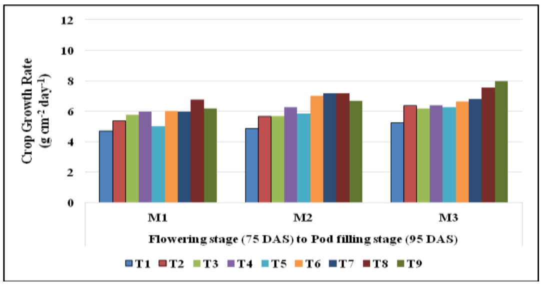


Figure 1 & 2 Leaf area index and Specific leaf weight at flowering and pod filling stages



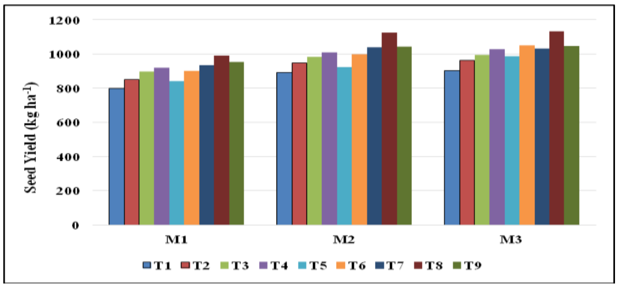


Figure 3 & 4 Crop growth rate and Seed yield per hectare at different growth stages

Reference

Williams, SRF. 1946. "Methods of growth analysis." *Plant photosynthetic production manual and methods, Drow, Jenk, NU Publishers,* ***The Hague***: 348-391.

Pearce, RB, RH Brown, and RE Blaser. 1968. "Photosynthesis of Alfalfa Leaves as Influenced by Age and Environment 1." ***Crop Science*** 8 (6):677-680.

Watson, DJ. 1956. "Comparative physiological studies on the growth of field crops I. Variation in net assimilation rate and leaf area between species and varieties and within and between years." ***Annals of botany*** 11:41-46.

Isolation of High Yielding Early Mutants of Sesame (*Sesamum indicum L.*) Based on the relationship between Traits Governing the Yield and Earliness

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Keywords: *sesame, mutation, earliness, yield*

Introduction

Sesame (*Sesamum indicum* L.), a member of the Pedaliaceae family, is a traditionally cultivated oilseed crop called "Queen of oilseed" because of its high oil content (45-55 %), quality edible oil with rich nutritional quality (Navaneetha *et al*,2019). Due to the indeterminate nature of the crop and the inability to adopt mechanical harvesting of sesame done manually. The early maturity characteristic in sesame important for the crop can escape from biotic and abiotic stresses before it occurs, efficient usage of nutrients, avoiding monsoonal problems and uniform maturity reduce capsule shattering losses, and adopt mechanical harvesting (Yousif and Babiker 2018). With this backdrop, the study was carried out to isolate early maturing putative mutants with uniform maturity and high yield based on different selection criteria and study the association of these traits with yield.

Methodology

The genetically pure seeds of white seeded sesame variety VRI 3 were obtained from Agricultural Research Station, Virudhachalam, and used for this study. In this experiment, both gamma-ray treatment and gamma + EMS combinational treatments were used. Totally six treatments were T_1 -300 Gy, T_2- 350 Gy, T_3- 400 Gy, T_4 - 300 Gy + 10 mM EMS, T_5 - 350 Gy + 10 mM EMS and T_6 - 400 Gy + 10 mM EMS. Five capsules from each plant of M_1 generation were forwarded to M_2 generation and raised during summer 2020 with normal spacing (30 × 30 cm). The yield and earliness related traits *viz.*, Height at the beginning of flowering (HTBF), Height at the termination of flowering (HTTF), Days to the beginning of flowering (DBF), Days to termination of flowering (DTF), Number of nodes at the beginning of flowering (NOBF), Numbers of nodes at the termination of flowering (NOTF), Degree of stem termination (NOTF-NOBF), Flowering period (DOTF-DOBF), Growth during flowering (HTTF-HTBF), Number of capsules per plant (NOC), Capsule length (CL), Single plant yield (SPY) and Crop period (CP) were observed in all the mutants of M_2 plants (Wongyai 1997). The relationship between earliness and yield-related traits was assessed using correlation and path analysis.

Results and Discussion

The putative early mutants were grouped into low, medium, and high variants based on their single plant yield (SPY). The traits were recorded for all the 14 putative early mutants. Wide variation was observed in the trait values for low (< 4 g), medium (4.1-8 g), and high (>8 g) SPY putative mutants. The high SPY group registered higher values than the low and medium SPY groups for most observed traits. The high SPY group recorded higher values for the traits *viz.*, height at the termination of flowering, growth during flowering, number of nodes at the termination of flowering, degree of stem termination, number of capsules, and capsule length **(Fig 1)** than the low and medium SPY group. The uniformity-related trait of the 'flowering period' was found to be positively correlated with nodes at the termination of flowering (NOTF) and growth during flowering (GF) and capsule length (CL) (**Fig 2**). we conclude that for obtaining high yielding early sesame mutants/lines, selection should mainly be focused on the increased height at the beginning of flowering (HTBF), reduced days to the beginning of flowering (DBF) with the short flowering period (FP) in addition to other yield-related traits *viz.*, a higher number of capsules (NOC) and long capsules (CL). Also, it was observed that the tri-leaf trait increased single plant yield. So, selection based on the above-mentioned combination of traits will help achieve high-yielding, early and uniform maturing sesame lines for future breeding program.

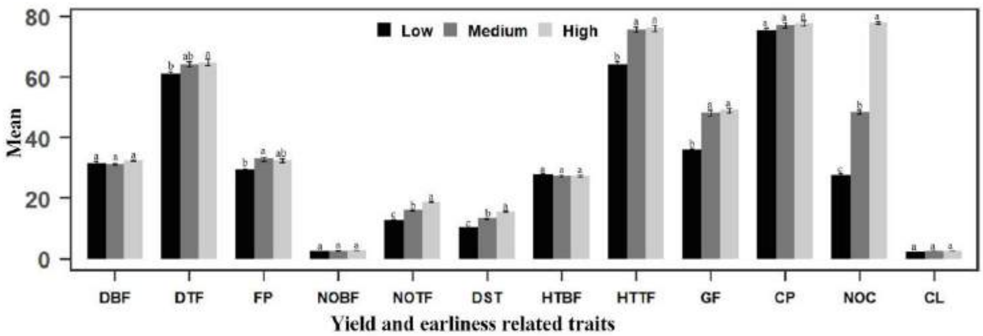
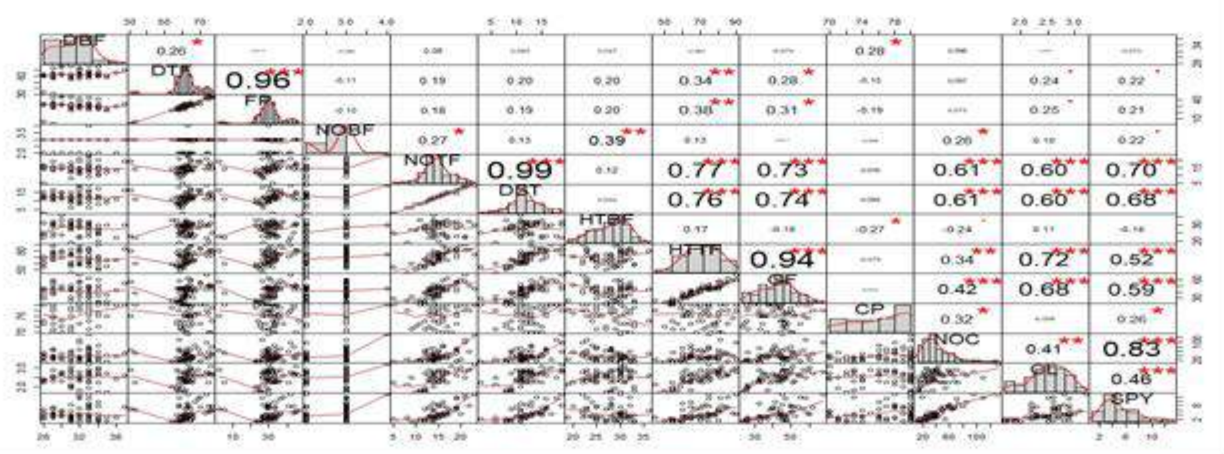


Fig 1. Trait values of low, medium, and high single plant yielding early mutants



(**, **, * indicate significant level on 0.001,0.01 and 0.05 %)

Fig 2. Correlation of earliness and yield-related traits

Reference

Navaneetha, J., E. Murugan, and C. Parameswari. 2019. Correlation and path analysis for seed yield and its components in sesame (Sesamum indicum L.). ***Electronic Journal of Plant Breeding.***, 10 (3):1262-1268.

Wongyai, W. 1997. Evaluation of stem growth termination in sesame. ***Sesame and Safflower Newsletter.***, 12:51-54.

Yousif, L.A., and E.H. Babiker. 2018. Estimation of sesame mechanical harvesting losses in the mechanized rainfed areas of Eastern Sudan. ***Gezira Journal of Agricultural Science.***, 14 (2).

Mitigation of Abiotic Stress in Rice by Xerophytic Microorganisms

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Keywords: *Bacillus, In-vitro, Isolates, Xerophytes*

Introduction

One of the major constraints faced in agriculture these days is drought. One alternative way for growing crops under dry conditions is to utilize microflora obtained from xerophytes. These microfloras are naturally adapted to moisture stress conditions. In a previous study, efficient drought mitigating xerophytic microbes were isolated and were identified as *Bacillus aryabhattai* APSB18 (MT729997), *Bacillus velezensis* VKSB5 (MT729963) and *Bacillus altitudinus* MLSB2 (MT729964) (Karvembu *et al.*, 2020). In this study, these microbes were utilized to enhance the germination and seedling establishment of Rice (CO 51) under moisture stress conditions.

Methodology

In vitro assessment of plant growth under moisture stress

Rice seeds were surface sterilized and colonized with drought tolerant strains (10^8 cells/g). The seeds were shade dried and sown in sterilized germination sheet. 25 seeds were placed in moistened paper towel which is placed in containers with solutions of different mannitol concentrations. Different concentration of mannitol was used to impose moisture stress in the following levels of water potential (-0.3, -0.6 and -1.2 MPa). Water stressed seedlings and their corresponding unstressed controls were observed after 15 days of exposure to drought.

Antioxidant enzyme assays in moisture stressed seedlings:

Freshly collected leaves were homogenized by liquid nitrogen and one gram of the powdered leaf samples were added with 1.5 ml of 50mM sodium phosphate buffer, containing 4% polyvinylpyrrolidine, 5mM β-mercaptoethanol and 2mM EDTA at pH 7.0 in test tubes and mixed well. The samples were centrifuged for 30 min at 12,000 rpm. The collected supernatant was used for enzyme studies. CAT activity was measured following the method of (Elavathi and Martin, 2010). POD activity was measured using the guaiacol oxidation method (Chance and Maehly, 1955).
T1- Uninoculated control, T2- *Bacillus altitudinis,* T3- *Bacillus aryabhattai,* T4- *Bacillus velezensis* T5- *Bacillus altitudinis* FD48 S1- Without moisture stress, S2 -(-0.3Mpa), S3- (-0.6Mpa), S4- (-1.2 Mpa)

Results and Discussion

The treated seedlings showed higher germination and growth traits both with and without moisture stress. Among the treatments, seedlings treated with *Bacillus altitudinis* (T_2) showed the highest germination percentage (96% at -1.2 Mpa) and growth traits (13.9 cm root length and 6.8 cm shoot length at -1.2Mpa) among the xerophytic isolates and was on par with standard culture used, which is *Bacillus altitudinis* FD48 (T_5) (Table 1). The treated seedlings showed higher enzyme activity than non-treated plants in both stressed and non-stressed conditions. Among the selected strains *Bacillus altitudinis* (T_2) showed the highest activity of 19.9 U min-1 g-1 FW for CAT and 21.8 U min-1 g-1 FW for POD at-1.2Mpa (Fig1).

Table 1. ***In vitro*** **assessment of plant growth under moisture stress**

Treatment	Germination%*	Root Length (cm)*	Shoot Length (cm)*	Seedling Vigour
T1S1	100	17.5	9.7	2720
T2S1	100	20.5	11.5	3200
T3S1	100	18.4	10.7	2910
T4S1	100	18	10.4	2840
T5S1	100	19.7	11.8	3150
T1S2	100	13	7.5	2050
T2S2	100	17.5	10.4	2790
T3S2	100	15.5	8.9	2440
T4S2	100	14.6	8.4	2300
T5S2	100	16.9	10.1	2700
T1S3	96	11.8	6.4	1747.2
T2S3	100	16.9	8.6	2550
T3S3	100	15.1	8.2	2330
T4S3	96	14.3	7.7	2112
T5S3	100	16.2	8.7	2490
T1S4	88	8	4.7	1117.6
T2S4	96	13.9	6.8	1987.2
T3S4	92	12.2	6.4	1711.2
T4S4	92	11.2	6.2	1600.8
T5S4	96	13.8	6.7	1968
SE	0.793	0.691	0.437	122.597

*mean of three replications

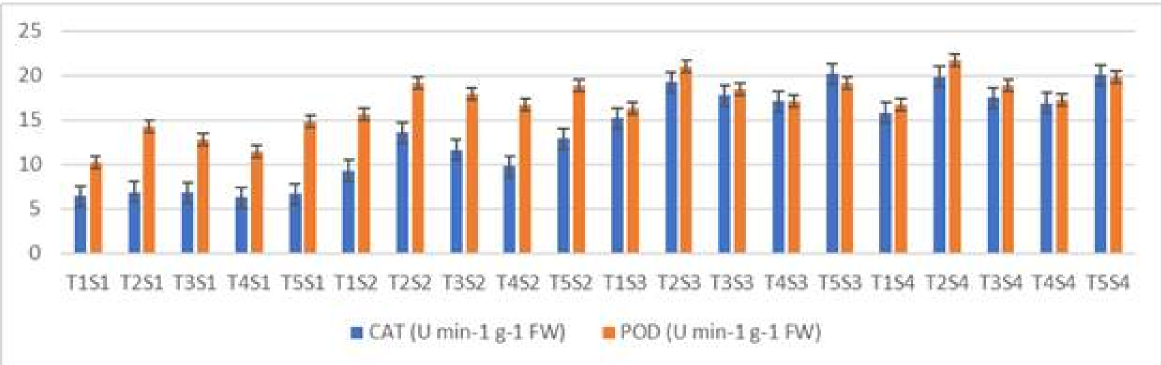

Fig 1 Antioxidant enzyme assays in moisture stressed seedlings

Reference

Chance, B., & Maehly, A. C. (1955). Assay of catalases and peroxidases. U: Methods in Enzymology. Colowick SP, Kaplan NO, (ur.).

Elavarthi, S., & Martin, B. (2010). Spectrophotometric assays for antioxidant enzymes in plants. In *Plant Stress Tolerance* (pp. 273-280). Humana Press.

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Karvembu, P., Gomathi, V., Anandham, R., & Mary, J. K. (2020). Isolation, screening and identification of moisture stress tolerant Rhizobacteria from xerophyte Prosopis juliflora (Sw). *Journal of Pharmacognosy and Phytochemistry*, 9(6), 605-609

Productivity of Chilli Crop under Climate Change

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Keywords: *Climate change, chilli, crop simulation model*

Introduction

Climate change hurdles the growth of any economy especially the agricultural sector. For a horticultural spice crop like chilli which is abundantly produced, consumed and exported in India, the future climate could pose threat to the productivity. Climate change is for sure to hit the horticultural sector also. Spices which are "high value-low volume" crops will be definitely be affected in the gamble of climate change. For a crop like chilli which is both spice and vegetable the value gets added to target on climate change studies. The future scenarios of extremities in temperature and precipitation with summer droughts would be the major production reducers of chilli crop. So, a resilient crop is the need of the hour to face the grievances of climate change, especially for an agricultural country like India. When chilli is grown as a rainfed regional crop, the farmers who endure the vagaries of monsoon can still be profited with this explicable crop to sustain the dry land production.

Methodology

The impact of climate change on chilli crop over Tamilnadu state was understood with the yield projections until 21st century being estimated with DSSAT crop simulation model using CCSM4 climate data that was downscaled from RegCM 4.4 under RCP 4.5 scenario.

Results and Discussion

Future projection if chilli yield was estimated using DSSAT crop simulation model (Table 1) where it could be found that the yield tends to fluctuate during the decadal scale. But down the century time scale, there had been a decline in crop yield by – 3.9 per cent (near), - 6.7 per cent (mid) and – 5.4 per cent (end) respectively (Figure 1). As explained by Ramraj (2014) and Pradipa (2016) the excess rainfall condition during the mid-century could be a possible reason for a higher yield decline and changing climate could have negatively influenced the chilli yield in all the time scales. This decline could be due to the adverse effects of climate change *viz*., increasing temperatures, irregular rainfall patterns, seasonal shifts in cropping *etc*. which is to be studied and addressed for adaptation measures.

Table 1. Decadal productivity of chilli crop

Century time scale	Year	Decadal Yield (kg/ha)	Century time slice Yield (kg/ha)	Percentage Deviation (%)
	1971-1980	1272		
BASE	1981-1990	1306	1282	
	1991-2000	1269		
	2001-2010	1245		
	2011-2020	1184		
NEAR	2021-2030	1248	1232	-3.9
	2031-2040	1266		
	2041-2050	1209		
MID	2051-2060	1205	1196	-6.7
	2061-2070	1175		
	2071-2080	1240		
END	2081-2090	1283	1213	-5.4
	2091-2099	1116		

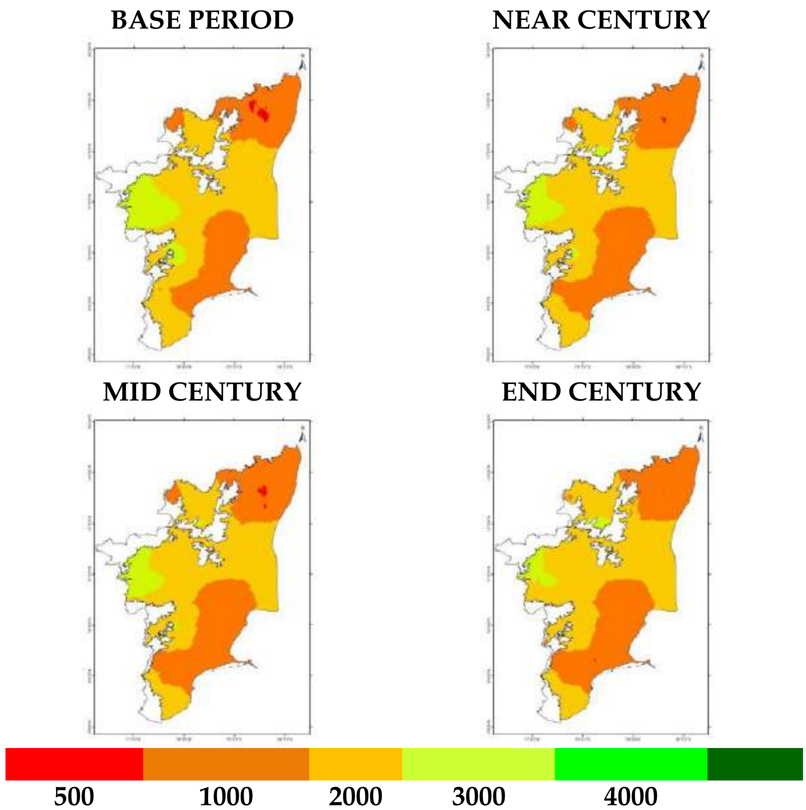

Fig 1. Spatial distribution chilli yield

Reference

Ramraj, A.P. 2014. "Integrated assessment of cascading uncertainty in climate and crop models." PhD (Agricultural Meteorology and Climatology), Agro Climate Research Centre, Tamil Nadu Agricultural University.

Pradipa, C. 2016. "Sustaining Pulse Production in changing climate over Tamil Nadu." Ph. D (Meteorology), Agro Climate Research Centre, Tamil Nadu Agricultural University.

Response of Transplanted Finger Millet to Weed Management Practices under Sodic Soil Condition

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Keywords: *Transplanted finger millet, weed management practices, growth, yield*

Introduction

Finger millet production requires a lot of labour, particularly for weed management practices. Prashanth Kumar *et al.* (2015) opined that use of herbicides for controlling weeds is now gaining importance in Indian agriculture due to the labour scarcity at critical stages of crop growth and increased wages. The increase in yield provided higher monetary returns, similarly when compared to unweeded control, considering the gross return and cost of weed management practices, the benefits accrued due to weed management was considerably higher.

Methodology

Field experiment was conducted during *Kharif*, 2018 at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli, Tamil Nadu. The field experiment was laid out in randomized block design (RBD) with three replications and ten treatments. The finger millet variety used for the experiment was TRY 1.

Results and Discussion

Adoption of different weed management practices improved the growth parameters (plant height, total number of tillers/m^2, dry matter production), physiological parameters (Leaf area index), grain and straw yields of transplanted finger millet. The increased plant height (43.8, 90.9 and 98.1 cm), higher number of total tillers/m^2 (137, 181 and 198/m^2), dry matter production (1112, 6036 and 9822 kg/ha), higher LAI (2.24, 4.26 and 3.64) at vegetative, flowering and harvest stages respectively, earliness (51 DAT) in 50% flowering, higher grain and straw yields (3560 and 6617 kg/ha) were recorded in PE application of bensulfuron methyl at 60 g/ha + pretilachlor at 600 g/ha *fb* EPOE bispyribac sodium at 25 g/ha. This might be due to reduced weed competition and increased availability of resources like nutrients, soil moisture and light which resulted in maximum LAI, thereby increasing the photosynthetic activity, ultimately resulting in increased growth of crops. This is in consonance with the findings of Satish *et al.* (2018) and Rathika and Ramesh (2019).

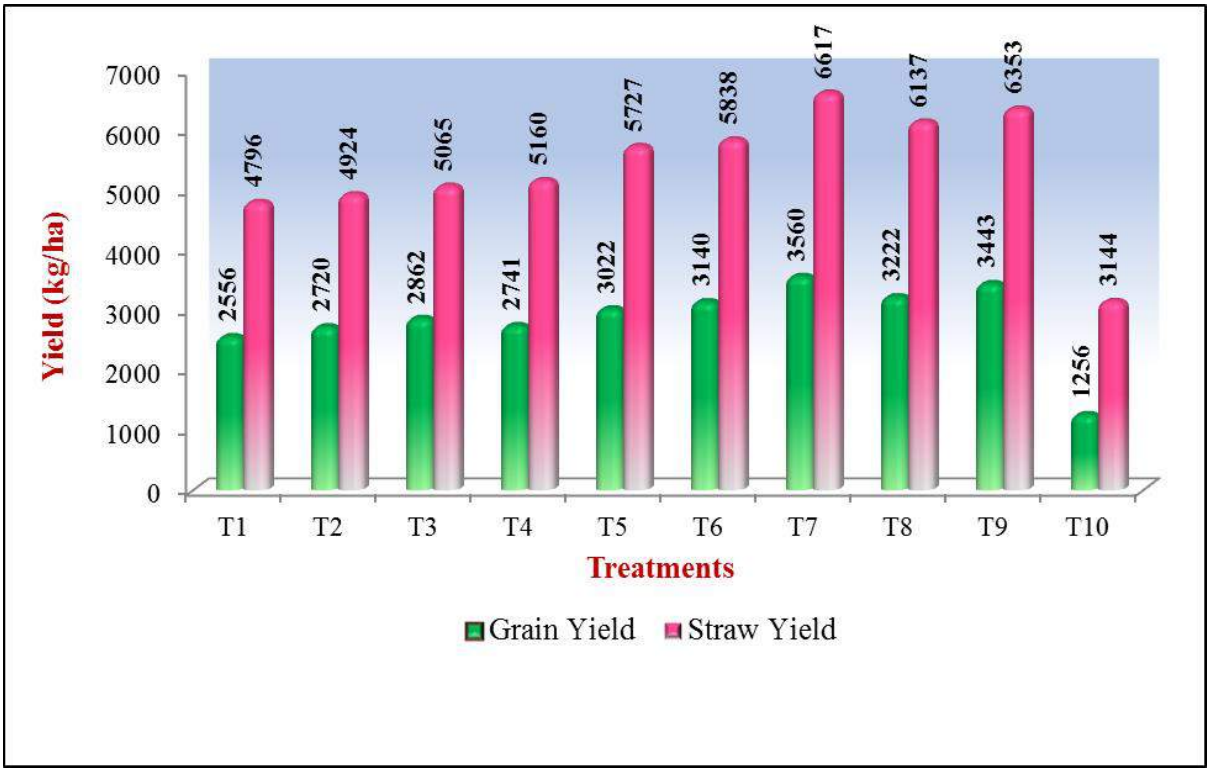

Fig 1. Effect of weed management practices on yield of transplanted finger millet

Reference

Prashanth Kumar, M. K., B. G. Shekara, Sunil, C. M. and B. G. Yamuna. 2015. Response of drill sown finger millet [*Eleusine coracana* (L.)] to pre and post emergent herbicides. ***The Bioscan,*** 7(2): 45-67.

Rathika. S. and T. Ramesh. 2019. Weed management in direct wet seeded rice. ***Journal of Pharmacognosy and Phytochemistry,*** SP2: 978-981.

Satish, P., R. K. Lakra, K. Nargis, Alam, P. and A. N. Puran. 2018. Weed management on direct seeded finger millet (*Eleusine coracana* L.) under rainfed condition of Jharkhand. ***International Journal of Current Microbiology Applied Sciences,*** (special issue-7): 844-850

Screening of Spary Fluid for Herbicide Application for Drones in Irrigated Maize (*Zea mays* L.)

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Keywords: *Weed control efficiency, atrazine, tembotrione, 2,4-D, phytotoxicity, spray fluid*

Introduction

Among different weed management options, chemical weed management is turning out to be more reliable in maize. Hand spraying consumes more spray volume. In order to save water, time and energy, spraying by drones is the best alternate method for application of herbicides. The present investigation was conducted to understand the impact of spray fluid for herbicides on phytotoxicity, identification of spray fluid and WCE in maize (*Zea mays* L.)

Methodology

A field experiment was conducted at eastern block farm, Tamil Nadu Agricultural University, Coimbatore during *summer* season (March 2021) on maize variety COH(M)8. The study was carried out with 30 treatments laid out under Randomized complete block design with two replications with the plot size of 1x1 meter. T_1-T_{10} contains RD (recommended dosage) of PE (pre−emergence) Atrazine 1 kg a.i/ha on 3 DAS (Days After Sowing)- EPoE (early post emergence) Tembotrione 120g a.i/ha on 15-20 DAS - PoE (post emergence) 2,4-D 75g/ha on 25-30 days with spray fluid of 20,30,40,60,80,100,200,300,400 and 500 l ha^{-1}, T_{11}-T_{20} contains 125% or 75% of RD of PE - EPoE with spray fluid of 20,30,40,60 and 80 l ha^{-1} each and T_{21}-T_{30} contains 125% or 75% of RD of PE - PoE with spray fluid of 20,30,40,60 and 80 l ha^{-1} each. The observations were recorded on 3, 5, 7 and 9 days after PE, EPoE and PoE herbicide treatments. The phytotoxic effect of herbicides was assessed by rating scale of 0 to 10 (equal to 0 to 100%) as suggested by Rao (2000), where 0 indicates no injury and 10 indicates complete destruction. Weed density and weed dry weight were recorded. Weed count was recorded by placing quadrats in each plot. The weeds present within the quadrats were collected and dried in hot-air oven at 80^{0}C for 72 hrs. The weed density and weed dry weight were analysed after transforming the data by square root transformation [$\sqrt{x+0.5}$].

Results and Discussion

Phytotoxicity and crop injury scoring

The treatment involving early post-emergence herbicide tembotrione resulted in severe injury, which was assigned a score of 5-4 up to 9 DAA (Days after Application). EPoE tembotrione showed severe stunting, discolouration and tip burning which were pronounced on 7 DAA. T_8,T_9,T_{17},T_{19},T_{20} show slight stunting up to 7 DAA and recovered later. PoE 2,4- D caused stunting of plant, growth reduction. Crop injury scoring was very high in T_9,T_{10},T_{11},T_{13},T_{15}, T_{18}, T_{19} and T_{20}. RD of atrazine, oxyflurofen, pendimethalin and topramezone, 2, 4-D, tembotrione resulted in no phytotoxic effect. This was in accordance with Veeresh hatti *et al.* (2014)

Weed control efficiency

The experiment revealed that based on phytotoxicity, highest WCE and reduced spray fluid treatments of T_5,T_6,T_7 and T_8 were selected for drone application. GuobinWang *et al.*,(2019) stated the an optimal control efficacy using the UAV was obtained at >16.8 l ha^{-1} with systemic insecticide. T_1,T_2,T_3,T_4,T_5,T_6,T_7 and T_8 showed no phytotoxicity and obtained optimum WCE but it was not suitable for drone application.

Table 1. Effect of weed management on weed control efficiency (%) in maize at 20 and 40 DAS

Treatments	WCE (%)	
	20 DAS	40 DAS
T_1 -RD of PE Atrazine - EPoE Tembotrione - PoE 2,4 D (spray fluid 500 lit of water ha $^{-1}$)	0	0
T_2- RD of PE Atrazine - EPoE Tembotrione - PoE 2,4 D (spray fluid 400 lit of water ha $^{-1}$)	61.26	74
T_3- RD of PE Atrazine - EPoE Tembotrione - PoE 2,4 D (spray fluid 300 lit of water ha $^{-1}$)	55.85	66
T_4- RD of PE Atrazine - EPoE Tembotrione - PoE 2,4 D (spray fluid 200 lit of water ha $^{-1}$)	62.16	56
T_5- RD of PE Atrazine - EPoE Tembotrione - PoE 2,4 D (spray fluid 100 lit of water ha $^{-1}$)	69.36	72
T_6- RD of PE Atrazine - EPoE Tembotrione - PoE 2,4 D (spray fluid 80 lit of water ha $^{-1}$)	81.08	76
T_7- RD of PE Atrazine - EPoE Tembotrione - PoE 2,4 D (spray fluid 60 lit of water ha $^{-1}$)	85.58	84
T_8- RD of PE Atrazine - EPoE Tembotrione - PoE 2,4 D (spray fluid 40 lit of water ha $^{-1}$)	92.79	88
T_9- RD of PE Atrazine - EPoE Tembotrione - PoE 2,4 D (spray fluid 30 lit of water ha $^{-1}$)	84.68	96
T_{10}- RD of PE Atrazine - EPoE Tembotrione - PoE 2,4 D (spray fluid 20 lit of water ha $^{-1}$)	60.36	58
T_{11}- 125% of RD of PE Atrazine - EPoE Tembotrione (spray fluid 80 lit of water ha $^{-1}$)	27.92	76
T_{12}-75% of RD of PE Atrazine - EPoE Tembotrione (spray fluid 80 lit of water ha $^{-1}$)	56.75	64
T_{13}- 125% of RD of PE Atrazine - EPoE Tembotrione (spray fluid 60 lit of water ha $^{-1}$)	51.35	54
T_{14}-75% of RD of PE Atrazine - EPoE Tembotrione (spray fluid 60 lit of water ha $^{-1}$)	45.04	78
T_{15}- 125% of RD of PE Atrazine - EPoE Tembotrione (spray fluid 40 lit of water ha $^{-1}$)	9.00	48
T_{16}- 75% of RD of PE Atrazine - EPoE Tembotrione (spray fluid 40 lit of water ha $^{-1}$)	89.18	86
T_{17}- 125% of RD of PE Atrazine - EPoE Tembotrione (spray fluid 30 lit of water ha $^{-1}$)	78.37	74
T_{18} -75% of RD of PE Atrazine - EPoE Tembotrione (spray fluid 30 lit of water ha $^{-1}$)	83.78	80
T_{19}- 125% of RD of PE Atrazine - EPoE Tembotrione (spray fluid 20 lit of water ha $^{-1}$)	84.68	80
T_{20}- 75% of RD of PE Atrazine - EPoE Tembotrione (spray fluid 20 lit of water ha $^{-1}$)	60.36	58
T_{21}- 125% of RD of PE At - PoE 2,4 D (spray fluid 80 lit of water ha $^{-1}$)	63.06	46
T_{22}-75% of RD of PE Atrazine - PoE 2,4 D (spray fluid 80 lit of water ha $^{-1}$)	60.36	46
T_{23}-125% of RD of PE At - PoE 2,4 D (spray fluid 60 lit of water ha $^{-1}$)	58.55	58
T_{24}-75% of RD of PE Atrazine - PoE 2,4 D (spray fluid 60 lit of water ha $^{-1}$)	46.84	68
T_{25}-125% of RD of PE At - PoE 2,4 D (spray fluid 40 lit of water ha $^{-1}$)	77.47	66
T_{26}-75% of RD of PE Atrazine - PoE 2,4 D (spray fluid 40 lit of water ha $^{-1}$)	39.63	58
T_{27}- 125% of RD of PE At - PoE 2,4 D (spray fluid 30 lit of water ha $^{-1}$)	30.63	38
T_{28}- 75% of RD of PE Atrazine - PoE 2,4 D (spray fluid 30 lit of water ha $^{-1}$)	39.63	40
T_{29}- 125% of RD of PE At - PoE 2,4 D (spray fluid 20 lit of water ha $^{-1}$)	22.52	24
T_{30}- 75% of RD of PE Atrazine - PoE 2,4 D (spray fluid 20 lit of water ha $^{-1}$)	1.80	6

Reference

GuobinWang, Yubin Lan, Haixia Qi,Pengchao Chen, Andrew Hewittd and Yuxing Han (2019). Field evaluation of an unmanned aerial vehicle (UAV) sprayer: Effect of spray volume on deposition and the control of pests and disease in wheat, *Society of Chemical Industry Pest Manag Sci 2019.*

Veeresh hatti, M, T. Sanjay, V. Ramachandra prasad, K. N. Kalyana murthy, Basavaraj kumbar and M. K. Shruthi (2014). Effect of new herbicide molecules on yield, soil microbial biomass and their phytotoxicity on maize (zea mays l.) Under irrigated conditions *an international quarterly journal of life sciences* 9(3): 1127-1130, 2014.

Screening of Groundnut (*Arachis hypogaea* l.) Genotypes for Iron Absorption/ Use efficiency in Nutrient solution Culture based on Morpho - Physiological Responses

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Keywords: *Screening, Arachis hypogaea, calcareous soils*

Introduction

Groundnut (*Arachis hypogaea* L.) is a significant food legume and oilseed crop, cultivated on an area of 295 lakh ha worldwide, producing 487 lakh tonnes. India ranks first in Groundnut acreage, with a cultivated area of 47 lakh hectares, producing 66.9 lakh tonnes and with a low productivity of 1422 kg ha^{-1} (FAOSTAT 2019). Calcareous soils are ubiquitous, with an estimated 800 million hectares globally, with the majority concentrated in arid or Mediterranean regions. The IDC is more prevalent in Gujarat, Maharashtra, Rajasthan, Tamil Nadu, and Karnataka states in India, causing a significant reduction in pod yield (15–32 percent). Iron is the fourth most abundant element on the earth's crust, followed by oxygen, silicone and aluminium. Despite its abundance in nature, iron (Fe) is not readily available in reduced ferrous form (Fe^{2+}) and reduces crop yield (Kobayashi and Nishizawa, 2012). The identification and production of Fe-efficient genotypes can be a successful method for overcoming calcareous soil disorders and also for improving crop yield and quality (Imtiaz *et al.*, 2010).

Methodology

A solution culture experiment was conducted to evaluate the groundnut genotypes for lime induced chlorosis tolerance ($KHCO_3$ concentration of 15 mM, buffered with 1.5 g l^{-1} $CaCO_3$ was used to mimic calcareousness). To identify a suitable genotype for calcareousness through physiological indices was investigated to evaluate groundnut varieties. Seeds of Fourty groundnut genotypes were assessed for calcareous stress tolerance *in vivo* experiment. After 21 DAS plant morphological, enzymatic and physiological parameters were measured. All the data were converted to relative values, i.e. Fe tolerance indexes before cluster analysis. Fe tolerance index was defined as the observations under Fe deficiency divided by the means of the controls (Fe sufficient). Cluster analysis was performed and Cluster group rankings were obtained based on Ward's minimum variance cluster analysis on the means of the Fe tolerance indexes for different morphological and physiological parameters.

Results and Discussion

Based on multivariate analysis using Fe tolerance indexes in morphological and physiological parameters using Ward's minimum variance cluster analysis (Fig. 1), the genotypes were divided into seven cluster groups (Table.1). Based on this analysis varieties, TAG 24, CO 7, VRI 13113, VRI 16086, VRI 13149, JL 24 and TMV 1 ranked first falling in clusters ranked first with an averaged cumulative Fe tolerance indexes of 92.7 %, whereas TMV 13, AMABC 2017-8, VRI 16075 and VRI 13154 were among the stress sensitive genotypes with averaged Fe tolerance indexes of 80.51 %.

Table 1. Morphophysiological parameters were converted into mean Fe tolerance indexes. All the data was presented in relative values (%) calculated per plant.

Genotypes	ITI	Genotypes	ITI	Genotypes	ITI	Genotypes	ITI
CO 4	92.5	ALR 3	82.7	VRI- 13113	93.6	VRI 5	83.2
ALR 1	91.7	VRI 8	93.1	VRI- 16086	93.0	TMV 13	81.3
CO 1	90.7	TMV 2	93.1	VRI- 13149	91.8	AMABC 2017-8	80.8
VRI- 16083	90.1	ALR 2	92.6	JL 24	91.4	VRI- 16075	80.7
AMABC 2017-1	86.8	CO 6	92.4	TMV 1	90.5	VRI- 13154	79.3
VRI 6	86.4	DHARANI	92.2	VRI- 16084	87.2	ALG 320	85.0
ABHAYA	84.5	VRI- 13159	92.0	VRI- 13110	84.5	AVK 2015-3	83.7
VRI 2	84.3	VRI 7	91.2	VRI- 13153	84.1	INS - 2016 -10	84.9
GPBD - 4	84.0	TAG 24	94.6	TMV 7	83.7	ICGV 07772	84.7
CO 2	83.5	CO 7	94.0	AMABC 2017-2	83.4	NARAYANI	84.3

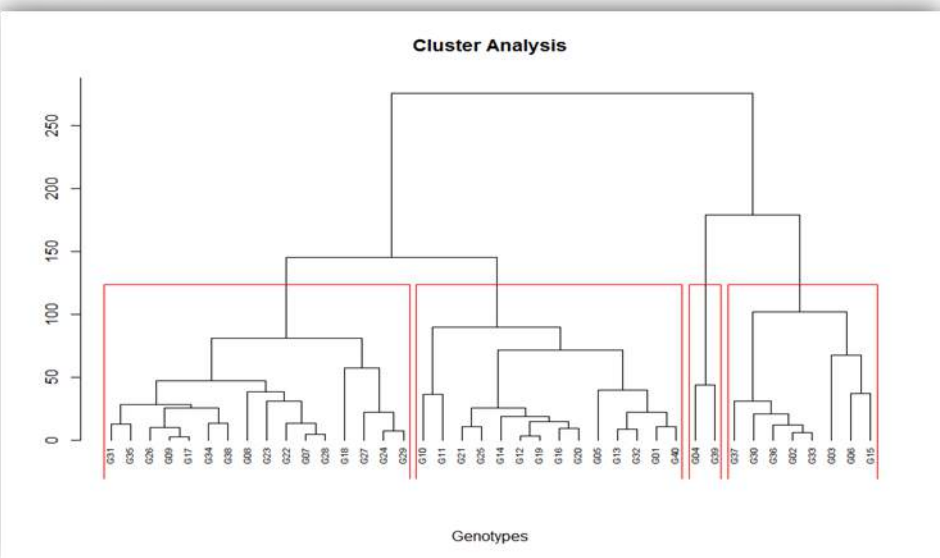

Figure.1. Multivariate analysis using Fe tolerance indexes in morphological and physiological parameters using Ward's minimum variance cluster analysis

Reference

FAOSTAT. 2019. "Food and Agricultural Organization (FAO) of the United Nations, FAO Statistical Database." *http://www.fao.org/india/fao-in-india/india-at-a-glance/en/*.

Imtiaz, M., A. Rashid, P. Khan, M. Memon, and M. Aslam. 2010. "The role of micronutrients in crop production and human health." *Pakistan Journal of Botany* 42 (4):2565-2578

Kobayashi, T., and N.K. Nishizawa. 2012. "Iron uptake, translocation, and regulation in higher plants: *Annual Review of Plant Biology*." 63:131-152.

Seed Coat Colour Assiciation with Physiological Parameters in Moringa (*Moringa olefiera* Lam.)

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Keywords: *Moringa, Seed quality, Seed coat colour*

Introduction

Moringa (*Moringa olefiera* Lam.) is well known for its medicinal and nutritional value. It is popularly cultivated for young seed pods, leaves and used as vegetable. Leaves of moringa contain significant measures of Fe, Ca, Cu, Mg and vitamins A, C and E. It alleviates the problem of undernourishment amidst women and children (Anwar *et al*., 2007, Beaulah and Mariappan, 2016). Moringa is fetching more attention as the world is becoming more aware of its uses. Seed colour is a simple and excellent indicator of seed quality. Association of seed colour with seed quality was reported by Srimathi and Malarkodi, 2002 in rice bean; Anuradha *et al*., 2009 in bengal gram; Latha *et al.,* 2013 in horse gram and Gulgun Yildiz Tiryaki *et al.,* 2016 in common vetch. Considering the importance of seed coat colour in various crops, studies were carried out to identify the effect of seed coat colour on seed quality in moringa var. PKM 1.

Methodology

The laboratory studies were carried out in the Department of Seed Science and Technology, Agricultural College and Research Institute, Madurai, Tamil Nadu, India during 2021.The fresh seeds of moringa var. PKM 1 were collected from Horticultural College & Research Institute, Periyakulam. Graded seeds of moringa were grouped into three colour groupings, on visual observation as dark brown, intermediate brown and light brown seeds. The following seed quality characters were recorded viz., germination (Percentage) (ISTA, 1999), root length (centimeter), shoot length (centimeter), dry matter production (g seedlings^{-10}) and vigour index (Abdul baki and Anderson, 1973). The data were analysed for significance as per Panse and Suchatme (1999).

Results and Discussion

Significant differences were observed between seed coat colour. Among the seed coat colour variations dark brown recorded higher seed quality parameters. The germination percentage was higher in dark brown (90 %) and lower values recorded in light brown (80 %). The vigour parameters like shoot length (18.5 cm), root length (9.5 cm), dry matter production (0.350 g) and vigour index (2520) were higher in dark brown seeds. The lower values recorded in light brown 14.00 cm, 5.8 cm, 0.320 g and 1386 of shoot length, root length, dry matter production and vigour index respectively. Similarly the influence of seed coat colour variations on bengal gram was studied by Anuradha *et al.,* 2009 and reported significant differences among colour grades for germination, seedling length and vigour index. Previous reports showed that phenolic compounds and light or loose adherence of the seed coat to the embryo influence rate of imbibition. In addition light coloured seeds were shown to have reduced germination and as darker seeds had higher, faster and more uniform germination (Pimpin *et al*., 2002).

It is concluded that dark brown seeds could be the preferred colour for moringa for future yield improvement programme.

Table 1: Effect of seed coat colour var. PKM 1 on germination percentage, root length, shoots length, DMP, Vigour Index I.

Treatments	Germination %	Shoot Length (cm)	Root Length (cm)	DMP (g seedlings^{-10})	Vigour Index I
T1-Bulk	84 (66.42)	15.14	6.12	0.334	1786
T2-Dark brown	90 (71.56)	18.50	9.50	0.350	2520
T3-Intermediate brown	86 (68.02)	16.20	6.70	0.337	1947
T4-Light brown	80 (63.43)	14.00	5.80	0.320	1386
SEd	1.077	0.257	0.104	0.005	38.19
CD (P=0.05)	2.35	0.596	0.226	0.009	83.22

(*Values in parentheses indicate arc sine transformed values)

Reference

Anuradha R, P. Balamurugan, P. Srimathi and S. Sumathi 2009. Influence of seed coat variations on seed quality in Bengal gram cv. CO 4 *Legume Res*., 32 (2): 136-138

Pimpin, F.M. F. Filippini, P. Sambo and G. Gianquinto 2002. "The effect of seed quality (seed colour variation) on storability, germination temperature and field performance of radicchio," *Seed Science and Technology*, 30, (2), Pp. 393-402.

Stomatal and Floral behavior affecting the Yield in Cotton Varieties under Drought Stress

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Keywords: *Cotton, TCH 1819, Drought, Stomata, floral traits and Yield*

Introduction

Cotton is one of the most important fiber crops playing a key role in the economic and social affairs of the world providing basic input to the textile industry. Worldwide, sustainability of cotton yield is the major challenge for meeting impending threats under climate change and abiotic stresses. Selection of cotton cultivars which survive and give better yields in water stress conditions have greater scope in India (Ashraf, 2010). With this background, present field experiment was taken up to study the floral and yield traits of two cotton varieties (TCH 1819 and KC3) after a brief drought during different stages.

Methodology

The present work was carried out during April – September, 2019 in the Rain Out Shelter (ROS) at Department of Forage Crops, TNAU, Coimbatore. The study comprised of pre-released compact Cotton culture TCH 1819 (Tamil Nadu Cotton *hirsutum*) and a check variety KC3 (Kovilpatti compodia3). The experiment had three treatments *viz.,* T1: Control (Well watered), T2: Drought at squaring stage, T3: Drought at flowering stage (level of stress - 55% moisture reduction from control) and monitored the soil moisture content by using sensors. At the end of the drought, observations were recorded on stomata, floral characters (Fig.1.) and yield traits (Table.1.).

Results and Discussion

Due to water stress, early flowering was observed in both the varieties. Check variety KC3 recorded its first floral bud emergence at the day of 50 and the plants under stress recorded flowering one day earlier to that of control (49). Whereas, TCH 1819 plants under stress recorded flowering two days earlier (46) when compared to control (48). Number of ovules and ovule size were reduced under drought stress in both the varieties. Drought stress reduced the yield by 37% in TCH 1819 and 22% in KC3. The results suggest that water stress during flowering stages is sensitive to both TCH 1819 and KC3. These results are in accordance with Wang *et al.* (2016). It can be concluded from the study that TCH 1819 is comparatively less tolerant to drought than KC3 and the traits could be the potential indicators for drought tolerance in breeding programme.

Table 1. Effect of drought stress on yield traits

Varieties	Treatments	Yield traits		
		No. of sympodial branches	Boll weight (g/plant)	Yield (kg/plant)
TCH 1819	Control	9.23	6.02	2125
	Squaring stress	8.1	5.36	1975
	Flowering stress	12.67	3.22	1463
KC3	Control	12.31	4.02	1377
	Squaring stress	11.52	3.62	1271
	Flowering stress	11.42	3.06	1090
CD (P<0.05)	V	10.88	4.22	1550.17
	T	0.16**	0.14**	0.70**
	V X T	0.20**	0.18**	0.86**

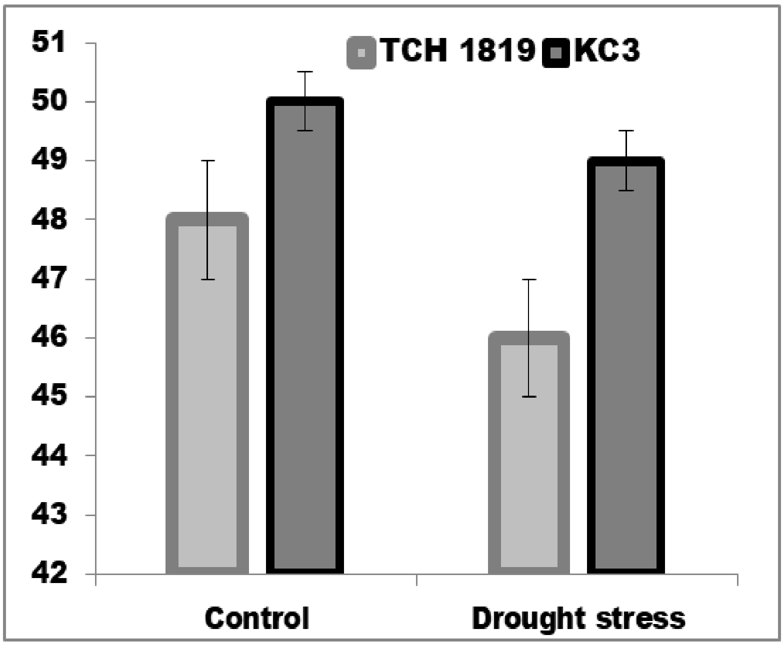

Fig 1. Effect of drought stress in TCH 1819 and KC3 (Early flowering)

Reference

Ashraf, M. 2010. Inducing drought tolerance in plants: recent advances. ***Biotchnol Adv.*** 28:169–83.

Wang, R, Gao, M, Ji, S, Wang, S, Men, Y and Zhou, Z. 2016. Carbon allocation, osmotic adjustment, antioxidant capacityy and growth in cotton under longterm soil drought during flowering and boll-forming period. ***Plant Physiol. Biochem.***, 107:137.

Studies on Compatibility of Pulse Crops with *Simarouba glauca* DC.

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Keywords: *Agroforestry, microclimate, Simarouba glauca*

Introduction

Agroforestry system as an ecologically sustainable land use option alternative to the prevalent subsistence farming patterns for conservation and development. Science of agroforestry system centers around four factors- competition, complexity, sustainability, and profitability and there should be a balance among all these factors to get fruitful results (Pratap and Shalini, 2019). Plant-plant interactions *viz.*, nutrients and water cycle, microclimate modification, tree litter production and its effect on soil properties are of paramount importance in agroforestry systems and also the biochemical interactions between the plant species are of great importance in agroforestry systems because more than two species are grown together. Woody perennials release some phytochemicals into the soil which adversely affect the germination and yield of understorey crops (Ravi *et al.*, 2009). In this context, this experiment was conducted with *Simarouba glauca* along with four inter-crops viz., black gram (*Vigna mungo),* green gram (*Vigna radiata*), cowpea (*Vigna unguiculata)* and red gram *(Cajanus cajan)*.

Methodology

Simarouba glauca and four pulses *viz.*, blackgram, cowpea, greengram and redgram were taken for the present investigation. The field experiment was conducted to study the compatibility of pulses crops with existing 3 years old *Simarouba glauca* plantation of 5m x 5m spacing at Forest College and Research Institute, Mettupalayam with an area of 0.5 acre. (80 Simarouba trees with average GBH (Girth at Breast Height) of 45 cm and Average height of 4.5 meters). The experimental field is situated at 11°19'N latitude and 77°56'E longitude at an altitude of 300 m above mean sea level. The intercrops *viz.*, black gram (*Vigna mungo),* green gram (*Vigna radiata*), cowpea (*Vigna unguiculata)* and red gram *(Cajanus cajan)* were raised in the inter-space of the trees and also as pure crops in the open field. This study was conducted in south west monsoon season between June and September.

Results and Discussion

The reduction in growth and yield attributes *viz.*, plant height, collar diameter, number of leaves and grain yield were observed under *Simarouba glauca* when compare to pure pulse crops. The plant height of intercrops *viz.*, blackgram, greengram, cowpea and redgram at 30 days after sowing (DAS) was significantly reduced under trees when compare with pure crops. Among the four crops, maximum reduction in plant height was observed in redgram (25%) and minimum reduction was observed in cowpea (8%). The same trend was observed at 60 DAS with 13 per cent reduction in redgram as maximum and five per cent reduction in cowpea as minimum (Table. 1).

The results showed that the grain yield of the intercrops was significantly reduced under intercropping when compare to pure crops. Among the four crops, maximum reduction in the grain yield was observed in redgram and black gram (7%) and minimum reduction was observed in cowpea (2%) (plate 1). Ravi *et al.*, (2009) revealed same findings under *Ailanthus excelsa* based silvipature system. Ashalatha *et al.*, (2015) supported that there was a least reduction in yield of cowpea when compared to other intercrops. Rajalingam *et al.,* (2016) supported same findings of vegetable yield under *Ailanthus excelsa* based agrisilviculture system and Rajalingam *et al.,* (2017) also reported same results under *Anthocephalus cadamba* based silvihorticultural system.Fig. 1 Effect of intercropping on grain yield of pulses crops after harvest (Kg ha^{-1}).

The present investigation revealed that growth and yield attributes viz., plant height, collar diameter, number of leaves and grain yield were observed under *Simarouba glauca* when compare to pure crops. Among the four pulses crops, maximum reduction in the grain yield was observed in redgram and black gram (7%) and minimum reduction was observed in cowpea (2%). It is recommended that cowpea is the suitable intercrop for *Simaruba glauca* based agroforestry system.

Table 1. Effect of intercropping on plant height of pulses crops (cm)

Crops	30 DAS		60 DAS	
	Pure cropping	Inter cropping	Pure cropping	Inter cropping
Blackgram	19.08	16.15 (-0.15)	44.05	40.33 (-0.10)
Greengram	19.72	15.54 (-0.21)	51.50	45.50 (-0.17)
Cowpea	23.10	21.53 (-0.08)	64.85	61.23 (-0.05)
Redgram	34.50	25.84 (-0.25)	101.43	87.70 (-0.13)
Mean	24.10	19.76	65.45	58.69

Values indicated in parenthesis are response index values

	SEd	CD	SEd	CD
C	0.24	0.49	0.87	1.79

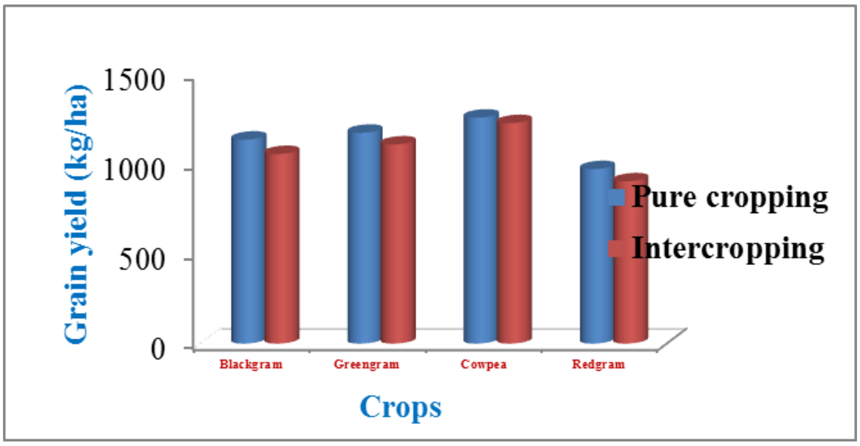

Fig 1. Grain Yield

Reference

Ashalatha, A., Divya, M. P., Ajayghosh, V. 2015. Development of Suitable *Melia dubia* based Agroforestry Models for Higher Productivity. Madras Agricultural Journal. 102 (7-9): 264-267.

Pratap, T and Shalini, T. 2019. Tree crop interaction in Agroforestry system: A review. International Journal of Chemical studies. 7(1):2359-2361.

Rajalingam G.V, Parthiban K.T. Sivakumar K and Divya M.P. 2017. Growth and productivity of vegetables under *Anthocephalus cadamba* based silvihorticultural system. Indian Journal of Agroforestry, 19(1): 79-82

Study on Adoption of Nutrient Management Practices among Finger Millet Growers in Krishnagiri District of Tamil Nadu

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Keywords: *Finger millet, Nutrient management, Adoption, Soil testing and NPK fertilizer*

Introduction

Finger millet (*Eleusine coracana L.)* is an important and nutritious small millet crop grown in India. Finger millet is rich in calcium, iron, protein and fiber and is a gluten-free food. It has low fat content and contains mainly unsaturated fat. Nowadays obesity is the most common problem among the youngsters in India due to the unhealthy food habits. In other side, a large population of children in the country affected with malnutrition with deficient in intake of calcium and protein. Promotion of finger millet based food habit among people can solve these problems and make food and nutrition security in the country. To meet the emerging needs of growing population the production of finger millet in the country has to be increased in the future.

Increase in the production of the crop, improved crop management practices has to be implemented throughout the country. Among the recommended crop management practices, nutrient management is imperative for boosting the production of finger millet. Finger millet is sustainable even under low rainfall situation and also responds well even to better rainfall, macro and micronutrient application (Sankar *et al.,* 2011). A long term fertilizer experiment conducted in TNAU has revealed that, application of 100% NPK along with FYM @ 10t/ha recorded significantly higher grain (2571 kg/ha) and straw yield of finger millet. But there is lack of data on adoption of nutrient management practices among finger millet growers. In this situation, a research on adoption of nutrient management practices among finger millet growers was carried out (Arulmozhiselvan *et al.,* 2013).

Methodology

The study was conducted in Krishnagiri district of Tamil Nadu, where the area and production of Finger millet cultivation is highest in the state. Thally and Kelamangalam blocks, where purposively selected for study based on area and production. A sample of 120 respondents from the selected ten villages was selected by following the proportionate random sampling technique. A well-structured interview schedule with necessary profile characteristics of finger millet growers and an index to measure their extent of adoption of recommended nutrient management practices was prepared based on literature survey and consultation with the experts in the field of agricultural extension and soil science. The interview schedule was pre-tested by a pilot survey in a non-sampling area and necessary changes were made for betterment of the survey tool. The main survey was conducted personally in the study area by direct interview method. The data collected were coded, tabulated and analyzed using suitable statistical tools. The statistical tools used for the analysis were cumulative frequency to stratify the data into different categories and descriptive statistics such as frequency and percentage analysis for presenting the result in a conclusive manner.

Results and Discussion

Results furnished in figure 1 reveals that slightly above half of the respondents (53.33 per cent) had medium level of adoption of recommended nutrient management practices followed by low (38.33 per cent) and high (8.34 per cent) level of adoption among finger millet growers. This finding is in accordance with the findings of Shashank *et al.* (2016).

Table 1. Practice-wise adoption of nutrient management practices (n=120)*

S. No.	Practices	Frequency	Per cent
1.	Soil testing	9	7.50
2.	Soil test recommendation based fertilizer application	0	0.00
3.	Seed treatment/ Seedling root dipping with bio-fertilizers	0	0.00
4.	Application of FYM / Compost in nursery	87	72.50
5.	Application of FYM / Compost in main field	110	91.67
6.	Application of Green manure / Green leaf manure	0	0.00
7.	Application of NPK fertilizer (60:30:30 kg / ha)	0	0.00
8.	Top dressing with nitrogenous fertilizer	113	94.17
9.	Application of DAP / Complex fertilizers	110	91.67
10.	Application of micronutrient mixture	2	1.67
11.	Soil application of bio-fertilizers	5	4.17

*** Multiple responses were obtained**

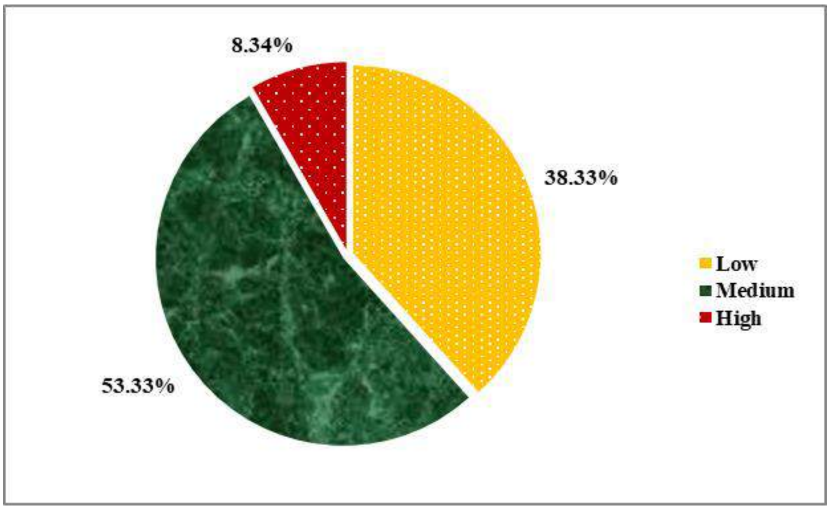

Fig 1. Overall adoption of recommended nutrient management practices

Reference

Sankar, G. M., K. L. Sharma, G. N. Dhanapal, M. A. Shankar, P. K. Mishra, B. Venkateswarlu, and J. K. Grace. 2011. Influence of soil and fertilizer nutrients on sustainability of rainfed finger millet yield and soil fertility in semi-arid Alfisols. ***Communications in soil science and plant analysis***, *42*(12): 1462-1483.

Shashank, D., I. S. Rao, A. Sailaja, and M. Madhavi. 2016. Comparative analysis of adoption of nutrient management packages by paddy farmers of Nalagonda district. ***International Journal of Humanities,and Social Sciences***, 5(6): 23-28.

Arulmozhiselvan, K., M. Elayarajan, and S. Sathya. 2013. Effect of Long Term Fertilization and Manuring on Soil Fertility, Yield and Uptake by Finger Millet on Inceptisol. ***Madras Agricultural Journal***, 100.

Synthetic Aperture Radar (SAR) based Rabi Groundnut Area at Thiruvannamalai District of Tamil Nadu

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Keywords: *Groundnut, MAPScape, Maximum likelihood classification, Sentinel-1A*

Introduction

Groundnut, commonly known as peanut, is a significant oil, food and feed legume crop grown in all seasons in Tamil Nadu, including *Kharif*, *Rabi* and Summer, and it is cultivated both under irrigated and rainfed conditions in all the seasons at Thiruvannamlai district. One of the most important applications of remote sensing in agriculture is Crop Acreage and Production Estimation (CAPE). The CAPE's main goal is to estimate crop acreage and production of important crops, so that advanced food production, distribution and supply were achieved.

Methodology

Multi-temporal Sentinel 1A SAR IW- GRD data with 20 m spatial resolution and 12 days temporal resolution of Vertical - Horizontal (V-H) polarization were downloaded for the period of 4th October 2020 to 8th January 2021 to have the full coverage during the crop growth period in the study area used for this work. A fully automated processing chain developed by Holecz *et al*., (2013) was used to convert the multi-temporal space-borne Sentinel 1A SAR IW-GRD data into terrain-geocoded σ° values. The processing chain was a module within the MAPscape-RICE software, developed by *sarmap*, Switzerland. The SAR time-series data underwent a series of basic processing steps to generate terrain-geocoded σ° values and presented in Fig. 1. Maximum likelihood classification (MLC) algorithm was used in this study for crop area identification. The error matrix and Kappa statistics are used for evaluating the classification accuracy.

Results and Discussion

Groundnut area

Groundnut area map for the Thiruvannamalai district were derived from multi temporal C-band SAR imagery of Sentinel-1A. Using the shape files of administrative boundaries, district wise and block wise maps and statistics of groundnut area were extracted for 18 blocks of Thiruvannamalai district. The classified groundnut area for the blocks and district were presented in the Table 1 and Fig 2. The total groundnut growing area during *Rabi* 2020-21 at Thiruvannamalai district was classified as 32298 ha. Among the blocks of Thiruvannamalai district, Thandrampet block recorded maximum area of 6970 ha and followed by Thurinjapuram, Thiruvannamalai, Keelpennathur and Chengam blocks with 5576, 5197, 4989 and 4111 ha, respectively. The minimum area of 29 ha was recorded at Jawadhu hills block.

Accuracy assessment

The accuracy assessment for the groundnut area maps was conducted on a groundnut or non-groundnut basis, where all other land cover types were grouped into single non-groundnut class. In total, 103 validation points covering 69 groundnut and 34 non-groundnut points were considered for validation and confusion matrix were presented in Table 2. The overall classification accuracy was 87.4 per cent with a kappa score of 0.75 indicating the accuracy of classification. The Overall accuracy (> 80 per cent) and kappa index (>0.50) indicated that good level of assessment. The high accuracy of classification in the study area demonstrated that the methodology was appropriate for groundnut area estimation using multi-temporal Sentinel 1A data and indicated the suitability of these remote sensing-based products for policy decisions including crop insurances as quoted by Deiveegan *et al.* (2016).

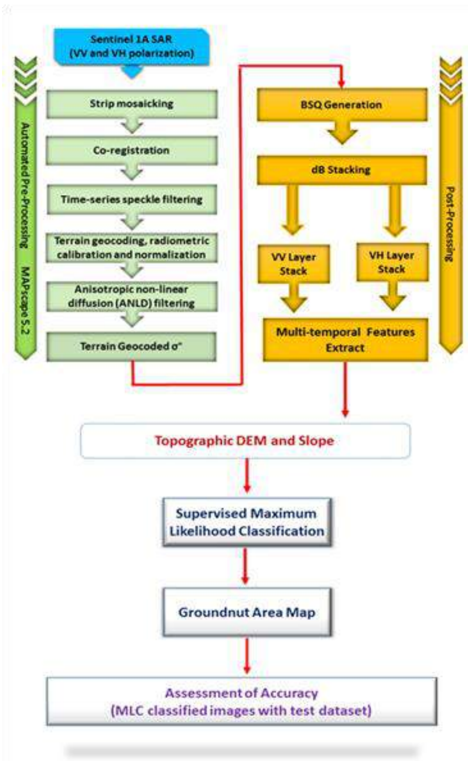

Fig 1. Flow chart for SAR data processing and area map

Table 1. Block-wise groundnut area

S.No.	Name	Groundnut Area (ha)
1	Vembakkam	36
2	Arni	220
3	West arani	421
4	Polur	216
5	Cheyyar	171
6	Jawadhu hills	29
7	Anakkavur	57
8	Peranamallur	491
9	Chetpet	454
10	Vandavasi	328
11	Thellar	103
12	Kalasapakam	757
13	Thurinjapuram	5576
14	Pudupalayam	2173
15	Chengam	4111
16	Keelpennathur	4989
17	Tiruvannamalai	5197
18	Thandrampet	6970
	Total	**32298**

Table 2. Confusion matrix for accuracy assessment

	Groundnut	Non-Groundnut	Accuracy (%)
Groundnut	59	10	85.5
Non-Groundnut	3	31	91.2
Reliability (%)	95.2	75.6	87.4
Average Accuracy		88.3 %	
Average Reliability		85.4 %	
Overall Accuracy		87.4 %	Good
Kappa Index		0.75	

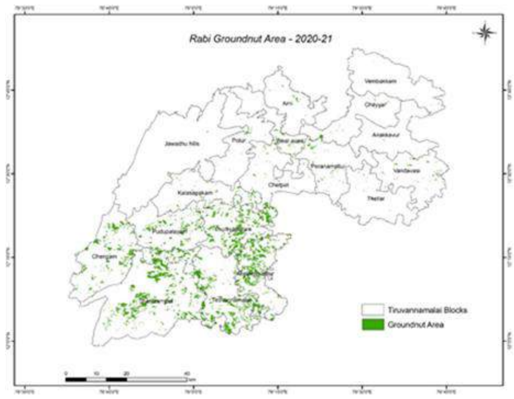

Fig 2. Groundnut area map

Reference

Deiveegan, M., S.Pazhanivelan, K.P.Ragunath and R.Kumaraperumal. 2016. Detection of agricultural vulnerability to drought using NDVI and land surface temperature in Salem and Namakkal districts of Tamil Nadu. Advances in Life Sciences, 5(17): 6868-6873.

Holecz, F., M.F.L. Barbieri, A. Collivignarelli, T.D.M. Gatti, Nelson, G. Setiyono, Boschetti, P.A.B. Manfron, J.E. Quilang. 2013. An operational remote sensing based service for rice production estimation at national scale. In: Proceedings of the Living Planet Symposium, Edinburgh, UK, 9

THEME 03

Emerging Paradigms in Crop Protection

Antioxidant Seed Priming Effect on Physiological and Biochemical Changes of Naturally Aged Soybean Seeds

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Keywords: *Antioxidant priming, Seed Germination, peroxidase, Malondialdehyde*

Introduction

Soybean [*Glycine max* (L.) Merrill] is the important economic pulse cum oil seed crop. Soybean seeds have classified as poor storer, because of their delicate endosperm, seed coat and vulnerable position of embryo. Seed deterioration is inexorable and unstoppable but can be reduced to some extent by seed priming with antioxidants, chemicals, growth regulators, osmotics and salts etc. Beneficial effect of seed priming treatment will result in good germination and early seedling emergence with greater cellular membrane integrity, counteraction of free fatty acid chain reaction, free radical chain reaction and lipid peroxidation.

Methodology

The naturally aged seeds were treated with different antioxidants and their effects on physiological, biochemical properties of seeds. Antioxidants treatments like α-tocopherol @ 1 %, Ascorbic acid @ 1 %, Salicylic acid @ 1 % and Aged seeds served as Control. The replication followed was 3 and experimental design was complete randomized design. The naturally stored seeds of 10 months were used for antioxidant priming. Seeds were soaked with different antioxidants like α-tocopherol @ 1 %, ascorbic acid @ 1 % and salicylic acid @ 1 % for 3 hours in 1:1.5 dilution and shade dried to original moisture content. The effects of antioxidants on different physiological and biochemical parameters were recorded.

Results and Discussion

Effects of antioxidant priming on physiological parameters

Among the antioxidant priming, α-tocopherol @ 1 % soaking (A_1) found effective in increasing seed germination, mean seedling dry weight and peroxidase activity followed by salicylic acid @ 1 % soaking.

Effects of antioxidant priming on biochemical parameters

The among the biochemical parameters, decrease in electrical conductivity (dS cm^{-1}) and in Malondialdehyde (µM/g of fresh weight) content was observed in antioxidant priming with α-tocopherol in yellow coloured genotypes followed by green coloured genotype. The maximum recovery in biochemical and physiological parameters were found low in yellow coloured genotypes (Poor storers) followed by green coloured genotype.

These differences in response by different genotypes may because of variation in their seed biochemical composition. The present result of enhanced seed germination in low vigour genotypes through antioxidant treatment was supported by Bailly *et al.* (2000) and Kaya et al. (2006), they reported that priming of aged seeds with antioxidants gradually restores the germination ability and reduces the level of lipid peroxidation.

Table 1. Response of soybean genotypes to antioxidant priming on seed germination (%)

Genotypes	Seed germination (%)						
	Control (Natural aged)	α-tocopherol (1 %)	Percent increase	Ascorbic acid (1 %)	Percent increase	Salicylic acid (1 %)	Percent increase
Black colour genotypes							
EC-76756	80.33	83.67	4.15	81.33	1.24	83.00	3.32
PB-5	79.67	82.33	3.33	79.67	0.00	81.00	1.66
IC-501268	72.33	77.67	7.38	75.33	4.14	76.00	5.07
TR-5	73.33	77.33	5.45	75.33	2.72	76.00	3.64
EC-57042	74.33	78.67	5.83	75.33	1.34	76.00	2.24
Yellow colour genotypes							
NRC-86	60.67	69.33	14.27	64.00	5.48	66.33	9.32
115-B	58.67	69.00	17.60	63.33	7.94	65.67	11.93
DSB-21	67.00	77.00	14.92	72.00	7.46	74.33	10.94
RKS-45	68.33	76.67	12.20	72.33	5.85	73.33	7.31
NRC-37	65.67	76.33	16.23	74.67	13.70	75.00	14.20
JS -9560	66.33	73.67	11.06	69.67	5.03	71.00	7.04
RKS-24	58.67	67.33	14.76	62.00	5.67	65.33	11.35
JS – 2069	59.33	69.67	17.42	65.67	10.68	67.33	13.48
JS – 335	69.00	77.67	12.56	73.67	6.76	75.00	8.69
JS – 2029	60.33	69.33	14.91	63.33	4.97	64.00	6.08
JS - 20 34	58.33	68.33	17.14	66.33	13.71	67.67	16.01
AGS 29	60.33	74.33	23.20	66.33	9.94	67.67	12.16
Brown colour genotypes							
DS-72-244	72.67	76.00	4.58	74.00	1.83	75.33	3.66
Green colour genotypes							
JS - 90 41	69.67	76.33	9.55	74. 00	6.21	75.33	8.12
Variegated colour genotypes							
RSC 10 71	70.00	76.00	8.57	74.00	5.71	75.33	7.61
Mean	63.40	74.49		71.16		72.58	
S.Em. ±	0.45	1.11		1.10		1.02	
C.D. (P= 0.01)	1.51	4.03		3.89		3.09	
CV (%)	1.08	2.56		2.67		2.43	

Reference

Bailly, C., Benma, A., Corbineau, F. And Come, D., 2000, Antioxidant system in sunflower (*Helianthus annuus* L.) seeds as affected by priming. *Seed Sci. Res.*, **10**(1): 35-42.

Kaya, M. D., Okcu, G. And Atak, M., 2006, Seed treatments to overcome salt and drought stress during germination in sunflower (*Helianthus annus* L.). *Eur. J. Agron.*, **24**(4): 291-295.

Arbuscular Mycorrhizal Fungi Induced Defense by Secondary Metabolites Production Against *Spodoptera litura* in Blackgram

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Keywords: *Arbuscular mycorrhizal fungi, Spodoptera litura, blackgram, secondary metabolites, plant defense.*

Introduction

Arbuscular mycorrhizal fungi (AMF) form a symbiotic association with almost all agricultural important crops. These fungi benefits to improve plant growth and health *via* various mechanisms *viz*., improve the uptake of water and immobile inorganic nutrients (primly phosphate) from the soil solution, increase the leaf area, chlorophyll content, and photosynthetic rate, regulates endogenous phytohormones production and modify the morphological and biochemical characteristics of host plants. Furthermore, it also improves plant defense against various biotic and abiotic environmental stresses. The current scenario of fluctuating climates leads to an increase in crop pest incidence, which in turn, affects crop production. To overcome this stress, plants have evolved with diverse defense systems, includes the production of secondary metabolites, which are toxic to herbivores and act as defensive compounds in plants. AMF symbiosis assists to augment secondary metabolites production in plants and thus potentially fortify both direct and indirect defense against the herbivorous insect.

Methodology

A pot culture experiment was conducted in the Department of Agricultural Microbiology, Tamil Nadu Agricultural University, Coimbatore by following completely randomized design (CRD) with four treatments. Blackgram seeds were surface sterilized with 10 % sodium hypochlorite for 10 min and rinsed thoroughly in distilled water for five times. Then, the surface sterilized seeds were treated with AMF spore (*Glomus intraradices*) @ 5 spores seed^{-1}. The seeds were sown in pots (17cm x15cm x15cm) filled with autoclaved red soil and sand (2:1) mixture. The plants were irrigated once in 2 days with 50-100 ml tap water and once in 4 days with 100 ml of Hoagland's nutrient solution. The herbivory treatment was initiated by releasing the three numbers of 3rd instar *S. litura* larvae on 40 days old blackgram seedling. The treatments include (CT) - Control without *G. intraradices* and *S. litura*, (SL) - *S. litura*, (AMF) - *G. intraradices*, and (AMF+ SL) - *G. intraradices* + *S. litura*. Leaf samples were collected after 24 h of *S. litura* larvae release and analyzed secondary metabolites *viz*., phenolics, flavonoids, terpenoids, and tannin (Mohamed *et al*., 2021).

Results and Discussion

Mycorrhizal colonization was examined in all the treatments. Only AMF inoculated blackgram plants showed the presence of mycorrhizal colonization and it registered maximum of 78.33 %. Similarly, leaf secondary metabolites were quantified, maximum phenolic content was observed in blackgram plants inoculated with AMF after 24 h of insect exposure (*G. intraradices* + *S. litura*; 124.77 mg GA g^{-1} FW). It was followed by plants challenged with *S. litura* (Figure 1). Even though feeding of leaves of un-inoculated control plants by *S. litura* reduced the flavonoids concentration, it was increased in AMF inoculated plants infested with *S. litura*. Related to phenolics, leaf terpenoids content of blackgram plants inoculated with AMF and infested with *S. litura* registered a significant quantity of 26.12 ± 0.27 mg g^{-1} FW after 24 h of *S. litura* infestation (Figure 1).

The tannin content of leaves of AMF inoculated blackgram plants infested with *S. litura* recorded significantly higher at 101.16 µg g^{-1} FW. Hence, the secondary metabolites like phenolics, terpenoids, and tannin content were increased after *S. litura* infestation and it increased further in AMF inoculated plants infested with *S. litura*. Plants defend themselves by producing secondary metabolites along with primary metabolites, which are toxic to herbivores and act as defense compounds. These secondary metabolites provide direct defense against herbivorous insects by affecting the growth and development of pests (Soltani *et al*., 2021). AMF symbiosis helps plant health by modulating secondary metabolism and thus potentially fortify both direct and indirect plant defense systems (Selvaraj *et al*., 2021).

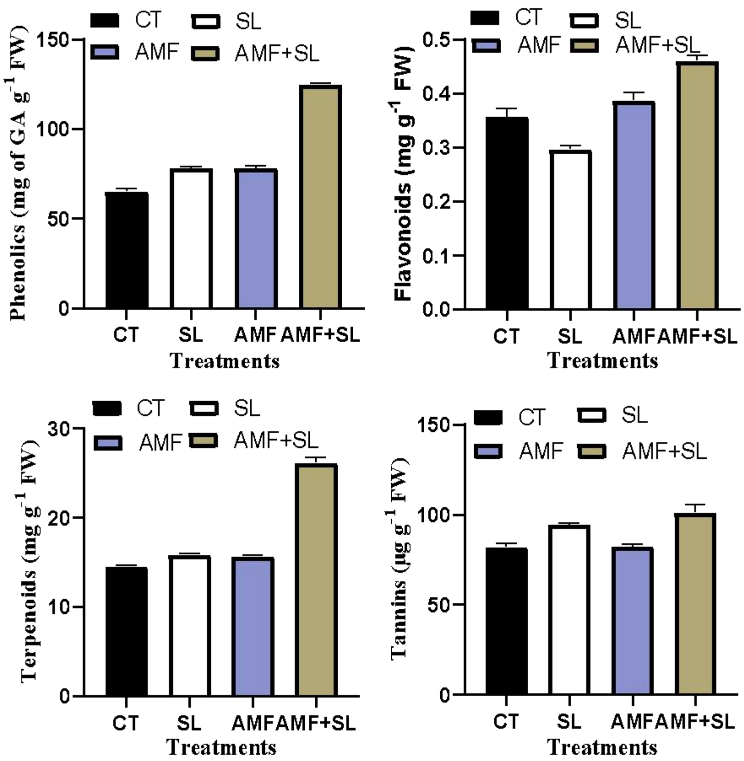

Figure 1. Accumulation of leaf secondary metabolites of blackgram plants inoculated with AMF and infested by *S. litura*

Reference

Mohamed, H. I., Mohammed, A. H. M., Mohamed, N. M., Ashry, N. A., Zaky, L. M., Mogazy, A. M. (2021). Comparative effectiveness of potential elicitors of soybean plant resistance against *Spodoptera Littoralis* and their effects on secondary metabolites and antioxidant defense system. ***Gesunde Pflanzen***, 1-13.

Selvaraj, A., Thangavel, K. (2021). Arbuscular mycorrhizal fungi: potential plant protective agent against herbivorous insect and its importance in sustainable agriculture. In ***Symbiotic Soil Microorganisms***. Springer, pp. 319-337.

Soltani, A., Zouali, Y., Haoual-Hamdi, S., Saadouni, D., Amri, M., Carapelli, A., Jemâa, J. M. B. (2021). Relationship between secondary metabolites and infestations caused by chickpea leafminer *Liriomyza cicerina* (Diptera: Agromyzidae). ***International Journal of Tropical Insect Science***, *41*(1): 251-259.

Artificial Epiphytotics of Foliar Fungal Diseases in Groundnut (*Arachis hypogaea* L.)

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Keywords: *Groundnut, Artificial screening, Late leaf spot, Rust, Yield attributes*

Introduction

Groundnut (*Arachis hypogaea* L.) also called peanut is one of the principal economic oilseed crops of the world and it occupies a pride place in Indian economy. It is utilized as a vegetable oil and protein for human consumption, as fodder for livestock and as green manure. Worldwide, diseases are important reducers of groundnut yield. Among the biotic stresses, two foliar fungal diseases namely late leaf spot (LLS) caused by *Phaeoisariopsis personata* and rust caused by *Puccinia arachidis* are widespread and economically most important. For instance, late leaf spot and rust together can cause up to 70 per cent yield loss in India (Subrahmanyam *et al.*, 1984). These foliar diseases besides reducing the yield, also have an adverse effect on seed quality and grade characteristics, deteriorate the quality of plant biomass and thus render the fodder unsuitable as animal feed. Moreover, the control of these diseases through application of plant protection measures not only increases the cost of cultivation but also lead to environmental and health hazards (Smith and Littrell, 1980). Hence, the host controlled resistance by means of use of resistant cultivars is considered the best strategy to surmount crop losses in groundnut. An insight into the screening methodology of crop species is of utmost importance as it forms the basis for selection in any disease resistance breeding programme.

Methodology

Crosses were made to develop foliar fungal disease resistant groundnut lines by using advanced / released popular variety ICGV 00350, ICGV 03128, VRI 2 and a foliar disease resistant parent, GPBD 4. Thus obtained F_1's were backcrossed with the respective recurrent parent. The BC_1F_1 population of three crosses *viz.*, ICGV 00350 × GPBD 4, ICGV 03128 × GPBD 4 and VRI 2 × GPBD 4 were used to screen for foliar disease resistance, at field level. The experiment was conducted at Oilseeds Farm, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore, during Rabi 2013-14. These BC_1F_1 crosses were evaluated along with parents in non-replicated trial. The spacing adopted was 30 × 10 cm and the recommended agronomic practices were followed throughout the crop growing period. Observations were recorded on ten yield and yield related characters, apart from late leaf spot (LLS) score and rust score.

Results and Discussion

Considering the mean disease scores, none of the crosses showed resistance to late leaf spot. Some crosses showed different levels of resistance to the two pathogens. Resistance to rust and moderate resistance to late leaf spot were recorded by two backcross derivatives *viz.*, ICGV 00350 × GPBD 4 and ICGV 03128 × GPBD 4 whereas, the remaining cross VRI 2 × GPBD 4 exhibited moderate resistance to both late leaf spot and rust diseases. The disease score ranged between 2.00-5.00, 3.00-6.00 and 2.00-7.00 for late leaf spot; 1.00-6.00, 1.00-5.00 and 2.00-8.00 for rust disease in ICGV 00350 × GPBD 4, ICGV 03128 × GPBD 4 and VRI 2 × GPBD 4 of groundnut, respectively. Considerable variations were noted among crosses with respect to leaf spot and rust disease reactions. Many sources of resistance against late leaf spots and rust diseases in groundnut have been identified and reported by several workers (Mehta and Mandal, 1978). The mean and range of disease scores in selected backcross progenies are shown in Table 1.

Table 1. Field disease scores for late leaf spot and rust for selected crosses in groundnut

S.No.	Entry	Mean	SE	Minimum	Maximum
Late Leaf Spot					
1.	**ICGV 00350 × GPBD 4**	3.13	0.17	2.00	5.00
2.	**ICGV 03128 × GPBD 4**	4.58	0.17	3.00	6.00
3.	**VRI 2 × GPBD 4**	4.63	0.14	2.00	7.00
4.	**CO Gn 4 (Infector row)**	6.87	0.15	6.00	8.00
Rust					
1.	**ICGV 00350 × GPBD 4**	2.90	0.33	1.00	6.00
2.	**ICGV 03128 × GPBD 4**	2.42	0.19	1.00	5.00
3.	**VRI 2 × GPBD 4**	4.78	0.19	2.00	8.00
4.	**CO Gn 4 (Infector row)**	7.71	0.26	5.00	9.00

Conclusion

Foliar fungal diseases are more prominent in *Kharif* rather than in *Rabi* season. So, there is a need to identify suitable alternative to screen for diseases during off season. Although molecular markers are used to screen for disease resistance at early stage of crop growth, it is necessary to access genotypes / crosses phenotypically for yield and yield attributes. It helps the breeder to identify high yielding progenies coupled with foliar fungal disease resistance in groundnut. The present study was undertaken to screen three backcross progenies against late leaf spot and rust diseases of groundnut under artificial epiphytotic conditions. These results indicated that in all the three backcross derivatives, varied number of progenies in each cross showed considerable resistance to late leaf spot and rust diseases. Interestingly, the progenies that showed resistance in artificial phenotypic screening were also resistant during molecular screening at early stage. Such progenies with resistance were selected and further evaluated for yield and yield related attributes. From the above discussion, it may be concluded that the high yielding progenies in each cross with good sources of resistance for both late leaf spot and rust may be again backcrossed to develop new / improved varieties with high yield potential and disease resistance.

Reference

Subrahmanyam, P., Williams, J.H., McDonald, D. and Gibbons, R.W. 1984. The Influence of foliar diseases and their control by selective fungicides on a range of groundnut (*Arachis hypogaea* L.) genotypes. ***Annals of Applied Biology***, 104: 467-476.

Smith, D.B. and Littrell, R.H. 1980. Management of peanut foliar diseases with fungicides. ***Plant disease***, 64: 356-361.

Mehta, P.P. and Mandal, K.K. 1978. Field screening of groundnut cultivars against tikka and rust. ***Indian Phytoppathology***, 31: 250-260.

Artificial Intelligence Powered Expert System (AIPES) for Identifying Fall Armyworm Infestation in Maize

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Keywords: *Artificial intelligence, Maize, Deep learning, Fall armyworm infestation detection, Convolutional neural networks, Mobile app.*

Introduction

Maize is one of the most salable cereal crops cultivated in an area of 180.63 million ha in 165 countries across the world with a production of 1134 million tonnes. In the recent past, maize crop has been by the fall armyworm (*Spodoptera frugiperda*, J.E.Smith) (FAW) that has caused massive yield loss in maize. The spread of FAW in India has been reported, since it's documented from Karnataka in May 2018 (Sharanabasappa *et al*., 2018). This study proposes the expert system that will enable to detect the fall armyworm infestation in the field using the technology of artificial intelligence to identify the pest infestation in the crop. The main advantage of this system is accurately identifying the pest infested crop and classifying them vis-c-vis the healthier crop. It is useful for reducing error rates and increasing the level of accuracy in the system.

Methodology

Dataset collection

The large dataset is required to classify the maize fall armyworm infested leaves, cobs, tassels. Maize fall armyworm infested leaves, cobs and tassels dataset of JPEG images were shot with a Nikon D7500 P-Digital Camera. A total of more than 10000 photographs with varying severity levels of infestations were shot from FAW infested maize field and stored in the system for image processing. Our dataset is collected from various maize growing research plots of TNAU and various blocks of Tiruvannamalai districts of Tamil Nadu. Then the collected images are annotated based on the symptoms caused by the maize fall armyworm.

Classification used for this model

Maize leaves were classified as healthy maize leaf, pinhole symptom, circular hole symptom, elongated lesions symptom and whorl leaf damage symptoms infested by maize fall armyworm. Maize cobs were classified based on the per cent ear damage infestation (TNAU unpublished protocol). Maize tassels were classified as healthier and infested tassels.

Hardware and software used in this study

Hardware and Software	Specification
Memory	8.00 GB (5.88 GB usable)
Processor	AMD Ryzen 5, 3500U with Radeon Vega Mobile Gfx 2.10 GHz
Operating system	Windows 10
Deep learning libraries	Keras and TensorFlow
Deep learning architecture	Convolutional neural network
Deep learning model	Mobile Net V2

Results and Discussion

The dataset of fall armyworm infested maize was split into 70 per cent, 20 per cent and 10 per cent for training, validation, and testing respectively. The image dataset was distributed into the following proportions for creating the banana model: 70 per cent, 20 per cent and 10 per cent for training, validation and testing respectively (Selvaraj, M.G. *et al*.,2019). The model was trained across 100 epochs, ensuing in a training data set that was 100 per cent accurate and a validation data set that was roughly 87 per cent accurate. This implies that the trained model is neither overfitting nor underfitting.

The model accuracy plots for both train and validation data were represented in (Fig.1). The model loss plots for both train and validation data were represented in (Fig.2). Training loss was only about 0.1 per cent, thus this model performs better and this implies that the trained model can perform accurate predictions based on images that will be fed to the system. The android application was built using the trained model with the assistance of Android Studio.

The agricultural sector is one of the most significant industries in the world, where crops symbolize the most basic necessity for nourishment. The agricultural industry relies on early detection and recognition of these FAW infestations. The applications of Deep Convolutional Neural Networks (DCNNs) have been formulated in this research to classify fall armyworm infestations in maize.

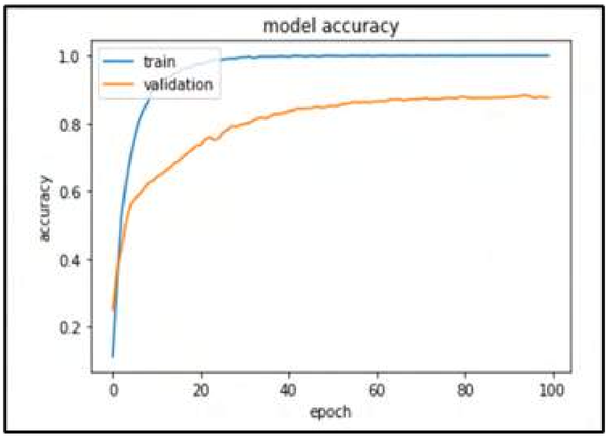

Fig.1. Model accuracy for train and validation dataset

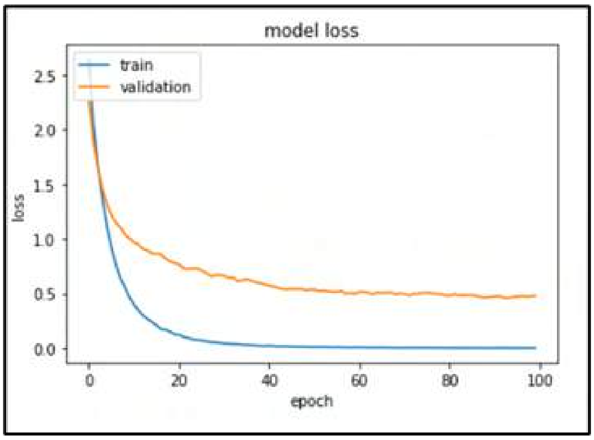

Fig.2. Model loss for train and validation dataset

Reference

Sharanabasappa, Kalleshwaraswamy, C.M., Asokan, R., Mahadeva Swamy, H.M., Maruthi, M.S., Pavithra, H.B.*et al*., 2018. First report of the Fall armyworm, Spodoptera frugiperda (JE Smith) (Lepidoptera: Noctuidae), an alien invasive pest on maize in India. *Pest Management in Horticultural Ecosystems* ,24(1),pp. 23-29.

Selvaraj, M.G., Vergara, A., Ruiz, H., Safari, N., Elayabalan, S., Ocimati, W. and Blomme, G., 2019. AI-powered banana diseases and pest detection. Plant Methods, 15(1), pp.1-11.

Assessment of Ochratoxigenic Fungi in Grapes Marketed in Tamil Nadu

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Keywords: *Grapes, Ochratoxin, Mycoflora assessment, Aspergillus, Penicillium.*

Introduction

Grapes (*Vitis vinifera* L.) is one of the major fruit crop cultivated in India. Grapes are the most important source of nutrients like fibre, potassium and other minerals and vitamins. Grapes itself used for the preparation of raisins, pre-serves, squashes, wines and related fermented products. Grapes and grape derived products are consumed by maximum peoples around the globe. There are some toxigenic fungi attacking grapes and grape derived products. The *Aspergillus* mould colonization on grapes will lead to Ochratoxin A (OTA) production. Ochratoxin A (OTA) is the mycotoxin produced by some species of *Aspergillus* and *Penicillium*. Ochratoxin A (OTA) has nephrotoxic, genotoxic, teratogenic and carcinogenic properties (Rocha *et al*., 2014).

Methodology

Grapes samples were collected from different grape growing regions of Tamil Nadu. Assessment of mycoflora in grape samples was carried out by serial dilution method (Abdel-Sater and Eraky, 2001). One gram of each sample was grinded with ten ml sterile distilled water. Further, the samples were diluted serially at known concentration and one ml aliquot of each sample from 10^{-3} and 10^{-4} dilution were inoculated into the sterile Petri plates containing 15 ml Rose Bengal chloramphenicol medium and incubated under room temperature at 28 ± 2 °C for five days with three replications. Based on the morphological observations the fungal colonies from each sample were classified into genera according to the appropriate keys for the identification given by Pitt and Hocking (2009). Colony forming unit (Cfu/g) and isolation frequency percentage were also calculated. The isolated fungal colonies visually analysed and subjected to microscopic observation using phase contrast microscope. Based on the mycelial, spore and conidial head characters, the fungal colonies were confirmed morphologically.

Results and Discussion

Mycoflora assessment in grapes samples

The fresh grape samples were revealed several microflora contamination in RBC medium (Plate. 1). The fresh grape samples collected from Coimbatore (GC), Salem (GS), Madurai (GM), Theni (GT), Krishnagiri (GK), Trichy (GT), Dharmapuri (GD) and Tirunelveli (GTR) were found significant amount of *Rhizopus*, *Penicillium* and *Aspergillus* infection ranging from 0.7±0.2 to 7.3±1.2, 0.8±0.1 to 11±1.2 and 5±0.6 to 24±1.4 CFU/ g, respectively (Table. 1). However, maximum frequency of *Aspergillus* colonies were observed among the overall grape samples tested (Fig. 1). The *Aspergillus* colonies were morphologically and microscopically proved and the maximum *Aspergillus* colonies were identified as *Aspergillus niger* in majority of samples. The toxigenic *Aspergillus niger* contamination in grapes may produce carcinogenic Ochratoxin A (OTA) that leads to high impact on human and animal health (IARC, 1993). Further studies on identifying the OTA level and detoxifying strategies may be used as effective methods to prevent the health impacts of OTA in grape.

Table 1. Mycoflora assessment in grape samples marketed in Tamil Nadu

S. No	Sample code	CFU/g (10^4)		
		Aspergillus	*Penicillium*	*Rhizopus*
1.	GC	24 ± 1.4	1.7 ± 0.3	3.2 ± 0.5
2.	GS	6 ± 0.5	0.0 ± 0	7.3 ± 1.2
3.	GM	5 ± 0.6	2.7 ± 0.2	0.0 ± 0
4.	GT	24 ± 0.5	0.0 ± 0	0.7 ± 0.2
5.	GK	0 ± 0	2.2 ± 0.6	0.0 ± 0
6.	GD	1 ± 0.4	0.8 ± 0.1	1.0 ± 0.3
7.	GTR	7 ± 0.6	11 ± 1.2	8 ± 2.1

Each value represents mean of three replicates. ±represent standard deviation

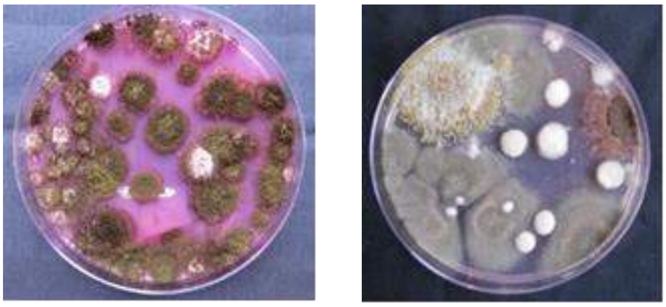

Fig 1. Plate 1 Mycoflora assessment in grape samples a) GC b) GTR

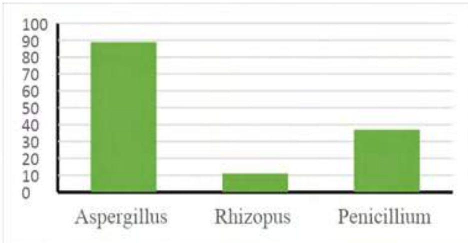

Fig 2. Frequency of mycoflora contamination in fresh grape samples collected

Reference

Rocha, M. E. B., F. C. O. Freire, F. E. F. Maia, M. I. F. Guedes and D. Rondina. 2014. Mycotoxins and their effects on human and animal health. ***Food Control***. 36(1): 159-165.

Abdel-Sater and S. A. Eraky 2001. Bulbs mycoflora and their relation with three stored product mites. ***Mycopathologia***. 153: 33-39.

Pitt, J. I. and A. D. Hocking. 2009. Methods for isolation, enumeration and identification in Fungi and Food Spoilage, 3rd ed. ***Springer***. 4: 19-52.

IARC (International Agency for Research on Cancer). 1993. Some Naturally Occurring Substances: Food Items and Constituents: Heterocyclic Aromatic Amines and Mycotoxins. ***IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans***. 56: 489-521.

Behavioural and Electrophysiological Response of Yellow Stem Borer Egg Parastoid *Tetrastichus sp.* to the Oviposition Induced Volatiles of Rice Landrace

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Keywords: Rice yellow stem borer, Tetrastichus schoenobii, OIPV, heptadecane

Introduction

Rice is an economically important crop facing many challenges including biotic stresses like insect pests. As far as India is concerned, one of the major insect pests of concern is rice yellow stem borer (YSB) *Scirpophaga incertulas* (Walker) causing yield loss of about 20- 80% Pallavi *et al.* (2017). Though there are many reported control strategies for the pest, studies on the insect plant interaction-based management are limited. Hence, the study was carried out to identify the volatile compounds that is responsible in attraction of a successful biocontrol agent *Tetrastichus schoenobii*.

Methodology

Pot culture of the rice landrace Mattai triveni was maintained at the paddy breeding station, TNAU, Coimbatore. Healthy potted plants grown in net cages were used for experiments. Field collected gravid YSB female moths were released for oviposition and the oviposited plants were taken for volatile extraction. Volatile collection was made by headspace sampling Agelopoulos *et al.* (1999). Yellow stem borer egg parasitoid *Tetrastichus* sp. were obtained from the field collected egg masses of rice yellow stem borer. Female *Tetrastichus* sp. were used for the olfactometer bioassays. The response of *Tetrastichus* sp. to the healthy and oviposited plant volatiles were tested using a Perspex four-arm olfactometer Pettersson (1970). 10 µl of volatile samples was taken in whatmann filter paper no. 1 (4×25 mm) and kept in the opposite arms of olfactometer. Other two arms were placed with solvent control (diethyl ether). The experiment was conducted for 12 mins and the time spent in each arm were noted. The volatile samples were also characterised using GCMS and identified using NIST library. The compounds responsible for the orientation of the parasitoids to the volatile samples, were detected using GC-EAD (Jayanthi *et al*., 2012).

Results and Discussion

The olfactormeter bioassay revealed a significant preference in the attraction of *Tetrastichus* parasitoids towards the mattai triveni ovipositedplant volatiles (OIPV) over healthy ones. Time spent by the parasitoids in the arm containing OIPV was higher (73.60%) than healthy and control (11.15% and 15.25% respectively). This attraction is due to the oviposition induced egg secretions of rice yellow stem borer (Hilker and Meiners, 2010).A total of 45 volatile compounds were identified from the yellow stem borer oviposited plant volatiles, out of which, ten compounds (**Figure 2**) were found to show antennal response in the insect. Among the ten, compounds like Hydrocoumarin and n-heptadecane showed good response in all the three replications. Attraction of parasitoids towards the alkane compounds like pentadecane, heptadecane, etc. have been reported by Tandon and Bakthavatsalam (2007).

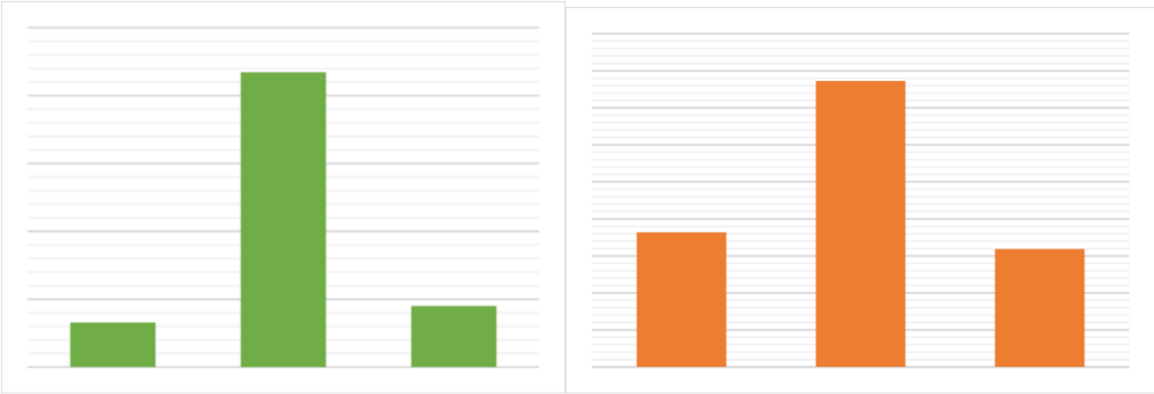
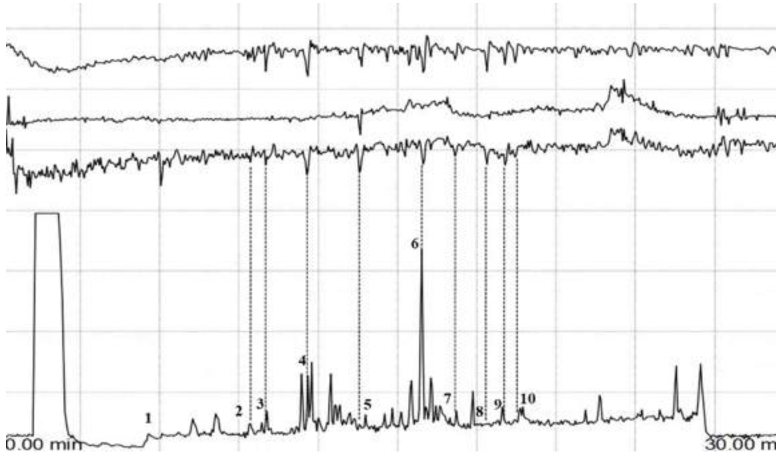


Fig 1. Orientational preference of the female *Tetrastichus* parasitoids to the volatiles



1.Tricyclo[2.2.1.0(2,6)]heptane, 1,7,7-trimethyl-; 2. Ethyl-benzaldehyde; 3. n-Dodecane; 4. 2,6,11-Trimethyldodecane; 5. Hydrocoumarin; 6. Phenol, 2,4,6-tris(1-methylethyl)-; 7. Benzoic acid, 2-amino-, 1-methylpropyl ester; 8. n-Heptadecane; 9.5,5,7,7-Tetraethylundecane;10. 2,6,11,15-Tetramethylhexadecane

Figure 2. Electrophysiological responses of *Tetrastichus* females to oviposited plant volatile

Reference

Agelopoulos, Nicky G, Antony M Hooper, Sangita P Maniar, John A Pickett, and Lester J Wadhams. 1999. "A novel approach for isolation of volatile chemicals released by individual leaves of a plant in situ." *Journal of Chemical Ecology* 25 (6):1411-1425.

Hilker, Monika, and Torsten Meiners. 2010. "How do plants "notice" attack by herbivorous arthropods?" *Biological Reviews* 85 (2):267-280.

Jayanthi, Pagadala D Kamala, Christine M Woodcock, John Caulfield, Michael A Birkett, and Toby JA Bruce. 2012. "Isolation and identification of host cues from mango, Mangifera indica, that attract gravid female oriental fruit fly, Bactrocera dorsalis." *Journal of Chemical Ecology* 38 (4):361-369.

Pallavi, D, Sharanabasappa, and GK Girijesh. 2017. "Crop loss estimation of yellow stem borer Scirpophaga incertulas (walker) damage on paddy." *J. Entomol. and Zool. Studies* 5 (6):635-638.

Pettersson, Jan. 1970. "An aphid sex attractant." *Insect Systematics & Evolution* 1 (1):63-73.

Tandon, PL, and N Bakthavatsalam. 2007. "Plant volatile diversity in different tomato genotypes and its influence on parasitization efficiency of Trichogramma chilonis Ishii on Helicoverpa armigera (Hubner)."

Journal of Biological Control 21 (2):271- 281.

Behavioural Response of Female Melon Fruit Fly, *Zeugodacus cucurbitae* (Coquillett) (Diptera: Tephritidae) to Bitter Gourd Accessions/Variety

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Keywords: *Bitter gourd, melon fruit fly, kairomone, Y- tube olfactometer.*

Introduction

The fruit fly is plays major role in causing yield loss from 30 to 100 per cent, based on bitter gourd crop growth stages and season. The general management practices that are used to manage fruit flies are spraying insecticides and so on has gained resistance and resurgence against new insecticides. Therefore, integrated pest management practices like trapping methods are one of the alternatives to synthetic chemical pesticides for pest management. The behavioural responses of female *Z. cucurbitae* to kairomone from fruits and leaves plants at different genotypes were compared using y- tube olfactometer.

Methodology

A preliminary screening was carried out with 50 bitter gourd accessions (wild types and commercial cultivars). Among these, 12 accessions (2 resistant, 6 moderately resistant, 3 susceptible and 1 highly susceptible) were selected to study the influence of biochemical and morphological traits on larval density and reaction to melon fruit fly. The kairomone compounds present in the bitter gourd leaves and fruits were extracted using different solvents viz., hexane, dichloromethane and distilled water. The behavioural response of fruit fly, *Z. cucurbitae* to kairomone compound emitted from bitter gourd leaves and fruits were estimated using y- tube olfactometer as per the procedure described by Sulaeha *et al*., (2017). The 0.1 ml of the extract was dropped on a 4 × 3 cm piece of whatman no. 42 filter paper. Then whatman paper was inserted into y-tube right side chamber and control (pure solvent hexane or dichloromethane) was placed in the left side chamber. Female fruit fly was released into olfactometer and the time duration taken by fruit fly to reach the extract sources was measured.

Results and Discussion

Screening of bitter gourd accessions for the resistance to melon fruit fly Z. cucurbitae

The maximum number of fruits was recorded in variety CO-1 (31.67 no. /plant) and minimum in accession/variety/local types viz, TCR 393 and Ucha small (22.33 no. /plant). The fruit infestation was minimum in resistant accession/variety/local types viz, TCR-393 (17.90 %) and Musiri local-1 (20.00 %) (**Table 1**).

Behavioural response of female melon fruit fly, Z. cucurbitae to hexane and dichloromethane extract of bitter gourd accessions/ variety/local types

Hexane and dichloromethane leaf and fruit extract of TCR 393 showed high duration for fruit fly attraction and lower attractancy followed by Musiri local-1, MC-10, Ucha small, Bikner -2, Musiri local-2 and CO-1 (**Fig. 1**).

Table 1. Screening of bitter gourd accessions for resistance to melon fruit fly *Z. cucurbitae*

Bitter gourd accessions/variety/ local types	Biological attributes			Fruit fly infestation* (%)	Resistance Index
	Total fruits* (no./plant)	Damaged fruit* (no./plant)	Maggots/ fruit* (no.)		
TCR-393	22.33	4.00	6.33	17.90	Resistant
Musiri local-1	25.00	5.00	6.50	20.00	Resistant
MC-10	24.67	5.67	7.25	23.00	Moderately Resistant
Ucha small	22.33	6.67	7.40	29.80	Moderately Resistant
Bikaner-2	30.33	11.67	7.80	38.50	Moderately Resistant
Musiri local-2	28.33	12.33	8.17	43.50	Moderately Resistant
Pkm local	24.33	11.67	9.16	47.90	Moderately Resistant
Co-1	31.67	15.67	9.33	49.50	Moderately Resistant
MC-39	23.67	15.67	10.10	66.20	Susceptible
MC-105	25.67	15.33	10.67	59.70	Susceptible
Paravai local	27.33	17.00	11.87	62.20	Susceptible
MC-41	27.00	21.00	13.89	77.79	Highly Susceptible

*Mean of five observations

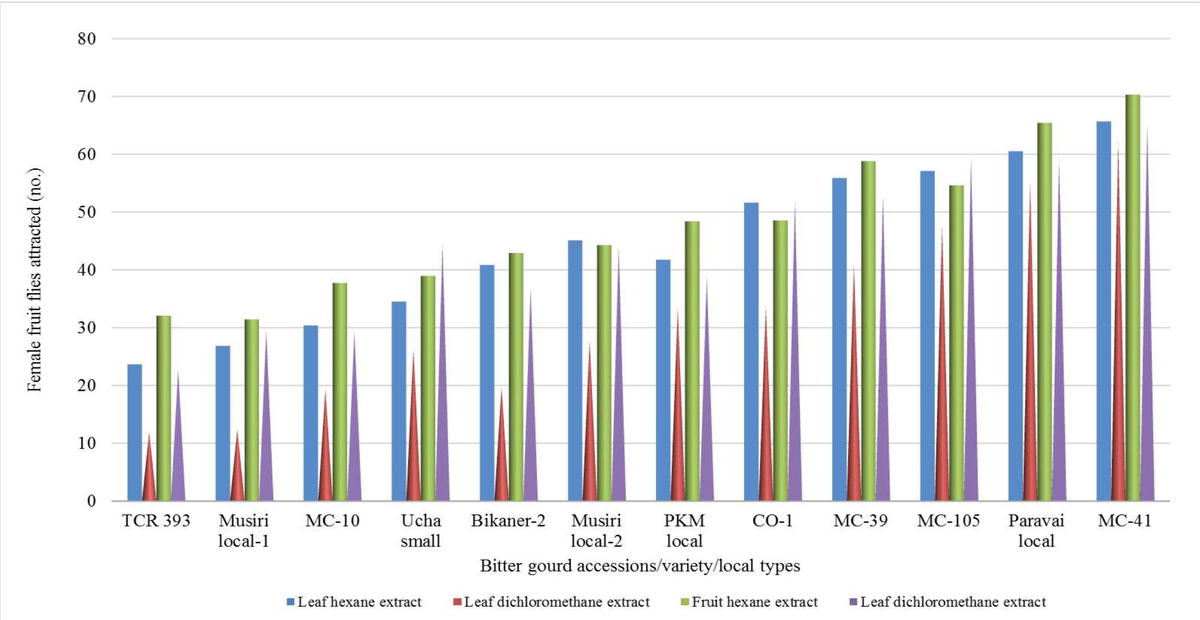

Fig.1. Behavioural response of female melon fruit fly, *Z. cucurbitae*

Reference

Sulaeha, T., Aunu, R., Purwantiningsih, S. and Endang, S. R. 2017. Identification of kairomonal compounds from host plants attractive to melon fly, *Zeugodacus cucurbitae* (Coquillett)(Diptera: Tephritidae). *Journal of Entomology*, 14:216-227.

Sapkota, R., Dahal, K. C. and Thapa, R. B. 2010. Damage assessment and management of cucurbit fruit flies in spring-summer squash. *Journal of Entomology and Nematology*, 2(1):007-012.

De Bruyne, M. and Baker, T. C. 2008. Odor detection in insects: volatile codes. *Journal of Chemical Ecology*, 34 (7):882-897.

Biochemical Basis of Synergism Between Entomopathogens and Insecticide Spinetoram Against *Plutella xylostella* (L.)

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Keywords: Plutella xylostella, spinetoram, Bacillus thuringiensis, Beauveria bassiana

Introduction

Diamond back moth, *Plutella xylostella* (Linnaeus) (Lepidoptera: Plutellidae), is a widely distributed insect pest of cruciferous vegetables causing 50-80 % of loss in yields with an annual crop loss of US$ 16 million in India. The frequent application of insecticides and rapid generation time, has led to the development of resistance against nearly 95 insecticides in *P. xylostella*. Rational and combined use of bioagents with insecticides has become an important aspect both in integrated pest management and insecticide resistance management. The entomopathogenic infection *viz*., fungi and bacterial infections increase susceptibility of *P. xylostella* to the insecticides. Keeping this in view, the present study is attempted to evaluate the joint action and mitigation of insecticide detoxifying enzymes in spinetoram-resistant *P. xylostella* using entomopathogens.

Methodology

Susceptible population of *P. xylostella* was continuously selected for 16 generations with spinetoram (LC_{60}) treated leaves to develop spinetoram-resistant population. After the 16 generations of selection, the population exhibiting a high resistance ratio was considered a resistance strain and was used to evaluate the joint action and insecticide detoxifying enzymes assay using entomopathogens. Leaf dip bioassay was conducted to determine the LC_{25} and LC_{50} values of spinetoram, *B. bassiana* and *B. thuringiensis* against insecticide-resistant *P. xylostella* through probit analysis. To find the joint action of *B. bassiana* and *B. thuringiensis* with spinetoram, the sublethal concentration of *B. bassiana* and *B. thuringiensis* at LC_{25} was combined with LC_{25} concentration of spinetoram and bio-assayed following leaf dip method. The enzyme assay was carried out to study the influence of fungi/bacterial infection on the activity levels of insecticide detoxification enzymes *viz*., mixed-function oxidase (MFO), glutathione-S-transferase (GST) and carboxyl esterase (CarE) in *P. xylostella*. Third instar larvae of *P. xylostella* were allowed to feed on the treated leaves. Samples of larvae from each treatment were collected in replicates of three at 6h, 24h and 48h intervals. The larvae surviving after treatment were homogenized to extract the detoxifying enzymes by following the standard procedure.

Results and Discussion

The result of the bioassay shows that the LC_{50} value of *B. bassiana* and *B. thuringiensis* subsp. *kurstaki* was 2.66 x10^8 spores mL^{-1} and 2.08 gL^{-1}, respectively against spinetoram-resistant population of *P. xylostella*. Similarly, LC_{25} value of *B. bassiana* and *B. thuringiensis* subsp. *kurstaki* was 1.01 x10^7 spores mL^{-1} and 1.10 gL^{-1}, respectively. The mortality of LC_{25} concentration of spinetoram, *B. bassiana* and *B. thuringiensis* subsp. *kurstaki* was found to be 21.11 ± 1.49, 23.33 ± 1.72 and 26.67 ± 2.05 per cent, respectively. The joint action of spinetoram + *B. bassiana* and spinetoram + *B. thuringiensis* exhibited 54.45± 3.18 per cent and 62.22 ± 1.41 per cent mortality which was higher than the theoretical mortality of 44.44 per cent and 62.22 ±1.41 per cent, respectively. Similarly, the joint application of entomopathogens with spinetoram resulted in suppression of MFO (7.93 to 9.23 per cent), CarE (5.64 to 6.18 per cent) over the spinetoram treatment alone (Table 1). Similarly, Shabbir et al. (2021) found that the combination of *B. thuringiensis* (LC_{50}) + chlorantraniliprole (LC_{50}) was more toxic than the individual treatment, suggest that synergistic interaction presents between *B. thuringiensis* and

chlorantraniliprole. Ali et al. (2017) also reported significant suppression of CarE and GST activity after the combined application of chemical insecticide and *Lecanicillium muscarium* against *Bemisia tabaci*.

Table 1. Mitigation of detoxifying enzymes in *P. xylostella* using entomopathogens

HAT	Mixed function oxidase					Increase(+)/Decrease (-) over resistant stain	
	Spinetoram	*B. Bassiana*	*B. thuringiensis*	*Bb* + Spinetoram	*Bt* + Spinetoram	*Bb* + Spinetoram	*Bt* + Spinetoram
6	154.21^{c}	147.84^{a}	151.04^{b}	154.58^{c}	155.26^{c}	-0.24	0.68
24	179.35^{d}	152.13^{a}	156.55^{b}	176.03^{c}	174.67^{c}	-1.85	-2.91
48	196.90^{d}	155.78^{a}	161.19^{b}	181.28^{c}	178.73^{c}	-7.93	-9.23
Control	147.73	-	-	-	-	-	-
	Glutathione S-transferase						
6	376.53^{b}	369.37^{a}	370.07^{a}	377.22^{b}	376.73b	-0.18	0.05
24	383.40^{c}	372.88^{a}	376.01^{b}	385.70^{d}	382.78c	0.60	-0.16
48	398.76^{d}	381.48^{a}	382.75^{a}	391.14^{c}	388.21b	-1.91	-2.65
Control	368.54	-	-	-	-	-	-
	Carboxyl esterase						
6	694.25^{b}	659.76^{a}	660.13^{a}	695.08^{b}	695.46^{b}	-0.12	0.17
24	722.11^{e}	664.13^{a}	667.36^{b}	704.54^{d}	701.72^{c}	-2.43	-2.82
48	753.38^{e}	678.37^{a}	681.21^{b}	710.91^{d}	706..84^{c}	-5.64	-6.18
Control	658.76	-	-	-	-	-	-

HAT indicates hours after treatments, Enzyme activity in n moles min^{-1} mg protein-1, Mean of four replications

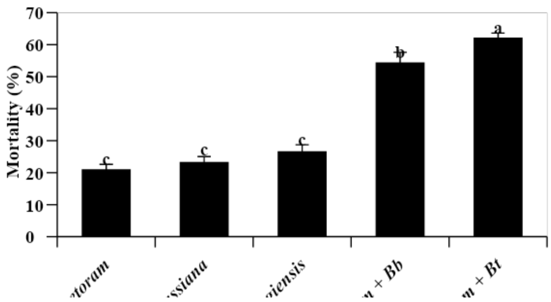

Fig 1. Joint action of entomopathogens with spinetoram against *P. xylostella*

Reference

Adhira, D., Kennedy, J. and Balasubramanian, G. (2004) Mitigation of insecticide detoxifying enzymes and suppression of quinalphos resistance in *Plutella xylostella* by *Bacillus thuringiensis* infection. in: National symposium on green pesticides for Insect Pest Management, 5-6, Feb., Loyola College, Chennai.,

Ali, S., Zhang, C., Wang, Z., Wang, X.-M., Wu, J.-H., Cuthbertson, A.G.S., Shao, Z. and Qiu, B.-L. (2017) Toxicological and biochemical basis of synergism between the entomopathogenic fungus *Lecanicillium muscarium* and the insecticide matrine against *Bemisia tabaci* (Gennadius). *Scientific Reports* 7, 1-14

Bioefficacy of Certain Chemical Insecticides Against Rice Yellow Stem Borer (*Scirpophaga incertulas* wlk.)

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Keywords: Rice, yellow stem borer, Scirpophaga incertulas, insecticides, bioefficacy

Introduction

The global population surge has resulted in an ever increasing need for food grain production. Rice is the staple food and primary source of nutrition for more than half of the world's population. But the surmounting infestation of pests has been threatening rice yields, especially the rice yellow stem borer, *Scirpophaga incertulas* Wlk.(Pathak and Khan, 1994). It has been estimated to cause a loss of upto 10-40% in grain yields. (Chatterjee and Mondal, 2014). Therefore, the timely management of the notorious pest is the need of the hour to meet the increasing demand for rice.

Methodology

The rice variety IR-64 Drt 1 was selected to study the effect of chemical insecticidal treatments on the incidence of yellow stem borer in rice. 10 insecticidal treatments in were selected, viz., Flubendiamide 240 SC + Thiacloprid 240 SC @ 200ml, Flubendiamide 240 SC + Thiacloprid 240 SC @ 250 ml, Imidacloprid 17.8 SL @ 150 ml, Flubendiamide 480 SC @ 50 ml, Rynaxypyr 20 SC @ 150ml, Fipronil 80 WG @ 65kg, Dinotefuran 20 SG @ 200g, Fipronil 0.3 GR + Chlorpyriphos 20 EC* 0.3 GR + 20 EC* @12.5 kg + 2.0 L, Chlorpyriphos 20 EC @ 2.0 L along with 1 untreated control. The sprays were given to the rice crop thrice, at 30, 50 and 85 DAT (days after transplanting). The percentage dead heart incidence (DH%) before spray and at 5, 10 & 15 days after each foliar spray and the mean values tabulated. Similarly, incidence of yellow stem borer in terms of white ear (%WE) was also recorded during both dough stage and maturity stage and means were recorded in the form of a table.

Results and Discussion

Dead heart

The mean %DH of all three sprays was studied (Table 1) and it indicated that the treatment flubendiamide 240 SC + thiacloprid 240 SC @250ml/ha showed the least incidence of yellow stem borer in terms of dead heart (2.71, 2.34 and 2.07% DH respectively for 1st, 2nd and 3rd sprays) which was at par with flubendiamide 480 SC @ 50 ml/ha (3.89, 2.69 and 1.89% DH respectively for 1st, 2nd and 3rd sprays).

White ear

The mean of %WE infestation recorded at dough stage and maturity stage was subjected to a careful perusal which indicated that the treatment flubendiamide 240 SC + thiacloprid 240 SC @250ml/ha (2.30% WE) was found to be the best treatment in the management of the yellow stem borer in the later stages of crop. Combining both the above results concluded that the treatment flubendiamide 240 SC + thiacloprid 240 SC @ 250 ml/ha recorded the lowest incidence of dead heart and white ear and hence the best out of all the treatments under study in effectively controlling the infestations of yellow stem borer in younger and mature crop.

Table 1. Effect of certain chemical insecticides on the incidence of dead heart caused by yellow stem borer (*Scirpophaga incertulas* Walk.) infesting rice

Trt no.	Insecticidal treatments	DH% before spray	Mean DH% after 1st spray	Mean DH% after 2nd spray	Mean DH% after 3rd spray	Mean WE% after spray
T_1	Flubendiamide 240 SC + Thiacloprid 240 SC (combination product) @ 200 ml/ha	6.23 (13.55)	4.48 (12.18)	3.90 (11.38)	3.40 (10.57)	3.73 (11.07)
T_2	Flubendiamide 240 SC + Thiacloprid 240 SC (combination product) @ 250 ml/ha	7.14 (13.72)	2.71 (9.46)	2.34 (8.75)	2.07 (8.11)	2.30 (8.71)
T_3	Imidacloprid 17.8 SL @150ml/ha	6.55 (14.77)	5.08 (13.01)	3.86 (11.29)	2.85 (9.62)	5.00 (12.91)
T_4	Flubendiamide 480 SC @ 50 ml/ha	6.45 (14.19)	3.89 (11.31)	2.69 (9.40)	1.89 (7.71)	2.49 (9.00)
T_5	Rynaxypyr 20 SC @150ml/ha	7.60 (15.72)	5.78 (13.90)	4.87 (12.74)	4.15 (11.70)	5.10 (13.01)
T_6	Fipronil 80 WG @ 65g/ha	6.38 (14.19)	4.63 (12.42)	4.47 (12.17)	4.17 (11.72)	4.83 (12.66)
T_7	Dinotefuran 20 SG @ 200g/ha	7.83 (15.78)	6.46 (14.7)	5.39 (13.41)	3.99 (11.37)	5.73 (13.84)
T_8	Fipronil 0.3 GR followed by Chlorpyriphos 20 EC @2000ml/ha	6.73 (14.43)	3.11 (10.11)	4.06 (11.58)	5.12 (13.07)	4.87 (12.73)
T_9	Chlorpyriphos 20 EC@ 2000ml/ha	6.85 (14.23)	3.93 (11.33)	3.57 (10.88)	3.11 (10.14)	4.99 (12.89)
T_{10}	Untreated control	6.77 (12.41)	8.59 (17.03)	12.08 (20.32)	16.70 (24.11)	14.05 (21.99)
	SEm (±)	(3.66)	(0.66)	(0.53)	(0.90)	(0.64)
	C.D. (P=0.05)	NS	(1.91)	(1.58)	(2.68)	(1.91)
	C.V. (%)	(15.60)	(8.82)	(7.52)	(13.13)	(8.56)

Figures under parentheses correspond to angular transformed values

DAA - Days after application NS- Non significant

Reference

Chatterjee, S. and Mondal, P. 2014. Management of rice yellow stem borer, *Scirpophaga incertulas* Walker using some biorational insecticides. ***J. Biopest,*** 7(supp):143-147

Pathak, M.D. and Khan, Z.R. 1994. *Insect Pests of Rice*. IRRI, Manila, 89pp.

Bioefficacy of Newer Molecules Insecticides against Tea Mosquito Bug, *Helopeltis theivora* Waterhouse under Laboratory Condition

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Keywords: *Bio efficacy, New Insecticides, Tea, Tea mosquito bug, Sucking pests*

Introduction

Tea, *Camellia sinensis* (L.) O. Kuntze is most important drinking beverages in world. Several insect pests attack tea, among them, the Tea mosquito bug, *Helopeltis theivora* Waterhouse causes 10-50 per cent economic loss in Southern India. Both nymph and adult suck the sap from new shoots, leaves and cause dieback symptoms. *H. theivora* has the capability to develop resistance to frequently used insecticides. Hence the newer molecules insecticides were tested against the tea mosquito bug for effective management.

Methodology

Field populations of *H. theivora* were collected and Bouquet bioassay method was used to assess the efficacy. Eleven insecticides with three replications (15 shoots/ replication) and Completely Randomized Design (CRD) were followed. The treatments include *viz.,* T1- Chlorantraniliprole 18.5 SC @ 0.3ml/lit., T2- Spirotetramate +Imidacoprid 11.01 SC @ 2ml/litre., T3 - Thiacloprid 21.7 SC @ 1ml/lit., T4 - Thiamethoxam 25 WG @ 0.5gm/lit., T5- Spinosad 45 SC @ 0.5ml/lit., T6- Dinotefuran 20 SG @ 0.5g/lit., T7- Emamectin benzoate 5 SG @ 0.5g/lit., T8- Buprofezin 25 SC @ 3ml/lit., T9- Sulfaxaflor 21.8 SC @ 1.8ml/lit., T10- Tolfenpyrad 15% EC @ 2ml/lit., and T11- Control (Water). The shots were sprayed with hand atomizer and observations on the % adult mortality and Feeding puncture/ shoots were recorded at 24, 48 and 72 hours after treatment (HAT). Moribund insects were considered as dead and taken for the count and data were analyzed statistically.

Results and Discussion

The results on the efficacy of newer insecticide molecules against TMB revealed that Tolfenpyrad 15% EC treated tea shoots showed less no of feeding punctures (85.33 Nos) with 100 per cent adult mortality followed by Dinotefuran 20 SG (100.00%) , Sulfaxaflor 21.8 SC (93.33%), Emamectin benzoate 5 SG (90.00%), Thiacloprid 21.7 SC (88.33%), Spirotetramate +Imidacoprid 11.01 SC (81.67%), Buprofezin 25SC (75.00%), Thiamethoxam 25 WG (71.67%), Chlorantraniliprole 18.5 SC(68.33%), Spinosad 45 SC (61.67 %) and control (feeding punctures was maximum 167.22 Nos). (Table 1). The present finding was strengthened by the field studies of Roy *et al.*, (2009) and Mality and Sarkar (2016). The present study concludes that the application of Tolfenpyrad 15% EC @ 2ml/lit. followed by Dinotefuran 20 SG @ 0.5gl/lit, Sulfaxaflor 21.8 SC@ 1.8ml/lit in rotation effectively control *H. theivora* in Tea. Thus, Tolfenpyrad 15% EC @ 2ml/lit. could be recommended for widespread application to successfully manage the tea mosquito bug.

Table 1. Bioefficacy of new insecticides against Tea mosquito bug under laboratory condition

Treatment details	Dose (ml or g/Lit.)	Adult mortality %			% reduction over control	Feeding punctures	% reduction over control
		24 HAT	48 HAT	72 HAT		72 HAT	
T1	**0.3**	21.67^{b}±0.10	38.33^{cd}±0.16	68.33^{de}±0.06	88.31	131.00^{bc}±0.12	32.69
T2	**2.0**	28.33^{b}±0.22	51.67^{bc}±0.07	81.67^{bcd}±0.11	90.72	120.33^{c}±0.13	37.87
T3	**1.0**	28.33^{b}±0.08	55.00^{b}±0.11	88.33^{abc}±0.14	91.26	121.33^{c}±0.09	38.54
T4	**0.5**	21.67^{b}±0.18	38.33^{cd}±0.16	71.67^{cde}±0.16	88.61	131.67^{b}±0.21	33.36
T5	**0.5**	18.33^{b}±0.10	28.33^{d}±0.08	61.67^{c}±0.06	86.15	135.00^{bc}±0.22	30.23
T6	**0.5**	48.33^{a}±0.07	75.00^{ab}±0.10	100.00^{a}±0.00	93.28	101.00^{d}±0.09	46.71
T7	**0.5**	25.00^{b}±0.16	51.67^{bc}±0.07	90.00^{ab}±0.10	91.00	122.00^{bc}±0.21	37.87
T8	**3.0**	21.67^{b}±0.10	48.33^{b}c±0.07	75.00^{bcde}±0.10	89.66	129.33^{bc}±0.20	33.29
T9	**1.8**	45.00^{ab}±0.00	71.67^{ab}±0.06	93.33^{ab}±0.09	92.86	104.00^{c}±0.15	45.51
T10	**2**	51.67^{a}±0.07	81.67^{a}±0.06	100.00^{a}±0.00	93.57	98.33^{c}±0.06	48.97
T11	**-**	5.00^{c}±0.00	5.00^{e}±0.00	5.00^{f}±0.00	-	233.33^{a}±0.34	-
CD (P=0.05)	**-**	0.35	0.28	0.27	-	0.54	-
SE(d)	-	0.18	0.14	0.13	-	0.26	-

Means ± SE within a column followed by the same letter are not significantly different from each other at 5% level of significance (LSD test)

Reference

Maity, L., and P. K. Sarkar. 2016. Bio-effectiveness of Dinotefuran against Tea mosquito bug, Helopeltis theivora waterhouse, in Tea Plantations of West Bengal, India. The Bios. 11(4): 2209-2213.

Roy, S., Mukhopadhyay, A. and Gurusubramanian G. 2009. Population dynamics of tea mosquito bug (Helopeltis theivora Waterhouse, Heteroptera: Miridae) in the sub-Himalayan Dooars tea plantation and possible suggestion of their management strategies. Curr. Biotica. 2(4): 414-428.

Bio-Efficacy of Selected Insecticides and Botanicals Against the Serpentine Leaf miner, *L. trifolii* (Burgess) on Watermelon

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Keywords: *Watermelon, leaf miner, Liriomyza trifolii, cyantraniliprole, insecticides, neem, botanicals*

Introduction

Watermelon (*Citrullus lanatus*) is an important summer fruit crop grown for its juicy fruits and its juice that contains 92 % water with ample amounts of carbohydrates, proteins and minerals. Watermelon production is severely affected by the direct and indirect influence of numerous insect pests. The serpentine leaf miner, *Liriomyza trifolii*¸ a native of North America introduced in India in the early 90s, has been assuming a major pest status in watermelon in some growing pockets. Literatures suggest that leaf damage up to 37 % has been reported due to the serpentine leaf miner (Patnaik, 2000). The blind dependence on synthetic chemicals for management of pests in watermelon ought to be discouraged and emphasis should be given to switch to more eco-friendly approaches.

Methodology

Watermelon crop (*var.* Sugar queen) was raised by adopting the standard package of practices at College of Agriculture, Anand Agricultural University, Jabugam, Gujarat from April to June, 2019. The experiments were carried out in completely randomized block design (RBD). A selected set of insecticides and botanicals recommended or practiced against the leaf miner in different crops were tested for their efficacy in managing the pest in watermelon. The first spray of respective insecticide/botanical was made at 5 per cent leaf damage and subsequent second spray was applied after 7 and 15 days after the first spray in case of botanicals and insecticides, respectively by using high volume sprayer (knapsack) with required concentration. Five plants were randomly checked per plot for two criteria: (i) mines per leaf, and (ii) per cent leaf damage. Observations of leaf mines were recorded before spray, as well as 5, 10 and 15 days after each spray for chemical treatment. For botanicals, the observations were recorded at 3, 5 and 7 days after spraying.

Results and Discussion

Efficacy based on mines per leaf

Based on the observations made on the basis of mines per leaf, it was inferred that among the selected insecticides, cyantraniliprole (0.018 %) showed significantly lesser number of mines per leaf (2.20 mines/ leaf) followed by abamectin (0.00057 %) and deltamethrin (0.0025 %) which recorded a mean of 2.28 and 2.85 mines per leaf, respectively. This validates the studies made by Mishra (2015) and Mandal (2012), who tested the bio-efficacy of cyantraniliprole against the leaf miner in gherkins and tomato, respectively. In case of botanicals, neem seed kernel extract (7.34 mines/ leaf) and neem oil 2 % (7.45 mines/ leaf) showed considerable reduction of leaf mines. These results were in accordance with works of Krishnakumar (1998) where NSKE was successfully tested against *L. trifolii* in vegetables.

Efficacy based on per cent leaf damage

In case of chemical insecticides, per cent damage on leaves was found the lowest in case of cyantraniliprole, 0.018 % (13.01 %) followed by abamectin, 0.00057 % (13.21 %), whereas neem seed kernel extract 5 % (19.16

%) followed by neem oil 2 % (19.44 %) were found to be the better treatments in case of the botanicals. The diamide cyantraniliprole showed least mines per leaf and per cent leaf damage compared to all other insecticides implying the efficacy of diamides in managing the leaf miner damage. Neem based botanicals like NSKE 5% and Neem leaf extract 2 % provided good results on par with some of the chemical treatments which suggests the use of these botanicals for eco-friendly management of leaf miner in watermelon.

Reference

Krishnakumar, N. K. (1998). Bio-ecology and the management of the serpentine leaf miner, *Liriomyza trifolii* on vegetable crops. *Final report of ICAR AD-hoc scheme*, IIHR, Bangalore.

Mandal, S. (2012). Bio-efficacy of Cyazypyr 10% OD, a new anthranilic diamide insecticide, against the insect pests of tomato and its impact on natural enemies and crop health. *Acta Phytopathologica et Entomologica Hungarica*, 47 (2), 233-249.

Mishra, H. P. (2015). Management of serpentine leaf miner, *Liriomyza trifolii* (Burgess) in gherkin with cyantraniliprole. *Indian Journal of Entomology*, 77 (1), 27-31.

Patnaik, H. P. (2000). Host preference of serpentine leaf miner, Liriomyza trifolii, under field conditions. *Insect Environment*, 6 (1), 31.

Biology and Feeding Preference of Invasive Fall Armyworm, *Spodoptera frugiperda* (J.E. Smith) on Different Host Plants

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Keywords: *Fall armyworm, Maize, Sorghum, Pearl millet, Feeding preference*

Introduction

Fall armyworm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) is a notorious invasive pest which feeds on different crops under more than 76 families, but with a high preference for Poaceae plants (Montezo *et al*., 2018). Comparing the growth and development of fall armyworm on different hosts under laboratory condition, might provide a better understanding on its host preference, suitability, the possibility of the pest expanding its host range. etc.

Methodology

For the study of biology of fall armyworm, three plants *viz*., maize, sorghum and pearl millet were selected. These three hosts have already been recorded as hosts on which Fall armyworm could complete its development. *Spodoptera frugiperda* colony was established by procurement of eggs from the laboratory culture of TNAU, Coimbatore. For each crop, two replication with n=30 larvae were released and maintained under laboratory conditions. Leaf bits were changed on a daily basis. Biological parameters like larval duration, pre-pupal and pupal period, adult longevity and total life cycle were observed. For feeding preference studies, I and III instar larvae were selected. Rearing box with 12cm diameter and agar as a base to prevent dehydration were used for 10 replications. Leaf bits of three hosts were placed at an equal distance in the box. The I instar and III instar larvae were subjected to feeding preference studies using 10 and 5 larvae under each instars, respectively. The position of larva was observed after 1 hour and 24 hours. The interpretation thus arising would also be helpful in ascertaining its establishment on hosts other than Maize under field conditions.

Results and Discussion

Biological studies

Among the three hosts plant larval duration was short in sorghum (14.83 days) than maize (15.86 days) and pearl millet (17.66 days). Pre-pupal period was minimum in maize (1.56 days) followed by sorghum (2.2 days) and pearl millet (2.4 days). Pupal period was least in maize (7.3 days). Male and female longevity was high in sorghum (7.76 and 7.4 days), but the total life cycle was short in maize (28.83 days) compared to sorghum (30.4 days) and pearl millet (30.0 days) (Table 1).

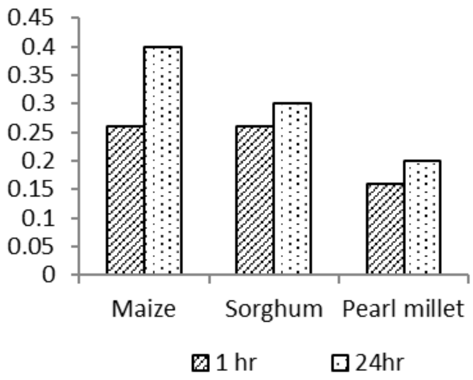
Feeding preference

The feeding preferences studies revealed that maize was the most preferred host for first instar larva followed by sorghum and pearl millet (Figure 1), while the order of preference was Maize followed by Pearl millet and Sorghum for third instar larva (Figure 2).

Table 1. Biology of fall armyworm on different hosts under laboratory conditions

All values are mean of 2 replication (n=30/replication), All values are represented as Mean ± Standard deviation

Host plant	Larval duration (days)	Prepupal duration (days)	Pupal period (days)	Adult longevity (days)		Total life cycle(days)
				Male	Female	
Maize	15.86±0.93	1.56±0.50	7.33±0.54	6.5±0.68	7.4±0.49	28.83±0.79
Sorghum	14.83±0.83	2.2±0.55	8.2±0.55	7.76±0.62	7.43±0.67	30.4±0.72
Pearl millet	17.66±0.84	2.46±0.62	7.43±0.72	6.56±0.77	7.6±0.72	30.0±0.69



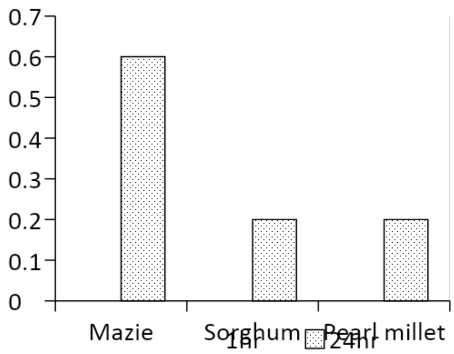


Fig 1. Feeding preference of I instar larva

Fig 2. Feeding preference of III instar larva

Reference

Praveen,T and C.P. Mallapur. 2019. Studies on host range of fall armyworm, *Spodoptera frugiperda* (J.E. Smith) under laboratory conditions. ***J. Entomol. Zool. Stud***. 7(4): 1385-1387.

Silva,D.M., F.A. Bueno, K. Andrade, C.S. Stecca, and C.C. Oliveira. 2017. Biology and nutrition of *Spodoptera frugiperda* (Lepidoptera : Noctuidae) fed on different food sources. ***Sci.Agric***., 74: 18-31.

Characterization and Expression Cloning of *Cucumber Mosaic Virus* Coat Protein Gene Infecting Banana in Kerala

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Keywords: *Cucumber mosaic virus, Sub groups, cloning, expression vector*

Introduction

Infectious chlorosis caused by *Cucumber mosaic virus* (CMV, genus: *Cucumovirus*; family: *Bromoviridae*) leads to significant yield losses in banana. Based on genomic characterizations, CMV strains are further classified into subgroups IA, IB and II. The infected plants usually appear stunted and the reproductive phase gets often retarded. The symptoms remain unnoticed when infection takes place at maturity. Therefore, cost effective serological diagnostic techniques are very essential. Hence in the present study, a CMV isolate was characterized based on coat protein (CP) sequence and was cloned to expression vector (pET28a+) for the purpose of recombinant CP mediated antiserum production.

Methodology

Cucumber mosaic virus infected banana leaf samples were collected based on characteristic symptoms (KAU, 2016). The sample recorded maximum absorbance in DAC ELISA, against anti-CMV CP polyclonal antiserum (1:1000; NRCB, Trichy) was selected for molecular analysis and expression cloning. The CP sequences of the isolate was amplified by reverse transcriptase PCR using forward (5'CATCGACCATGGACAAATCTGAAT CAAC3') and reverse (5'CTCTCCA TGGCGTTTAGTGACTTCAGCAG3') primers (Cherian et al., 2004). The amplicon was directly ligated into pGEM-T vector and transformed into *Escherichia coli* DH5α cells. The ligation (pGEM-T/CMV CP) was confirmed through standard protocols (Sambrook and Russell, 2006) and sequencing. A phylogram was drawn by Bootstrap method in MegaX (6.06) for illustrating phylogenetic relationships of the isolate with selected accessions (**Table 1**). For expression cloning, a new CP specific primer with restriction enzyme sites of BamH1 and Nhe1 (underlined),(Forward:5'GGG<u>GCTAGC</u>ATGG ACAAATTGAATCAACC3';Reverse:5'CCC<u>G GATCC</u>TTACTCTCCATGGCGTTTA3') was designed. PCR amplification was carried out using pGEM-T/CMV CP construct as template and high fidelity *Phusion* polymerase enzyme (Antony, 2019). The predigested amplicon and expression vector pET28a(+) were ligated using T_4 DNA ligase at 16°C and transformed to *E. coli* BL21(DE3)pLysS cells for expression studies and recombinant CP (rCP) production.

Results and Discussion

Variation in symptoms expression with respect to different cultivars was observed under field condition. In Nendran (AAB), severe interveinal chlorosis on infected leaves with distorted margin and rosette appearance of the plant was recorded. In cultivar Grand Naine (AAA), moderate interveinal chlorosis alone was observed. Based on the phylogenetic analysis, the selected CMV isolate from Kerala was included in the subgroup IB (**Figure 1**). Expression clones (pET28a/CMV CP in *E. coli* BL21(DE3)pLysS cells) were taken to antiserum production against rCP from Kerala isolate.

Table 1. Sources of *Cucumber mosaic virus* coat protein gene sequences used for comparison

Sl.No.	CMV Sub group	Country	Gen. Bank Accession No.
1.	Subgroup IB	India	MF280290
2.	Subgroup IB	India	AY125575
3.	Subgroup II	United States	AF127976
4.	Subgroup II	India	AY545924
5.	Subgroup II	Japan	AB006813
6.	Subgroup II	Hungary	L15336
7.	Subgroup IB	India	AF198622
8.	Subgroup IA	China	AJ006988
9.	Subgroup 1B	China	X65017
10.	Subgroup 1A	Japan	AB004781
11.	Subgroup 1A	Japan	D16405
12.	Subgroup 1A	Japan	D28486
13.	Subgroup 1A	Japan	D43800
14.	Subgroup 1B	China	AB008777
15.	Subgroup 1B	India	X89652
16.	Subgroup 1B	Japan	D42079
17.	Subgroup II	Australia	M21464

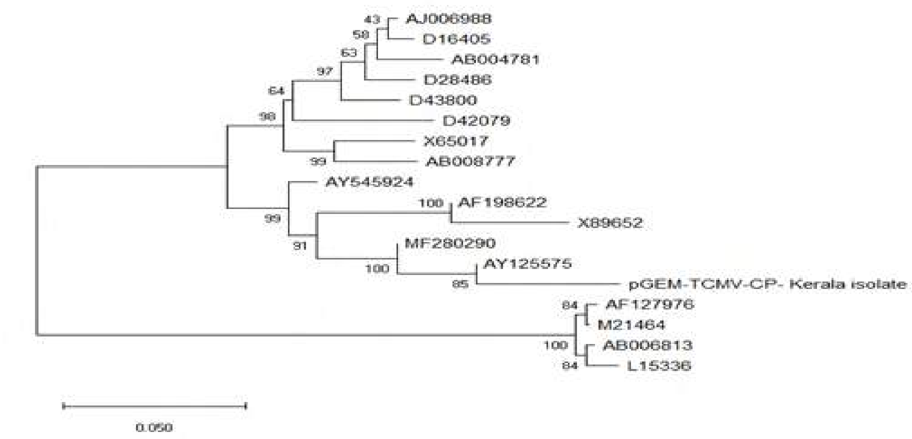

Figure 1. Phylogenetic relationships based on the multiple alignments of the coat protein amino acid sequences of 17 distinct isolates with Kerala isolate (named as pGEMTCMVCP)

Reference

Antony, A. C. 2019. Development of recombinant coat protein for immunodetection of Cucumber mosaic virus infecting banana. M.Sc. (Ag.) thesis, Kerala Agricultural University, Thrissur, 136 p.

Cherian, A. K., Praveen S. and Ahlawat. 2004. Cloning the coat protein gene of cucumovirus causing mosaic disease in India [abstract].In: Abstract, International congress on *Musa*; 6-9 July 2004, Malaysia, p.100. Abstract no. 119.

KAU [Kerala Agricultural University] 2016. Package of Practices Recommendations: Crops (15th Ed.). Kerala Agricultural University, Thrissur, 392p.

Sambrook, J. and Russell, D.W. 2006. The condensed protocols from molecular cloning: a laboratory manual.

Degree Days and Demographic Comparison of *Spodoptera frugiperda* (Lepidoptera: Noctuidae) on Maize at Different Temperatures

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Keywords: *Demography, population projection, degree days, Spodoptera frugiperda.*

Introduction

Pest biology, distribution and abundance are largely influenced by the relationship between temperature and the development rate. Since the development of insects occur within a specific temperature range, a change in temperature will, therefore, influence the development rate, the duration of the life-cycle and ultimately, survival. An increase in ambient temperature to near the thermal optimum of insects cause an increase in their metabolism and activity (Howe, 1967). The objective of the present study was to determine the number of degree days required for each stage to complete development, as well as the degree-days required for overall egg to adult development.

Methodology

The difference between the temperature at which the pest was reared and minimum threshold temperature, multiplied by the duration of development equals the heat accumulation for any one temperature and referred as degree-days (Wilson and Barnett, 1983). The degree days was calculated by using the formula; 'Degree days = (T-Tb) ×Days to develop'. The age-stage, two-sex life table approach was used to analyze the life history data for *S. frugiperda*. The age-stage-specific survival rate (*sxj*), (the probability of an individual of age *x* and stage *y* surviving to age *xj* and stage *j*), was evaluated. The age-stage-specific fecundity (*fxj*) (the daily number of eggs laid by an individual at age *x* and stage *j*), the age-specific fecundity curve (*mx*), the age-specific survival rate (*lx*) (the probability that a newly oviposited egg will survive to age x), and the population parameters were calculated accordingly (Chi and Liu, 1985).

Results and Discussion

Degree days

The total lifespan of *S. frugiperda* required 757.49-degree days at 32˚C and 603.66-degree days at 36˚C. The average degree days accumulated to complete the total lifespan of male and female *S. frugiperda* was 685.36 and 693.63, respectively. On an average, *S. frugiperda* required 690.38-degree days to complete the total lifespan (Table 1).

Fitness parameters

Age-stage-specific life expectancy (e_{xj}) describes an expected lifespan of *S. frugiperda* individuals of age *x* and stage *j* at ambient and five different elevated temperature levels (Figure 1). The life expectancy of a newly laid egg shortened with increasing temperature regimes. Age-stage-specific reproductive value (v_{xj}) indicates the contribution of a *S. frugiperda* individual at age *x* and stage *j* to the future population was presented in Figure 2. The highest v_{xj} peaks of *S. frugiperda* were obtained at 34°C, it was higher than the ambient.

Table 1. Accumulated degree days for *S. frugiperda* under different temperatures

Stage	Degree-days (days)					
	32˚C	33˚C	34˚C	35˚C	36˚C	Average
Egg	63.30	44.20	46.20	24.10	25.10	40.58
L1	37.14	38.90	36.04	27.96	28.11	33.63
L2	36.08	36.47	35.81	30.13	31.63	34.02
L3	36.08	37.13	33.03	30.37	30.37	33.40
L4	36.50	36.02	34.19	30.85	33.13	34.14
L5	37.56	39.34	38.12	37.11	28.61	36.15
L6	58.03	53.70	49.43	49.65	40.41	50.24
Larval total	247.08	245.75	234.47	229.67	229.92	237.38
Pupa	214.38	210.83	197.27	158.58	141.31	184.47
Pre adult	524.97	500.57	477.94	411.87	396.33	462.34
Male longevity	229.36	229.40	210.21	209.43	203.04	216.29
Female longevity	235.27	244.43	251.33	238.35	213.35	236.55
Adult longevity	232.52	238.46	235.39	226.78	207.33	228.10
Male lifespan	747.57	736.59	694.16	641.54	606.92	685.36
Female lifespan	766.14	740.79	725.11	636.72	599.39	693.63
Total lifespan	757.49	739.02	713.10	638.65	603.66	690.38

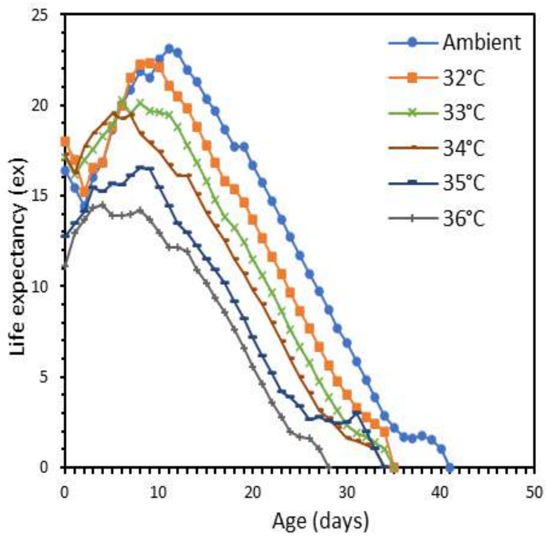

Figure 1. Age - specific life expectancy (e_x)

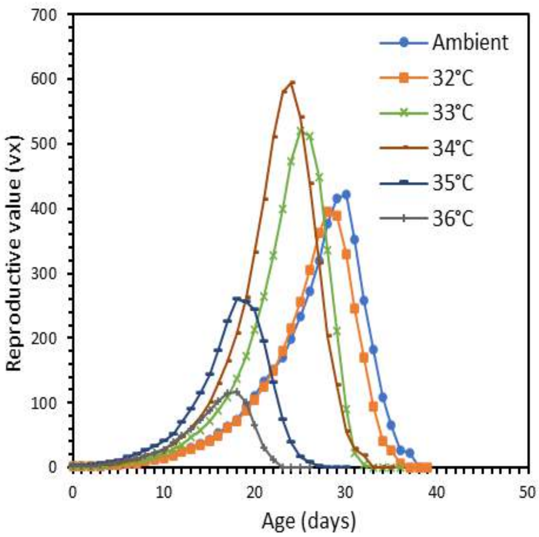

Figure 2. Reproductive value (v_x)

Reference

Chi, H. and Liu, H. 1985. Two new methods for the study of insect population ecology. Bulletin of the Institute of Zoology Academia Sinica, 24(2): 225-240.

Howe, R. W. 1967. Temperature effects on embryonic development in insects. Annual Review of Entomology, 12(1): 15-42.

Wilson, L. and Barnett, W. 1983. Degree-days: an aid in crop and pest management. California Agriculture, 37(1): 4-7.

Depletion of Parasitoid Community of South American Leafminer, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) in Tamil Nadu, India: a Need for its Revival

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Keywords: *Tuta absoluta, Bracon spp., Damage potential, depletion of parasitoid community, India*

Introduction

South American leafminer, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is an invasive, neotropical, highly destructive polyphagous pests of tomato causes an excessive leaf mining resulting in 100% yield loss. High reproductive capacity, short developmental time, high survival, rapid spread and resistance to insecticide makes this pest more challenging. Consequently, biological control may be an environmentally and economically-sound tool for managing this pest rather than the synthetic insecticides. In this situation, faunistic surveys of parasitoids could constitute the baselines upon which further applicative studies can be integrated. Therefore, an extensive survey was carried out to record the damage potential of *T. absoluta* and its associated parasitoids in tomato growing areas of Tamil Nadu.

Methodology

An Extensive Survey was carried out to reckon the damage potential of *T. absoluta* and its associated parasitoids in different districts of Tamil Nadu *viz.,* Dharmapuri, Dindigul and Coimbatore districts during 2016 to 2018. Damage potential of *T. absoluta* (Sharma *et al.*, 2011) on tomato was assessed from 20 leaflets/leaves at top, middle, bottom of five randomly selected plants in each location. To assess the per cent parasitization, 25 plants were selected at random from each location and infested leaves with live and parasitized larvae were brought to the laboratory and observed for the emergence of parasitoids. A sample size of 30 larvae per location was maintained. From the sample size, per cent parasitization and parasitoid (different) species emergence were worked out by the following formula.

$$\text{Parasitization}\% = \frac{\textit{Number of larvae parasitized}}{\textit{Total number of larvae collected}} \times 100$$

$$\text{Parasitoid(different) species emergence}(\%) = \frac{\textit{Number of larvae from which particular species of parasitoids emerged}}{\textit{Total number of larvae collected}} \times 100$$

The emerged parasitoids were preserved in 70 per cent ethanol and identified with the help of taxonomic expert, Dr. A.P. Ranjith, University of Calicut, Kerala.

Results and Discussion

The survey during 2016 to 2017 revealed highest incidence of *T. absoluta* in TNAU orchard (85.50 %), Coimbatore and the survey during 2017 to 2018 revealed highest incidence of *T. absoluta* in TNAU orchard (80.50 %), Coimbatore (Fig. 1 and 2). This is in accordance with Balaji *et al.* (2018) who reported the highest incidence of *T. absoluta* in a polyhouse at TNAU orchard (92.50 %). The survey also revealed highest parasitization at TNAU orchard (10.00 %), Coimbatore followed by Papparapatti village (6.67 %) of Dharmapuri district during 2016 to 2017 whereas nil or no parasitization was noticed during 2017 to 2018. *Bracon* spp. was the only parasitoid recorded on *T. absoluta* in both the locations. This is in contrast with the results of Ferracini *et al.* (2012) who reported several parasitoid associations with *T. absoluta.* Nevertheless, this might be attributed to the low developmental rate of wasp's larval stages, implying that the invasive host is unfit for native parasitoid's biology. Another element that could affect the successful development of immature wasps is the accumulation of toxins within the host. Besides, indiscriminate usage of pesticides against the invasive species might have eliminated their natural enemies in the ecosystem (Abbes *et al.*,2014). In this framework, a thorough understanding of the impact of various pesticides on the natural enemies and conservation of parasitoid community is mandatory through habitat manipulation and manipulation of host plant attributes.

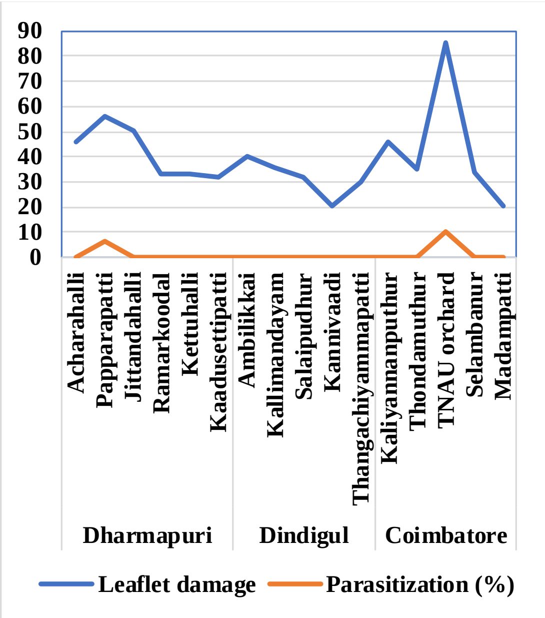

Fig 1. Occurrence of *T. absoluta* and its parasitization in tomato growing regions of Tamil Nadu during 2016 to 2017

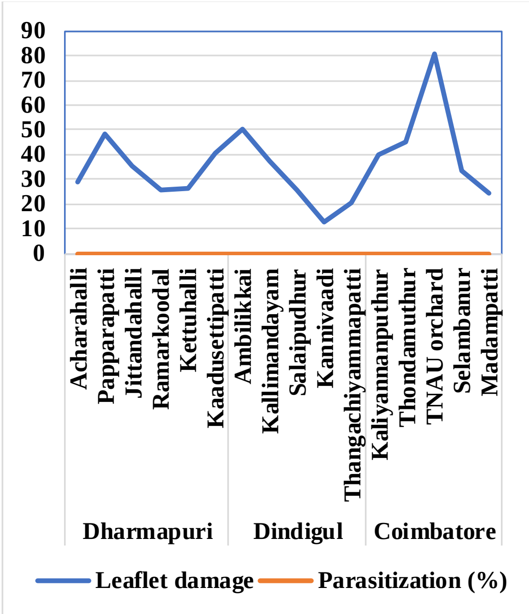

Fig 1. Occurrence of *T. absoluta* and its parasitization in tomato growing regions of Tamil Nadu during 2017 to 2018

Reference

Sharma, P.L., U. Chauhan, P.R. Gupta, K.C. Sharma and S.P. Verma. 2011. Studies on the parasitoids of the serpentine leaf miner, *Liriomyza trifolii* (Burgess) in tomato ecosystem under mid hill condition of Himachal Pradesh. ***Journal of Biological Control***, 25 (4):320-322.

Abbes, K., A. Biondi, L. Zappalà, and B. Chermiti. 2014. Fortuitous parasitoids of the invasive tomato leafminer, *Tuta absoluta* in Tunisia. ***Phytoparasitica***, 42 (1): 85-92.

Ferracini, C., B. L. Ingegno, P. Navone, E. Ferrari, and Mosti, M. 2012. Adaptation of indigenous larval parasitoids to *Tuta absoluta* (Lepidoptera: Gelechiidae) in Italy. ***Journal of Economic Entomology***, 105, 1311–1319

Detection and Documentation of *Tomato Leaf Curl New Delhi Virus* Association with Mosaic Disease of Cucurbits and in Seeds in Tamil Nadu

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Keywords: *Cucurbits, Tomato leaf curl New Delhi virus (ToLCNDV), Polymerase chain reaction (PCR)*

Introduction

Cucurbits are important vegetable crops being cultivated throughout the year in Tamil Nadu and they are severely affected by mosaic disease caused by *Begomovirus* (family, *Geminiviridae*). The virus is transmitted by whitefly (*Bemisia tabaci*). It has emerged as a serious production constraint in a number of economically important cucurbitaceous crops including ash gourd, ridge gourd, bitter gourd, snake gourd, pumpkin and ivy gourd. In this study, we report the natural occurrence of ToLCNDV associated with mosaic disease of cucurbitaceous crops.

Methodology

Field survey and sampling

A survey was conducted for two years (2020 and 2021) in the traditionally grown cucurbitaceous crops (pumpkin, snake gourd, bitter gourd, ridge gourd, bottle gourd, ivy gourd) of Tamil Nadu. Two fields were selected in each region and roving survey was conducted with a uniform field size of 100 plants per field. The viral infections were diagnosed on the basis of the mosaic symptom, enations present in the leaves and deformities in the fruits. The leaf samples which exhibited the characteristic symptoms of the disease, such as yellow mosaic, puckering, distortion, and enation were collected and stored at –20 °C.

Confirmation of the begomovirus infection

The total DNA was extracte from the collected leaf samples following the GEM-CTAB method. The universal primers, Roja's PALIc 1960 and PALIr 772 were used to detect begomovirus. For this, PCR was carried out in a reaction volume of 25 µL. The samples which were positive for the begomovirus were selected for further characterization. Once the begomovirus was identified as ToLCNDV, the specific primers were used for the specific detection of the virus.

Seed transmission

Fruits were collected from the standing crop of cucurbits from two different locations (Pollachi and TNAU orchard) of Coimbatore district. The fruits were dissected into their different constituent parts (pericarp, mesocarp, seed coat, endosperm, and embryo), and then analyzed for the presence of the virus by performing PCR with 100 ng of total nucleic acid. PCR was performed using the degenerate Roja's primers, PAR1v 772 and PAL1c 1960. Further presence of the virus was confirmed using ToLCNDV-specific primers (Sangeetha *et al*., (2018).

Results and Discussion

Detection of Begomovirus

The fields at the different agro climatic zones in Tamil Nadu were surveyed during 2020 and 2021. The presence of begomovirus was confirmed by subjecting the samples to PCR with Roja's primers. Among a total of 20 samples tested, the virus was detected in10 samples, resulting in PCR amplicons of around 1.2 kb was sequenced. The sequences obtained from this sample exhibited 97% identity with the genome of ToLCNDV DNA- A matched from Bangalore isolate.

Seed transmission

In order to test the presence of the virus, fruits of the standing crop having immature seeds and the fruits which were used as a seed material were tested for the presence of the virus, a uniform amplification was observed in the fruits and also in seed tissues. Among the seed tissues the virus was detected in the seed coat, endosperm and embryos of seeds of ridge gourd, bitter gourd, snake gourd and ash gourd. Using the same lot of seed material which was used for the PCR detection, 25 seed samples of each 5 cucurbitaceous crops were planted in pots in an insect proof glasshouse, and were observed up to 30 days. Out of the 25 seeds planted and resulted in a good crop growth. All the plants from these seed material were symptom-free. The symptom-free plants were also tested for the presence of the virus by performing PCR, 30 days post sowing. Amplicons of size 1.2 kb and 1.6 kb were obtained in the PCR with Roja's and ToLCNDV-specific primers. Eui-Joon Kil *et* al. (2020) reported that the presence of ToLCNDV in seed coats and seedlings.

Reference

Sangeetha B, Malathi VG, Alice D, Suganthy M, Renukadevi P, A distinct seed-transmissible strain of tomato leaf curl New Delhi virus infecting Chayote plants in India, *Virus Research* (2018).10.009.

Eui-Joon Kil, Thuy Thi Bich Vo, Chairina Fadhila, Phuong Thi Ho, Aamir Lal, Elisa Troiano, Giuseppe Parrella and Sukchan Lee. Seed Transmission of Tomato Leaf Curl New Delhi Virus from Zucchini Squash in Italy. *Plants* (2020). 9. 563.

Diversity of Lymantriinae in Leeward Side of Western Ghats, Tamil Nadu

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Keywords: *Lymantriinae, Diversity, Coimbatore, Orvasca subnotata, Dindigul, Perina nuda.*

Introduction

The Lymantriid moths referred as 'tussock moths' for their striking tuft of hairs belonging to subfamily Lymantriinae are poorly pondered group in the family Erebidae. The subfamily Lymantriinae comprise 2,500 species under 360 genera world over and is represented by 173 species and 28 genera in British India (inclusive of the geographical area of Myanmar, Bhutan and Sri Lanka). Once stated by Swinhoe as neglected family Liparidae has undergone active hierarchical changes in the recent years and currently takes the subfamily rank in the family Erebidae (Order: Lepidoptera).

Methodology

Collections from that of Tamil Nadu Agricultural University (TNAU) Insect Museum, Coimbatore and surveys undertaken between 2017 and 2021 to assess the diversity of Lymantriinae in Coimbatore and Dindigul was attempted. Districts Coimbatore and Dindigul were selected from the leeward side of Western Ghats in Tamil Nadu owing to convenience of survey and abundance in museum collections. Survey and collections in Coimbatore district comprised of regions in and around Anaikatti, Mettupalayam, Pollachi, Ramanathapuram, Siruvani, and New area, Orchard, and Wetland of TNAU. Survey and collections of Dindigul district comprised of regions in and around Kodaikanal, Lower Pulneys, Perumalmalai, Thadiyankudisai and Thandikudi. Diversity analysis *viz*., Shannon-Wiener index (Hughes, 1978) ($H' = -\Sigma\, Pi\ ln\ (Pi)$), Simpson's diversity index (Simpson, 1949) ($D = \Sigma\, n(n-1)/N(N-1)$), Margalef index (Margalef, 1958) ($\alpha = (S-1)/ln(N)$) and Equitability J (Magurran, 1987) ($\alpha = -\Sigma\, (n/N\ ln\ (n/N))/ln\ N$), were used to assess the species diversity, richness and dominance. The indices were calculated using https://www.alyoung.com/labs/biodiversity_calculator.html.

Results and Discussion

A total of 237 and 157 individuals from Coimbatore and Dindigul were documented respectively in a span of 16 years (2006 - 2021). There were about 24 and 14 species in Coimbatore and Dindigul respectively. In Coimbatore, the species *Orvasca subnotata* was abundant followed by *Artaxa guttata* and *Somena scintillans*, while in Dindigul, *Perina nuda* abundant followed by *Lymantria aryama* and *Nygmia icilia*. The diversity analyses indicate that Coimbatore district was more diverse (*H'*- 3.843, D- 0.0938, α- 4.206 and E- 0.8383) than Dindigul (*H'*- 3.041, D- 0.1744, α- 2.571 and E- 0.7986) **(Table 1)**.

Table 1. Diversity analysis of Lymantriinae in Coimbatore and Dindigul districts

S. No.	District	Shannon-Wiener index	Simpson index	Margalef index	Equitability J
1.	Coimbatore	3.843	0.0938	4.206	0.8383
2.	Dindigul	3.041	0.1744	2.571	0.7986

Reference

Swinhoe, C.C. 1922. L.—A revision of the genera of the family Liparidae. ***Annals and Magazine of Natural History***, 10(58): 449-484.

Hampson, G. F. 1893. "Moths." In The Fauna of British India, including Ceylon and Burma, edited by W T Blandford, 527. Red Lion Court, Fleet Street: Taylor and Francis.

Van Nieukerken, E J, L Kaila, I J Kitching, N P Kristensen, D C Lees, J Minet, C Mitter, M Mutanen, J C Reiger, T J Simonsen, and N Wahlberg. 2011. Order Lepidoptera Linnaeus, 1758. Edited by Z Q Zhang. Vol. 3148, Animal biodiversity, an outline of higher-level classification and survey of taxonomic richness: **Zootaxa**.

Dosage and Time-Mortality Response of Okra Leafhopper, *Amrasca biguttula biguttula* (Ishida) (Hemiptera: Cicadellidae) to Entomopathogenic Fungi

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Keywords: *Amrasca biguttula biguttula, Entomopathogenic fungi, Bioassay, Dosage-Time-mortality*

Introduction

Okra, *Abelmoschus esculentus* (L.) Moench is one of the important vegetables in India and predominantly grown in many tropical and subtropical parts of the world. A sucking insect pest, leafhopper (*A. biguttula biguttula*) is considered as the most destructive pest of this crop, due to the conducive environmental conditions for pest attack and causing hopper burn symptom which resulting 55-60 per cent yield loss. Entomopathogenic fungi acts as a safer alternative to the management of okra leafhopper as against the indiscriminate use chemical pesticides.

Methodology

The experiment was carried out at Post Graduate Laboratory, Department of Plant Protection, ADAC & RI, Tiruchirappalli during 2019-2020. The dosage-time-mortality response of third instar leafhopper nymphs was estimated to the relative pathogenicity of entomopathogenic fungi *viz., Lecanicillium lecanii* (Zimmermann), *Metarhizium anisopliae* (Metchnikoff) and *Beauveria bassiana* (Bals.) at 2×10^9 cfu/ml were evaluated in serial dilutions such as 2.5, 5.0, 7.5, 10.0, 12.5 and 15.0 ml/l by leaf dip bioassay method. The different dilutions were prepared using distilled water. Okra leaves were obtained from untreated field without moisture loss to the laboratory. The leaves were dipped in freshly prepared entomopathogenic solution for five seconds and shade dried for 5-10 min. Then, moist Whatman no. 10 filter paper (9.5 cm dia.) was placed at the bottom of Petri dishes (10 cm dia.) to maintain optimum moisture and to prevent dehydration of leaves and the treated leaves were transferred to the Petri dishes. The petiole of treated okra leaves was covered with moist absorbent cotton to maintain the turgidity of leaves. Twenty third instar leafhopper nymphs were released to each treated leaf in the Petri dish. Each dilution was replicated thrice in a Completely Randomised Design (CRD) including control and the control okra leaves were dipped in distilled water. Observations on the mortality of the insects were recorded at 6 h interval. The concentration that had the mortality from 10 to 80 per cent were selected for calculating LC_{50} dose.

Results and Discussion

Entomopathogenic fungi *viz., L. lecanii, M. anisopliae* and *B. bassiana* at 2×10^9 cfu/ml in different dilutions showed the mortality from 30.00 to 93.33, 26.67 to 86.67 and 20.00 to 83.33 per cent, respectively against third instar nymphs of okra leafhopper. Among the serial dilutions, *L. lecanii* at 15.0 ml/l recorded the maximum mortality of 93.33 per cent. Karthikeyan and Selvanarayanan (2011) reported the efficacy of *L. lecanii* with mortality of 93.33 per cent against *A. devastans* and 100 per cent mortality against *Aphis gossypii* and *Bemisia tabaci* at the concentration of 1×10^8 spores/ml. Among them, high pathogenicity and low LC_{50} recorded in *L. lecanii* with the value of 8.01 ml/l and its fiducial limit of 6.77- 9.47 ml followed by *M. anisopliae* (9.79 ml; 8.19 – 11.71) and low pathogenicity with high LC_{50} observed in *B. bassiana* (10.87 ml; 9.40 – 12.57) (Table 1). The low LT_{50} recorded in *L. lecanii* with 78.22 h and its fiducial limits of 66.32 – 92.25 h followed by *M. anisopliae* and *B. bassiana* with 94.06 and

104.39 h, respectively (Table 2). Similarly, Manivannan *et al.* (2018) reported that, the low LC_{50} of 1.83×10^4 spore/ml in *L. lecanii* followed by *B. bassiana* (6.06×10^5 spores/ml) and highest in *M. anisopliae* (1.52×10^7 spores/ml). *L. lecanii* also recorded, the lower LT_{50} value of 115.37 h followed by *B. bassiana* (164.18 h) and *M. anisopliae* (210.21 h) at 1×10^8 spores/ml. The fungal hyphae penetrated in dead leafhopper nymph on 3 DAT and fungal sporulation growth on 5 DAT were observed in *L. lecanii* (Plate 1). An insect dies due to mechanical pressure exerted by excessive fungal growth and action of mycotoxins. The mycotoxins produced by *L. lecanii* are bassianolide, beauvercin, dipicolinic acid, vertilecanin-A1, decenedioic acid and 10-hydroxy-8-decenoic acid (Shinde *et al.*, 2010).

Table 1. Dosage-mortality response of leafhopper to entomopathogenic fungi

Entomopathogenic fungi	LC_{50} (ml)	Fiducial limits (95%)		χ^2	Regression equation (Slope)
		Lower	Upper		
L. lecanii	8.01	6.77	9.47	14.86	2.410+2.985x
M. anisopliae	9.79	8.19	11.71	8.97	2.533+2.515x
B. bassiana	10.87	9.4	12.57	5.34	1.774+3.116x

LC50 – Lethal Concentration (ml); 210 test insects used per treatment

Table 2. Time-mortality response of leafhopper to entomopathogenic fungi

Entomopathogenic fungi	LT_{50} (h)	Fiducial limits (95%)		χ^2	Regression equation (Slope)
		Lower	Upper		
L. lecanii	78.22	66.32	92.25	15.78	- 0.575+3.003x
M. anisopliae	94.06	78.71	112.4	8.97	0.063+2.515x
B. bassiana	104.39	90.25	120.75	5.34	- 1.286+3.116x

LT_{50} – Lethal Time (h); 210 test insects used per treatment

(a) (b)

(a) Fungal hyphae formation in dead leafhopper nymph - 3 DAT

(b) Fungal mycelial mat of conidiophores over the integument surface on leafhopper nymph - 5 DAT

Plate 1. Entomopathogenic fungi – *L. lecanii* growth on okra leafhopper

Reference

Karthikeyan, A. and Selvanarayanan, V. (2011). *In vitro* Efficacy of *Beauveria bassiana* (Bals.) Vuill. and *Verticillium lecanii* (Zimm.) viegas against selected insect pests of cotton. ***Recent Research in Science and Technology***, 3(2): 142-143.

Manivannan, A., Sridhar, R. P., Kamalakannan, A., Ganapathy, N. and Karthikeyan, S. (2018). *In vitro* efficacy of bio control agents against cotton leafhopper, *Amrasca biguttula biguttula* (Ishida) (Homoptera:Cicadellidae). ***International Journal of Current Microbiology and Applied Sciences***, 7(9): 2026 - 2031.

Shinde, S. V., Patel, K. G., Purohit, M. S., Pandya, J. R. and Sabalpara, A. N. (2010). "*Lecanicillium lecanii* (Zimm.) Zare and Games" An important biocontrol agent for the management of insect pests–a review. ***Agricultural Reviews***, 31(4): 235-252.

Dynamics of Insect Pests and Natural Enemies in Selected Rice Varieties

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Keywords: *Rice, Net sweeping, Yellow Pan Trap, Insect Pests, Parasitoids*

Introduction

Rice is one of the important target cereal crops to provide food and livelihoods for millions. Rice is mainly grown by direct-seeded rice and transplanted rice. All these factors demanded a major shift from Transplanted Rice (TR) production to Direct-seeded Rice (DSR) in irrigated and assured or high rainfall areas (Edirisinghe and Bambaradeniya, 2006). Among the major insect pests attacking rice are yellow stem borer, leaf folder, green leafhopper, grasshopper, earhead bug, white leafhopper. Naturally occurring biological control has a potential role to play in the management of rice fields and there is a need to emphasize the impact of indigenous natural enemies as an essential part of IPM Programme (Ooi and Shephard, 2005). Abundance and diversity of natural enemies, such as parasitoids and predators, contributes to biological arthropod pest control in different stages of paddy crop. A change from transplanting to direct seeding may affect the status of various pests.

Methodology

The field experiment was conducted during 2018-19 at Annamalai University, Experimental farm, Chidambaram, under the direct-seeded and transplanted rice and the variety CR Dhan 200, CR Dhan 201, CR Dhan 202, CR Dhan 203, CR Dhan 204, CR Dhan 205, CR Dhan 206, CR Dhan 207, CR Dhan 209 was sown. A Sweep net was used for the collection of a large number of species in a short period (Noyes and Valentine, 1989). The observations on the occurrence of major insect pests were recorded. Yellow Pan Trap method was used for collecting parasitoids, notably small insects as well as other groups of insects. It works on the principle that many insects were attracted to yellow color (Noyes, 1982). The traps are filled three-fourth with a mild detergent solution to break the surface tension. Many insects get attracted to the yellow color and get collected in the soap solution. The contents are then filtered the same day and the parasitic hymenopterans are preserved in 70% ethyl alcohol.

Results and Discussion

The results showed that the maximum number of yellow stem borer were observed in the direct-seeded rice variety of CR Dhan 209 (7.33) In the case of stem borer, direct-seeded rice was damaged more than the transplanted rice, and this might be due to the reason that the direct-seeded rice was in the main field for more duration than the transplanted rice, which might have caused more chances for infestation than the transplanted rice and it might have coincided with the life cycle of rice stem borer (Ashrith *et al*., 2016) and the leaf folder population was maximum in the direct-seeded rice variety of CR Dhan 204 (7.33) (Fig 1.). The peak population of grasshopper and green leafhopper was recorded in the transplanted rice variety of CR Dhan200 (11.00), CR Dhan 209 (8.00). The maximum number of Braconidae was observed in direct-seeded rice variety of CR Dhan 205 (3.66) and Ichneumonidae was recorded the highest number of direct-seeded rice variety of CR Dhan 202 (2.66). Among parasitids maximum population of family Chalcididae was collected in transplanted rice variety of CR Dhan 207 (2.66). The peak population of Trichogrammatidae was recorded in direct-seeded rice of CR Dhan 207 (3.66) (Fig 2.). The presence of Platygastridae was high in the transplanted rice variety of CR Dhan 201 (8.66). The presence of Eulophidae was high in the direct-seeded rice variety of CR Dhan 201

(10.66) and the parasitoid family Pteromalidae was collected maximum numbers in the direct-seeded rice variety of CR Dhan 203 (6.00), respectively. Among the rice ecosystems more insect pests and crop damage were noticed in direct-seeded rice more than the transplanted rice.

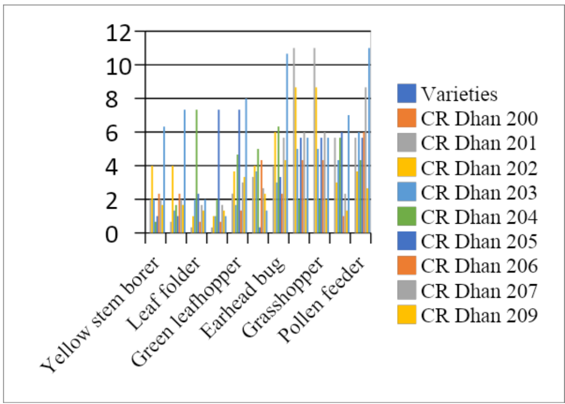

Fig 1.Rice insect pests in direct seeded and transplanted rice varieties using sweep net

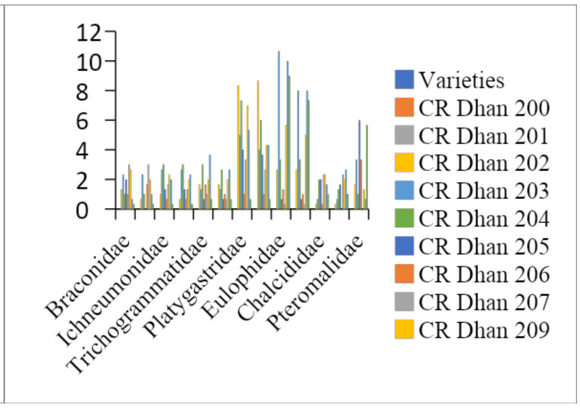

Fig 2. Natural enemies in direct seeded and transplanted rice varieties using yellow pan trap

Reference

Ashrith K N, Sreenivas A G, Guruprasad G S, Hanchinal S G, Krishnamurthy D. 2016. Status of insect pests and natural enemies of direct-seeded and transplanted rice. International Journal of Agriculture Sciences 8(52): 2472-2476.

Edirisinghe J P, Bambaradeniya C N B. 2006. Rice Fields: An ecosystem rich in biodiversity, Journal of National Sciences Foundation of srilanka 34(2): 57-59.

Noyes J S. 1982. Collecting and preserving chalcid wasp (Hymenoptera: Chalcidoidea). Journal of Natural History 16: 315-334.

Noyes J S, Valentine E W. 1989. Chalcidoidea (Insecta: Hymenoptera) - introduction, and review of genera in smaller families. Fauna of New Zealand. 18 pp.

Ooi P A C, Shephard B M. 2005. Predators and parasitoids of rice insect pests. In Biology and Management of Rice Pests, Ed. Heinrichs, EA, Wiley Eastern Limited. 779 pp.

Effect of Antibiotic Materials on Rugose Spiraling Whitefly (RSW), *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) Oviposition

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Keywords: *Rugose Spiraling Whitefly, antibiotic materials, oviposition, egg hatchability, host plants*

Introduction

In India, *Aleurodicus rugioperculatus* was first observed in the coconut farms of the Tamil Nadu and Kerala and during July-August 2016. Per-cent infestation of RSW, 25-40% and 40-60% was recorded in coconut (40-60%) and banana leaves, respectively (Selvaraj *et al*., 2017). Antibiotic materials with different mode of action alters the endosymbiont population of the whiteflies (Costa *et al*., 1997). Growth, offspring emergence from the adult and enzyme for synthesis of trehalulose present in the honeydew secretion was affected using antibiotics for the management of whiteflies. RSW produces copious amount of honeydew which covers the leaflets and influence the sooty mould growth affect the photosynthesis of the plant (Stocks and Hodges, 2012).

Methodology

Effect of antibiotics on RSW oviposition

Efficacy of antibiotic treatments (T1– Carbenicillin 100 µg/mL (100 ppm), T2- Ciprofloxazin 5 µg/mL (5 ppm); T3- Erythromycin 15 µg/mL (15 ppm); T4- Cefotaxime 30 µg/mL (30 ppm); T5- Carbenicillin 100 µg/mL (100 ppm) + Ciprofloxazin 5 µg/mL (5 ppm); T6- Carbenicillin 100 µg/mL (100 ppm) + Erythromycin 15 µg/mL (15 ppm); T7- Carbenicillin 100 µg/mL (100 ppm) + Cefotaxime 30 µg/mL (30 ppm); T8- Ciprofloxazin 5 µg/mL (5 ppm)+ Erythromycin 15 µg/mL (15 ppm); T9- Ciprofloxazin 5 µg/mL (5 ppm)+ Cefotaxime 30 µg/mL (30 ppm); T10- Erythromycin 15 µg/mL (15 ppm)+ Cefotaxime 30 µg/mL (30 ppm) and T11-control were assayed on RSW. Above mentioned antibiotic treatments were sprayed on coconut, banana, sapota and guava plants. Clip cages (pair of whiteflies) were placed on antibiotic treated leaves to RSW feeding and oviposition for 48h. RSW adults were removed after 48h oviposition and number eggs laid/ spiral and percentage of eggs hatched into immature stages of RSW was recorded.

Results and Discussion

Eleven antibiotic treatments were evaluated for RSW oviposition and egg hatchability ( ). Number of eggs laid per spiral (Table 1) and egg hatchability per cent of RSW was significantly reduced by the 3 antibiotic treatments namely, CB^{100} + CIP^{5} followed by CIP^{5}+ CTX^{30}, CB^{100} when compared to the control in all host plants. CB^{100} + CIP^{5} significantly reduced the RSW oviposition and egg hatchability per centage of RSW reared in coconut (13 eggs /spiral and 61.54%), banana (15 eggs /spiral and 60.00 %), sapota (15 eggs/ spiral and 66.67 %) and guava (16 eggs /spiral and 56.25 %). Similarly, curing of secondary symbionts through antibiotics on *B. tabaci* may cause negative effects on host insect (Shan *et al*. 2016). Rifampicin and oxytetracycline treatment on *B. tabaci* negatively affect the growth and development of the offspring (Costa et *al*. 1997; Ruan *et al*. 2006; Xue *et al*. 2012). In conclusion, CB^{100} + CIP^{5} antibiotic treatment significantly influence the RSW oviposition. Antibiotic based materials are the effective way to reduce the RSW fecundity.

Table 1. Effect of antibiotics on rugose spiraling whitefly oviposition

Antibiotics	No of eggs/ Spiral				Egg hatchability (%)			
	Coconut	Banana	Sapota	Guava	Coconut	Banana	Sapota	Guava
CB100	16.00 ± 0.04bc	18.00 ± 0.12b	19.00 ± 0.19bc	17.00 ± 0.13ab	81.25 ± 0.90b	61.11 ± 0.56a	68.42 ± 0.37ab	64.71 ± 0.78b
CIP5	18.00 ± 0.09de	20.00 ± 0.45c	21.00 ± 0.48de	18.00 ± 0.07b	88.89 ± 0.51c	75.00 ± 1.80b	66.67 ± 0.87a	83.33 ± 0.18d
E15	20.00 ± 0.17fg	23.00 ± 0.43d	22.00 ± 0.30ef	22.00 ± 0.22d	95.00 ± 2.60cd	86.96 ± 2.08cd	90.91 ± 1.89def	90.91 ± 1.30f
CTX30	20.00 ± 0.17fg	22.00 ± 0.10d	23.00 ± 0.07fg	20.00 ± 0.39c	90.00 ± 2.70c	77.27 ± 0.24b	82.61 ± 0.33c	85.00 ± 0.66de
CB100 + CIP5	13.00 ± 0.04a	15.00 ± 0.38a	15.00 ± 0.25a	16.00 ± 0.12a	61.54 ± 1.92a	60.00 ± 0.69a	66.67 ± 0.56a	56.25 ± 0.95a
CB100 + E15	16.00 ± 0.13bc	18.00 ± 0.25b	18.00 ± 0.22b	16.00 ± 0.12a	93.75 ± 2.69cd	94.44 ± 2.36de	72.22 ± 0.41b	93.75 ± 1.28fg
CB100 + CTX30	17.00 ± 0.07cd	20.00 ± 0.07c	20.00 ± 0.43cd	18.00 ± 0.23b	94.12 ± 2.82cd	75.00 ± 1.76b	90.00 ± 0.42de	83.33 ± 0.40d
CIP5+ E15	19.00 ± 0.47ef	22.00 ± 0.06d	21.00 ± 0.01de	21.00 ± 0.39cd	94.74 ± 2.96cd	86.36 ± 2.16c	95.24 ± 1.19f	90.48 ± 1.07cef
CIP5+ CTX30	15.00 ± 0.26b	17.00 ± 0.33b	19.00 ± 0.18bc	18.00 ± 0.19b	80.00 ± 1.38b	76.47 ± 1.95b	94.74 ± 0.59f	72.22 ± 0.32c
E15+ CTX30	21.00 ± 0.40g	23.00 ± 0.17d	24.00 ± 0.12g	21.00 ± 0.22cd	90.48 ± 2.13cd	91.30 ± 1.05cde	87.50 ± 1.05d	80.95 ± 0.18d
Control	29.00 ± 0.27h	27.00 ± 0.11e	31.00 ± 0.34h	26.00 ± 0.53e	100.00 ± 0.29d	100.00 ± 0.76e	93.55 ± 0.83ef	100.00 ± 0.65g

Reference

Ruan, Y.M., Xu, J. and Liu, S.S. 2006. Effects of antibiotics on fitness of the B biotype and a non-B biotype of the whitefly *Bemisia tabaci*. ***Entomol Exp Appl.,*** 121: 159-166.

Shan, H.W., Zhang, C.R., Yan, T.T., Tang, H.Q., Wang, X.W., Liu, S.S. and Liu, Y.Q. 2016. Temporal changes of symbiont density and host fitness after rifampicin treatment in a whitefly of the *Bemisia tabaci* species complex. ***Insect Sci.,*** 23: 200-214.

Costa, H.S., Enneberry, T.J. and Toscano, N.C. 1997. Effects of antibacterial materials on *Bemisia argentifolii* (Homoptera: Aleyrodidae) oviposition, growth, survival, and sex ratio. ***J Econ Entomol.,*** 90: 333-339.

Selvaraj, K., Gupta, A., Venkatesan, T., Jalali, S.K., Sundararaj, R. and Ballal, C.R. 2017. First record of invasive rugose spiraling whitefly *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) along with parasitoids in Karnataka. ***J Biol Control.,*** 31: 74-78.

Stocks, I.C. and Hodges, G. 2012. The rugose spiraling whitefly, *Aleurodicus rugioperculatus* Martin, a new exotic whitefly in South Florida (Hemiptera: Aleyrodidae). *Gainesville (FL): Florida Department of Agriculture and Consumer Services, Division of Plant Industry.DPI publication.*

Effect of Organic Amendments on Basal Rot Disease of Onion Under *in Vivo*

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Keywords: *Allium cepa, Basal rot, Bulbs, Neem cake.*

Introduction

Aggregatum onion (*Allium cepa* L. var. *aggregatum* Don.) is one of the important vegetables as well as a spice crop and plays an important role in the Indian market with plenty of curative properties making it medicinal and nutrients making it an indispensable part of culinary dishes. Onion crop is extensively affected by soil borne pathogens. Among them Fusarium basal rot caused by *Fusarium oxysporum* f. sp. *cepae* is one of the destructive diseases that attacks onion which affects both quantity and quality of onion and cause huge economic loss. This study was undertaken with a view to find an alternate method to chemical management which is having several disadvantageous.

Methodology

The organic amendments *viz*., sesame cake, groundnut cake, castor cake, neem cake, cotton cake, coconut cake, FYM, vermicompost and coir pith were tested under pot culture to find its efficacy against *Fusarium oxysporum* f. sp. *cepae*. For this experiment, the virulent isolate was multiplied on sand maize medium (Riker and Riker, 1936). The pots were filled with a mixture of Soil: Sand: FYM (1:1:1) mixed with the pathogen inoculum @ 50g/Kg of soil. These mixtures were kept undisturbed for fifteen days and watered for the multiplication of pathogen in pots containing soil mixture (Patel *et al*., 2010). The organic amendments were taken and made into a powdered form. The amendments were mixed @ 50g/kg of potting mixture and mixed thoroughly. The pots without organic amendments were taken as control. Each pot was planted with five onion bulbs and three replications were maintained for each treatment. The observations were taken periodically at regular interval of 15 days. The final disease incidence exhibited in the pot culture was recorded and per cent reduction of disease over control was calculated.

Results and Discussion

In vivo evaluation of organic amendments against the basal rot pathogen

Among the nine treatments, neem cake showed lower disease incidence and recorded maximum reduction of 69.04 per cent over untreated control. This was followed by groundnut cake which showed 66.66 per cent reduction over control. (Table 1; Fig 1). Similarly, Yadav *et al.* (2014) reported that neem cake extract was most effective against *Fusarium oxysporum* f. sp. *cepae* followed by other extracts *viz*., mustard cake and groundnut cake. As an eco-friendly management, it is concluded that basal application of neem cake showed maximum reduction of basal rot disease incidence of onion by the action of improving the activity of beneficial microorganisms.

Table 1. Efficacy of different organic amendments against *Fusarium oxysporum* f. sp. *cepae in vivo*

S.No.	Treatments	Disease incidence(%)	Percent disease reduction over control
1	Neem cake	21.66 (27.71)	69.04 (56.22)[a]
2	Groundnut cake	23.33 (28.85)	66.66 (54.75)[a]
3	Sesame cake	30.00 (33.00)	57.13 (49.22)[ab]
4	Cotton cake	34.44 (35.90)	50.79 (45.45)[bc]
5	Coconut cake	50.00 (45.00)	28.56 (32.19)[de]
6	Castor cake	42.50 (40.66)	39.59 (38.89)[cd]
7	FYM	45.83 (42.58)	34.52 (35.85)[d]
8	Vermicompost	56.66 (48.84)	19.04 (25.57)[ef]
9	Coir pith	61.66 (51.75)	11.90 (19.96)[f]
10	Control	70.00 (56.78)	-
	CD(P=0.05)	**5.69**	**8.38**
	SE(d)	**2.72**	**4.02**

*Mean of three replications
Values in parentheses are arcsine transformed.

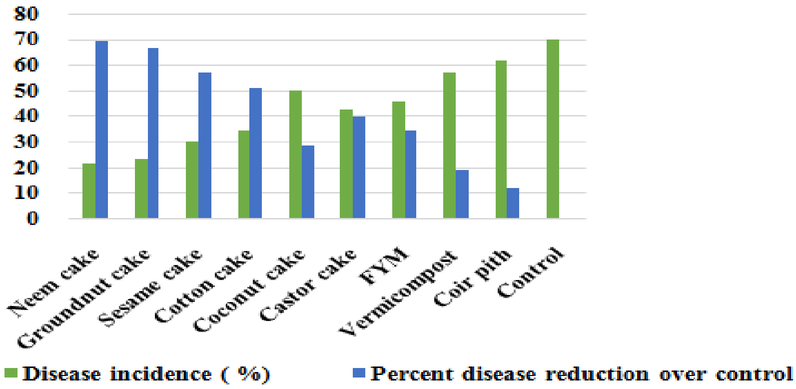

Figure 1. Efficacy of organic amendments

Reference

Jadhav, Sonali Daga. 2014. "Interaction effect of organic amendments and plant extracts on wilt of gladiolus caused by Fusarium oxysporum f. sp. gladioli." Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra.

Patel, N.N., K.R. Joshi, P.M. Patel, M.R. Patel, and R.M. Patel. 2010. "Management of cowpea wilt by organic amendments." International Journal of Plant Protection 3 (2):350-352.

Riker, Albert Joyce, and Regina Stockhausen Riker. 1936. "Introduction to research on plant diseases." John S. Swift Company, Incorporated

Yadav, S.L., R.R. Ahir, B.S. Rathore, and S.M. Yadav. 2014. "Efficacy of different fungicides and organic amendments against basal rot of onion caused by Fusarium oxysporum in vitro." Plant Pathology Journal (Faisalabad) 13 (1):56-58.

Effect of Supplementary Sugar Feeding on Colony Growth of Asiatic Hive Bee, *Apis cerana indica*

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Keywords: Apis cerana indica, Colony growth, Sugar feeding,

Introduction

Honey bees are eusocial insects belonging to the *Apis* genus. Honeybees are considered as one of the most essential pollinators of angiosperms because of their foraging habits and special anatomical adaptations to collect their rewards from flowers. Honey bees are responsible for around 85 percent of the pollination activity required to feed roughly one-third of the world's food supply (Klein *et al.,* 2006). Honey bees are crucial for providing this vital ecosystem service that ensures fruitset in several crops. The bee colonies require ample supply of nectar and pollen from flowering plants to sustain their colony growth and reproduction. During dearth periods, bee colonies must be fed with supplementary feeding for their survival. The main purpose of the study is to evaluate asuitable supplementary sugar feeding and to assess its effect ton colony growth and development of Asiatic bees.

Methodology

Asiatic hive bee colonies should be given with supplementary feeding to meet their energy requirements during dearth period. Supplementary feeding was prepared with combination of sugar and water at 1:1 and 2:1 ratio and in another treatment glucose was added and these treatments was compared with control colonies. Selected bee colonies were given with two supplementary feedings at 14 days interval and observations recorded periodically for a month. Brood rearing area was measured with the help of a frame sized wire grid in cm^2 and calculated after multiplying with 6.45. The experiment was conducted with four treatment and five replications and data were statistically analysed with one-way ANOVA.

Results and Discussion

The observations recorded during the study period are presented in table 1. The results indicated that, among the four treatments, the colonies fed with Sugar + Water (1:1) + glucose (2%) recorded maximum brood area development (203.3 cm^2) followed by sugar + water (2:1) and Sugar + water (1:1) treatments. The control colonies recorded slow brood area development (178.6 cm2) compared to all other treatments. Ahmet Guler et al (2018) also indicated the positive effect of supplementary sugar feeding on colony growth of honey bees and emphasised the importance of supplementary sugar feeding for colony survival and further development.

Table 1. Effect of sugar feeding on brood area development of Apis cerana colonies (cm)2

TREATMENTS	WEEK 1	WEEK2	WEEK 3	WEEK4	MEAN
T1-Sugar+ Water (1:1)	153.400 (12.401) b	174.600 (13.230) b	189.600 (13.786) ab	212.000 (14.555) bc	182.4
T2-Sugar+ Water (2:1)	156.600 (12.533) b	173.800 (13.200) b	193.800 (13.931) ab	214.000 (14.613) ab	184.55
T3-Sugar+Water(1:1)+glucose(2%)	164.600 (12.847) a	180.800 (13.464) a	211.200 (14.532) a	256.000 (15.996) a	203.3
T4–Control	153.000 (12.387) b	169.200 (13.026) b	184.400 (13.596) abc	208.000 (14.423) bc	178.6
CD (0.05)	0.3739	0.3188	0.6783	1.2219	
SED	0.1716	0.1463	0.3113	0.5608	

In a column means followed by a common alphabet are significantly different at five per cent, mean of four replications.

Reference

Ahmet Guler, Deniz Ekinci, Selim Biyik, Ali V. Garipoglu, Hasan Onder and Hasan Kocaokutgen. 2018 "Effects of Feeding Honey Bees (Hymenoptera: Apidae) With Industrial Sugars Produced by Plants Using Different Photosynthetic Cycles (Carbon C3 and C4) on the Colony Wintering Ability, Lifespan, and Forage Behavior ". Journal of Economic Entomology, 111(5)

R Mark Goodwin. (2015) "Feeding sugar syrup to honey bee colonies to improve pollination: a review". Bee World 78(2): 56--62

Evaluating the Efficacy of Certain Plant Derivatives for the Management of Brinjal Shoot and Fruit Borer *Leucinodes orbonalis* on Kharif Season

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Keywords: *BSFB, Leucinodes orbonalis, kharif, plant derivatives, shoot and fruit infestation.*

Introduction

Among the insect pests infesting brinjal, the shoot and fruit borer, *Leucinodes orbonalis* Guenee (Pyraustidae: Lepidoptera) is the most destructive and the major limiting factor in quantative as well as qualitative harvest of brinjal fruits. Chemical control is widely used for managing insect pests in brinjal. Repeated use of broad-spectrum synthetic chemicals also results in environmental contamination, bioaccumulation and biomagnifications of toxic residues and disturbance in ecological balance (Dadmal *et al*., 2004). With the views, research was carried out to find ecofriendly solution for this destructive pest. In this study certain plant derivatives are used for the management of brinjal shoot and fruit borer.

Methodology

The plant products which are indigenous and locally available were collected. Plant parts like leaves / seeds were shade dried, before preparing the ethanolic extracts, by Soxhlet's apparatus. The natural oils used in the study were purchased from commercial vendors which were diluted Emulsions of different concentrations were prepared by dilution method for conducting the field trials. The observations of shoot infestation were recorded on 7 and 14 days after each spray. At each fruit picking the number of healthy and infested fruits were recorded on ten plants from each treatment. The per cent shoot and fruit infestation was calculated pooled data was subjected for statistical analysis.

Results and Discussion

Among the treatments evaluated Annona seed extract 2% recorded a cumulative mean fruit damage (16.33 %) on number basis after four rounds of harvest and significantly superior over untreated control (43.21 %). Annona seed extract 2% which recorded highest fruit yield 17.69 t/ha (Table 1). The present findings are in agreement with the reports of Ghatak *et al.* (2009) that reduction of fruit infestation treated with seed extracts of *Annona squamosa* L. were better than seed extract of *Strychnos nuxvomica* L.

Table.1. Bio- efficacy of certain plant derivatives against fruit infestation of brinjal shoot and fruit borer Leucinodes orbonalis (L) Gue. Season – Kharif 2018.

T. No.	Treatments	PTC	Percent fruit infestation *						Yield* (t/ha)	ROC
			Number basis							
			1st picking	2nd picking	3rd picking	4th picking	Mean	ROC		
T_1	Notchi leaf extract	16.58 (24.03)	19.90 (26.49)^{bc}	23.31 (28.87)^{e}	30.58 (33.57)^{f}	34.47 (35.95)^{e}	27.06 (31.35)^{d}	37.36	12.10 (3.48)^{f}	33.19
T_2	Annona seed extract	13.37 (21.44)	16.41 (23.90)^{a}	12.46 (20.67)^{a}	16.19 (23.73)^{a}	20.24 (26.74)^{a}	16.33 (23.83)^{a}	62.21	17.69 (4.21)^{a}	54.30
T_3	Tulsi leaf extract	18.04 (25.13)	25.88 (30.58)^{e}	26.97 (31.29)^{f}	31.75 (34.3)^{f}	40.87 (39.74)^{f}	31.37 (34.06)^{e}	27.40	10.50 (3.24)^{g}	22.96
T_4	Adathoda leaf extract	16.90 (24.28)	20.71 (27.07)^{c}	21.78 (27.82)^{cd}	27.83 (31.84)^{e}	35.48 (36.56)^{e}	26.45 (30.95)^{d}	38.78	12.89 (3.59)^{e}	37.28
T_5	Garlic bulb extract	15.65 (23.3)	28.16 (32.05)^{f}	22.12 (28.05)^{de}	25.13 (30.08)^{d}	28.28 (32.13)^{c}	25.92 (30.61)^{d}	40.01	14.77 (3.84)^{cd}	45.24
T_6	Iluppai oil	16.39 (23.88)	18.88 (25.75)^{b}	16.53 (23.99)^{b}	18.05 (25.14)^{b}	25.05 (30.03)^{b}	19.63 (26.3)^{b}	54.57	16.91 (4.11)^{b}	52.17
T_7	Pungam oil	14.81 (22.63)	22.89 (28.58)^{d}	20.53 (26.94)^{c}	21.11 (27.35)^{c}	30.85 (33.74)^{d}	23.84 (29.23)^{c}	44.81	15.33 (3.92)^{c}	47.26
T_8	Neem oil (standard check)	17.13 (24.45)	23.55 (29.03)^{d}	22.13 (28.06)^{de}	26.97 (31.29)^{e}	23.65 (29.1)^{b}	24.08 (29.38)^{c}	44.27	14.38 (3.79)^{d}	43.77
T_9	Untreated check	25.56 (30.37)	36.90 (37.41)^{g}	41.15 (39.90)^{g}	44.12 (41.62)^{g}	50.65 (45.37)^{g}	43.21 (41.09)^{f}		8.09 (2.84)^{h}	
	SEd		0.61	0.63	0.60	0.77	0.63			
	CD (p=0.05)		1.29	1.33	1.28	1.63	1.34			
	CV%		3.15	3.34	2.76	2.93	2.93			

*Each value is the mean of three replications.
Figures in parentheses are arc sine transformed values.
In each column, means with similar alphabets do not vary significantly at P=0.05 and P=0.01 by LSD.

T_1- Notchi leaf extract @ 5%; T_2- Annona seed extract @ 2%; T_3- Tulsi leaf extract @ 5%; T_6-IluppaioiL@3%; T_4- Adathoda leaf extract @ 5%; T_5- Garlic bulb extract @ 2%; T_7- Pungam oil @ 3%; T_8- Neem oil (standard check) @; T_9 -Untreated check

Reference

Dadmal, S.M, S.B. Nemade and M.D. Akhare. 2004. "Field screening of brinjal cultivar for resistance to *Leucinodes orbonalis* (Guen.)". ***Pest Management in Horticultural Ecosystems***, 10(2): 145-150.

Ghatak, S.S, S. Mondal, and R.Vishwakarma. 2009. "Bioefficacy of Botanicals and Biopesticides against Brinjal Shoot and Fruit Borer, *Leucinodes orbonalis* Guen.(Pyraustidae: Lepidoptera)." ***Indian journal of Entomology***, 71 (4): 284-87.

Evaluation of Different IPM Components against Jasmine Budworm, *Hendecasis duplifascialis* Hampson (Crambidae: Lepidoptera)

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Keywords: *Jasmine budworm, Synthetic insecticides, Microbials, Botanicals.*

Introduction

Jasmine is commonly grown flower crop in India had export value of premium quality flowers. It is severely affected by budworm, *Hendecasis duplifascialis* Hampson which cause 40-50% yield loss. Jasmine farmers are mostly depending on pesticides and apply once in fortnight intervals to manage this pest. Development of alternative strategies for the management of jasmine budworm and including biorational pesticides will be effective in minimizing chemical use in the ecosystem. With the view, present investigations were carried out with the objective to evaluate the different IPM components against jasmine budworm.

Methodology

Experiments was conducted in the farmer's field at Sevandhanagar village, Tiruchirappalli district of Tamil Nadu, India. A total of nine treatments were used for the study purpose (Table 1). Pre and post-treatment observations on the incidence of budworm damage were counted, as per the standard methodology. Since there were different IPM components utilized for the study purpose, phytotoxic effects of each treatment were recorded (Pirithiraj *et al*., 2020).

Results and Discussion

The mean bud worm damage after spray was 4.88 % in Chlorantraniliprole followed by 5.12 % in Thiacloprid treated jasmine plots (Table 1). Microbial formulations of *B. bassiana* and *L. lecanii* showed reduction of 65.05 and 62.25 per cent over control. The bacterial formulation, *Bt*. sp. *kurstaki* treated plots had the damage of 8.60 per cent with 64.28 per cent reduction over control. There was no phytotoxic symptoms observed on leaves as well as flowers in all the treatments during the study. Harini *et al.* (2018) reported the efficacy of Chorantraniliprole 18.5 SC and Thiacloprid 21.7 SC in managing the budworm with 81 percent and 76.64 percent respectively. In vitro bio-assay of microbial agents revealed that *B. thuringiensis* recorded maximum larval mortality (80.20%) over untreated control followed by *B.bassiana* (74.61%) and *L. lecani* (65.88%) (Kamala and Kennedy, 2016). The present study revealed that *B. bassiana* is quiet effective among the microbials in reducing the damage caused by jasmine budworm. Hence use of *B. bassiana* will be helpful in managing jasmine budworm as well as in the attempt to overcome the detrimental effects of chemical insecticides.

Table 1. Table 1. Field evaluation of different IPM components against jasmine budworm

S. No.	Treatments	Dosage	Pre-count (% damage)	1 DAS	3 DAS	7 DAS	14 DAS	MEAN	PROC
T_1	*Beauveria bassiana*	2 x 10^8cfu /ml	11.16	10.82 (19.20)^b	7.16 (15.52)^c	6.6 (14.89)^c	9.08 (17.54)^f	8.42 (16.87)^d	65.05
T_2	*Lecanicillium lecanii*	2 x 10^9cfu /ml	10.64	11.08 (19.44)^b	9.05 (17.51)^d	8.67 (17.12)^e	7.56 (15.96)^d	9.09 (17.55)^e	62.25
T_3	Neem Seed Kernel Extract (NSKE)	5%	11.82	11.65 (19.96)^c	10.26 (18.68)^e	9.16 (17.62)^e	8.26 (16.70)^e	9.83 (18.27)^f	59.17
T_4	Pungam oil	3%	11.48	11.69 (19.99)^c	10.86 (19.24)^f	10.58 (18.98)^f	9.89 (18.33)^g	10.76 (19.15)^g	55.34
T_5	*Bacillus thurinjiensis* sp. *kurstaki*	2ml/l	10.92	10.93 (19.31)^b	8.75 (17.21)^d	6.97 (15.31)^c	7.76 (16.17)^d	8.60 (17.05)^d	64.28
T_6	Chlorantraniliprole 18.5 SC	0.75ml /l	11.64	8.84 (17.30)^a	5.31 (13.32)^b	3.51 (10.80)^a	1.87 (7.86)^a	4.88 (12.76)^a	79.72
T_7	Thiacloprid 240 SC	1ml/l	10.91	8.77 (17.23)^a	4.53 (12.29)^a	4.09 (11.67)^b	3.07 (10.09)^b	5.12 (13.08)^b	78.76
T_8	Fenazaquin 10 EC	1ml/l	11.84	8.82 (17.28)^a	7.53 (15.93)^c	7.69 (16.10)^d	6.94 (15.27)^c	7.75 (16.16)^c	67.84
T_9	Control	-	10.63	13.72 (21.74)^d	17.25 (24.54)^g	27.14 (31.40)^g	38.2 (38.17)^h	24.08 (29.39)^h	
	SE			0.19**	0.19**	0.24**	0.20**	0.13**	
	CD (0.05)			0.40	0.41	0.52	0.42	0.28	

NS – Non significant, **highly significant, PROC- Percent reduction over control, Each value is the mean of three replications, Values in parentheses are arc sine transformed value

Reference

Harini, K. Elanchezhyan, K. Murugesan, N. Allwin, L. and T. Prabhu. 2018. Seasonal incidence and management of budworm, *Hendecasis duplifascialis* (Hampson) in *Jasminum Sambac* L. ***International Journal of Advances in Agricultural Science and Technology***, 5(7):42-51

Kamala, I.M. and J.S. Kennedy. 2016. Evaluation of microbial agents against jasmine budworm, *Hendecasis duplifascialis* Hampson in jasmine (*Jasminum sambac* L.). ***Current Biotica***, 10 (3):230-240.

Pirithiraj, U. 2020. Ecology and management of major insect pests of jasmine. Masters dissertation. Tamil Nadu Agricultural University. pp - 41-52.

Evaluation of Organic Inputs against Citrus Butterfly, *Papilio demoleus* Linnaeus on Citrus Trees

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Keywords: *Citrus Butterfly, Botanical extracts, Ecofriendly, Organic pest management*

Introduction

Citrus industry is the third largest, in the world after mango and banana. In India citrus crop occupies a prominent place covering an area of about 8.5 L ha with an annual production of 74.64 L tonnes with a productivity of 8.8 t/ha (NHB, 2011). The lemon butterfly, *Papilio demoleus* Linnaeus (PDL) is one of the economically important pests whose larval forms cause serious damage to citrus family by devouring large quantity of foliage during the later stages of their development. The caterpillars are voracious feeders of young seedlings and cause death of seedling within no time. Under present globalized situation of the world scenario, the side effect of chemical pesticides on non-target organisms including Natural enemies, Animals and human beings has been increased. Hence pest management with botanicals and bio-rational pesticides are the only method to solve these environmental pollution problems. More than 2500 plant species belonging to 235 families have been found to possess the characteristic properties required for an ideal botanical insecticide (Raghavendra *et al.*, 2016). Therefore, in this study, we have evaluated the different botanicals and organic inputs against Citrus butterfly.

Methodology

Experiment was conducted in the Citrus orchard of SBAC & RF, Karaikudi in 100 numbers of Citrus trees. The experimental materials used are Botanical Herbal Extract (100 ml/L) prepared by the combination of *Calotropis*, *Azadirachta*, *Ipomea fistulosa* and *Ocimum* foliages, Panchakavya (30ml/L), Agni Asthra (50ml/L), Neem Asthra (10ml/L), Coleus whole plant aqueous extract (10ml/L), Lemon grass aqueous extract (10ml/L) and Neem oil (3%). Botanical extracts were sprayed to run off point using a high volume hand operated knapsack sprayer with hydraulic cone nozzle. Larval population of Citrus butterfly, *P. demoleus* per tree was assessed from all treated citrus trees on pre-treatment (one day before treatment) 3, 7 and 10 days after sprays / treatments (DAT). The data from various field experiments were scrutinized by RBD analysis of variance (ANOVA) after getting transformed into □x+0.5, logarithmic and arcsine percentage values where appropriate (Gomez and Gomez, 1984).

Results and Discussion

From the following Table 1, the data revealed that Agni Asthra shows significant larval reduction with lowest population of mean value 0.60 with 62.2 per cent reduction over control. Botanical herbal extract was the next best treatment shows 0.89 larvae per tree (62% reduction over control) and Panchakavya shows 0.70 larvae per tree (45% reduction over control), Neem Asthira revealed that 0.71 larvae per tree (45% reduction over control), Coleus extract resulted 0.72 larvae per tree (45% reduction over control) and this was on par with the Neem Asthira, Lemon grass extract shows that 1.16 larvae per tree (47% reduction over control) and this was on par with the Neem oil with 1.16 larvae per tree after the spray.

Table 1. Effect of organic inputs against citrus butterfly, *P. demoleus* on citrus trees

Treatments and doses (per litre of water)	Number of larvae per tree on days after treatment				Mean	Per cent reduction over control
	Pre count	3rd DAT	7th DAT	10th DAT		
T1-Botanical herbal extract (100 ml)	1.5	0.8 b	0.8 b	1.0 b	0.89 c	62.0
T2-Panchakavya (30 ml)	0.8	0.6 a	0.7 a	0.8 a	0.70 b	45.0
T3-Agni asthra (50 ml)	1.5	0.5 a	0.6 a	0.7 a	0.60 a	62.2
T4-Neem asthra (10 ml)	0.8	0.6 a	0.7 a	0.8 a	0.71 b	45.0
T5-Coleus extract (10 ml)	0.8	0.6 a	0.7 a	0.8 a	0.72 b	45.0
T6-Lemon grass extract (10 ml)	1.4	1.3 c	1.2 c	1.0 b	1.16 d	47.5
T7-Neem oil (3 %)	1.5	1.3 c	1.2 c	1.0 b	1.16 d	51.3
T8-Untreated check	1	1.2 c	1.4 d	1.8 c	1.35 e	-
CD (0.05%)	-	0.09	0.18	0.20	0.28	-
SEd	-	0.04	0.08	0.10	0.13	-

- ✓ Data are mean values of three replications.
- ✓ Figures were transformed by square root transformation and the original values are given.
- ✓ Means within columns lacking common lower case superscript are significantly different (P<0.05)

Reference

Atwal, A.S. 1964. Insect Pests of Citrus in the Punjab-Biology and control of citrus Caterpillar *Papilio demoleus* L. (Lepidoptera: Papilionidae).

Boomathi, N.P. Sivasubramanian and S. Raguraman.2006. Biological activities of cow excreta with neem seed kernel extract against *Helicoverpa armigera* (Hubner). *Annals of Plant Protection Sciences* 14:11-16.

Raghavendra, K.V., R. Gowthami, N.M. Lepakshi, M. Dhananivetha and R. Shashank. 2016. Use of Botanicals by Farmers for Integrated Pest Management of Crops in Karnataka. *Asian Agri-History* 20 (3).pp.173-180.

Sadawaste, A.K., G.K. Giri and N.E. Jaawar. 2010. Bio Intensive management of citrus butterfly, *Papilio demoleus*, L. National seminar on citrus biodiversity for livelihood and nutritional security Nagpur, Maharastra.pp.393.

Sarada, G.K., K.T. Gopal, V. Ramana, L.M. Lakshmi and T. Nagalakshmi. 2013. Citrus butterfly (*P. demoleus*) Biology and Management, *J. Agri. And Allied Sci.* 2(1): 12-15.

Foliar Nutrition Enhances the Host Immunity against Papaya Ring Spot Virus

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Keywords: Carica papaya, foliar nutrition, host immunity, Papaya ring spot virus

Introduction

Carica papaya L. is the most economically important and widely cultivated fruit tree belongs to the family *Caricaceae*. The fresh papaya fruit is consumed widely, which has high nutritive value and rich source of vitamins and minerals. Papaya is infected by number of viruses, among them Papaya ring spot virus (PRSV) causes deleterious effects on papaya production worldwide. PRSV is a destructive and devastating disease in papaya cultivation which leads to cause even 100% yield loss. The infected papaya plants shows variety of symptoms *viz*., mosaic and chlorophyll lobbing, leaf distortion, oily streaks on petiole and trunk, Chlorosis and mottling of leaves, and shoe-string formation (Purcifull *et al*., 1984). PRSV induces typical ring spot symptoms on papaya fruits and leads to 50-% or even more reduction in fruit production. Aphids are involved in the transmission of PRSV and its population density is directly influences the disease severity. Induction of host immunity is a feasible strategy to manage the PRSV infection at field level. In the present study, micro nutrients along with different organic inputs were tested against PRSV infection in papaya.

Methodology

Efficacy of micronutrients against PRSV

To study the efficacy of micronutrients against PRSV in papaya plants, a pot culture experiment was conducted with the following treatments *viz*., T1 - ZnSo4 @ 0.5 % ; T2- Borax @ 0.1 %; T3- Urea @ 1% ;T4 – (T1+T2+T3) and T5 – T4+ Drenching of humic acid @ 0.2 %. A glass house trial was laid out in completely randomised block design with seven treatments with three replications per treatment. The hybrid red lady was used for this experiment which is the most susceptible variety to PRSV. The micronutrients were sprayed at 3rd, 4th and 7th month after planting. Transplanting of 45 days old seedlings was done in the grow bags containing potting mixture in the ratio of red soil: sand: farm yard manure at 1:1:1 w/w/w. The plants were maintained in ambient glass house condition. The papaya plants were treated with micronutrients as foliar spray and after 24 hrs of each treatment, plants were inoculated with PRSV inoculum following a standard protocol. PRSV disease severity was recorded from the appearance of symptoms till the final application of micronutrients treatment. The PRSV disease severity was assessed using the 0-5 scale developed by Bos (1982) and expressed as percent disease severity (PDS).

Results and Discussion

The present investigation concludes that foliar spray of nutrient solution such as 0.5% of $ZnSO_4$, 0.1% of Borax and 1% of Urea along with humic acid drenching is a feasible method for the reduction of PRSV severity in papaya. The individual nutrient spray, Borax @ 0.1% was also found to reduce PRSV severity significantly when compared to untreated control. The maximum disease severity of 73.33 per cent was recorded in untreated control plants whereas minimum disease severity of 53.33 was recorded in T5 at 7 th MAP and also showed enhanced growth in treated plants. This result indicates that application of Zn and B along with humic acid drenching may accelerates the cell division and cell elongation thus stimulates the plant growth. Hanamanth (2002) reported that auxin synthesis stimulated through the application of Zinc which increased plant growth. Manjunatha *et al*., (2014) said that combination of nutrients ZnSO4+Borax+FeSO4 increased the vegetative parameters *viz*., plant height, stem diameter, number of leaves, petiole length and plant spread in papaya plant. The per cent reduction over control of different treatments *viz*., T1, T3 and T4 was recorded as 66.66 per cent, 71.11 per cent and 64.44 per cent respectively.

Table 1. Efficacy of micronutrients against PRSV in pot culture studies

S.No.	Treatments	PDS (Percent disease severity)		
		3rd MAP	4th MAP	7th MAP
1.	T1 ($ZnSo_4$ @ 0.5 %)	51.11* (45.65)^{d}	60 (50.81)^{d}	66.66 (54.80)^{d}
2.	T2 (Borax @ 0.1 %)	28.88 (32.48)^{b}	46.66 (43.08)^{b}	55.55 (48.25)^{b}
3.	T3 (Urea @ 1%)	55.55 (48.20)^{e}	64.44 (53.41)^{e}	71.11 (57.52)^{e}
4.	T4 (T1+T2+T3)	31.11 (33.87)^{bc}	48.88 (44.36)^{c}	64.44 (53.41)^{c}
5.	T5 (T4+ Drenching of humic acid @ 0.2 %)	24.44 (29.58)^{a}	44.44 (41.80)^{a}	53.33 (46.92)^{a}
6.	T6 (Control)	55.55 (48.25)^{ef}	68.88 (56.13)^{f}	73.33 (59.03)^{f}
	CD	42.20	53.83	61.62

*Each value represents mean of 3 replications MAP - months after planting

The values in the parenthesis are arc sine transformed. In the columns, means followed by a common letter are not significantly different according to DMRT at ($P < 0.01$).

Reference

Harish A and K. Anita Cherian (2019). Ecofriendly management of papaya ringspot disease. Journal of Tropical Agriculture 57 (1): 78-85.

Hanamanth YA. Irrigation and fertigation studies in high density mango (Mangifera indica L.). M.Sc. Thesis. UAS, Bangalore, 2002.

Manjunatha S, G.S.K. Swamy, N.B. Prakash, R.C. Jagadeesha, Mukesh Chavan and K.S. Shankarappa (2014). Effect of Micronutrients and Silicon on Growth and Yield of Papaya cv. Red lady. J.agric. Res. Technol.,39 (1): 015-020.

GC-MS-MS Analysis and Toxicity of Ethyl Acetate Extracts of Some Botanicals Against Rice Weevil *Sitophilus oryzae* (L.) in Stored Maize

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Keywords: *Sitophilus oryzae, ethyl acetate extracts, botanicals, contact toxicity, oral toxicity, Mentha spicata.*

Introduction

Rice weevil, *Sitophilus oryzae* L. is the most destructive insect pest of stored maize. One pair of *S. oryzae* can reproduce about one million of its species within a period of three months under favorable conditions (Thomas *et al*., 2002). There is an urge to protect them safely from qualitative and quantitative loss, but the indiscriminate use of chemical pesticides in storage has given rise to many well-known serious problems including resistance, residues, resurgence, pollution, health hazards, etc., To combat these problems, botanicals can be used as an alternative agents, as they contain a large number of bioactive potential phytochemicals and have little or no damaging effect on non-target organisms and the environment.

Methodology

The toxicity of 12 botanical ethyl acetate extracts were tested at 5% with *Acorus calamus* 1% as treated check acetone alone served as control against *S. oryzae* in the Natural Pesticides Laboratory at the Department of Agricultural Entomology, Agricultural College and Research Institute Madurai during 2020 - 2021. The contact toxicity of the extracts was evaluated by filter paper method (Kim and Ahn, 2001). Observations were recorded on dead insects after 24, 48 and 72 hours of treatment and expressed as per cent mortality. For oral toxicity, 10 grams of maize seeds were treated with 5% extract of different botanicals (1 ml), shaked thoroughly to ensure uniform coating of extracts on the maize seeds and the treated seeds were placed in plastic jars and 10 number of weevils were released (Rani Selva *et al*., 2019). The number of dead weevils was recorded after 7 and 15 days of treatment. The ethyl acetate extracts were subjected to GC-MS-MS analysis, to characterize the phytochemicals present in it.

Results and Discussion

With regard to contact toxicity, *M.spicata* ethyl acetate extracts caused the highest mortality (86.67%) of *S. oryzae*, followed by *V. negundo* and *O.sanctum* 5%, which caused 83.33% mortality after 72 hrs of treatment. In oral toxicity, *M. spicata* showed maximum toxicity (93.33%), which was statistically on par with *V. negundo*, *O.sanctum* and *T.erecta* leaf extract (90.00%) after 15 days after treatment at 5% concentration. Among the tested botanicals, the *M. spicata* exhibited the maximum mortality by both contact and oral means. Our GC-MS-MS study revealed that the presence of carvone (33%) phytochemical with insecticidal potential in *M. spicata*. Several authors have reported the toxic effect of *M. spicata* (Hamdi *et al*., 2021). The toxic effect of *M. spicata* is attributed to the presence of carvone (Mansoori *et al*., 2020). It is concluded that the ethyl acetate extract of *M. spicata* is having contact and oral toxicity against *S. oryzae*, which possess the bioactive principle, carvone. It shall be explored further for the development of botanical formulation.

Table 1. Toxicity of ethyl acetate extract of certain botanicals against *S. oryzae* adults

Treatments	Cumulative mortality (%)				
	Contact toxicity			Oral toxicity	
	24 hrs	48 hrs	72 hrs	7 DAT	15 DAT
T1- *C.aurantium* leaf 5%	40.00± 10.00 (39.14)e	56.67± 5.77 (48.84)d	66.67± 5.77 (54.78)d	70.00± 0.00 (59.79)d	76.67± 5.77 (61.21)de
T2- *C. longa* rhizome 5%	50.00± 10.00 (44.99)cde	56.67± 5.77 (48.84)d	63.33± 5.77 (52.77)d	70.00± 0.00 (56.79)d	73.33± 5.77 (59.00)e
T3- *E. globulus* leaf 5%	53.33± 15.28 (47.00)cde	63.33± 15.28 (53.06)cd	70.00± 10.00 (56.99)d	73.33± 5.77 (59.00)cd	86.67± 5.77 (68.85)bcd
T4- *L. camara* leaf 5%	56.67± 11.55 (48.93)cd	63.33± 15.28 (53.06)cd	66.67± 15.28 (55.07)d	73.33± 5.77 (59.00)cd	80.00± 10.00 (63.92)cde
T5- *M. spicata* leaf 5%	73.33± 5.77 (59.00)b	83.33± 5.77 (66.14)ab	86.67± 5.77 (68.85)b	83.33± 5.77 (66.14)b	93.33± 5.77 (77.54)b
T6- *M. koenigii* leaf 5%	56.67± 5.77 (48.84)cd	60.00± 0.00 (50.76)cd	66.67± 5.77 (54.78)d	76.67± 5.77 (61.21)bcd	86.67± 5.77 (68.85)bcd
T7- *O. sanctum* leaf 5%	73.33± 5.77 (59.00)b	83.33± 5.77 (66.14)ab	83.33± 5.77 (66.14)bc	80.00± 0.00 (63.43)bc	90.00± 0.00 (71.56)bc
T8- *R. communis* leaf 5%	40.00± 10.00 (39.15)e	56.67± 5.77 (48.84)d	70.00± 10.00 (56.99)d	73.33± 5.77 (59.00)cd	80.00± 10.00 (63.92)cde
T9- *T. erecta* leaf 5%	60.00± 10.00 (50.85)bc	73.33± 5.77 (59.00)bc	73.33± 5.77 (59.00)cd	76.67± 5.77 (61.21)bcd	90.00± 0.00 (71.56)bc
T10- *T. erecta* flower 5%	43.33± 5.77 (41.15)de	53.33± 5.77 (46.92)d	60.00± 0.00 (50.76)d	70.00± 0.00 (56.79)d	73.33± 5.77 (59.00)e
T11 - *V. negundo* leaf 5%	73.33± 5.77 (59.00)b	80.00± 0.00 (63.43)ab	83.33± 5.77 (66.14)bc	76.67 ± 5.77 (61.21)bcd	90.00± 0.00 (77.54)b
T12-*A. calamus* 1% (Standard check)	86.67±5.77 (68.85)a	90.00±0.00 (71.56)a	100.00±0.00 (89.50)a	100.00±0.00 (89.50)a	100.00±0.00 (89.50)a
T13-Acetone (Control)	0.00 (0.66)e	0.00 (0.66)e	0.00 (0.66)e	0.00± 0.00 (0.66)e	0.00± 0.00 (0.66)f
T14- Untreated check	0.00 (0.66)e	0.00 (0.66)e	0.00 (0.66)e	0.00± 0.00 (0.66)e	0.00± 0.00 (0.66)f
Mean	50.48	58.57	63.57	69.29	72.86
SEd	3.99	3.72	3.67	3.78	4.14

*Mean values of three replications are represented as mean ± standard deviation; Figures in the parentheses are arcsine transformed values; In a column, the mean followed by the same letter are not significantly different from each other, DMRT ($p \leq 0.05$); SEd: Standard Error of the difference.

Reference

Hamdi H., Soumaya.B, Soltani A., Jmal R., Messaoud C., Zaouali Y., Boushih E., Jemaa J. M. B. 2021. Use of binary mixtures of three Mentha essential oils for the control of rice weevil Sitophilus oryzae (Curculionidae). International Journal of Tropical Insect Science 41(2): 1333-1342.

Kim D.H., Ahn Y.J. 2001. Contact and fumigant activities of constituents of Foeniculum vulgare fruit against three coleopteran stored- product insects. Pest Management Science: formerly Pesticide Science. 57 (3) : 301-306.

Mansoori S, Bahmanyar H, Jafari Ozumchelouei E, Najafipour I.2020. Investigation and optimisation of the extraction of carvone and limonene from the Iranian Mentha spicata through the ultrasound-assisted extraction method. Indian Chemical Engineer 14:1-0.

GC-MS Analysis of Antimicrobial Compounds Produced by Mahua Oil Cake Against the Stem Rot Pathogen - *Sclerotium rolfsii*

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Keywords: *Stem rot, Sclerotium rolfsii, Mahua oil cake, Oil cake extract, GC-MS.*

Introduction

Oil cakes like mahua and neem having antifungal activity significantly reduced the plant disease incidence. The destructive soil-borne pathogen *Sclerotium rolfsii* is highly threatening to groundnut and other crops, which may incur 10–40% yield losses, especially under irrigated conditions. Mahua oil cake has a high antifungal property and produced secondary metabolites against the stem rot pathogen of groundnut. The compounds, namely n- hexadecanoic acid, octadecenoic acid present in the mahua oil cake extract inhibited the growth of *Sclerotium rolfsii* successfully.

Methodology

The efficacy of five different oil cakes was assessed against the stem rot pathogen (*Sclerotium rolfsii*) through a poisoned food technique under *in-vitro* conditions(Schmitz, 1930). The oil cakes extracts like mahua cake, neem cake,pungam cake, coconut cake, castor cake extract were prepared by adding1g of oil cake with 1.25 ml of water and it was kept overnight, followed by filteration through a sterile muslin cloth this made the 100 % extract solution. The various concentration 5% and 10% were prepared by adding required quantity of PDA medium (Dubey, 2002). A 9mm plug of *Sclerotiumrolfsii* was placed in the center of the Petri plates containing the PDA medium in the above concentrations separately. Likewise, all the oil cake extracts were analyzed against the *Sclerotium rolfsii*. Percent inhibition of mycelial growth was calculated. The oil cake extract showed the maximum antifungal activity against the pathogen was chosen, and the bioactive compounds were extracted through hexane solvent extraction under the soxhlet apparatus (Dean, Abdullah, *et al.*, 1997). Finally, these secondary metabolites were analyzed through GCMS.

Results and Discussion

The result of an *in-vitro* assay of oil cakes (organic amendment) extract against the stem rot pathogen (*Sclerotium rolfsii*) revealed that mahua oil cake produced the minimum mycelial growth at 5% and 10% concentration (1.57cm) (1.29cm) and maximum percent growth inhibition (83.33 %), (86.66 %). In the case of coconut oil cake extract, it produced the high mycelial growth (8.22cm), (7.92 cm) and poor mycelial growth inhibition (8.88%) and (12.22%) at 5% and 10% concentration (Table 1),

GCMS result of mahua oil cake

The Mahua oil cake GCMS results are shown in fig1. GC-MS analysis depicted the presence of five major compounds with high Retention Time and peak area percentage. They are n-Hexadecanoic acid (24.968),(12.22), Hexadecanoic acid, ethyl ester(23.655), (2.9), 9,12-Octadecadienoicacid(Z,Z)-(28.659), (35.61), 9-Octadecenoicacid,(E) (28.786),(13.15), Octadecanoicacid (29.137), (33.59) in (Figure 1).

Table 1. Antifungal efficacy of different oil cakes against the *Sclerotium rolfsii* under poisoned food technique.

S.NO	Organic amendments	Concentration (%)			
		5%		10%	
		Mycelial growth (cm)*	Per cent growth reduction over control (%)	Mycelial growth(cm)*	Per cent growth reduction over control (%)
1	Pungam cake	3.81c	57.77	3.24c	64.44
2	Neem cake	2.48b	73.33	1.93b	78.88
3	Coconut	8.22e	8.88	7.92e	12.22
4	Mahua cake	1.57a	83.33	1.29a	86.66
5	Caster	7.64d	15.55	6.78d	25.55
6	Control	9.00f	-	9.00f	-
	CD (P=0.05)	0.22		0.31	
	CV	2.24		3.48	

*Mean of three replications. Means with the same letter do not have significant difference according to Duncan's multiple range test at p<0.05.

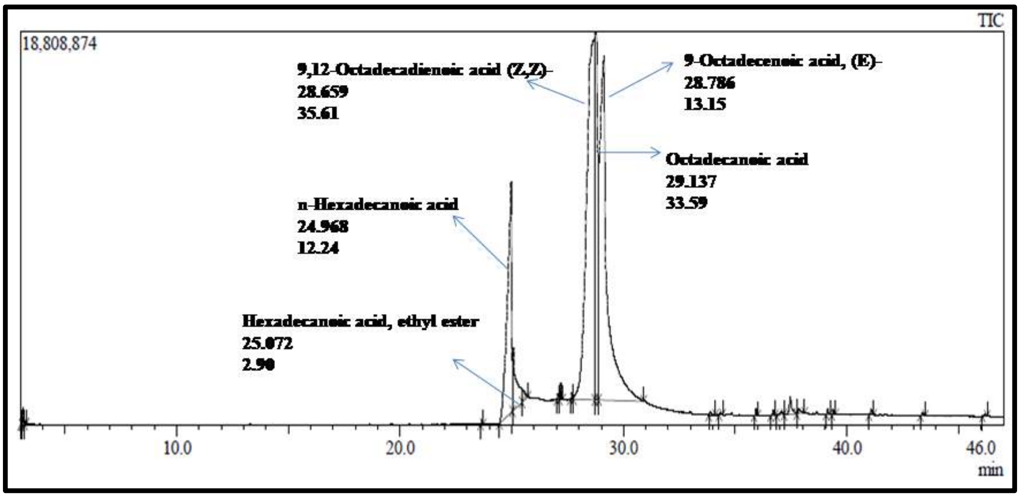

Figure 1. Gas chromatogram of antimicrobial compounds identified from Mahua oil cake through GC/MS

Reference

Dean, J. R., Abdullah, M. P., & Zakaria, Z. (1997). Extraction of polycyclic aromatic hydrocarbons from contaminated soil using Soxhlet extraction, pressurised and atmospheric microwave-assisted extraction, supercritical fluid extraction and accelerated solvent extraction. Journal of Chromatography A, 791(1-2), 361-366.

Dubey, S. (2002). Efficacy of some oil cakes and plant extracts against web blight of urd and mung bean caused by Thanatephorus cucumeris. Journal of Mycology and Plant Pathology, 32(2), 158-161.

Schmitz, H. (1930). Poisoned food technique. Industrial and Engineering Chemistry-Analytical Edition, 2(4), 361-363.

Impact of Watermelon Bud Necrosis Virus (WBNV) infected plants on the volatile emission pattern in cowpea plants

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Keywords: *Thrips, Tritrophic interactions, WBNV, VOCs, Virus, Vector and Volatiles.*

Introduction

Cowpea (*Vigna unguiculata* (L); Family: Fabaceae), also known as Black eye pea is an annual herbaceous grain legume originated and domesticated in Southern Africa. It is an economically important food legume constituting a valuable source of protein in millions of people's diet. Root nodules of cowpea plants are capable of fixing atmospheric nitrogen and making it available to plants and are widely used for intercropping. Whole plant after harvest used as cattle feed. Melon thrips, *Thrips palmi* Karny (Family: Thripidae; Order: Thysanoptera) had been first recorded on tobacco plants in Sumatra during 1925 and later on it is spread to all the tropical countries as invasive pest. The preference of thrips towards virus infected plants were due to release of volatiles by virus infected plants after acquisition by vector changes its behaviour making it for further spread of the virus.

Methodology

Test plants for volatile collection-healthy and WBNV infected cowpea plants

Healthy cowpea plants were grown in small pots and maintained in 4" plastic pots containing mixture of (Sand: compost: Loamy soil) in the ratio 1:2:1 enclosed by insect proof bugdorm at growth chamber at 25 ± 1^{0}C. WBNV virus infected watermelon, *Citrullus lannatus* showing typical symptoms of WBNV like stunted growth, chlorosis, bud necrosis, stem pitting, stem necrosis, leaf mottling, bronzing and drying of leaves which were transmitted by *T. palmi* collected from field and used as the source of virus inoculum. Mechanical inoculation was done for virus maintenance in two leaf stage of healthy cowpea plants. One gram of WBNV infected leaf samples were macerated using 0.1M phosphate buffer adjusted to pH 7 under refrigerated condition. Mechanical inoculation was done by swabbing the virus inoculum on two leaf stage cowpea plant during the early morning or evening hours. Before swabbing the inoculum to the leaves, injury was caused with small number of abrasives namely, 1% celite 545 and Carborundum 320 grit (Fisher scientific, USA). 2-3 minutes after swabbing the inoculum to the leaves, washed with distilled water. 7-10 after inoculation plants will express the symptom of virus infection. HPLC grade Dichloromethane was used as solvent for extraction of VOCs and 2-week-old healthy and virus inoculated plants were selected for volatile collection and analyzed through Gas chromatography-Mass spectrometry.

Results and Discussion

The changes in VOCs emitted from healthy and WBNV infected cowpea plants were studied. About nine class (amine, acids, alcohol, amide, aldehyde, alkane, hydrocarbon, ketone, phenyl pyrazole) of VOCs were documented from both healthy and WBNV infected cowpea plants (Table 1). Amine group of compounds were recorded highest proportion among healthy cowpea plants whereas, a hydrocarbon group of compounds was recorded highest proportion among WBNV infected cowpea plants.

Headspace VOCs trapped from healthy and WBNV infected cowpea plants

In case of healthy cowpea plants, VOCs identified were 2-Pentanamine (0.11%), 2-Octanamine (0.17%), 1,2-Propanediamine (0.62%), 1-Octanamine, N-methyl- (0.29%), Octodrine (0.01%), Pterin-6-carboxylic acid (0.0048%), Acetic acid (0.27%), Cyclobutanol (0.06%), Propanamide (0.03%), Acetaldehyde (0.06%), 2-Aminononadecane (0.09%), Tuaminoheptane (0.55%). Similarly, VI-VOCs emitted from WBNV infected cowpea plants were 1-Pentanol (0.05%), 2-Ethyl-1-dodecanol (0.21%), 1-Hexanol (0.07%), 2-Coumaranone (0.07%), Dodecane (0.08%), Undecane (0.05%), Octadecane (0.17%), Hexadecane (0.10%), Tetradecane (0.35%), Tetracosane (0.15%), Eicosane (0.08%), 4H-1,3-Benzodioxin (0.03%).

Table 1. Headspace VOCs trapped from healthy and WBNV infected cowpea plants

<table>
<tr><th colspan="4">Healthy cowpea plants</th><th colspan="4">WBNV infected cowpea plants</th></tr>
<tr><th>Retention Time (min)</th><th>Area %</th><th>Name of the compound</th><th>Group/class</th><th>Retention Time (min)</th><th>Area%</th><th>Name of the compound</th><th>Group/class</th></tr>
<tr><td>4.3162</td><td>0.1174</td><td>2-Pentanamine</td><td rowspan="5">Amine</td><td>5.6769</td><td>0.0567</td><td>1-Pentanol</td><td rowspan="3">Alcohol</td></tr>
<tr><td>5.7346</td><td>0.1713</td><td>2-Octanamine</td><td>6.7808</td><td>0.2187</td><td>2-Ethyl-1-dodecanol</td></tr>
<tr><td>6.5463</td><td>0.6209</td><td>1,2-Propanediamine</td><td>6.8588</td><td>0.0767</td><td>1-Hexanol</td></tr>
<tr><td>6.7532</td><td>0.2966</td><td>1-Octanamine, N-methyl-</td><td>10.1977</td><td>0.0757</td><td>2-Coumaranone</td><td>Ketone</td></tr>
<tr><td>8.5171</td><td>0.0184</td><td>Octodrine</td><td>6.2131</td><td>0.0813</td><td>Dodecane</td><td rowspan="7">Hydrocarbon</td></tr>
<tr><td>29.6209</td><td>0.0048</td><td>Pterin-6-carboxylic acid</td><td rowspan="2">Acids</td><td>6.735</td><td>0.0585</td><td>Undecane</td></tr>
<tr><td>5.8149</td><td>0.2792</td><td>Acetic acid</td><td>9.3184</td><td>0.1764</td><td>Octadecane</td></tr>
<tr><td>4.6254</td><td>0.06</td><td>Cyclobutanol</td><td>Alcohol</td><td>9.5725</td><td>0.1075</td><td>Hexadecane</td></tr>
<tr><td>29.3614</td><td>0.0342</td><td>Propanamide</td><td>Amide</td><td>10.9012</td><td>0.3599</td><td>Tetradecane</td></tr>
<tr><td>8.0704</td><td>0.062</td><td>Acetaldehyde</td><td>Aldehyde</td><td>14.6293</td><td>0.1521</td><td>Tetracosane</td></tr>
<tr><td>10.1458</td><td>0.0992</td><td>2-Aminononadecane</td><td>Alkane</td><td>16.8705</td><td>0.0896</td><td>Eicosane</td></tr>
<tr><td>5.5137</td><td>0.5571</td><td>Tuaminoheptane</td><td>Hydrocarbon</td><td>8.621</td><td>0.0347</td><td>4H-1,3-Benzodioxin</td><td>Phenyl pyrazole</td></tr>
</table>

Reference

Eigenbrode, S. D., Ding, H., Shiel, P., and Berger, P. H. (2002). Volatiles from potato plants infected with potato leafroll virus attract and arrest the virus vector, Myzus persicae (Homoptera: Aphididae). Proceedings of the Royal Society of London. Series B: Biological Sciences, 269(1490), 455-460.

Kumar, J., Paul, B., Nebapure, S. M., and Singh, S. (2017). Comparative GC-MS analysis of two Brassica rapa L. varieties for identification of volatile compounds. Chem. Sci. Rev. Lett, 6, 884-889.

Rajabaskar, D., Ding, H., Wu, Y., and Eigenbrode, S. D. (2013). Behavioral responses of green peach aphid, Myzus persicae (Sulzer), to the volatile organic compound emissions from four potato varieties. American Journal of Potato Research, 90(2), 171-178.

Impact of Elevated Temperature on the Survivorship of *Plutella xylostella* (L.)

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Keywords: *Plutella xylostella, elevated temperature, survivorship, 50% mortality.*

Introduction

Diamondback moth, *Plutella xylostella* (L.) (Lepidoptera: Plutellidae) is a crucial pest of crucifers distributed along different climatic regions across the world. The yield loss estimated due to this destructive insect pest was around 90%. The ability to complete several generations per year, higher reproductive rate and insecticide resistance made *P. xylostella* management difficult. Temperature is considered a critical abiotic factor influencing the survival, development and reproduction of insects. Temperature and generation time of insects are highly inter-related to each other and elevated temperature reduces the generation time of most of the insects with more generations per season and finally leads to exacerbation of crop losses. Keeping these views in mind, the present study was conducted to understand the population dynamics of *P. xylostella* on cauliflower in relation to temperature changes.

Methodology

The mother culture of *P. xylostella* larvae and pupae were collected from the cauliflower fields of Thondamuthur and Narasipuram, Coimbatore during February 2019. The collected larvae were reared on the leaves of cauliflower at 28 ± 2°C, 70 ± 5% RH. The pupae formed were placed in adult emergence cage (60 × 60 × 60 cm). Honey solution (10%) was soaked in a cotton wick (10 cm) and given to adult as feed along with fresh cauliflower leaves. The cage was covered with black muslin cloth for egg laying. Every 24h, the leaves with freshly laid eggs were collected from the cage and used for experiments. Developmental parameters of *P. xylostella* were studied at six constant temperatures (31, 32, 33, 34, 35 and 36°C) in separate Open Top Chambers (OTC). A total of 100 eggs were examined at each temperature. The eggs were carefully examined until hatching. Each egg was noted as a replication. After emergence, fresh cauliflower leaves were given every day during the experimental period. The mortality, developmental time of *P. xylostella* were recorded at each temperature treatment. The survivorship curves were prepared by plotting the survival rate of *P. xylostella* (l_x) against the age of an insect. It helps in assessing variations among different groups of populations and gives visual presentation. The probability of survival concerning an insects' age follows a logistic curve of type III. Hence the curves are fixed by Doesn't Use Derivative (DUD) by the formula.

$$\text{Probability of survival} = \frac{1}{1 + \exp\left(\frac{x - a}{b}\right)}$$

Where,

a : Day in which 50 per cent mortality was observed (Point of inflexion)

b : Intercept (Shape of the curve)

x : Age (Days)

Results and Discussion

The survival of *P. xylostella* population depicted a type III survivorship curve which indicated the rate of survival decreased with increased temperatures. The mortality rate was more pronounced during the early life stages at higher temperatures. 50 per cent mortality was observed on 22.0 days at 31°C followed by 19.6 days at 32°C whereas at 34°C, it occurred as early as on 12.8 days (Table 1). The survival was greatly reduced at 35°C and cent percent mortality was observed at 36°C. Our results were consistent with the results of Golizadeh *et al*. (2007) who reported 100 per cent mortality of *P. xylostella* second instar larvae at 35°C. Kuo *et al.* (2006) found 50 per cent mortality of corn aphid, *Rhopalosiphum maidis* on 38th pivotal age at 6°C and cent percent mortality on 14th pivotal age at 35°C. Temperature is considered to as a key factor influencing the growth and development of insects. Insects' physiological mechanisms and metabolic rate decides their developmental rate. The rate of metabolism is mostly dependent on the body temperature. The insects' efforts to maintain their body temperature equivalent to the prevailing atmospheric ambient temperature. Hence, the metabolic rate increases linearly with increasing atmospheric temperature (Grodzicki , 2011). Folguera *et al.* (2010) opined that impact of temperature varies among different insects. In general, lower temperature reduces the developmental rate and increases the duration of each life stage. The most probable reason for the incomplete development of the insects at higher temperature was the inability of the larvae to consume adequate nitrogen to support the temperature dependent development rate (Bezemer and Jones, 1998).

Table 1. Survival response of *Plutella xylostella* to different temperatures

Temperature (° C)	'a' (50% mortality)	'b' (intercept)	Regression equation	r^2
31	22.0	1.118	y = - 0.020x + 1.118	0.471
32	19.6	1.184	y = - 0.029x + 1.184	0.569
33	16.8	1.203	y = - 0.040x + 1.203	0.757
34	12.8	1.114	y = - 0.048x + 1.114	0.885

Reference

Bezemer, T. M., and T.H. Jones. 1998. Plant-insect herbivore interactions in elevated atmospheric CO_2: quantitative analyses and guild effects. ***Oikos,*** 212-222.

Folguera, G., J. Mensch, J. L. Muñoz, S. G. Ceballos, E. Hasson and F. Bozinovic. 2010. Ontogenetic stage-dependent effect of temperature on developmental and metabolic rates in a holometabolous insect. ***Journal of insect physiology,*** *56*(11), 1679-1684.

Golizadeh, A. L. I., K. Kamali, Y. Fathipour and H. Abbasipour. 2007. Temperature-dependent development of diamondback moth, *Plutella xylostella* (Lepidoptera: Plutellidae) on two brassicaceous host plants. ***Insect Science,*** *14*(4), 309-316.

Grodzicki P, K. (2011). Hypometabolism in insects. ***Research Signpost,*** *661*(2), 19-37.

Kuo, M. H., M. C. Chiu and J. J. Perng 2006. Temperature effects on life history traits of the corn leaf aphid, *Rhopalosiphum maidis* (Homoptera: Aphididae) on corn in Taiwan. ***Applied Entomology and Zoology,*** *41*(1), 171-177.

Impact of Weather on Aquatic Insect Diversity in Irrigated Rice of Coimbatore, Tamil Nadu

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Keywords: *Morphological characterization, Conocephalus, Rice.*

Introduction

The irrigated rice fields contribute to sustaining the regional biodiversity of many invertebrate and vertebrate species (Lawler, 2001). The abundance of aquatic insects' changes with rice growth stage (Ban and Kritani, 1980). Dearth of studies on the aquatic insect diversity of rice fields in Tamil Nadu necessitated this study on the impact of weather on aquatic insects in the wake of climate change.

Methodology

Aquatic insect diversity in irrigated rice fields of Coimbatore was studied during 2018-2019 in late *Samba, Navarai*, early *Samba* and late *Thaladi* seasons. Aquatic insect samples were taken at three days interval at different growth stages of rice viz., early vegetative stage, vegetative, reproductive and grain maturity stage using dip net and D-frame kick net. The weather parameters *viz.*, maximum temperature, minimum temperature, rainfall and relative humidity on aquatic insects was studied by correlation and multiple regression analysis.

Results and Discussion

A total of 8,989 individual insects were collected representing six insects' orders, 19 families, 22 genera and 22 species. Among the different insect orders under study, *Micronecta* sp. (Micronectidae) and *Anisops* sp. (Notonectidae) of Hemiptera were the dominant all insect fauna during rice growing seasons. The result of regression analysis showed that abiotic factors significantly affected the population of *Anisops* sp. in late *Samba* (R2=1.00), *Navarai* (R^2=1.00), early *Samba* (R^2=0.99) and late *Thaladi* (R^2=0.79), whereas *Micronecta* sp. in late *Samba* (R^2=1.00), *Navarai* (R^2=1.00), early *Samba* (R^2=0.98) and late *Thaladi* (R^2=0.39) (Table 1). Weather parameters viz., maximum temperature, minimum temperature, relative humidity and rainfall highly impacted the dominant fauna *Micronecta* sp. populations (R^2=0.99 to 1.00) during all the seasons of cultivation except for comparatively lesser impact during late *Thaladi* (R^2=0.39) while for the remaining fauna, impact of weather parameters was not intended owing to lesser abundance of population. Insect being ectothermic organisms, regulate their body temperature to the ambient temperature is one of the reasons for their success of survival rates and abundance (Bale *et al.*, 2002). Thus, it is inferred that temperature has profound influence on the biology and reproductive success of the insects, and are critical in determining the species profile of insects in these irrigated systems which in turn affect the overall diversity and richness of the ecosystems.

Table 1. Regression equation on aquatic insect (Notonectidae and Micronectidae) with the abiotic factors

Season	Family	R2 values	Equation
Late *Samba*	Notonectidae	0.79	$Y=-732.85-1.22X_1+2.63X_2+8.89X_3-0.39X_4$
	Micronectidae	0.39	$Y=-88.09+11.31X_1-4.91X_2+7.44X_3+0.43X_4$
Navarai	Notonectidae	1.00	$Y=169.65-4.72X_1+4.99X_2-0.779X_3-1.136X_4+9.038X_5$
	Micronectidae	1.00	$Y=-804.00+26.28X_1-15.58X_2-0.506X_3+7.17X_4-28.72X_5$
Early *Samba*	Notonectidae	1.00	$Y=111.45-4.227X_1+11.67X_2+0.77X_3-41.28X_4-51.02X_5$
	Micronectidae	1.00	$Y=-2904.75-38.35X_1+100.08X_2+29.51X_3-11.81X_4-3.41X_5$
Late *Thaladi*	Notonectidae	0.99	$Y=-570.58+10.51X_1+3.42X_2+3.30X_3-1.74X_4$
	Micronectidae	0.98	$Y=-85.87+2.42X_1+0.24X_2+0.02X_3+0.34X_4$

X_1=Maximum Temperature °C, X_2=Minimum Temperature, X_3=Relative Humidity (%) (evening), X_4=Relative Hummidity (%) (evening), X_5=Rainfall (mm)

Reference

Ban, Y., and Kiritani. 1980. Seasonal prevalence of aquatic insects inhabiting paddy fields. Japanese Journal of Ecology, 30:393-400.

Lawler, S. P. (2001). Rice fields as temporary wetlands: a review. Israel Journal of Zoology, 47(4), 513-528.

Bale, J. S., Masters, G. J., Hodkinson, I. D., Awmack, C., Bezemer, T. M., Brown, V. K., ... & Whittaker, J. B. (2002). Herbivory in global climate change research: direct effects of rising temperature on insect herbivores. Global change biology, 8(1), 1-16.

Impact of Weather Parameters on Population Fluctuation of Invasive *Tuta absoluta* (Meyrick, 1917)

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Keywords: *Tuta absoluta, population dynamics, temperature, rainfall, relative humidity.*

Introduction

Tomato pinworm, *Tuta absoluta* (Gelechiidae: Lepidoptera) is a microleidopteran moth native of neotropical region. It is an oligophagy on many solanaceous crops and considered as a key pest of tomato. In India the initial incidence was recorded at Pune during October 2014. Following that pinworm incidence was reported at Bengaluru, Tamil Nadu, Delhi, Gujarat, Himachal Pradesh, Uttar Pradesh and Meghalaya (Fand *et al*., 2020). The world is experiencing global warming and such changes in climate are expected to seriously affect the population dynamics and status of insect pests (Negi *et al*., 2020). Hence it is necessary to analyse the impact of local climatic conditions on the population dynamics of an insect pests. Hence it is mandatory for an invasive pest to understand their capability of adopting to new habitat to establish better forecast system.

Methodology

Experiment was conducted in open tomato fileds at three locations *viz*., kinnimangalam, Checkanurani and Thenpalanji of Madurai district, Tamil Nadu, India during 2016 to 2017. Synthetic sex pheromone of *T. absoluta* was purchased from Pest Control India Ltd., Chennai.Delta traps baited with pheromone rubber septa were installed in the newly transplanted tomato fields. Traps were placed at the rate of 3 per ha^{-1}. Pheromone rubber septa were renewed every four weeks and subsequently delta trap bottoms were replaced at the time of moth counting. Captured male moths were counted weekly. Weather parameters *viz*., maximum and minimum temperature and relative humidity were recorded weekly. Weekly male moth counts and weather parameters were subjected to simple correlation and linear regression analysis (Hassan *et al*., 2021).

Results and Discussion

The studies on weekly average catch of trapped males of *T. absoluta* in three locations of Madurai showed a progressive rise in male catches during the period of study. Indeed, the average of captured males were low during the first week of study (Nov 05- 11) (4.67 males/ trap/ week). Then the catches of male attain a peak of 667.33 males/ trap/ week on the 13th week. The maximum average of captured males was 654.67 during 11th – 13th week of installation. Afterwards the count begins to decline and reaches 474 males/ trap/ week on the last week of study. The correlation (r) between weather parameters and adult capture of *T. absoluta* revealed that the maximum temperature and morning relative humidity showed non-significant positive relationship (r = 0.046 and 0.097 respectively), while minimum temperature showed significant negative relationship (r = -0.505). Evening relative humidity and rainfall exhibited non-significant negative relationship (r = - 0.360; r = - 0.05) with *T. absoluta* adult population (Table 1). From the correlation analysis, it was evident that an increase in maximum temperature by 1^{0}C and morning relative humidity by 1 per cent resulted in an increase of *T. absoluta* population by 7.85 and 6.18 per cent respectively, where as a decrease in minimum temperature by 1^{0}C and morning relative humidity by 1 per cent resulted in a decrease of *T. absoluta* population by 113.11 and 11.80 per cent respectively. From multiple regression analysis the coefficient of determination was low (R^2 = 0.354), which implies that these weather factors *i.e.*, maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and rainfall contributes little towards the population growth of *T. absoluta* to the extent of 35.4 per cent (Table 2). The weather factors, maximum temperature, minimum temperature and evening relative humidity had negative relationship, while morning relative humidity exhibited positive association with *T. absoluta*. Our present finding was in accordance with (Hassan *et al*., 2021). who stated that the temporal patterns of male flight and temperature were similar and highest captures were recorded concurrently with the highest mean daily temperatures. Similarly, In the greenhouse crop, male captures and leaf infestation were low in winter and increased steadily in spring up to 797.3 males/trap/week and 6.4 mines/leaf, respectively which concord with the present finding.

Table 1. Correlation of weather parameters on the population of *T. absoluta*

Correlation	Temperature (⁰C)		Relative Humidity (%)		Rainfall (mm)
	Maximum	Minimum	Morning	Evening	
R	0.046	-0.505*	0.097	-0.360	-0.05
Y=a+bX	112.201+7.850 X	3045.72-113.11X	-135.475+6.183X	905.43-11.802X	375.55-10.36X
Significance (P value)	0.860	0.039	0.7110	0.156	0.833
Non significance (P value)	NS**	-	NS	NS	NS

*Significant at 5% Probability. **NS- Non Significant

Table 2. Multiple linear regression models for weather parameters on *T. absoluta*

Constant	Temperature (⁰C)		Relative Humidity (%)		Rainfall (mm)	R^2
	Maximum	Minimum	Morning	Evening		
	(X_1)	(X_2)	(X_3)	(X_4)	(X_5)	
5028.67	-73.831	-96.307	5.518	-16.365	-1.801	0354

Reference

Fand, B.B., Shashank, P.R., Suroshe, S.S., Chandrashekar, K., Meshram, N.M. and Timmanna, H.N. 2020. Invasion risk of the South American tomato pinworm *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) in India: predictions based on MaxEnt ecological niche modelling. *International Journal of Tropical Insect Science*, pp.1-11.

Hassan, E.S.M., Mesbah, I.I., Ali, F.A. and El-Shesheny, I.A. 2021. Prevalence, population dynamics and associated natural enemies of Tomato Leafminer, *Tuta absoluta*, in Egypt. *International Journal of Tropical Insect Science*, pp.1-20.

Negi, S., Sharma, P.L., Verma, S.C. and Chandel, R.S. 2020. Thermal requirements of *Tuta absoluta* (Meyrick) and influence of temperature on its population growth on tomato. *Journal of Biological Control*, **34(1)**:73-81.

Introgression of *Vigna mungo* Genome into *Vigna radiata* towards the Broadening of Genetic Base for MYMV Resistance and Yield Attributes

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Keywords: *Vigna, Interspecific hybridization, background analysis, genome introgression*

Introduction

Green gram (*Vigna radiata*(L.) Wilczek) is an important pulse crop of Asia, Africa and Latin America, where it is consumed as dry seeds and fresh green pods (Karuppanapandian *et al*., 2006). The main cause for low yield is susceptibility to pests and diseases, among which Mungbean Yellow Mosaic Virus (MYMV) is one of the most devastating diseases of greengram causing 85 - 100 per cent yield loss. Interspecific hybridization is a method for creation of genetic variability and widening of genetic base in a crop species. the present investigation was undertaken to assess the introgression level of blackgram genome into the green gram genome among the interspecific derived progenies.

Methodology

Crosses were made between greengram (*Vigna radiata* cv. VBN(Gg)2) and blackgram (*Vigna mungo* cv. Mash 114) and forwarded up to F_4 generation. The F_4 population was evaluated at National Pulses Research Centre, Tamil Nadu Agricultural University, Vamban during *July – Sep*., 2017 for yield components and MYMV disease resistance. Each progeny was evaluated along with highly susceptible variety, CO5 of blackgram (*Vigna mungo* (L.) Hepper) as infector row to raise MYMV disease incidence. Individual plants with MYMV disease resistance and high yield were selected and evaluated in F_5 generation as progeny rows during *Dec- Feb*., 2017-18. Genomic DNA of parents and selected MYMV disease resistance plants in F_4 generation were extracted using CTAB method suggested by Doyle and Doyle (1987) with modifications. Poly Acrylamide Gel Electrophoresis (PAGE) (6% w/v) was used for better separation of DNA fragments. The allelic pattern was marked as A, B and H for green gram homozygote, blackgram homozygote and heterozygote genome respectively. The allelic data was subjected to GGT (Graphical Genotyper version 2.0) to find out the genome contribution.

Results and Discussion

The present investigation was carried out at National Pulses Research Centre, Vamban to assess the introgression level of blackgram (*Vigna mungo* cv. Mash 114) genome into greengram (*Vigna radiata* cv. VBN(Gg)2) genome background through interspecific hybridization. Superior progenies with high yield potential and MYMV disease resistance were selected in F_4 generation of cross VBN(Gg)2 and Mash 114 and evaluated in F_5 generation. Based on *per se,* and yield performance, six superior F_5 progenies were selected and subjected to background analysis. A set of 84 SSR primers were surveyed, and 33 SSRs were found to be polymorphic between parents. These markers were uniformly distributed among the 11 linkage groups of mungbean (Isemura *et al*., 2012). The results showed that 10.9 to 34.9 per cent of *Vigna mungo* genome was introgressed into *Vigna radiata* background. The proportion of homozygotes and heterozygotes among the progenies ranged from 5.4 to 28.8 and 7.2 to 22.2 per cent respectively (**Table. 1**). Among the six progenies surveyed, one progeny 3-10-19 recorded a maximum of 34.9% of blackgram genome (**Fig. 1**). The present investigation showed the successful introgression of *Vigna mungo* genome into the *Vigna radiata* background.

Table 1. Background analysis on selected superior progenies for introgression of *Vigna mungo* into *Vigna radiata*

S. No.	Progeny No.	A (%)	B (%)	H (%)	Total (cM)	Recombinant segments	H-segments	Total Introgressed genome (%)
1	3-1-11	81.0	10.2	8.7	555.2	7	1	14.6
2	3-7-6	83.6	5.4	11.0	555.2	5	1	10.9
3	3-7-8	76.7	16.1	7.2	555.2	11	3	19.7
4	**3-10-19**	54.0	23.8	22.2	555.2	10	3	**34.9**
5	3-12-13	65.0	20.3	14.7	555.2	9	3	27.7
6	3-13-3	74.3	13.0	12.7	555.2	9	3	19.4

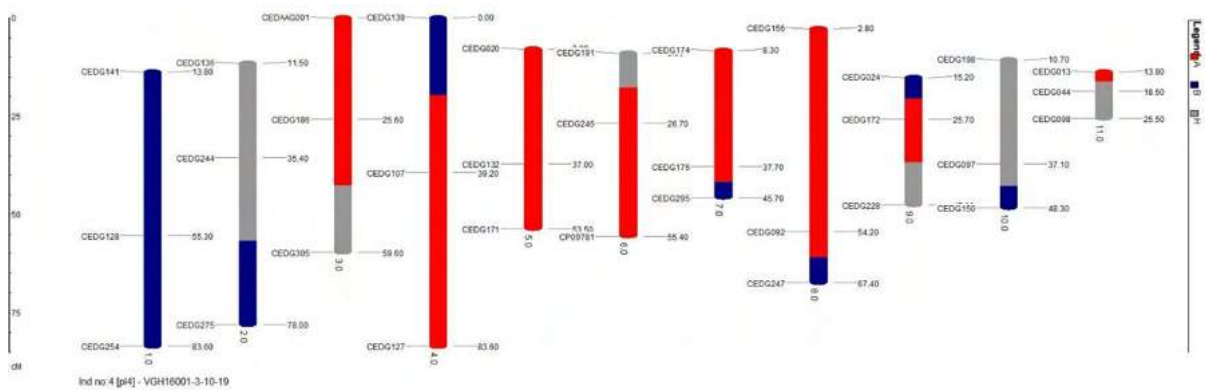

Fig 1. Graphical display of the best superior progeny 3-10-19

Reference

Karuppanapandian, T., Karuppudurai, T., Sinha, P. B., Kamarul, H., Manoharan, K. (2006) Genetic diversity in green gram [*Vigna radiata* (L.)] landraces analyzed by using random amplified polymorphic DNA (RAPD). *African J Biotechnol,* 5(13).

Isemura, T., Kaga, A,, Tabata, S., Somta, P., Srinives, P., Shimizu, T., Jo, U., Vaughan, D. A., Tomooka, N. (2012). Construction of a genetic linkage map and genetic analysis of domestication related traits in mungbean (*Vigna radiata*). *PLoS One,* 7(8); e41304.

Doyle, J. J. and Doyle, J. L. (1987). A rapid DNA isolation procedure for small quantities of fresh leaf tissue. *Phytochemical Bulletin,* 19; 11 15.

Laboratory Evaluation of Insecticides against Rice Stem Borer Species and Their Safety to Natural Enemies

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Keywords: Rice, Stem borer species, Laboratory evaluation, Insecticides, Natural enemies

Introduction

Rice (*Oryza sativa* L.) is the principal cereal crop for more than 50 per cent of the world population. Stem borers constitute an economically important pest causing 40 per cent yield loss in rice production. In India, there are five stem borer species of rice, with the dominant occurrence of yellow stem borer (YSB), *Scirpophaga incertulas* (Walker) and pink stem borer (PSB), *Sesamia inferens* (Walker). Rice ecosystem is harboured with a wide range of natural enemy complex.

Methodology

Laboratory culture of YSB and PSB were maintained. Preliminary studies were conducted in the laboratory to evaluate the effect of some newer molecules of insecticides on different stages of YSB and PSB (Heinrichs, 1981) and their safety to the predators *viz*., rove beetle (*Paederus fuscipes* Curtis) and coccinellid (*Micraspis discolor* Fab.) in rice ecosystem and the egg parasitoids of YSB.

Results and Discussion

Effect of insecticides on different stages of YSB and PSB

Chlorpyriphos 20EC @ 2.0 ml/l and spinetoram 11.7 SC @ 0.75 ml/l exhibited maximum ovicidal action in terms of 100 and 91.85 per cent reduction in hatching of YSB eggs respectively. The toxicity of chlorantraniliprole 18.5 SC 0.30 ml/l, spinetoram 11.7 SC @ 0.75 ml/l and flubendiamide 39.35 SC 0.10 ml/l resulted in 100, 93.33 and 90.00 per cent mortality of YSB larvae respectively (**Table 1**) and were persistent upto 15 Days after treatment (DAT) (**Figure 1**). The maximum antioviposition effect on YSB adults was witnessed in chlorantraniliprole 18.5 SC @ 0.30 ml/l (100.00 %), cartap hydrochloride 4 G @ 50 g/l (100.00 %) and flubendiamide 39.35 SC @ 0.1 ml/l (91.67 %). Fumigation effect was maximum in chlorantraniliprole 18.5 SC @ 0.3 ml/l (56.67 %), cartap hydrochloride 4G @ 50g/l (53.33 %) and spinetoram 11.7 SC @ 0.75 ml/l (46.67 %) (**Table 1**). However, the toxicity to the pink stem borer larvae was maximum in spinetoram 11.7 SC @ 0.75 ml/l (100.0 %) followed by chlorantraniliprole 18.5 SC 0.30 ml/l (96.67 %) and flubendiamide @ 0.1 ml/l (96.67 %) and were persistent up to 15 DAT (**Figure 1**). The present results were in accordance with the toxic effect of insecticides on YSB by Vennila (2012).

Safety of insecticides on predators in rice ecosystem and egg parasitoids of YSB

The effect of insecticides on the safety to *Telenomus dignus* (Gahan) as evidenced by adult emergence was maximum in spinetoram 11.7 SC @ 0.75 ml/l (87.74 %) followed by chlorantraniliprole 18.5 SC 0.30 ml/l (84.16 %). Similarly, emamectin benzoate 5 SG @ 0.44g/l (100.0 %), chlorantraniliprole 18.5 SC 0.30 ml/l (97.62 %), cartap hydrochloride 4G @ 50 g/l (92.46 %) and spinetoram (91.67 %) were safe to *Tetrastichus schoenobii* (Ferriere) followed by flubendiamide 39.35 SC @ 0.1 ml/l (91.67 %). The insecticides spinetoram 11.7 SC @ 0.75 ml/l, chlorantraniliprole 18.5 SC 0.30 ml/l and cartap hydrochloride 4G @ 50 g/l were safe to *Trichogramma japonicum* Ashmead and the predators (**Figure 2**). The toxicity of insecticides on natural enemies reported by Prema *et al.* (2016) was in agreement with the present findings.

Table 1. Laboratory evaluation of insecticides on different stages of rice yellow stem borer

Treatments	Dose/l	Hatching (%)*	Larval mortality 48 HAT* (%)	Oviposition deterrent effect (%)*	Adult mortality due to fumigation effect 48 HAT*(%)
T_1 Dinotefuran 20 SG	0.30 g	14.69 (22.53)ab	40.00 (39.23)e	21.67 (27.74)e	90.00 (71.57)b
T_2 Spinetoram 11.7 SC	0.75 ml	8.14 (16.58)ab	93.33 (75.03)b	85.00 (67.21)bc	100.00 (89.10)a
T_3 Emamectin benzoate 5 SG	0.44 g	51.51 (45.87)c	63.33 (52.73)cd	53.33 (46.91)d	100.00 (89.09)a
T_4 Flubendiamide 39.35 SC	0.10 ml	36.25 (37.02)bc	90.00 (71.57)b	91.67 (73.22)ab	100.00 (89.09)a
T_5 Cartap hydrochloride 4G	50 g	20.31 (26.79)ab	73.33 (58.90)c	100.00 (89.10a	100.00 (89.09)a
T_6 Chlorantraniliprole 18.5 SC	0.30 ml	33.80 (35.55)bc	100.00 (89.10)a	100.00 (89.10)a	100.00 (89.09)a
T_7 Chlorpyriphos 20EC	2.00 ml	0.00 (0.90)a	46.67 (43.09)de	78.33 (62.26)c	96.67 (79.49)ab
T_8 Control	-	100.00 (89.10)d	0.00 (0.90)f	0.00 (0.90)f	0.00 (0.90)c
SEd		10.36	5.38	6.99	3.91
CD (p=0.05)		21.97	11.40	14.83	8.29

*Mean of three replications; HAT- Hours After Treatment,In a column, means followed by similar letter(s) are not different statistically (p=0.05) by, LSD; Figures in parentheses are arcsine transformed values

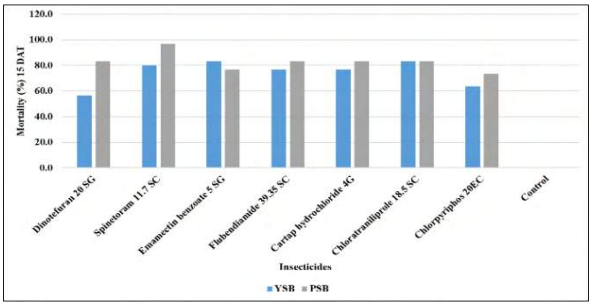

Fig 1. Persistent toxicity of insecticides against YSB and PSB

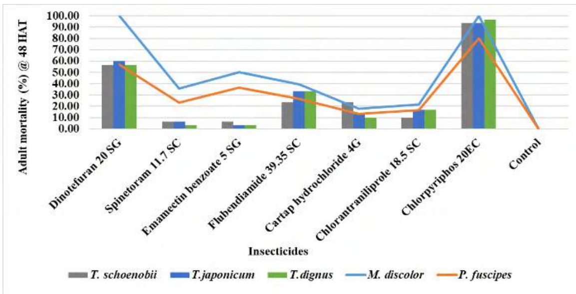

Fig 2. Safety of insecticides to natural enemies

Reference

Heinrichs, E.A. 1981. Manual for testing insecticides on rice. ***International Rice Research Institute***, Phillippines,: 142.

Prema, M.S, S Sridharan, and S. Kuttalam. 2016. Evaluating the Biosafety of Newer and Conventional Insecticides against Parasitoids, Predators and Pollinators Prevailing in Agricultural Ecosystem: To achieve Agricultural Sustainability in Future. ***Res. J. Recent Sci***., 5 (8): 11-15.

Vennila, P. 2012. Efficacy of certain insecticides against paddy stem borer, *Scirpophaga incertulas* (Walker). ***Doctoral dissertation***, Acharya NG Ranga Agricultural University. http://krishikosh.egranth.ac.in/handle/1/68240.

Loop Mediated Isothermal Amplification Assay for Rapid and Sensitive Detection of Rice Seed Borne Pathogens

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Keywords: *Rice, Seed borne disease, LAMP assay, Sensitive detection*

Introduction

Rice (*Oryza sativa)* is one of the most important staple food for more than half of the world population. Rice crop is affected by more than 30 seed borne diseases, of which 20 species of fungal pathogens were detected from rice seed at one time. A rapid and sensitive technique for the detection of rice seed borne pathogens were performed using loop-mediated isothermal amplification assay (LAMP). The LAMP assay protocol was standardized to examine the presence of seed.

Methodology

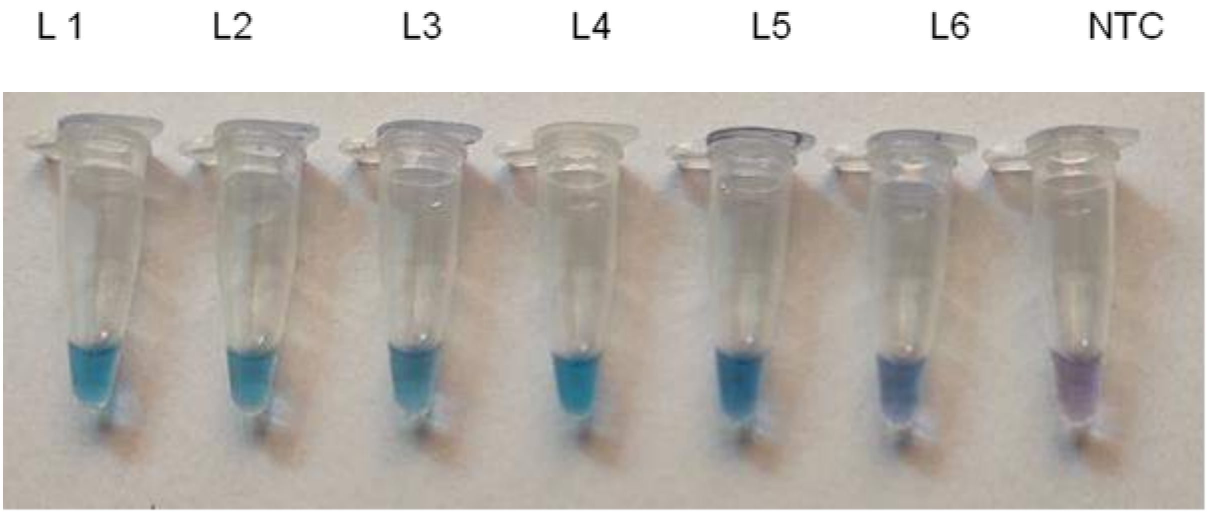
Rice grains infected by different seed borne pathogens were collected from different regions of Tamil Nadu. The infected grains were surface sterilized and placed in petri plates containing 15 ml potato dextrose agar and incubated at 28°C ±2°C for 3 days. The culture was purified and stored at 28°C for further studies. Molecular confirmation for different fungal pathogens viz., *Magnaporthe oryzae* and *Bipolaris oryzae* was done was done using ITS1 and ITS 4 (TCCGTAGGTGAACCTGCGG and TCCTCCGCTTATTGATATGC). Using primer explorer software version 5, a set of six primers were designed to standardize LAMP assay protocol.

Results and Discussion

The PCR assay for the detection of *Magnaporthe oryzae* and *Bipolaris oryzae* using ITS and specific primers showed positive results, when the DNAs of respective pathogens were used. No amplification was detected when template DNA from the healthy rice seeds was used. Further, the PCR amplification was confirmed on a 1.2% agarose gel. At a constant temperature for 60 mins DNA samples from infected portion were incubated. An intensity of sky blue colour development was seen in positive samples and violet color development was seen in negative samples. Prasannakumar *et al.* (2020) targeted the highly conserved RNA polymerase II largest subunit gene for the detection of *Magnaporthe oryzae.* Li *et al.* (2019) designed LAMP primers by targeting the A1b1 nuclear shuttle protein, which is highly conserved in the pathogen *Magnaporthe oryzae.* LAMP assay has a remarkable advantage over other conventional PCR methods. Hence this rapid LAMP assay protocol will be highly useful for insight detection of rice seed borne pathogens under field and storage conditions.

Table 1. Presence of rice seed borne pathogens *Magnaporthe oryzae* and *Bipolaris oryzae* under LAMP assay.

S.No	Rice seed Borne Pathogens	LAMP Assay
1.	*Magnaporthe oryzae*	+
2.	*Bipolaris oryzae*	+



Reference

Prasannakumar, M. K., Parivallal, P. B., Pramesh, D., Mahesh, H. B., & Raj, E. (2021). LAMP-based foldable microdevice platform for the rapid detection of *Magnaporthe oryzae* and *Sarocladium oryzae* in rice seed. *Scientific Reports*, *11*(1), 1–10.

Li, L., Zhang, S. Y., & Zhang, C. Q. (2019). Establishment of a rapid detection method for rice blast fungus based on one-step loop-mediated isothermal amplification (LAMP). *Plant Disease*, *103*(8), 1967–1973. https://doi.org/10.1094/PDIS-11-18-1964-RE

Management of Post harvest Spoilage in Tomato with Various Post harvest Treatments

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Keywords: *Tomato, Post harvest treatment, Disease incidence*

Introduction

Tomato (*Lycopersicon esculentum* Mill.) is an important vegetable and fruit crop in India. Kader (1992) listed out the important factors responsible for post harvest spoilage *viz*., pre harvest practices, adaption of poor production techniques, rough handling, moisture condensation causing pathogen infestation, bulk packaging without sorting and grading, damage during transport and storage due to mechanical injuries. The present study was undertaken to minimize the pathogen causing post harvest spoilage in tomato with different post harvest treatments after harvesting the tomatoes.

Methodology

The post harvest treatments were imposed on the collected tomato fruits as per the experimental design. The experiment design consisted of two factors as follows: After the treatment, the fruits were kept on a brown paper which was previously placed on the laboratory floor at ambient condition. The experiment was laid out in a completely randomized design with three replications. The diseased fruits were identified symptomatically. The disease incidence was calculated as follow:

$$\text{Disease incidence (\%)} = \frac{\text{Number of infected fruits}}{\text{Total number of fruits}} \times 100$$

The significance of difference between the pair of means was compared by least significant difference (LSD) test at the 1% and 5% levels of probability (Gomez and Gomez, 1984).

Factor 1 (Calyx retention)	Factor 2 (Post harvest treatment)
C1: With calyx C2: Without calyx	T1: Tomato washed with garlic extract (1:1= water: garlic) T2: Tomato washed with neem extract (2:1= water: neem) T3: Hot water treatment at 50 5°C for 5 min T4: Tomato stored at 15°C temperature T5: Tomato stored in unperforated plastic bags containing $KMnO_4$ (cotton was soaked in saturated KMnO4 solution) T6: Control (not subjected to any treatments)

Results and Discussion

In the present study, the lowest disease incidence was observed in calyx retention and the highest in without calyx retention (Figure 1). Disease incidence increased with the advancement of storage period. Post harvest treatment used in present study caused highly significant difference in respect of disease of tomato at all day of storage (Figure 1). No disease was recorded in T5 and the highest disease incidence was recorded in T6 (55.67%) at the 8th day of storage. At the 18th day of storage the lowest (22.00%) disease incidence was recorded in T5 and the highest disease incidence was recorded in T6 (69.50%). The results were confirmed with Bhadra and Sen (1997), who described that polythene bagging with KMnO4 was found to be the best for reducing physiological weight loss for custard appleduring storage. Figure 1. Effect of calyx retention (right)and different postharvest treatments (left) on disease incidence of tomato during storage and ripening. T1 (Tomato washed with garlic (1: 1 = water: garlic)); T2 (Tomato washed with neem extract

(2:1), T3: Hot water treatment at 50 5°C); T4 (unwrapped tomato stored at 15°C); T5 (Tomato stored in unperforated plastic bags contain KMnO4 (115 mg cotton was soaked in saturation KMnO4 solution)); T6 (Control)

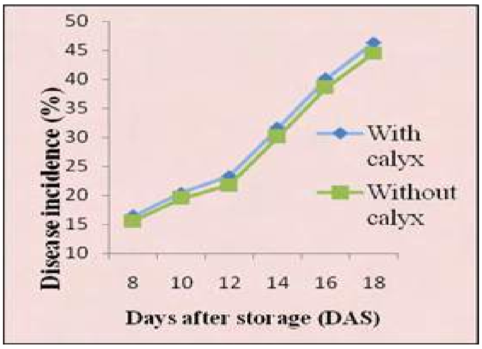

Figure 1

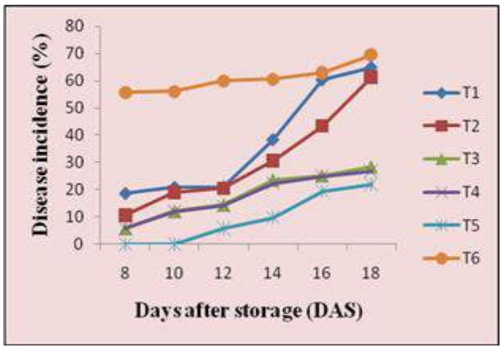

Figure 2

Table 1. Combined effect of calyx retention and different post-harvest treatments on disease incidence of tomatoes during storage and ripening

Calyx retention	Post-harvest treatments	Disease incidence (%) at different days after storage (DAS)					
		8	10	12	14	16	18
With calyx	T1	20.00	22.00	21.67	40.33	61.33	65.33
	T2	10.67	19.67	21.17	31.33	44.67	62.33
	T3	5.87	12.67	15.33	24.67	25.67	28.33
	T4	5.63	12.33	14.33	22.33	25.33	28.00
	T5	0.00	0.00	6.33	10.33	20.33	22.33
	T6	56.67	56.00	61.33	60.67	63.00	72.00
Without calyx	T1	17.33	19.83	20.33	36.33	59.00	64.33
	T2	10.33	18.33	19.67	29.67	42.00	60.33
	T3	5.77	11.67	13.67	22.67	24.67	28.67
	T4	5.67	11.17	13.50	22.17	24.33	25.33
	T5	0.00	0.00	5.53	9.33	18.67	21.67
	T6	54.67	55.67	58.33	60.33	62.67	67.00
LSD 0.05		0.805	0.747	0.872	1.568	0.749	1.726
LSD 0.01		1.084	1.007	1.175	2.113	1.010	2.326
Level of significance		**	**	**	**	**	**

**: Significant at 1% level of probability, NS: Not significant. T1 (Tomato washed with garlic (1: 1 = water: garlic)); T2 (Tomato washed with neem extract (2:1), T3: Hot water treatment at 50 5°C); T4 (unwrapped tomato stored at 15°C); T5 (Tomato stored in unperforated plastic bags contain KMnO4 (115 mg cotton was soaked in saturation KMnO4 solution)); T6 (Control)

References

Bhadra, S and SK. Sen. 1997.Postharvest storage of custard apple (*Annona squamosa* L) fruit variety local green under various chemical and wrapping treatments. *Environmental Ecology*.,4: 228-322.

Gomez, K.A and A.A. Gomez. 1984: Statistical Procedure for Agricultural Research (2nd Edn.). John Willey and Sons, Now York. Pp: 28 – 92.

Kader, A.A. 1992. Post-harvest biology and technology: In: A.A. Kader (ed.) Post-harvest technology of horticultural crops. University of California, *Agriculture and Natural Resources*., 3311:15-20.

Mechanisms of Resistance against Okra Leafhopper, *Amrasca biguttula biguttula* Ishida in Okra Genotypes

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Keywords: *Amrasca biguttula biguttula, Okra, Antixenosis, Antibiosis, Tolerance*

Introduction

Okra leafhopper, *Amrasca biguttula biguttula* Ishida is one of the serious sucking pests causing severe damage in the early phase of the okra crop. It sucks the cell sap from lower surface of leaf and injects toxic substances causing phytotoxemia, curling, yellowing and drying of leaves, as a result the plant growth is retarded. Iterate use of chemical insecticides leads to the development of resistance and destruction of natural enemies. Thus, it has become imperative to seek built-in-protection by plants against pest species wherever possible. The resistance in okra (*Abelmoschus esculentus* (L.)) Moench genotypes to leafhopper are governed by antixenosis (non-preference), antibiosis and tolerance mechanisms. Hence, resistance mechanisms of selected genotypes were evaluated under free-choice and no-choice tests against okra leafhopper.

Methodology

Antixenosis:

Ovipositional preference was studied by collecting fifteen leaves in selected okra genotypes on three days interval to recover the number of eggs deposited in the midrib and lamina. Location of individual eggs in plant tissues was determined by clearing the leaves in hot lacto-phenol glycerine solution and examining them under low power on a microscope. Feeding preference was determined by raising okra seedlings in small plastic cups and releasing insects into cage to feed. The number of leafhoppers settled on each entry was counted after 4h, 12h and 24h after release. The experiment was replicated five times.No choice test was employed to study leafhopper preference on selected okra genotypes. 15 days old seedlings from each test entry were placed separately in each cage and 10-20 adults were released. Numbers of insects that have not settled on seedling was counted at different time intervals 4h, 12h and 24 h after release.

Antibiosis:

Mylar cages with muslin cloth were fixed on the leaves of plants of each test genotypes. The first instar nymphs collected from stock culture raised on Pusa Sawani were transferred at the rate of 10 on to caged leaf. Observations were made daily on the rate of development, number of surviving nymphs until they developed into adults. This study was replicated thrice.

Tolerance (Recovery resistance):

Tolerance to leafhopper was estimated by recording number of days required for wilting and death of plant due to leafhopper infestation. A total of 25 numbers of first instar leafhopper nymphs were released on okra genotype and allowed to feed. The day on which the plant wilted and dried completely was recorded in comparison with a resistant and susceptible genotype. In each genotype, four potted plants were used and each plant represents a replicate.

Results and Discussion

Behavioral studies on leafhopper under free choice test against susceptible and resistant genotype revealed that genotype AE 26 was highly preferred when compared to other genotypes. AE 26 genotype was screened as highly susceptible based on field screening and trichome density parameter (Prithiva *et al.,* 2019).

Ovipositional preference study also proved that maximum numbers of eggs were laid in midrib of AE 15 when compared to AE 65. Leafhoppers highly preferred leaf midrib for egg laying than leaf lamina. Eggs were laid singly and at very less distances and are cigar shaped. When eggs are dissected from leaf midrib and seen under image analyzer, blackish coloured eggs were seen with translucent covering over it. This finding was supported by Shinde *et al.* (2014) who had reported that leafhopper in cotton genotypes prefers midrib for oviposition and those genotypes were highly susceptible to leafhopper. Under no choice test (repellency test), 61 % of leafhoppers repelled from AE 65 genotype and less repulsion was seen in AE 26 (28.00%). Antibiosis studies revealed that total nymphal duration and per cent nymph developed were significantly different and nymphal duration was maximum in AE 65 (16.34 days) while per cent nymph developed was maximum in Pusa Sawani (83.33%). These findings were in line with Hussain *et al.* (2014) who reported that genotype Pusa Sawani suffered less antibiosis mechanism with highest mating period (19.67 minutes), increased number of nymphal emergence (19.33 per female), number of nymphs reaching to adult stage (17.67), survival of nymphs (91.36%) and the lowest nymphal period (7.33days). Results from tolerance study showed that AE 64 took 15 days for complete wilting and there is no regain of plant growth. Hence, AE 64 was categorized under highly susceptible which is uncertainity in field studies with high leafhopper population. From the present study, the genotype AE 65 was less preferred for feeding, exhibited increased nymphal duration and development period which proves the presence of antixenosis and antibiosis mechanism of resistance. Hence, genotype with moderate resistance may perform well in field and it can be used as a source of resistance in breeding program of okra against leafhopper.

Reference

Hussain, D., S. Sultana, T. Sultana, F. Jabeen, M. Akhter and A. Ali. 2014. Antibiosis Studies on okra genotypes against *Amrasca biguttula biguttula* (Ishida). ***Journal of Entomology and Zoology Studies,*** 2(4): 78-81.

Prithiva, J.N., N. Ganapathy, N. Muthukrishnan, S. Mohankumar and C.N. Chandrasekhar. 2019. Field evaluation of okra genotypes for resistance against leafhopper, *Amrasca biguttula biguttula* (Ishida) (Homoptera: Cicadellidae). ***Indian Journal of Entomology,*** 81(3): 411-417.

Shinde, B.A., S.S. Gurve., A.D. Gonde and U.B. Hole. 2014. "Studies on resistance of cotton genotypes against jassids (*Amrasca biguttula biguttula* Ishida)." ***Bioinfolet-A Quarterly Journal of Life Sciences,*** 11(3a): 758-762.

Molecular Indexing of Viruses Associated with Mosaic Diseases in Hot Pepper (*Capsicum annuum.* L) in Tamil Nadu

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Keywords: *Severe mosaic, RT- PCR (Reverse Transcription Polymerase Chain Reaction), Cucumovirus, Orthotospovirus and Potyvirus.*

Introduction

Hot pepper (*Capsicum annuum.* L) is the most important commercial spice and vegetable crop over worldwide. Apparently, chilli crop to be infected by more than 45 viruses with 60-100 per cent yield loss. Speculatively, the notorious viruses of Orthotospovirus, Cucumovirus and Potyvirus were prevalently documented on chilli growing regions and pose serious threat to chilli cultivation in India. The common characteristic symptoms of systemic mosaic with fruit lesion and leaf distortion certainly affect the marketable quality and yield of chilli. Cucumovirus is a positive sense, ssRNA virus with tripartite genome under the family, *Bromoviridae*. Orthotospo viruses are isometric, ambi-sense, ssRNA virus with tripartite genome of small (S), medium (M) and large (L) segment under family *Bunyaviridae*. Potyvirus is also a positive sense, ssRNA virus under the family, *Potyviridae*. The molecular indexing of virus concerned with mosaic disease is vital for development of improvised diagnostic measures and to develop management strategies. Hence, the present study envisaged to underpin the viruses associated with occurrence of severe mosaic disease on chilli in Tamil Nadu.

Methodology

A survey was conducted during 2018-2020 in major chilli growing area of Tamil Nadu to assess the prevalence of mosaic disease in chilli. The symptomatic chilli leaves showing prominent mosaic symptoms were collected and sap inoculated on same host plants to maintain virus inoculum under glasshouse condition. The total RNA was isolated from collected plant samples (Chomczynski and Sacchi 2006) and the first stand complementary DNA (cDNA) was synthesized from the extracted RNA. Thus, enabled for RT-PCR with coat protein specific primer of Cucumber mosaic virus (CMV),tospovirus universal primer corresponding to the L segment (RdRp) and potyvirus universl primer specific to NIb and coat protein genes. The positive amplicons were purified with GenJET PCR purification kit (Themo scientific Inc.) and cloned into pGEM-T vector separately and subsequently sequenced at both the orientations. The data base searches performed with NCBI BLAST (http://blast.ncbi.nlm.nih.gov) and the phylogenetic relationships were analyzed using MEGA 7.0 software (www.megasoftware.net) by Neighbor joining tree method with 1000 bootstrap replication (Tamura et al. 2013).

Results and Discussion

The mosaic incidence in chilli observed to be varying from 50 to 60% on surveyed areas in Tamil Nadu depending on the stage of the crop and cropping seasons. The virus symptoms *viz.,* systemic mosaic with filiformity, mosaic mottling, mosaic with necrosis and mosaic with chlorosis were observed and the samples from these plants were collected. The virus isolates collected from different districts of Tamil Nadu were subjected to RT-PCR analysis using specific primers. Amongst, positive amplicons were observed for cucumovirus, tospovrus and potyvirus. The further, sequence analysis explicates that Cucumber mosaic virus (CMV), Capsicum chlorosis virus (CaCV), Groundnut bud necrosis virus and Potato virus Y (PVY) to be associated with mosaic disease.The nucleotide sequences of CMV (MT647887) showed 98% identity with chilli isolate of Karnataka (HM348786); GBNV (MT553997)showed 98.96% of identity with chilli isolate of Trichy(KU941833) and CaCV (MT553996) had an identity of 97.5% at nucleotide level with chilli isolate of Coimbatore (KU941835). Phylogenetic analysis explicates that CaCV and GBNV isolates clustered with other GBNV and CaCV chilli isolates of Tamil Nadu, PVY clustered with other N strains of PVY and correspondingly, CMV isolate clustered with Indian CMV isolates and other members of subgroup IB. Since, symptomology based detection would not be reliable to detect the virus, it has to be validated either by serological or by molecular method of detection. RT-PCR based method will be the reliable to detect the virus and more accurate to detect even at very low titer in the infected leaf samples than serology based assays (Kunkalikar et al. 2010; Katoch et al. 2003).

Reference

Chomczynski P and Sacchi N. (2006). The single-step method of RNA isolation by acid guanidiniumthiocyanate–phenol–chloroform extraction: twenty-something years on. Nature protocols 1(2): 581-585.

Katoch M, Abdin MZ, Ram R and Zaidi AA. (2003). An overview of diagnostics for viruses infecting gladiolus. Crop Protection 22(1): 153-156.

Kunkalikar SR, Sudarsana P, Rajagopalan P, Zehr UB and Ravi KS. (2010). Biological and molecular characterization of *Capsicum chlorosis virus* infecting chilli and tomato in India. Archives of virology 155(7): 1047-1057.

Tamura A, Kato T, Taki A, Sone M, Satoh N, Yamagishi N, Takahashi T, Ryo BS, Natsuaki T and Yoshikawa N. (2013). Preventive and curative effects of Apple latent spherical virus vectors harboring part of the target virus genome against potyvirus and cucumovirus infections. Virology 446(1-2): 314-324.

Molecular Understanding of the Invasive Fall Armyworm, *Spodoptera frugiperda* (J.E. Smith) Feeding on Finger Millet, *Eleusine coracana* (L.) Gaertn.

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Keywords: *Fall armyworm, Finger millet, PCR-RFLP, Phylogenetic analysis.*

Introduction

The fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) is an introduced insect pest, native to the Western hemisphere. In India, its occurrence was first reported in maize fields at Shivamogga, Karnataka, India during 2018 (Sharanabasappa *et al*., 2018). Thereafter the pest has spread to all agro-climatic zones of the nation. The pest has a broad host range of more than 350 plant species. Genetically, FAW consists of two races, one is the corn strain designated as 'C' strain mainly feeds on maize, sorghum, cotton, pulses *etc*. and another is the rice 'R' strain prefers rice crop and other grasses (Nagoshi *et al*., 2006). Genetic diversity analysis revealed that, FAW population occur in India belongs to 'R' strain identity based on the polymorphic sites present in the *Cytochrome oxidase subunit I (COI)* gene. PCR-RFLP analysis helps in differentiating the strains in FAW. In India, FAW infestation is being noticed in various hosts though maize is the preferred host. Hence, it is essential to study the genetic variation present in FAW. The present study was aimed to genetically characterize the FAW feeding on finger millet.

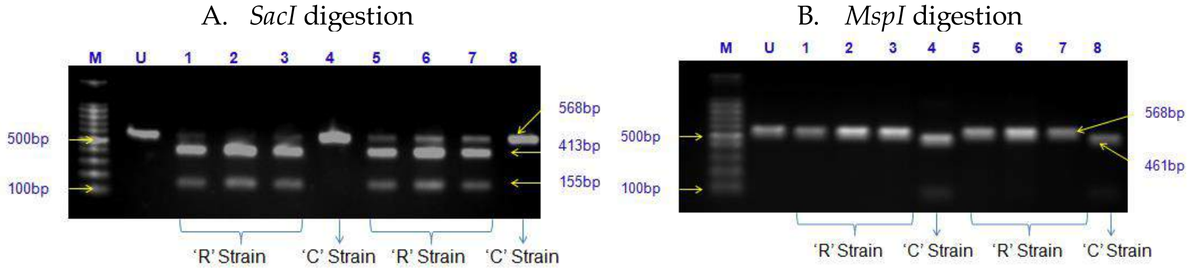
Methodology

Survey was done to collect FAW larvae from the finger millet crop under three different locations of Tamil Nadu *viz*. Morappur (Dharmapuri district), Sandhiyur (Salem district) and Vridhachalam (Cuddalore district) of Tamil Nadu, India. The molecular study was carried out at the Department of Plant Biotechnology, Centre for Plant Molecular Biology and Biotechnology, TNAU, Coimbatore, India. DNA isolation from FAW larvae was done using CTAB method. Primer pairs, JM 76F (5'GAGCTGAATTAGG(G/A)ACTCCAGG3') and JM 77R (5'ATCACCTCC(A/T)CCTGCAGGATC3') were used to amplify the fragment (568bp) of mitochondrial COI using Eppendorf thermocycler with ambient thermo-cycling profile at 94^{o}C (1 min) followed by 33 cycles of 92^{o}C (45 s), 56^{o}C (45 s), 72^{o}C (1 min) and a final segment of 72^{o}C for 3 min. PCR-RFLP analysis was done with *SacI* and *MspI* restriction enzymes to differentiate R and C strain. Phylogenetic tree was constructed employing Mega 7 software using Clustalw.

Results and Discussion

PCR-RFLP analysis of mitochondrial COI fragment revealed the presence of both 'C' and 'R' strains of fall armyworm collected from finger millet (Fig. 1). The uncut fragment was 568bp. Out of eight samples analyzed, two samples possessed 'C' strain identity and six showed 'R' strain identity. The occurrence of FAW in finger millet was first noticed with 26.22 to 46.82 per cent infestations in Gujarat, India during September, 2020 (Damasia *et al*., 2020). Swamy *et al*. (2018) observed the prevalence of 'R' strain in FAW collected from maize, sweet corn and sorghum in India with nucleotide variations in four positions. In our finger millet isolate (Ac. No. MT215031), three nucleotide variations were observed at 18th, 159th and 501st positions in which, the bases A, T and T were replaced by G, C and C respectively.

Based on the nucleotide sequence analysis, FAW collected from finger millet at Morappur exhibited 99.40 per cent identity with S. frugiperda in sugarcane from Coimbatore, maize in Shivamogga, and maize from Chikballapur shared 99 to 99.40 per cent identity with previously deposited sequences of FAW in the NCBI gene bank database. The phylogenetic analysis clearly showed that our sequence was diverged from other sequences of S. frugiperda from different host plants as well as different parts of the country. The sugarcane FAW mtCOI partial sequence showed 99 per cent identity with the U72974, U72975 and U72976 were designated corn strain (Chormule et al., 2019). The molecular characterization revealed strain identity and divergence pattern of the FAW feeding on finger millet. We found both 'R' and 'C' strains in the FAW occurring in finger millet crop. Intensive study on FAW occurrence in different host plants could provide enough information on host preference, migration, incidence *etc.* and for efficient management of this pest.



Lane M – Ladder (100bp); Lane U – Undigested PCR product; Lane 1 – Morappur, Dharmapuri; Lanes 2-3 – Sandhiyur, Salem; Lanes 4-8 – Vridhachalam, Cuddalore

Fig. 1. Agarose gels displaying strain specific RFLPs from the *mitochondrial COI* gene.
(A) *SacI* digestion denotes 'R' Strain identity (413bp and 155bp fragments) and the uncut fragment denotes 'C' Strain identity (B) *MspI* digestion denotes 'C' Strain identity (461bp and 107bp fragments) and the uncut fragment denotes 'C' Strain identity

References

Nagoshi, R.N., Meagher, R.L., Adamczyk, J.J., Braman, S.K., Brandenburg, R.L., Nuessly, G. (2006). New restriction fragment length polymorphisms in the *Cytochrome oxidase I* gene facilitate host strain identification of fall armyworm (Lepidoptera: Noctuidae) populations in the southeastern United States. *Journal of Economic Entomology*, 99(3):671-677.

Sharanabasappa, Kalleshwaraswamy, C.M., Asokan, R., Swamy, M.H.M., Maruthi, M.S., Pavithra, H.B., Hedge, K., Navi, S., Prabhu, S.T., Goergen, G. (2018). First report of the fall armyworm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera, Noctuidae, an invasive pest on maize in India. *Pest Management in Horticultural Ecosystems*, 24(1): 23-29.

Swamy, M.H.M., Asokan, R., Kalleshwaraswamy, C.M., Sharanabasappa, Prasad, Y.G., Maruthi, M.S. (2018). Prevalence of "R" strain and molecular diversity of fall armyworm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) in India. *Indian Journal of Entomology*, 80 (3): 544-553.

Morphological Characterization of Genus *Conocephalus* Thunberg, 1815 (Orthoptera: Tettigoniidae: Conocephalinae) in Rice

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Keywords: *Morphological characterization, Conocephalus, Rice.*

Introduction

Genus *Conocephalus* (Orthoptera: Tettigoniidae: Conocephalinae) was erected by Thunberg in 1815 with *Gryllus (Tettigonia) conocephalus* L., as type species along with description of 24 species. Genus *Conocephalus* is the largest in the tribe Conocephaliini and cosmopolitan in distribution. Presently, the genus constitutes about 9 subgenera and 151 species worldwide (Cigliano *et al.*, 2018). Remarkable taxonomic works on *Conocephalus* include: Harz (1969), Hudson (1972) and Pitkin (1980) revised the genus *Conocephalus* from New Caledonia, New Zealand and Pacific species respectively. Zhou et al., (2010) revised the genus *Conocephalus* from China and Storozhenko et al., (2015) studied Korean Orthoptera (including *Conocephalus*). Xia and Liu (1992), Gorochov (2009) and Shi and Wang (2015) identified some new species belonging to this genus. Ten species of *Conocephalus* are recorded in India (Shishodia *et al.*, 2010; Nagar and Swaminathan, 2016; Farooki and Usmani 2018). Study of these predatory Conocephalinae remains to be studied in rice fields of Tamil Nadu. Hence, this study was taken on the *Conocephalus* species complex in rice.

Methodology

Insects were collected from rice fields in Wetlands of Tamil Nadu Agricultural University, Coimbatore and Bhavanisagar Research Station, Erode, India between 6.00 and 8.00 hours with sweep nets. Collected specimens were killed with 99.8% chloroform and dried specimens were pinned, labeled and deposited in Tamil Nadu Agricultural University Insect Museum. Characters of taxonomic significance of dried specimens were observed under stereo zoom microscope (Leica M205C). Morphological description follows Pitkin (1980) and Farooki and Usmani (2018). Digital photographs and morphological measurements were taken with LAS X Application Suite montage software.

Results and Discussion

Three species belonging to genus *Conocephalus* namely *Conocephalus (Anisoptera) longipennis* (Haan, 1843), *C. (Anisoptera) maculatus* (Le Guillou, 1841) and *C. (Anisoptera) rentzi* were collected from rice fields of Coimbatore and Bhavanisagar districts of Tamil Nadu. Adults of the three listed species are re-described.

Genus *Conocephalus* Thunberg, 1815

Conocephalus Thunberg, 1815. *Mem. Acad. Imp. Sci. St. Peterburg*. 5: 214, 271.

Diagnosis: Body small to medium in size and fragile. Antenna filiform and long (2 times longer than body length or more). Vertex nearly flat with rounded apex; fastigium broad and obtuse. Lateral lobes of pronotum appear slanted; secondary tympanum present. Prosternum bispinose. Forewings parchment-like and shorter than hind wings. Femur of all pairs lack dorsal spines. Male cerci in variable forms, either with a tubercle just above an internal tooth or only with an internal tooth. Ovipositor sword-shaped for piercing the plant tissue while laying eggs.

Key to the species of *Conocephalus* in Rice

1. Hind femur armed with spines on ventral side………………..........................

……………………………………………Conocephalus (Anisoptera) longipennis (Haan, 1843)

Hind femur not armed with spines on ventral side………... 2

2. Median carina of male sub-genital plate indistinct; Stridulatory file of ventral left tegmen with 50 teeth……………………………..…….. *C. (Anisoptera) maculatus* (Le Guillou, 1841)

Median carina male sub-genital plate distinct; Stridulatory file of ventral left tegmen with 44 teeth………………………………….. *C. (Anisoptera) rentzi* (Farooki and Usmani, 2018)

***Conocephalus (Anisoptera) longipennis* (Haan, 1843)** (Fig. 1)

Redescription. Male: Hind wings when relaxed, reach mid hind tibia. Left ventral tegmen with 65 teeth on stridulatory file. Hind genicular lobes with single spine on inner side. Mid tibia with 29-30 inner spines and 33-34 outer spines. Hind tibia with 6 six inner spines and 7 outer spines.

***C. (Anisoptera) rentzi* (Farooki and Usmani, 2018)** (Fig. 3)

Redescription. Male: Pronotum with rounded posterior margin. Outer meta genicular lobes bispinose; number of spines less in number on both sides of dorsal margin on hind tibia. Left ventral tegmen with 44 teeth on stridulatory file. Cerci broad with narrow apex. Female: Sub-genital plate triangularly excised apically.

***C. (Anisoptera) maculatus* (Le Guillou, 1841)** (Fig. 2)

Redescription. Male: Hind wings not reach mid hind tibia when relaxed. Left ventral tegmen with 50m teeth on stridulatory file. Hind genicular lobes with two spine on inner side. Mid tibia with 38 inner spines and 32 outer spines. Hind tibia with 7 six inner spines and 11 outer spines.

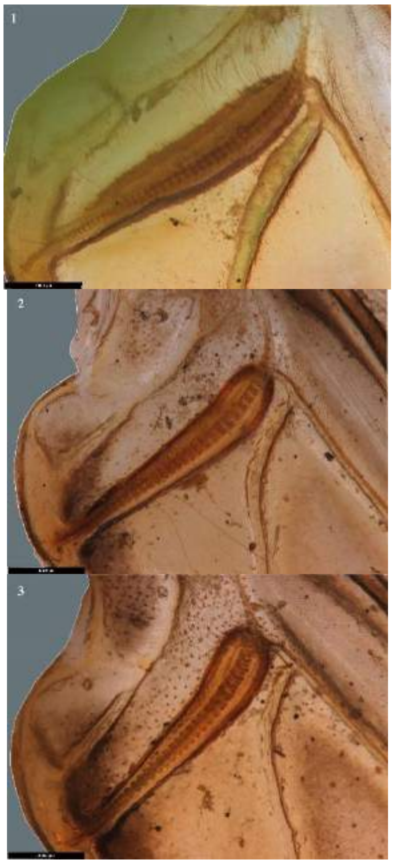

Fig. (1-3). Stridulatory file. 1, *C. longipennis* (Haan, 1843); 2, *C. rentzi* (Farooki and Usmani, 2018); 3, *C. maculatus* (Le Guillou, 1841)

Reference

Farooki, M. K. and Usmani, M. K. (2018). Review of genus *Conocephalus* Thunberg, 1815 (Orthoptera: Tettigoniidae: Conocephalinae) with one new species from India. *Zootaxa*. **4461**(3): 381-393.

Pitkin, M. L. (1980). A revision of the Pacific species of *Conocephalus* Thunberg (Orthoptera: Tettigoniidae). *Bulletin of the British Museum (Natural History) Entomology*. **41**(5): 315-355.

Morphology and Distribution of Antennal Sensillae of Both the Sexes of *Spodoptera frugiperda* (Smith) (Lepidoptera: Noctuidae)

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Keywords: *Spodoptera frugiperda, Antennal morphology, Sensillae distribution.*

Introduction

Fall Armyworm, *Spodoptera frugiperda* (J E Smith) (Lepidoptera: Noctuidae) is an invasive pest introduced to India in 2018. It is a serious pest of maize and is also reported to damage more than 100 hosts in its place of origin, i.e. the tropical and subtropical region of America. With the reports of R-strain and M-strain in the populations of fall armyworm (Unbehendit *et al*., 2014) and failure of readily available management practices, it is important to develop accurate and precise formulation of pheromone lure in combination with the plant volatiles for fall armyworm under Indian conditions. Study of antennal morphology and sensillae distribution on antennae of *S. frugiperda* is the fundamental aspect to understand the type of sensillae and their role in perception of pheromone and plant volatiles.

Methodology

Insects

Spodoptera frugiperda egg masses were collected from different maize growing research plots at TNAU campus, Coimbatore and upon hatching the larvae were reared in TNAU lablab based artificial diet. After pupation the pupae were separated and kept in a cage containing sugar solution and *Nerium oleander* twigs as ovipositional site. The freshly emerged male and female moths were used for studying the antennal morphology by using Scanning Electron Microscopy (SEM).

Scanning Electron Microscopy

Male and female antennae of 5 adults each were separately soaked in 2% formaldehyde and 70% ethanol solution for 24 hours (Malo *et al*., 2004). The scales were removed by ultrasonication with a Labman Scientific Instruments ultrasonic cleaner (LMUC-6) at 40 ± 3 kHz ultrasonic frequency and 150 W ultrasonic wattage for 50 minutes. Further the antennae were dehydrated in 80%, 90% and 100% ethanol solution for 1 hour each (Malo *et al*., 2004). Then they were critical point dried, gold coated (30nm), examined and images were taken using Scanning Electron Microscope model, Quanta 250 manufactured by FEI, Czech Republic with tungsten electron source and Everhart Thornley detector to study the sessilla characters. The observations such as average length, basal diameter of antennae and number of antennal segments of each sex were counted. Different types of sensillae were separately identified and measurements were taken for each sex.

Results and Discussion

Male antenna is longer than female antenna in *S. frugiperda* (**Table 1**). Different types of sensilla observed in male and female *S. frugiperda* are sensillum trichoideum, sensillum chaetica, sensillum coeloconica, sensillum styloconica, sensillum squamiformia, sensillum auricillica and Bohm's bristles (**Table 2**). Sensillum trichoideum is noticed in maximum number and is abundant in males than in females (**Table 3**)

Table 1. Antennal length, basal diameter and number of antennal segments (Mean ± SE) of *Spodoptera frugiperda.*

Observations	Male	Female
Length of the antennae (mm)	8.98 ± 0.03[a]	8.76 ± 0.03[b]
Number of subsegments	67 ± 0.52[a]	66.1 ± 0.43[a]
Length of scape (µm)	281.69 ± 0.41[a]	276.54 ± 0.49[b]
Basal diameter of scape(µm)	202.17 ± 0.41[a]	197.56 ± 0.15[b]
Length of pedicel(µm)	151.98 ± 0.26[a]	147 ± 0.22[b]
Basal diameter of pedicel(µm)	163.46 ± 0.16[a]	152.02 ± 0.09[b]

Unpaired t-test, P<0.05, N=10 (from both antenna of 5 individuals of each sex), values comparing male and female within a row followed by the same letter are not significantly different.

Table 2. Dimensions of the sensilla (µm) on the antennae (Mean ± SE) of *Spodoptera frugiperda*.

Type of sensilla	Male		Female	
	Length	Basal diameter	Length	Basal diameter
Trichoidea	34.68±0.16[a]	2.26±0.06[a]	32.43±0.17[b]	2.15±0.03[b]
Central chaetica	41.22±0.24[a]	5.16±0.02[a]	38.28±0.16[b]	4.53±0.02[b]
Lateral chaetica	67.51±0.22[a]	5.75±0.02[a]	56.17±0.19[b]	4.69±0.02[b]
Dorsal chaetica	46.48±0.24[a]	3.70±0.01[a]	45.69±0.16[b]	3.79±0.02[a]
Styloconica	27.58±0.10[a]	6.11±0.01[a]	25.41±0.12[b]	6.34±0.02[b]
Coeloconica	-	9.21±0.02[a]	-	9.71±0.01[b]

Unpaired t-test, P<0.05, N=10 (from both antenna of 5 individuals of each sex), values comparing male and female within a row followed by the same letter are not significantly different.

Table 3. Mean number of sensilla of male and female *Spodoptera frugiperda* ±SE

Type of sensilla	Number of sensilla	
	Male	Female
Trichoidea	3638.5±30.98[a]	2734.2±24.03[b]
Chaetica (three subtypes)	404.4±2.45[a]	398.6±1.33[b]
Styloconica	60.1±0.9[a]	59.1±0.95[a]
Coeloconica	405.3±1.41[a]	400±1.25[b]

Unpaired t-test, P<0.05, N=10 (from both antenna of 5 individuals of each sex), values comparing male and female within a row followed by the same letter are not significantly different.

Reference

Ljungberg, H., Anderson, P. and Hansson, B.S., 1993. Physiology and morphology of pheromone-specific sensilla on the antennae of male and female *Spodoptera littoralis* (Lepidoptera: Noctuidae). Journal of insect physiology, 39(3), pp.253-260.

Malo, E.A., Castrejón-Gómez, V.R., Cruz-López, L. and Rojas, J.C., 2004. Antennal sensilla and electrophysiological response of male and female *Spodoptera frugiperda* (Lepidoptera: Noctuidae) to conspecific sex pheromone and plant odors. Annals of the Entomological Society of America, 97(6), pp.1273-1284.

Seada, M.A., 2015. Antennal morphology and sensillum distribution of female cotton leafworm *Spodoptera littoralis* (Lepidoptera: Noctuidae). The Journal of Basic & Applied Zoology, 68, pp.10-18.

Nutritional Composition of Castor Genotypes and its Influence on Growth Attributes of Eri Silkworm (*Philosamia ricini*)

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Keywords: *Eri silkworm, Castor genotypes, Nutritional composition, Growth parameters*

Introduction

Eri silkworm (*Philosamia ricini*) is exclusive privilege and agro based small scale industry of North Eastern States of India. As an additional income generating avocation which has recently spread over to some non-traditional states of India like Tamil Nadu, Andhra Pradesh and Karnataka. Eri silkworm is a multivoltine and polyphagous feeds on wide range of food plants. However, Castor is considered as the primary food plant which is rich in varietal composition and many local and high yielding varieties/genotypes are widely grown in Tamil Nadu and rest of India. Nutritional parameters of leaves are well thought-out as a foremost factor in the survival of non-mulberry silkworms (Pandey, 1995). Better the quality of leaves, greater would be the chances of getting the good cocoon harvest. In connection to the above line, the present investigation was carried out to evaluate the nutritional composition of genotypes and its influence on growth attributes on eri silkworm in non-traditional area of Tamil Nadu.

Methodology

The present investigation deals with studying the leaf nutritional composition of different castor genotypes and its influence on growth performance of eri silkworm. The experiment was carried out under laboratory conditions with three brushing in Completely Randomized Design (CRD) with three replications. Different castor genotypes, *viz*., GCH 4, GCH 7, DCH 519 and TMV 5 along with local variety were selected for the studies which were procured from Tapioca and Castor Research station, Yethapur, Salem. Leaf samples at three different positions were collected at 90 days after sowing from all genotypes, shade dried for 3 days and then dried in hot air oven at 70°C until constant weight was obtained. The dried leaf samples were ground into fine powder and preserved in butter paper bags for nutritional analysis. The leaf nutritional parameters such as Nitrogen, Phosphorous, Potassium, Calcium, Magnesium and Sulphur using the standard procedures (Jackson (1973). Disease free layings (Dfls) of commercial breed of eri silkworm were obtained from Central Sericulture Germplasm and Research Institute, Hosur and reared following the standard rearing method (Dayashankar, 1982) by feeding different castor genotypes and the following growth attributes viz., larval weight, Cocoon weight, pupal weight, shell weight, shell ratio, ERR and Hatching % were observed.

Results and Discussion

Nutritional composition of castor genotypes

The nutritional composition revealed that there was a notable difference recorded among the castor genotypes with a higher level in GCH 4. The genotypes DCH 519 and Local variety were next in order. TMV 5 registered with a lower nutritional level and on par with GCH 7. (Fig.1). Similarly, Chandrappa *et al.* (2006) noticed variations in the nutritional status of leaves among different castor genotypes and this could be attributable for the inherent characteristic feature of castor cultivars.

Growth attributes of eri silkworm

The growth response of eri silkworm fed with castor genotypes showed significant variation. Among the five castor genotypes, the silkworm fed with GCH 4 showed better growth and rearing performance followed by DCH 519 and local variety and least was observed in TMV 5 genotype (Table 1). The present study strengthen with the findings of Mandali and Narayanamma (2015) that the genotypes vary in the composition of foliar nutrients, which in turn contribute for differences in larval and cocoon parameters of eri silkworm fed with various castor genotypes.

Table 1. Growth attributes of Eri silkworm fed with castor genotypes

Castor genotypes	Hatching (%)	Larval weight (g)	Cocoon weight (g)	Pupal weight (g)	Shell weight (g)	Shell ratio (%)	ERR (%)
GCH 4	98.55	9.61	3.79	3.23	0.56	14.77	91.57
GCH 7	97.06	9.46	3.56	3.10	0.46	12.92	89.47
TMV 5	96.89	9.38	3.48	3.15	0.43	12.01	88.65
DCH 519	98.23	9.55	3.70	3.17	0.53	14.32	90.72
Local variety	97.37	9.50	3.63	3.18	0.50	13.58	90.42
SEd	3.122	0.061	0.115	0.089	0.020	0.455	3.032
CD (0.05%)	6.245	0.124	0.246	0.178	0.041	0.965	6.071

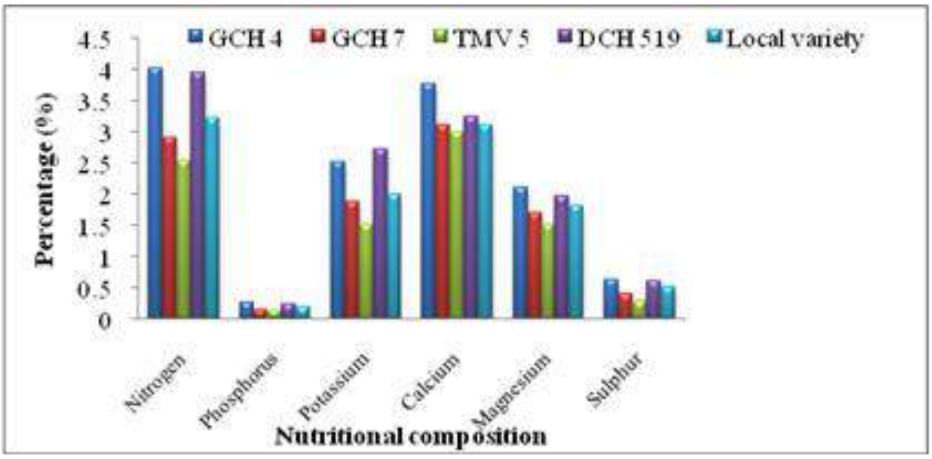

Fig.1 Nutritional composition of castor genotypes

In respect to nutritional composition and growth attributes of eri silkworm, genotype GCH 4 was the most promising followed by DCH 519 genotype.

Reference

Chandrappa, D., R. Govindan, and B. Sannappa. 2006. "Nutrient status of leaves of some castor genotypes in Eastern dry zone of Karnataka."*Int. J. Agric. Sci.*,2:225-227.

Dayashankar, K. N. 1982. "Performance of eri silkworm, *Samia cynthia ricini* Boisduval on different host plants and economics of rearing on castor under Dharwad conditions." *M. Sc.(Agri.) Thesis*. p.86.

Jackson, M. L. 1973. "Soil chemical analysis prentice Hall."*Inc., Englewood Cliffs*, pp.498.

Pandey, R. K. 2003. "Ericulture in Uttar Pradesh."*Indian silk*.**41**(12):21-24.

Mandali, R. and V. L. Narayanamma. 2015. "Eri silkworm rearing on different castor genotypes and their economic analysis."*The Bioscan*.**10**(2):567-571.

Olfactory Response of Legume Pod Borer, *Maruca vitrata* Moths (Lepidoptera, Crambidae) to Volatiles from Different Plant Parts of Dolichos Bean (*Lablab purpureus* var. *typicus*)

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Keywords: *Olfactory response, Maruca vitrata, Dolichos bean, plant parts volatile.*

Introduction

Dolichos bean or Lablab (*Lablab purpureus var. typicus*) is an important food legume and is cultivated throughout the tropics. It is being cultivated in all parts of our country especially in Tamil Nadu, Andhra Pradesh, Karnataka, Madhya Pradesh and Maharashtra (Pengelly, B. C. and Maass, B. L. 2001). Even though, it is affected by many pests and diseases, the Legume pod borer, *Maruca vitrata* (Lepidoptera: Crambidae) is a serious yield constraint on major food legumes globally including Dolichos bean. The damage potential, abundance, sex pheromone communication and behavioural bioassay responses of *M. vitrata* to host plant volatiles of pigeon pea and cowpea has been studied extensively so far. Hence, this study has been formulated to understand the olfactory response of *M. vitrata* adults in response to an important proteinaceous vegetable Dolichos beans plant infochemicals.

Methodology

Dolichos bean (*Lablab purpureus* var. *typicus*) [Variety: Co (GB)14] healthy and *M. vitrata* larva infested flower buds and pods at pod filling stage (matured pods) were collected separately from the Orchard farm, TNAU, Coimbatore. These collected plant parts were used for studying the olfactory response of adult female *M. vitrata* moths. The volatile/ odour source combinations were between; flower buds alone, pods alone, both flower buds and pods and whole plant were preliminary tested against the olfactory response of adult female *M. vitrata* moths. The response of three days old gravid females of *M. vitrata* were tested towards the ovipositional preference on Dolichos bean healthy and infested flower buds and pods was studied in two-choice tests with a closed system Y-tube olfactometer. Purified air through an active charcoal filter was pumped through teflon tubing and humidified through a glass jar containing distilled water. An air pump was used to provide an airflow with an approximate wind speed in the olfactometer of 1.5 L/min. Each gravid *M. vitrata* females (30 No's) was transferred individually to the Y-tube, and the behaviour of each individual was observed for 5 min as soon as it started moving. The positions of the odour sources were exchanged once after testing five moths to avoid prejudgment by accidental asymmetry in the experimental setup. Each odour source was renewed after one hour. After testing each combination of odour sources, the olfactometer was cleaned with 75% ethanol followed by distilled water and then dried to avoid the odour contamination. All tests were carried out at the same laboratories condition as insect rearing. Differences in the percentage of attraction to different plants were tested using analysis of variance (ANOVA) (SPSS). Percentage of *M. vitrata* female moths responding to plant volatiles were compared pairwise among experimental treatments using a Chi-square test.

Results and Discussion

The results confirmed that the gravid females significantly preferred unopened flower buds. From the tested odour source combinations in Y-tube olfactometer, 83.33 % of gravid females prefers the volatiles emanated from the flower buds (T1: χ^2=13.33; p=0.000). The next level of preference is to the odour combinations between healthy flower buds and healthy pods (T7: χ^2=8.53; p=0.003), with the percentage of moth response of 76.67% and 23.33% respectively. Meanwhile, the fewest response was noticed to the healthy plant with 33.33% in combination with the infested plant volatiles of 66.67%. This shows that the adults respond better to the host induced plant volatiles. Similar findings by Hussain *et. al.*, (2020) confirmed that, HIPVs emitted from *B. vulgaris* affect the behaviour of adult diamondback moth *Plutella xylostella* females oviposition. From the results incurred, it is evident that the *M. vitrata* females prefers the healthy unopened Dolichos bean flower buds. Further, the responsive floral volatile compounds in GC-EAD (Gas Chromatography - Electroantennogram Detector) can be blended with the sex pheromone for effective management of the pest.

Table 1. Y-tube olfactometer response of *Maruca vitrata* adults to volatiles from different plant parts of Dolichos bean

Treatments		*Percentage of ♀ moths response ± SE (for respective combinations)		**Chi square value (χ^2 test)	P value
T1	Clean air vs Healthy flower buds	16.67	83.33	13.33[a]	0.000
T2	Clean air vs infested flower buds	43.33	56.67	0.53[h]	0.465
T3	Healthy flower buds vs infested flower buds	70.00	30.00	4.80[d]	0.028
T4	Clean air vs Healthy pods	46.67	53.33	0.13[i]	0.715
T5	Clean air vs infested pods	60.00	40.00	1.20[g]	0.273
T6	Healthy pods vs infested pods	63.33	36.67	2.13[f]	0.144
T7	Healthy flower buds vs Healthy pods	76.67	23.33	8.53[b]	0.003
T8	Healthy flower buds vs infested pods	73.33	26.67	6.53[c]	0.011
T9	Infested flower buds vs healthy pods	43.33	56.67	0.53[h]	0.465
T10	Infested pods vs infested flower buds	46.67	53.33	0.13[i]	0.715
T11	Healthy plant vs infested plant	33.33	66.67	3.33[e]	0.068

*Each value is the response/replication of 30 moths
In a column, Chi square values sharing similar letters do not differ significantly (Chi square test, α = 0.05).

Reference

Jalali, M.A., Gharaei, A.M., Ziaaddini, M., Jalali, M. and Frerot, B., 2019. Oviposition preference and olfactory response of *Diaphania indica* (Lepidoptera: Pyralidae) to volatiles of uninfested and infested cucurbitaceous host plants. ***European Journal of Entomology***, 116, pp.392-401.

Pengelly, B.C. and Maass, B.L., 2001. *Lablab purpureus* (L.) *Sweet*–diversity, potential use and determination of a core collection of this multi-purpose tropical legume. ***Genetic Resources and Crop Evolution***, 48(3), pp.261-272.

Hussain, M., Gao, J., Bano, S., Wang, L., Lin, Y., Arthurs, S., Qasim, M. and Mao, R., 2020. Diamondback moth larvae trigger host plant volatiles that lure its adult females for oviposition. Insects, 11(11), p.725.

Olfactory Studies and Volatile Profiles of Food Baits on Female Melon Fruit Fly, *Zeugodacus cucurbitae* (coquillet) (Diptera: Tephritidae) in Gourds Ecosystem

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Keywords: *Fruit fly, Food bait, Volatile collection, Air entrainment, olfactometer*

Introduction

The melon fruit fly, *Zeugodacus cucurbitae* (Coquillett), (Diptera: Tephritidae) , a major pest of vegetable crops is ranked among world's most serious pest of horticultural crops (Gopaul *et al*., 2000). Economic damage caused by this pest varies from 30 to 100 % in cucurbits depending on its species (Dhillon *et al*., 2005). Eggs are laid inside the fruit and maggots grow inside the fruit. This concealed behaviour of fruit flies is formidable to manage through insecticidal management. As male focused traps are widely disseminated in the market, this study aims in the attraction of female melon fruit flies using food baits. For more insight into it, this study deals with the olfactory responses of the female melon fruit flies through olfactometer experiments and compounds responsible for provoking the olfactory response through GC-MS analysis.

Methodology

Insects:

Infested fruits (Bitter gourd, Snake gourd, Bottle gourd and Ridge gourd) were collected from fields in and around Tamil Nadu Agricultural University, Coimbatore. Collected fruits were placed inside the polyester netted cages for adult emergence. After emergence, adults were fed in Petri dishes comprising cotton balls steeped in sugar: yeast solution in the ratio of 3:1. Fruits were kept inside the cages for oviposition of the flies. These flies oviposited on fruits kept inside the cages. Subsequent generations of emergence were maintained. Female fruit flies were used in all the experiments conducted thereafter.

Olfactometer study:

Choice experiment studies were carried out with Y- tube olfactometer of borosilicate glass. Female flies were pre-starved for about 6 hours prior to experiment. Choices between control and food baits followed by the choices among the selected three food baits were tested. Individual flies were allowed to enter through the common arm and odour sources (bait material – 10ml) were placed in the upstream arms. For each experiment 30 fruit flies were used.

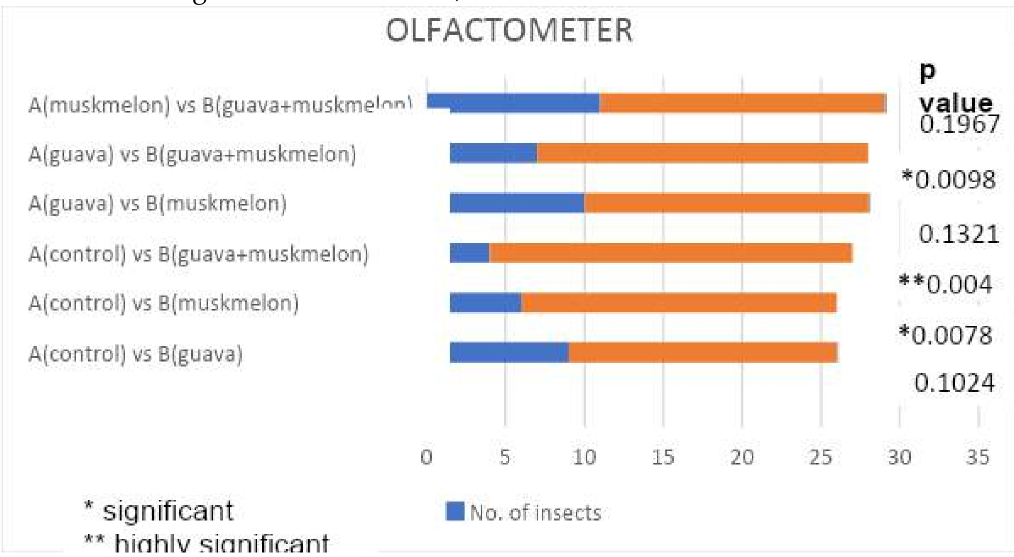
GC-MS analysis:

Air entrainment method was employed to collect volatiles from the food bait samples. Collected volatiles were analysed and quantified with the mass selective detector (Shimadzu GC-MS Ultra QP 2010). Two microlitres of the eluent (food bait VOCs extracts) were injected into the GC inlet port through an autosampler. The GC column was a Rxi®-5MS fused silica capillary. The VOCs from food baits were identified based on their retention time and compared with mass spectral fragmentation patterns stored on the MS library [NIST 2020 database].

Results and Discussion

Results revealed that B3 [Guava (20g) + Muskmelon (20g) + Cane Sugar (4g) + Yeast (0.4g) + Food Grade Alcohol (10ml)] had shown highly significant attraction ($p = 0.000445$) followed by B2 [Muskmelon (40g) + Cane Sugar (4g) + Yeast (0.4g) + Food Grade Alcohol (10ml)] ($p = 0.007853$) when tested against control (clean air). When the choices were given among the food baits in both the arms, B3 (Guava + Muskmelon bait admixture) has shown highly significant attraction (p= 0.009823) compared to Guava (Graph.1).

Results obtained through GC-MS revealed that compounds such as 2-Octenal, methyl anthranilate and benzyl acetate were predominant in all the three food baits. Through Principal Compound Analysis, methyl anthranilate of guava bait admixture, 2-octenal and benzyl acetate of musk melon bait admixture and compound α- methyl linolenate, 9-(Z)- tricosene of guava + muskmelon bait admixture recorded greater variation influencing the attraction of *Z. cucurbitae* compared to other volatile compounds recorded.



Graph1. Olfactometer bioassay

P value < 0.05 are significant (*), p value < 0.005 are highly significant (**) at 0.05 probability level of chi-square test

Reference

Abinaya, S., T. Elaiyabharathi, T. Srinivasan, and M. Paramasivam. 2020. "Field evaluation of food baits against female melon fruit fly, Zeugodacus cucurbitae (Coquillett)(Diptera: Tephritidae)." *Journal of Entomology and Zoology studies* 8 (6):895-899.

Biasazin, T.D., H.T. Chernet, S.L. Herrera, M. Bengtsson, M.F. Karlsson, J.K. Lemmen-Lechelt, and T. Dekker. 2018. "Detection of volatile constituents from food lures by tephritid fruit flies." *Insects* 9 (3):119.

Siderhurst, M.S., and E.B. Jang. 2010. "Cucumber volatile blend attractive to female melon fly, *Bactrocera cucurbitae* (Coquillett)." *Journal of chemical ecology* 36 (7):699-708.

Parasitic potential of *Telenomus remus* Nixon (Hymenoptera: Scelionidae) on *Spodoptera frugiperda* (Smith) (Lepidoptera: Noctuidae) in Maize

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Keywords: *T. remus, parasitic potential, parasitoid: host ratio*

Introduction

The fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) is one of the alien pests reported for the first time in India by Sharanabasappa *et al*. (2018). Biological control based on natural enemies is one of the most important control measures providing environmentally safe and sustainable plant protection. Among the biocontrol agents, *Telenomus remus* Nixon is a promising egg parasitoid for augmentative biological control of FAW in maize, since it can effectively parasitize the inner layers of its host's egg masses. However, adoption of *T. remus* for FAW control has remained low owing to the lack of knowledge on parasitoid: host density and its performance under field conditions. With this lead, the present study was carried out both under laboratory and pot culture condition.

Methodology

Experiment was conducted to determine the parasitic potential of *T. remus* at different parasitoid: host ratios (1:10, 1:20, 1:30, 1:40, 1:50) under laboratory and 15 days old pot cultured maize seedling. raised in plastic pots (15 cm X 8 cm). For laboratory studies, freshly laid egg masses were glued to paper strips (2 cm X 5 cm) kept in a plastic container (18 cm X 7 cm) and were subjected to parasitization by mated females of *T. remus*. For pot culture, after 15 days of sowing, mated females of FAW were left to lay eggs individually in each seedling covered with mylar film cages. After 24 hours of egg laying, the moths were removed from the cages and the number of eggs in each egg masses were counted using a 10 X hand lens and subjected to parasitization by mated females of *T. remus*. Besides, parasitic potential *T. remus* on the alternate host insect, *S. litura* eggs in comparison with the *S. frugiperda* eggs, efficacy of parasitoid progenies from *S. litura* eggs against FAW at 1:40 ratio, influence of maize plant age (15, 25, 35 and 45 DAS) on the parasitic potential of *T. remus* and relative safety of insecticides / botanicals recommended for the management of FAW against *T. remus* was also studied at 1:20 ratio based on previous experimental results.

Results and Discussion

Laboratory experiment on the parasitic potential study indicated the highest parasitization at the parasitoid: host ratio of 1:10 with 99.50 per cent parasitization followed by 1:20 (98.50 %), 1:30 (97.20 %), 1:40 (98.20 %) 1:50 (96.00 %). However, parasitoid adult emergence was found to be the highest at the ratio 1:40 (97.0 %) and was found to be lowest at the ratio of 1:10 (51.1%). In pot culture experiment, parasitization (97.60 %) and parasitoid emergence (94.50 %) were found to be maximum at the ratio of 1:20 (Table 1). Experiment on the parasitic potential on *S. litura*, revealed highest parasitization and parasitoid adult emergence by *T. remus* on *S. frugiperda* (98.20 and 97.42 %) followed by *S. litura* (93.70 and 92.58%) (Fig. 1) and similar results as that of previous experiment was also obtained with their progenies (Fig. 2). Effect of plant age on the efficacy of *T. remus* revealed highest parasitization (95.3 %) and parasitoid emergence (91.4%) on FAW egg masses laid on 15 DAS followed by 25 DAS (91.6 and 82.0 %, respectively) (Table 2). Assessment of relative safety of insecticides / botanicals recommended for the management of FAW against *T. remus* under pot culture experiment revealed maximum parasitization and parasitoid emergence (97.0 and 90.1 %) in egg masses treated with chlorantraniliprole followed by Azadirachtin (95.9 and 88.0 %), Emamectin benzoate (45.9 and 24.0 %), Flubendiamide (33.2 and 15.9 %) and Spinetorum (27.1 and 9.0 %). Our results suggest that the *T. remus* is having enormous potential against FAW eggs both under laboratory and pot culture conditions. Further confirmation under field condition will pave way for the effective deployment of the parasitoid, *T. remus* for the management of FAW.

Table 1. Parasitic potential of *T. remus* on FAW eggs at laboratory and pot culture condition

Parasitoid : Host ratio	Egg mass glued to paper strips		Egg mass on maize seedlings (15 DAS)	
	Parasitization (%)	Parasitoid Emergence (%)	Parasitization (%)	Parasitoid Emergence (%)
1 : 10	99.50 (87.48)a	51.1 (45.63)d	95.6 (78.03)a	88.8 (70.44)b
1 : 20	98.50 (83.87)ab	61.4 (51.59)c	97.6 (81.12)a	94.5 (76.43)a
1 : 30	97.20 (80.55)bc	67.9 (55.49)b	87.2 (69.26)b	67.2 (55.06)c
1 : 40	98.20 (82.46)bc	97.0 (80.02)a	84.9 (67.38)b	62.8 (52.41)c
1 : 50	96.00 (78.55)c	63.3 (52.71)bc	75.3 (65.51)c	42.5 (40.68)d
SE (d)	1.93	1.40	2.20	2.68
CD (0.05)	4.12	2.98	4.69	5.72

Figure 1. Laboratory parasitic potential of *T. remus*

Figure 2 : Parasitic potential of *T. remus* progenies from FAW and *S. litura* eggs against FAW

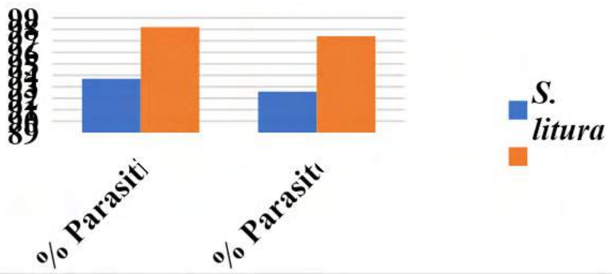

Table 2. Parasitic potential of *T. remus* on eggs of Fall armyworm on Maize seedlings of different ages – A pot culture experiment at parasitoid : host ratio of 1:20

Age of the Maize Seedling	Parasitization (%)	Parasitoid Emergence (%)
15 DAS	95.3 (77.63)a	91.4 (72.94)a
25 DAS	91.6 (73.21)b	82.0 (64.9)b
35 DAS	87.8 (69.68)c	66.7 (54.8)c
45 DAS	84.8 (67.06)c	54.7 (47.7)d
SE (d)	1.33	1.59
CD (0.05)	2.83	3.37

Reference

Sharanabassapa, Kaleshwaraswamy, C. M., Asokan, R., Swamy, H. M. M., Maruthi, M. S., Pavithra, H. B., Hedge, K., Navi, S., Prabhu, S. T. and Goergen, G. E. (2018). First report of the Fall armyworm, *Spodoptera frugiperda* (J E Smith) (Lepidoptera: Noctuidae), an alien invasive pest on maize in India. *Pest Management in Horticultural Ecosystems*, 24 (1): 23 – 29.

Pathogenicity of the *Beauveria bassiana* (Balsamo) Vuillemin Isolate MZ674187 against Two Spotted Spider Mite, *Tetranychus urticae* Koch

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Keywords: *Beauveria bassiana, Tetranychus urticae, Pathogenicity, LC50 Value*

Introduction

The two spotted spider mite, *Tetranychus urticae* Koch is a serious polyphagous pest infesting bhendi, causing a severe yield loss up to 50 per cent (Roseleen *et al*., 2010). The management of two spotted spider mite mostly rely on acaricides. Due to the continuous use of acaricides resulted in quick development of resistance in mites. Hence there is a need to develop alternate eco-friendly management strategy against two spotted spider mites. With this objective, the present study was taken up to isolate the *Beauveria bassiana* and test its pathogenicity against two spotted spider mites.

Methodology

The EPF infected mites were collected from bhendi fields of Thondamuthur block, Coimbatore district during Dec 2020. The mites were examined using a 40-x magnifying hand lens in field and the mite cadavers showing natural external growths of fungi were collected and isolation of the entomopathogenic fungi was done using the potato dextrose agar medium after surface sterilization using 70% ethanol for a minute followed by 1 per cent sodium hypochlorite for a second and rinsed using distilled water for four to five times and were incubated at room temperature of 25±2°C and 80±10 % RH till sporulation. After that sub culturing was made by inoculating a single colony into 90mm petri dish containing PDA medium and incubated at a temperature of 25±2°C and 80±10 % for two weeks in order to obtain the pure culture. The morphological characters were studied by phase contrast microscopy. The molecular characterization was done by CTAB method to confirm the EPF as *Beauveria bassiana*.

The two spotted spider mites collected from the field were transferred to the caged potted Bhendi (Bhendi hybrid COBh H 1) plants maintained at Insectary, Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu. For testing the pathogenicity of EPF, fully sporulated (15 days old) culture were used. The fungal surface was scraped using a sterile surgical knife with 10 ml of sterile distilled water with 0.02% Tween 80 as a wetting agent. The spore concentration was estimated using the Neubaur haemocytometer. After assessing the number of conidia, a series of dilutions were made with the spore concentrations ranging from 10^4 to 10^9 conidia/ml. Healthy mulberry leaf discs of 5cm was prepared and dipped in the prepared fungal suspensions of various concentrations ranging from 10^4 to 10^9 conidia/ml and air dried over a filter paper. Mulberry leaf discs dipped in the sterile water containing 0.05% Tween 80 was used as control and replicated four times. After drying, the leaf discs were placed in a petri dish with moist filter paper and 30 uniform aged adult mites were released to each petri dish and mortality was observed at 24 hrs interval. The dead mites were kept in a petri dish with sterile moist filter paper and re-isolation of the pathogen was done to confirm the death due to *B.bassiana*.

Results and Discussion

The morphological identification revealed that the isolate produced whitish colony on front and reverse side, white colored hyaline and septate mycelium with globose conidia of size 2.22 µm confirming *B. bassiana,* which is similar to the results of Gebermariam *et al*., (2021) The molecular characterization results revealed that the sequence had 99.2 per cent homology with the other *B.bassiana* isoltes, confirming the EPF as *B.bassiana* and the accession number was obtained as MZ674187. The mortality of the mites due to mycosis begins at the fourth day after treatment. The isolate MZ674187 was highly virulent against two spotted spider mite, causing a maximum mortality of 81.7 percent mortality at 14 days after inoculation at the spore concentration of 3 x 10^9 conidia/ml (**Table 1 and Fig-1)** which is identical to the results of Yanar *et al.,* (2018) where the two isolates F-12 and F-56 of *B.bassiana* caused the maximum mortality of 78.3 and 76.7 per cent respectively at the conidial concentration of 1 x 10^8 conidia/ml against two spotted spider mite. The mortality of two spotted spider mite increased as the concentration of the conidia get increased. The LC 50 value of MZ674187 was found to be 3.4 x 10^6 conidia /ml against two spotted spider mites.

Table 1. Pathogenicity of the *B.bassiana* isolate MZ674187 against *T.urticae*

Treatment details	7 DAI	9 DAI	11 DAI	13 DAI	15 DAI	Per cent mean mortality	Per cent reduction over control
3 x 10^4	2.00^{f}±0.084	3.00^{f}±0.072	3.00^{f}±0.072	4.25^{e}±0.056	5.75^{e}±0.094	19.17	91.30
3 x 10^5	3.25^{e}±0.063	4.75^{e}±0.051	6.00^{e}±0.055	8.00^{d}±0.048	10.00^{d}±0.044	33.33	95.00
3 x 10^6	5.00^{d}±0.059	7.00^{d}±0.051	8.50d±0.066	11.25^{c}±0.068	14.25^{c}±0.061	47.50	96.49
3 x 10^7	7.25^{c}±0.044	9.50^{c}±0.063	11.75c±0.068	15.50^{b}±0.050	18.00^{b}±0.033	60.00	97.22
3 x 10^8	9.25^{b}±0.040	12.25^{b}±0.035	15.00^{b}±0.036	19.50^{a}±0.045	22.00^{a}±0.030	73.33	97.73
3 x 10^9	10.75^{a}±0.07	16.00^{a}±0.035	18.00^{a}±0.033	21.75^{a}±0.078	24.25^{a}±0.047	80.83	97.94
Control	0.50^{g}±0.000	0.50^{g}±0.000	0.50^{g}±0.000	0.50^{f}±0.000	0.50^{f}±0.000	1.67	0
CD (P=0.05)	0.169	0.145	0.157	0.161	0.153	-	-
SE(d)	0.081	0.069	0.075	0.077	0.073	-	-

Means ± SE within a column followed by the same letter are not significantly different from each other at 5% level of significance (LSD test)

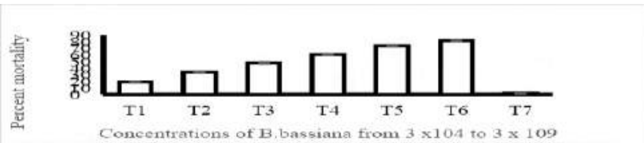

Figure-1 Per cent mortality of the *B.bassiana* isolate MZ674187 against *T.urticae*. Bars indicate S.E

Reference

Gebremariam, A., Y. Chekol and F.Assefa, 2021. Phenotypic, molecular, and virulence characterization of entomopathogenic fungi, *Beauveria bassiana* (Balsam) Vuillemin, and *Metarhizium anisopliae* (Metschn.) Sorokin from soil samples of Ethiopia for the development of mycoinsecticide. ***Heliyon Microbiology***,7(5):70-91.

Roseleen, S. S. J. and K. Ramaraju. 2010. Host-plant resistance in okra against the two-spotted spider mite, *Tetranychus urticae* Koch. ***Pest Management and Economic Zoology***, 18: 179-187.

Phoma sp. Shows the Dominant in Phyllosphere of Powdery Mildew Leaves

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Keywords: *Phoma sp, powdery mildew, dominance in phyllosphere*

Introduction

Powdery mildews are plant diseases that are distinguished by their white mycelia and powdery conidia. Species of *Ampelomyces* and *Phoma* are frequently mistaken for one another. Studies of their appearance and life history, as well as ribosomal DNA internal transcribed spacer region 1 sequence analysis, revealed that isolates previously attributed to the genus *Ampelomyces* were *Phoma* isolates. *Phoma glomerata* may colonise oak and limit the growth of powdery mildew, suggesting that it could be useful as a mycoparasitic agent. Due to the limitations of fungicides and resistant cultivars, alternative methods for controlling powdery mildews have been sought (Liyanage and Kuruvilla, 1992). Non-fungicide products like oils, salts, soluble silicon and plant extracts has not yet proven to be effective. The objective of this study is to use mycoparasite to suppress powdery mildew fungus in bhendi and cucumber.

Methodology

Isolation and growth

During August 2019, the leaves of bhendi (*Abelmoschus esculentus* L.) and cucumber (*Cucumis sativus*) with powdery mildew (*Erysiphe chicoracearum*) infections were observed in Tamil Nadu. The leaves revealed two forms of pycnidia: stipulate pycnidia, which are characteristic of *A. quisqualis*, and sessile pycnidia, which are characteristic of the genus *Phoma* (Fig. 1). Needles were used to remove and separate both the forms of pycnidia from leaves and mount them on potato dextrose agar (PDA) with streptomycin (20 mg/liter). In a stereo zoom microscope, two distinct fungus were consistently observed. The stipitate pycnidia grew into slow-growing colonies with features that were similar to those of *A. quisqualis*. The sessile pycnidia grew into fast-growing colonies with features that were similar to *P. glomerata*.

Results and Discussion

A. quisqualis and *Phoma* spp. were found in all of the leaf, flower, and bud samples taken from five distinct locations in Tamil Nadu. Given the fact that *Ampelomyces* spp. and *Phoma* spp. had not previously been identified as parasitizing the bhendi and cucumber powdery mildew fungus, light microscopic (LM) examination of powdery mildew colonies revealed that specimens collected from Tamil Nadu were infected by *Ampelomyces* spp. mycelia were hyaline, branching, and septate, and were superficial or penetrated.The disease incidence and severity were documented in order to evaluate the suppressive effect of mycoparasitic fungi on powdery mildew disease progression on the leaves of bhendi and cucumber. Plants parasitized with mycoparasites showed a reduction in disease severity, with an 18% incidence rate. The pycnidia and spores of *Phoma* sp and *Ampelomyces* spp. infecting bhendi powdery mildews were pale brown in colour, and the mycelia were hyaline. However, Lee *et al.* (2007) and Angeli *et al.* (2011) found colour variations in the mycelium and pycnidia of different mycohosts belonging to the genus *Erysiphe*, ranging from olive green to pale and dark brown. Pycnidia and spores in *Ampelomyces* isolated from rubber powdery mildews were smaller than those isolated from other mycohosts in the same genus (Angeli *et al.*, 2011).

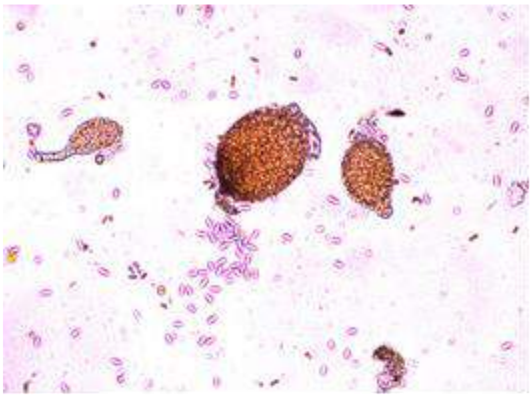

Fig 1. Pycnidia of *Ampelomyces* and *Phoma*

Reference

Angeli, D., Maurhofer, M., Gessler, C., and Pertot, I. (2011). Existence of different physiological forms within genetically diverse strains of *Ampelomyces quisqualis*. *Phytoparasitica* 40, 37–51.

Lee, S.Y., Hong, S. K., Kim, Y. K., and Kim, H. G. (2007). Selection and identification of a hyperparasite, *Ampelomyces quisqualis* 94013 for biocontrol of cucumber powdery mildew. *Korean J. Mycol.* 35, 121–127.

Liyanage De S. A. and Kuruvilla, J. C. (1992). "Diseases of economic importance in rubber," in Natural Rubber: Biology, Cultivation and Technology, Developments in Crop Science, Vol. 23, eds M. R. Sethuraj and N. M. Mathew (Amsterdam: Elsevier Science), 324–359.

Phylogenetic Analysis of Okra Enation Leaf Curl Virus (OELCV) Transmitted by *Bemisia tabaci* using Coat Protein Gene Fragment of OELCV in Tamil Nadu

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Keywords: Bemisia tabaci, OELCV, PCR, Phylogenetic analysis

Introduction

The Okra enation leaf curl virus (OELCV) incidence has reached serious proportions in recent years both in Northern India (Sanwal *et al.*, 2016) and Southern India as well (Sayed *et al.*, 2014) and causes systemic infections and has a very effective mode of transmission by the sweet potato whitefly, *Bemisia tabaci*; thus, preventing their spread made very complicated. The directions of disease epidemics changes with transitions of either the pathogen and or its insect vector(s). Hence, it is important to understand the OELCV isolates to study the disease reactions in plant accessions

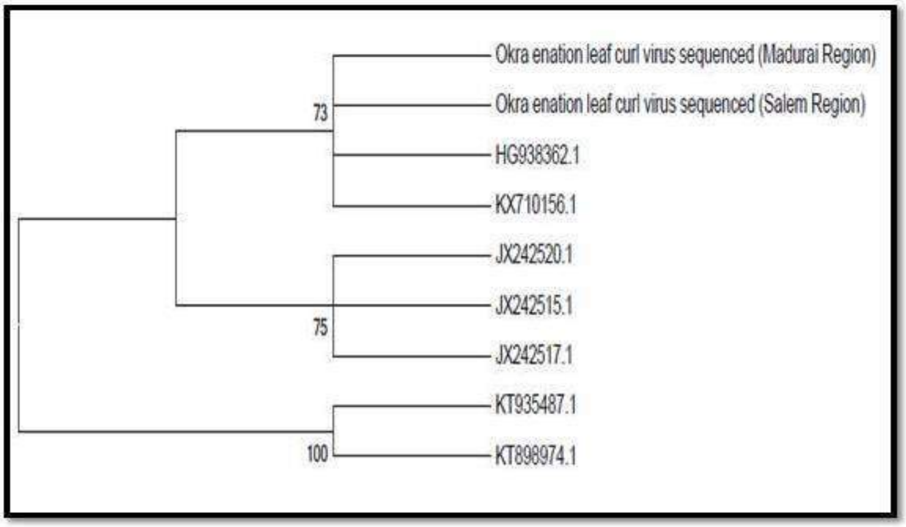
Methodology

The OELCV infected Okra young leaves were collected from hot spot regions of its occurrence in Tamil Nadu *viz.*, Salem (Northwestern Zone) and Madurai (South Zone), transported in frozen condition to the laboratory and the DNA was extracted and used to amplify the OELCV utilizing specific primers (JKOE34F, JKOE35R) (Rakesh Kumar, 2016) targeting the OELCV coat protein gene and produced a 796 bp band in the polymerase chain reaction (PCR). The homology analysis of nucleotide sequence was carried out using BLAST programme.

The phylogenetic tree was constructed using nine sequences of the coat protein gene of OELCV and the difference in the sequences were determined using the sequence alignment editor Bio-Edit version (7.1) and compared against the consensus sequences of National Center for Biotechnology Information (NCBI). The alignment was further analyzed using the MEGA 6.0 program, using the neighbor joining method with a bootstrap value of 1000.

Results and Discussion

The results revealed that the Salem region coat protein gene sequence grouped into OELCV clone 6.2, complete genome (MK084768.1) with 99.71% of homology and Madurai region coat protein gene sequence grouped into OELCV isolate Vijayawada coat protein (AV1) gene, complete cds (KT935487.1) with 99.38% of homology. The amplified OELCV (Salem and Madurai zone) from the study had fallen in the same cluster along with HG938362.1 and KX710156.1 (Fig. 1). This study had indicated that the OELCV pathogen were alike in these zones that were successfully being transmitted by *B. tabaci*.



HG938362.1 Okra enation leaf curl virus Rep gene, CP gene, V2 gene, REn gene and TrAP gene, segment DNA-A, isolate NEO-32 OELCuV-PKS, clone Neo-32; KX710156.1 Okra enation leaf curl virus clone SZ157 pre-coat protein (V2), coat protein (V1), replication enhancer protein (V3), and transcriptional activator protein (C2) genes, complete cds; JX242520.1 Mesta yellow vein mosaic virus isolate Okra:Tirupati:2010 pre-coat protein (V1) gene, partial cds; JX242515.1 Mesta yellow vein mosaic virus isolate Okra:ASR:2010 pre-coat protein (V1) gene, partial cds; JX242517.1 Mesta yellow vein mosaic virus isolate Okra:Ludhiana:2010 pre-coat protein (V1) gene, partial cds; KT935487.1 Okra enation leaf curl virus isolate Vijayawada coat protein (AV1) gene, complete cds; KT898974.1 Okra enation leaf curl virus isolate Varanasi coat protein (AV1) gene, complete cds

Fig. 1 Phylogenetic analysis for Okra enation leaf curl virus (OELCV) using coat protein gene

Reference

Rakesh Kumar, V. R. 2016. Global prospectives in virus disease management, *International conference: virocon*. Bengeluru, India.

Sanwal, S., V. Venkataravanappa, and B. Singh. 2016. Resistance to bhendi yellow vein mosaic disease: a review. *Indian J. Agr. Sci*., 86: 835-843.

Sayed, S., D. Rana, G. Krishna, P. Reddy, and P. Bhattacharya. 2014. Association of Begomovirus with Okra (*Abelmoschus esculentus* L.) leaf curl virus disease in southern India. *SAJ Biotechnol*., 1(1).

Population Dynamics of Pest and its Natural Enemies Occurrence in Citrus Trees

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Keywords: *Citrus, Population dynamics, Economically important pests.*

Introduction

Citrus is the largest cultivated group of fruits in the world, which includes mandarin, sweet orange, lemons, tangerines and grape fruit. The various factor of lower yield in India pest problem is one of the major constraints in the production of citrus. Citrus crop is being infested by large number of economically important pests. However, 120 insect species were reported in citrus from India. The major pests of citrus are citrus butterfly larva, *P. demoleus* followed by Cowbug, Grasshopper, Ashweevil complex and Leaf miner. In this study, we assessed the variety of insect pests occur in citrus orchard.

Methodology

In order to study the population dynamics and impact of weather parameters on incidence of various pests and its natural enemies in citrus orchard, a field experiment was carried out at SBAC & RF, Karaikudi from December 2018 to April 2019 on existing trees of acid lime. The observations on various pest populations and its natural enemies incidence were recorded at weekly interval on the basis of number of larvae, grub, adult and leaf infestation for citrus leaf miner. Plots were kept completely free from the spray. For this purpose, 10 trees were randomly selected and tagged. Observation on pest population was recorded from randomly selected trees. Data regarding weather parameters were obtain from Agricultural Meteorology, SBAC & RF, Karaikudi. The relationship between weather factors and pest occurrence was established.

Results and Discussion

We have taken count at weekly basis for 20 weeks. All the data are pooled together to monthwise. So, totally 5 months observation has been recorded from December - April. The population density was at the peak during December and January based on our data. The maximum citrus butterfly *P. demoleus* larval population and leaf infestation were recorded with an average of 3.15 in the month of December and minimum was observed in the month of March (0.75) because of severe heat. Ash weevil incidence was found to be high in December (2.55) and found to be low in April (0.57). Population dynamics of cowbug incidence was found to be high in December (2.3) and found to be low in April (0.6). Citrus leaf miner incidence was observed very high in the month of December (2.2) because of moderate temperature and found to be low in April (0.8). Grasshopper incidence was found to be high in December (2.17) and found to be low in April (0.7) because of high temperature Each values are the mean 4 weeks. The above data revealed that population dynamics of pest was found to be high in winter season (December and January as temperature was low as well as moderate and pest population found to be low in succeeding summer months (February - April) as the temperature was high. We also recorded naturally occurring biocontrol agents like tachinid parasitoid and nuclear polyhedrosis virus affected larva with tree top disease symptom.

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Table 1. Population of different insect pests in Citrus

S. No.	Month	Average of pest incidence for different insect pests in Citrus				
		Citrus Butterfly	Ash weevil	Cow bug	Leaf miner	Grasshopper
1.	December	2.65	2.55	2.3	2.2	2.17
2.	January	2.4	2.05	1.5	1.9	1.43
3.	February	2.5	0.65	0.6	0.8	0.6
4.	March	0.75	0.75	0.8	0.9	0.7
5.	April	1.1	0.57	0.6	0.8	0.7

Citrus Butterfly

Ash weevil

Leaf Miner

Parasitized citrus larva By Tachinid

Figure 1. Insect Pests of Citrus and natural enemy of Citrus butterfly

Reference

Atwal, A.S. 1964. Insect Pests of Citrus in the Punjab-Biology and control of citrus Caterpillar Papilio demoleus L(Lepidoptera:Papilionidae)

Butani D.K.Insect Pests of fruit crops-Citrus.1973.Pesticides.pp.23-26.

Nandni Durgesh., Raghuwanshi Arun and Shrivastava Vino Kumar. 2012. Life Cycle, Population index and feeding activities of the lime butterfly, Papilio demoleous (Lepidoptera: Papilionidae).Trends in Biosciences.5(1):31-34.

Profiling of Interactive Metabolomics of Bhendi Genotypes Against Root Knot Nematode, *Meloidogyne incognita* under Monopartite & Dipartite Interaction

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Keywords: *Secondary metabolites, Bhendi genotypes, Monopartite & Dipartite Interaction, Root knot nematodes, Meloidogyne incognita.*

Introduction

Bhendi (*Abelmoschus esculentus*) is one of the important nutritious vegetable crops grown across globe which is been invaded by root knot nematodes, *Meloidogyne incognita* and exploits the yield of crop by producing galls on root parts of plants. Phytochemicals serves as first line of defense compounds in plants which is been produced at time of biotic stress to resist the nematode attack. As resistant source is best option for nematode management, Bhendi genotypes is screened for root knot nematode resistance and their corresponding secondary metabolites of normal roots and galled roots i.e., under monopartite and dipartite interactions were identified through Gas Chromatography- Mass Spectroscopy analysis. The results showed that the produced phytochemical compounds not only served as resistant source but also possess nutritional value which makes the germplasm as a best source for commercial cultivation.

Methodology

Seventy- three Bhendi germplasms were screened for *M. incognita* resistance under *in- vivo* conditions (Ravichandra, 2013). Germplasms were sown in sterilized pot mixture which is then followed by nematode inoculation at twenty-one DAS and the readings were taken at forty-five DAS. At 45DAS, degree of resistance was assessed by Gall Index (GI) given by (Hartman and Sasser *et al*.1985.) Among seventy-three genotypes GED 19 showed good phenotypic growth and recorded minimum number of galls and so this germplasm was used to study the complete metabolite profile under monopartite and dipartite interaction.10g of normal and galled roots were taken and grounded as fine powder using liquid N_2 and to which 10ml of chloroform, methanol and ethyl acetate was added and kept in shaker for 24 hrs. Then contents in conical flask was transferred to petri plates and allowed to evaporate. 10 ml of methanol is been added to plates and the contents were scrapped from plates. This methanolic extract is then filtered through 0.2µ syringe filter and given for GC-MS analysis (Rosado-Souza *et al*.2019)

Results and Discussion

Metabolite profile of Bhendi roots under monopartite and dipartite interaction were compared using the chromatogram of GC-MS analysis which showed that plants under stress condition produces more no. of. metabolites than under normal conditions.

Metabolite profile under monopartite interaction

In our study GED-19 under normal conditions produced 11 phytochemical compounds **(Figure.1)** which includes 4-Penten-2-ol,3-methyl;
p-Xylene; Hexanoic acid, 1,1-Diisobutoxy-isobutane; à-D-Glucopyranoside,O-à-D-glucopyranosyl-(1.fwdarw.3)-á-D-fructofuranosyl; Ascaridole epoxide; Phenol, 2,4-bis(1,1-dimethylethyl)-; Hexanoic acid,2-ethyl-,oxybis(2,1-ethanediyloxy-2,1-ethanediyl) ester; Oleic Acid; 4-Hexyl-1-(7-methoxycarbonylheptyl)bicyclo[4.4.0]deca-2,5,7-triene;
Diisooctyl phthalate;7,8-Epoxylanostan-11-ol, 3-acetoxy-.

Metabolite profile under dipartite interaction

GED 19 when infested with nematodes produces nearly 20 different compounds (**Figure.2)** which includes 3-(3-Carboxy-4-hydroxyphenyl)-D-alanine; n-Butyl ethylenediamine; Methyl diethanolamine; Naphthalene; Strychane, 1-acetyl-20à-hydroxy-16-methylene-; Octadecane, 1,1′-[1,3-propanediylbis(oxy)]bis-; 9,12,15-Octadecatrienoic acid,2,3-bis[(trimethylsilyl)oxy]propyl ester, (Z,Z,Z)-, Trolamine, 2,8,9-Trioxa-5-aza-1-silabicyclo(3.3.3)undecane, 1-methoxy-, Triethanolamine, 2-Hexadecanol, Oleic acid, 3-(octadecyl oxy)propyl ester, 1-Hexadecanol, 2-methyl-, Dasycarpidan-1-methanol, acetate (ester), Cyclo propane butanoic acid,2-[[2-[[2-[(2-pentylcyclopropyl)methyl]cyclopropyl]methyl] cyclopropyl]methyl]-, methyl ester, Estra-1,3,5(10)-trien-17á-ol, Rhodopin, Linoleic acid ethyl ester, Oleic acid, eicosyl ester, 7,8-Epoxylanostan-11-ol, 3-acetoxy-.

From the peaks obtained it is clear that the plants produce phytochemical compounds naturally but their amount and intensity vary upon the stress which plant obtains. In our case the peak of Figure.2 clearly shows that plants produce some metabolites in high amount to resist the nematode attack and the produced compounds also had various biochemical, anti-cancer, anti-fungal, anti-diabetic, anti-microbial, anti-inflammatory & cardio and neuro protective compounds which makes the genotype more unique in case of human health prospects.

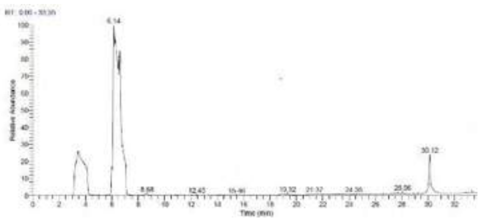

Fig 1. Chromatogram of monopartite interaction

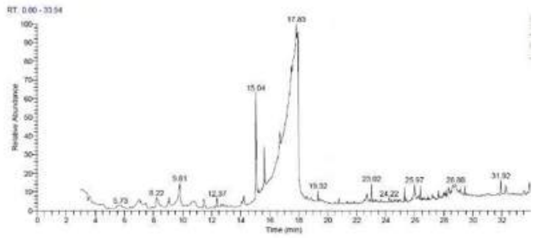

Fig 2. Chromatogram of dipartite interaction

Reference

Ravichandra, N. G., Krishnappa, K., & Setty, K. G. H. (1988). Evaluation of brinjal (*Solanum melongena* L.) germplasm for resistance against Meloidogyne javanica and race-1, race-2 and race-3 of M. incognita. Indian Journal of Nematology, 18(2), 165-174.

Rosado-Souza, L., David, L. C., Drapal, M., Fraser, P. D., Hofmann, J., Klemens, P. A., ... & Fernie, A. R. (2019). Cassava metabolomics and starch quality. Current protocols in plant biology, 4(4), e20102.Noble, R. and E. Coventry. 2005. Suppression of soil borne plant diseases with composts: a review. ***Biocontrol Science and Technology,*** 15(1): 3-20.

Hartman, K. M., & Sasser, J. N. (1985). AND PERINEAL-PATTERN MORPHOLOGY. An advanced treatise on *Meloidogyne*: methodology, 2, 69.

Screening of Turmeric Genotypes for Resistance to Rhizome Rot Disease

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Keywords: *Turmeric, Genotypes, Rhizome rot, Pythium, Resistant.*

Introduction

Turmeric (*Curcuma longa* L.), is one of the essential spice crop which is commercially grown in India. The major production problem in turmeric is rhizome rot disease caused by *Pythium aphanidermatum.* This disease cause's yield loses up to 95 % in Tamil Nadu and 80% in Andhra Pradesh. *Pythium aphanidermatum* is the most important constrain for the production of healthy turmeric rhizome. The chemical method is not economical sustainable to control of this pathogen due to high cost of chemicals materials, resistance break down environment of pollution. The chemical control also affects the beneficial soil microbes and reduces the soil fertility status. It also affects the beneficial soil microorganisms and finally the consumer preference also more towards the organic turmeric. Now the focuses on for developing resistant variety of turmeric against rhizome rot disease (Pandey *et al,* 2010). Use of resistant varieties and integrated diseases management techniques is one of the ways to increase the production and productivity of turmeric in India.

Methodology

Two hundred turmeric germplasm were maintained in the Department of Spices and Plantation Crops, Horticultural College and Research Institute, TNAU, Coimbatore and were used as the planting materials. 200 common turmeric genotypes were evaluated using *P. aphanidermatum* making the whole experimental units of 800 pots for experiment. In each pot with a mixture of sterilized soil and specific inoculums, four rhizomes of each common turmeric genotypes were planted.

Preparation of Pythium sp. inoculum and inoculation

Inoculums of *P. aphanidermatum* isolates were reactivated by culturing them on fresh Potato Dextrose Agar (PDA) growth media and incubated at 24°C for 10 days. 100g of millet grain was mixed with 70mls of water in 350 ml glass vessels and double autoclaved at 121°C for 15 minutes at 2 days intervals and left them to cool. In order to increase inoculums the prepared substrate (autoclaved grain millet) was mixed with a disc of PDA agar with *Pythium* culture and incubated for 12 days in the darkness at 24°C to allow a uniform growth of mycelia.

Screen house experiment.

After the incubation of the inoculum in the dark at 24°C, sterilized soil was mixed with inoculums at a ratio of 1:10v/v. Pots (12cm diameter) were then filled with the mixture. Pots with different *Pythium* isolates were arranged in a completely randomized block design with three replications and assigned bean genotypes randomly. 200 common turmeric genotypes were evaluated using *P. aphanidermatum* making the whole experimental units of 800 pots for experiment. In each pot with a mixture of sterilized soil and specific inoculums, four rhizomes of each common turmeric genotypes were planted. Three weeks after planting, seedlings were uprooted and washed with tap water to remove soil from the roots. The disease severity assessed based on 1 to 9 scale developed by CIAT with 1 being non-pathogenic and 9 being highly pathogenic (Abawi and Pastor-Corrales, 1990). Generally, average score of 0 percent were considered as resistant while that with 1 to 10 percent as moderately resistant, 11 to 25 percent as moderately susceptible, 26 to 50 per cent (Susceptible) and >50 per cent highly susceptible to *Pythium* rhizome rot disease. Disease scoring was done independently on 4 turmeric seedlings per each turmeric genotype.

Results and Discussion

Rhizome rot pertains to the economic aspects of turmeric cultivation, because of its severe damage on the consumable part of the crop, leading to much pecuniary distress for the farmer. It is the most damaging of all the diseases affecting turmeric and is reported as a major soil borne problem in all turmeric-growing tracts. Crop loss can be as much as 50%, but can vary in extent from region to region. The screening studies revealed that 36 genotypes *viz,.,* CL 4, CL 5, CL 9,CL 10, CL 14, CL 20, CL 27, CL 37 , CL 38, CL 39, CL 40, CL 68, CL 76, CL 80, CL83, CL 84, CL 105, CL 110, CL 112, CL 113, CL 118, CL 124, CL 125, CL 127, CL128, CL 136, CL 137, CL 143, CL 145, CL 157, CL 236, CL 239, CL 249, CL 250, CL270, CL 275 were resistant, eight genotypes were moderately resistant, 75 genotypes recorded as moderately susceptible, 62 genotypes showed as susceptible and 19 genotypes registered as highly susceptible. Our results suggest that, identification of resistant genotypes, allowing for a wider control of *Pythium* rhizome rot disease through improved host resistance across the major common turmeric growing regions. The resistance of turmeric genotypes to *P.aphanidermatum* is associated with colored rhizome, several evaluation of turmeric germplasm conducted earlier (Dickson and Petzoldt, 1987; Lucas and Griffiths, 2004) found that colored common rhizome turmeric genotypes have higher level of resistance to *Pythium*.

Plate 3. Percent Disease Incidence (PDI)

1. Resistant
2. Tolerant/Moderately resistant (MR)
3. Moderately susceptible (MS)
4. Susceptible (S)
5. Highly susceptible (HS)

Scoring scale	Percent diseases incidence	Reaction	Number of genotypes
1	0	Resistant	36
2	1-10	Tolerant/Moderately resistant (MR)	08
3	11-25	Moderately susceptible (MS)	75
4	26-50	Susceptible (S)	62
5	>50	Highly susceptible (HS)	19

Reference

Ban, Y., and Kiritani. 1980. Seasonal prevalence of aquatic insects inhabiting paddy fields. Japanese Journal of Ecology, 30:393-400.

Lawler, S. P. (2001). Rice fields as temporary wetlands: a review. Israel Journal of Zoology, 47(4), 513-528.

Bale, J. S., Masters, G. J., Hodkinson, I. D., Awmack, C., Bezemer, T. M., Brown, V. K., ... & Whittaker, J. B. (2002). Herbivory in global climate change research: direct effects of rising temperature on insect herbivores. Global change biology, 8(1), 1-16.

Sensitivity of Cowpea (*Vigna unguiculata* (L.) Walp.) to Extreme Levels of Atrazine Imposed in Preceding Maize (*Zea mays* L.)

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Keywords: *Atrazine, Cowpea, Maize, Sensitivity, Cropping system.*

Introduction

Maize (*Zea mays* L.) is the cardinal crop in the world's agricultural economy and it is cultivated in sequence with different crops under several agro-ecologies of the globe. Climate change either globally or regionally, endangers universal food and economic security (Adarsh *et al*., 2019). Worldwide, more than eight hundred million people are suffering from profound hunger and malnutrition (WHO, 2018). The globe has to seek for a solution to this problem in a viable manner and pulses are the best answer. Growing pulses foster sustainable agriculture since they help reduce greenhouse gases, increase soil health and utilize less water than other crops. Cowpea (*Vigna unguiculata* (L.) Walp.) is one of the eleven kinds of pulses appreciated by Food and Agricultural Organization of the United Nations (FAO). Weeds are major economic problems for maize farmers, and the extent of damage depends largely on the constitution of weed flora, time of crop-weed competition and its intensity (Rai *et al*., 2018). Atrazine is being extensively used in India by maize growers in order to increase crop production by preventing weed-crop competition. The amount of time that atrazine remains vital in the soil is of particular significance, as it may be associated with phytotoxic effects that can later damage the succeeding crops. In general, sequence cropping has manifested effectual in increasing farm productivity and profitability. Considering the above facts, a research was conducted to evaluate the sensitivity of cowpea to extreme levels of atrazine in irrigated maize-cowpea cropping system.

Methodology

Field experiment was carried out during *Kharif* and *rabi* seasons of 2019-20 at Eastern Block Farm, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore. The experimental farm is geographically situated in the Western agro-climatic zone of Tamil Nadu (11° N, 77° E) and at an altitude of 426.72 m above mean sea level. The soil of the experimental field was sandy clay loam. The initial soil was high in available potassium (469 kg ha^{-1}), low in available nitrogen (246 kg ha^{-1}), available phosphorus (6.68 kg ha^{-1}), organic carbon (0.29 %) and has the pH of 7.59 and EC (0.76 dSm^{-1}). The field experiment was laid out as a randomized block design (RBD) with three replications. The experiment was composed of 11 treatments viz. pre-emergence atrazine 50 % WP at 0.50 kg a.i ha^{-1} (T_1), pre-emergence atrazine 50 % WP at 0.75 kg a.i ha^{-1} (T_2), pre-emergence atrazine 50 % WP at 1.00 kg a.i ha^{-1} (T_3), pre-emergence atrazine 50 % WP at 1.25 kg a.i ha^{-1} (T_4), pre-emergence atrazine 50 % WP at 1.50 kg a.i ha^{-1} (T_5), pre-emergence atrazine 50 % WP at 1.75 kg a.i ha^{-1} (T_6), pre-emergence atrazine 50 % WP at 2.00 kg a.i ha^{-1} (T_7), pre-emergence atrazine 50 % WP at 0.50 kg a.i ha^{-1} *fb* tembotrione at 120g a.i ha^{-1} as post-emergence at 25 DAS (T_8), pre-emergence atrazine 50 % WP at 0.50 kg a.i ha^{-1} *fb* hand weeding at 30 DAS (T_9), weed free check (T_{10}) and weedy check (control) (T_{11}). The gross plot size was 4.8 m x 4.5 m. As per the treatments schedule, atrazine (50% WP) was applied as pre-emergence at 2 days after sowing of maize. Cowpea (var. Co (CP) 7) was raised in the same undisturbed layout of the experimental field as a succeeding crop to evaluate its sensitivity to extreme levels of atrazine administered to preceding *Kharif* maize.

Results and Discussion

Extreme levels of atrazine imposed in Kharif maize had no significant influence on germination percentage, leaf chlorophyll content and dry biomass weight of cowpea. No visual toxicity due to atrazine was observed in cowpea crop. Grain yield of cowpea was significantly affected by extreme levels of atrazine. However, significant increase over weedy check and all treatments with atrazine was noted in weed-free (T10) with mean value of 324.33 kg ha-1 (Table 1). This designate that it is obligatory to protect the crop from weed competition throughout most of its growth to guarantee maximal yield.

Table 1. Germination %, crop injury, leaf chlorophyll content, plant dry biomass weight and grain yield of cowpea as influenced by extreme levels of atrazine imposed in *Kharif* maize

Treatment	Germination percentage (7 DAS)	Crop injury (15 DAS)	Leaf chlorophyll content (SPAD) (30 DAS)	Dry biomass weight (kg ha^{-1}) (At harvest)	Grain yield (kg ha^{-1})
T_1	85.33	0	39.33	3693.82	49.33
T_2	87.67	0	36.07	3822.22	46.33
T_3	87.00	0	40.21	2350.62	112.67
T_4	79.00	0	37.91	2069.14	66.33
T_5	87.67	0	35.11	2874.07	13.67
T_6	88.00	0	36.63	3950.61	134.00
T_7	80.33	0	41.54	2671.60	20.00
T_8	84.33	0	39.15	3481.48	123.33
T_9	77.00	0	36.70	1980.25	108.00
T_{10}	76.67	0	37.15	4197.53	324.33
T_{11}	82.67	0	38.81	1288.89	4.67
SEd	6.25	-	3.23	1461.05	57.01
CD (P=0.05)	NS	-	NS	NS	103.33

T_1: Pre-emergence atrazine 50 % WP at 0.50 kg a.i ha^{-1}, T_2: pre-emergence atrazine 50 % WP at 0.75 kg a.i ha^{-1}, T_3: pre-emergence atrazine 50 % WP at 1.00 kg a.i ha^{-1}, T_4: pre-emergence atrazine 50 % WP at 1.25 kg a.i ha^{-1}, T_5: pre-emergence atrazine 50 % WP at 1.50 kg a.i ha^{-1}, T_6: pre-emergence atrazine 50 % WP at 1.75 kg a.i ha^{-1}, T_7: pre-emergence atrazine 50 % WP at 2.00 kg a.i ha^{-1}, T_8: pre-emergence atrazine 50 % WP at 0.50 kg a.i ha^{-1} *fb* tembotrione at 120g a.i ha^{-1} as post-emergence at 25 DAS, T_9: pre-emergence atrazine 50 % WP at 0.50 kg a.i ha^{-1} *fb* hand weeding at 30 DAS, T_{10}: weed free check and T_{11}: weedy check (control).

Reference

Adarsh, S., J. Jacob and T. Giffy. 2019. Role of pulses in cropping systems: A review. ***Agricultural Reviews***, 40(3): 185-191.

Rai, A, D. Mahata, E. Lepcha, K. Nandi, and P.K. Mukherjee. 2018. A review on management of weeds in maize (*Zea mays* L.). ***International Journal of Current Microbiology and Applied Sciences***, 7(8): 2906-2922.

WHO (World Health Organization). 2018. Global hunger continues to rise, new UN report says. Available: https://www.who.int/news/item/11-09-2018-global-hunger-continues-to-rise---new-un-report-says. Retrieved: 29.07.2021.

Studies on Host Preference for Citrus Butterfly, *Papilio demoleus* Linnaeus

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Keywords: *Citrus butterfly, Host preference.*

Introduction

Citrus is one of the most significant and widely grown amidst the fruit crops which support our agricultural economy by its abundant usage. It has a greater adaptability to various climatic condition. Citrus industry is the third largest in the world next to banana and mango. It has been affected by around 165 species economically important insect pest causing yield loss of about 30 per cent (Pruthi and Mani, 1945) Among the economically important pest, Citrus butterfly, *P. demoleus* are more prone to citrus crop. Host plant selection by the herbivore insect involves not only choosing the right species of plant, but also selecting an individual plant within that species which is suitable for feeding, survival and development of immature stages. Apart from this factor, chemical profile of the plant also plays a pivotol role in host selection (Prashant *et al*., 2017). Considering the importance of this pest, the present study was investigated to generate information regarding the host preference.

Methodology

Experiment was conducted at Entomology laboratory of SBAC & RF, Karaikudi with five different Rutaceae host species for citrus butterfly, *P. demoleus*. Preference of *P. demoleus* to five Rutaceae plants (citrus, *Citrus aurantifolia*; mandarin, *Citrus reticulata*; bael, *Aegle marmelos*; wood apple, *Limonia acidissima*; and curry leaf, *Murraya koenigii*) was investigated in laboratory, where five second instar larvae of the citrus butterfly were transferred to each plastic trays which containing leaves of different host plants. The degree of preference was determined by measuring the total leaf weight of each host by before consumption and after consumption of larvae. Leaves were renewed daily. The quantity (mg) of leaf consumed by the larvae was determined by deducting the weight of the healthy leaves from that fed leaves. In this way the weight (mg) of leaf consumed by larva in different host was recorded with the help of an electronic balance (Karim *et al*., 2007).

Results and Discussion

When the second instar larvae were fed with citrus leaves, the mean leaf consumption by the larva was 441 mg which was significantly greater than other host leaves. Mean leaf consumption by the larva in mandarin and curry leaf host were 402 mg and 385 mg respectively. This was followed by the hosts Bael and wood apple which shows that 312 mg and 293 mg mean leaf consumption respectively. According to the results obtained in this study, *C. aurantifolia* and *C. reticulate* appeared to be the most favourable hosts for *P.demoleus* among the Rutaceae hosts tested and this was followed by *M. koenigii, A. marmelos* and *L. acidissima*. The present study was in coincidence with the findings of Mahesh *et al*., (2003) who reported that lemon was the most preferred and most suitable food for the development of *P. demoleus*.

Fig 1. Experimental set up for host preference study of citrus butterfly *P. demoleus* among Rutaceae family

Table 1. Revealed Amout of leaf consumption by citrus larvae on various hosts among Citrus family

S. No.	Host	Amount of Leaves consumed by larva on different days in mg					Total consumption of leaves by larva (mg)
		1st day	2nd day	3rd day	4th day	5th day	
1	Citrus, *Citrus aurantifolia*	50	75	82	96	138	441
2	Mandarin, *Citrus reticulata*	45	62	78	91	126	402
3	Bael, *Aeglemarmelos*	37	55	72	68	80	312
4	Wood apple, *Limoniaacidissima*	35	53	70	64	71	293
5	curry leaf, *Murrayakoenigii*	42	60	76	87	120	385

Reference

Asokan, R. 1997. Massrearing and an additional star of *Papilio demoleus L.* on the acidlime, *Citrus aurantifolia* Swingle. *Insect Environ*. 2(4): pp.128-129.

Prashant, P. P., Snehal, M. P., Pandya H. V and Amlani M. H. 2017. Survey on host plants and host plant preference by lemon butterfly *Papilio demoleus* Linnaeus. *Journal of Entomology and Zoological studies*. 5(6): pp 792 - 794

Schoonhoven, L.M., J.J.A. Vanloon and M.Dicke, 2005. Insect-Plant Biology. Oxford University Press, Oxford, UK.

Studies on Pathogenicity and Virulence of Tuber Rot Pathogen (*Macrophomina phaseolina* (Tassi) Goid.) of Glory Lily (*Gloriosa superba*)

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Keywords: *Glory lily, Pathogenicity test, Macrophomina phaseolina*

Introduction

Gloriosa superba L. is an important medicinal plant belonging to *Liliaceae* family, and cultivated in Tirupur, Erode, Dindigul, Karur, Ariyalur, Perambalur and Nagapattinam districts of Tamil Nadu (Alice *et al*., 2012). It is rich in alkaloids like colchicines and colchicocides, highly demanded by pharma industries. Though it is high yielding, farmers are facing severe outbreak of tuber rot disease caused by *Macrophomina phaseolina*, a soil inhabiting pathogen. During the off-season time, the pathogen spreads from infected tubers of previous crop to healthy tubers through soil and lead to loss both at field and storage. The yield loss is upto 25 to 30 per cent has been reported both in field and storage (Thiribhuvanamala *et al*., 2018).The present study, proved the Kochs' postulate of the tuber rot pathogen *in-vitro*.

Methodology

Samples collection and pathogen isolation

The tuber rot infected tubers of glory lily were collected from different districts of Tamil Nadu *viz*., Dindigul, Tiruppur and Coimbatore. The infected bits of rotten tubers were immersed in 1% sodium hypochlorite solution for 1 min followed by rinsing with a series of sterile distilled water. The surface-sterilized bits of tubers were placed in a sterilized Petri plate containing Potato Dextrose Agar (PDA) medium and incubated at 28 ± 2ºC for five days (Alice *et al*., 2012).The pure culture of the pathogen was obtained by the single hyphal tip method and maintained the culture on PDA slants. Four isolates of *M. phaseolina* were obtained by isolation from the infected samples of different growing regions, named as MPSRM, MPMLR, MPKAR and MPKAL.

Pathogenicity test

The healthy tubers were used in this experiment. Equal sized tubers were selected and sliced lengthwise using sterilized scalpel. The sliced tubers were surface sterilized with 1 % sodium hypochlorite for 1 mins and rinsed with sterile distilled water for three times. An 8mm mycelial disc of each isolate of *M. phaseolina* were placed on the centre of sterilized tubers. Three replications were maintained for each isolates. Inoculated tubers were incubated at 28±2º C (Oladoye *et al*., 2016).The measurements were taken based on the necrotic lesions visible to naked eye. The tubers were cut through the inoculation point and the degree of rots were estimated based the scale given by Theron and Holz (1989): a = no visible symptom (non-virulent); b = 5 to 10 mm^2 of rotted area (hypo virulent); c = 11 to 20 mm^2 of rotted area (Moderately virulent); d = 21 to 30 mm^2 of rotted area (Virulent); e = more than 31 mm^2 of rotted area (Highly virulent).

Results and Discussion

The survey conducted in major glory lily cultivating regions of Tamil Nadu revealed a maximum disease incidence of tuber rot (25%) at Kallimandhyam followed by 22% incidence at Kariyampatty of Dindigul district (Table 1). Alice and Sundaravadhana (2012) reported the incidence ranged from 20 to 100 % in major growing regions of Tamil Nadu.

The artificially inoculated tuber showed clear evidence of infection in the sliced and also rotting of the tubers when the site of the inoculation was compared with the control site. The tubers were cut at the point of inoculation the prominent lesions were clearly exhibited in each isolate.The measurement was carried out based on lesion width and depth, MPKAL showed 49 mm^2 followed by 30 mm^2 of rotten area in MPKAR (Table 1, Figure 2 & 3). Chehri *et al*. (2014) considered measurements of the lesion's depth and width in the pathogenicity tests. Lesion sizes were completely variable and ranged from 0.0 mm^2 to 45mm^2. Based on lesions size, the pathogenicity of each isolate was divided into five groups: highly-virulent, virulent, moderately virulent, hypo-virulent and non-virulent.

Among the four isolates, MPKAL (Kallimandhayam) is characterized as a highly virulent followed by MPKAR (virulent) and MPSRM, MPMLR (moderately virulent) (Table1).

Table 1. Disease incidence and *in-vitro* pathogenicity of tuber rot pathogen

Isolate Number	District	Village	Latitude Longitude	Percent disease incidence	Radial mycelial growth (mm)	Measurement (mm)		Virulence
						Width	Depth	
MPSRM	Coimbatore	Sirumugai	11.3216°N 77.0089°E	20%	76	2.5	5	c
MPMLR	Tiruppur	Mulanur	10.7947°N 77.7111°E	12%	65	4	4	c
MPKAR	Dindigul	Kariyampatty	10.1662° N 77.8725° E	22%	80	5	6	d
MPKAL	Dindigul	Kallimandhyam	10.5912° N 77.6864° E	25%	90	7	7	e

Virulence scale: a: healthy, no visible symptoms (non-virulent); b: (hypovirulent); c: (moderately virulent); d: (virulent); and e: (high virulent).

Fig 1. Pure culture of *M.phaseolina* on PDA; method;

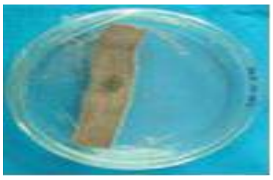

Fig 2. *In-vitro* pathogenicity – tuber slice

Fig 3. Cross sectional view of infected tuber

Reference

Alice D. and Sundravadana S. (2012): Effects of biocontrol agents and plant products on *Macrophomina phaseolina* and colchicine content in *Gloriosa superba*. Plant Protect. Sci., 48: 110–115.

Khosrow Chehri, Hamid Reza Ghasempour, Naser Karimi (2014): Molecular phylogenetic and pathogenetic characterization of *Fusarium solani* species complex (FSSC), the cause of dry rot on potato in Iran. Microbial Pathogenesis 67-68.

Oladoye.C.O, Connerton.L.F, Kayode.M.O, Omojasola.P.F (2016): Biomolecular characterization, identification, enzyme activities of molds and physiological changes in sweet potatoes (*Ipomea batatas*) stored under controlled atmospheric conditions. *Biomed & Biotechnol 17(4):317-332.*

Studies on Pesticide Use Behavior of Non-IPM Farmers of Rice Ecosystem in Southern Districts of Tamil Nadu

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Keywords: *Rice, Oryza sativa, Pesticide use behavior, Tamil Nadu*

Introduction

Paddy, *Oryza sativa* (Linneaus), is the most popular cereal food crop and one of the most important carbohydrate sources in human diets, supplying a large source of food nutrition for more than half of the world's population. Paddy cultivation is affected by biotic factors including insect pests according to Bekele *et al.* (2018) Yellow Stem Borer, green leafhoppers, leaf folder, brown planthoppers, gall midge, grasshoppers, gundhi bugs,etc., and diseases like sheath blight, blast, bacterial leaf blight, etc., which adversely affect productivity in rice crop.The present study was framed to survey the pesticide use pattern of farmers who mainly relies on pesticide for their pest and disease management. The focused area for this study was four southern districts of Tamil Nadu where paddy is grown almost in two seasons in a year.

Methodology

This study was carried out in four southern districts of Tamil Nadu *viz.*, Tirunelveli, Thoothukudi, Kanyakumari and Tenkasi during the year 2020-2021 using a set of questionnaires where paddy is grown almost in two seasons in a year. A Totally 75 farmer who relies on pesticide for their pest management were selected and the farmers were identified through the local pesticide dealers as well as by the help of extension officials **Table 1.**

Results and Discussion

Socio-economic Characteristics of Farmers Growing Paddy Crop

Around 56 per cent of the farmers were in the age group of 40 to 50 and 25.33 per cent of in the age group of 30 to 40 years. About 90% of the farmers are in nuclear family system. Only 4% of the female paddy cultivating farmers.

Information Regarding Paddy Cultivation

The farmers adoption of seed recommended seed rate of 20-25 kg acre^{-1} was used by 69.33 per cent followed by 21.33 percent of farmers used 25-30 kg acre^{-1} and remaining farmers use higher seed rate. A total of 30.67 percent of paddy-growing farmers adopted seed treatment practices. Some of the farmers also used *Pseudomonas* for seed treatment.

Safe handling of pesticide usage

It was observed that 73.33, 24.00, and 2.67 percent of paddy farmers simply threw empty pesticide bottles in the trash, utilized them for house or farm purposes, and sold them to buyers, respectively.

Table 1. Details of number of farmers and number of villages interviewed for pesticide usage pattern studies

	Block	Village	No. of farmers contacted
Tirunelveli	Palayamkottai	Melaputhaneri	4
		Ariyakulam & Therku ariyakulam	8
	Manur	Thenpathu	3
	Nanguneri	Anikulam	4
Thoothukudi	Srivaikundam	Tholappanpannai	7
		Ktk nagar	2
		Padmanabamangalam	3
	Satankulam	Velavan puthukulam	5
	Karunkulam	Seythunganallur	5
Kanyakumari	Thovalai	Naanalkaadu	4
		Aananthabadmanathapuram	4
	Thuckalay	Kalkurichi	5
Tenkasi	Shenkottai	Shenkottaimelur	5
		Vadakarai	4
	Kadayam	Sivasailam	4
		Pottal puthur	4
	Kilapavoor	Vellakkal	4
Total			75

Reference

Banayo, P.M.C., Haefele, S. M., Desamero, N. V and Kato, Y. 2017. On-far assessment of site-specific nutrient management for rainfed lowland rice in the Philippines. *Field Crops Research*. 220: 88-96.

Bekele, B. G. 2018. Review on integrated pest management of important disease and insect pest of rice (*Oryzae sativa* L.). *World Scientific News*. 100: 184-196.

Borthakur, S., Mishra, P., Talukdar, R. K and Bortamuly, D. 2015. Scaling the adoption of recommended rice production technology by the farmers in Assam state. *Indian Research Journal of Extension Education.* 15(2): 32-37.

Deviprasad, A. G., Radha, and Manonmani, H. K. 2015. Pesticide usage pattern in four districts of Karnataka: A survey. *Journal of Environmental Science, Toxicology and Food Technology.* 9 (10): 48-51

Jallow, M. F. A., Awadh, D. G., Albaho, M. S., Devi, V. Y and Thomas, B. M. 2017. Pesticide knowledge and safety practices among farm workers in Kuwait: Results of a survey. *Internatioanl Journal of Environmental Research and Public Health.* 14 (4): 340-347.

Survey of Fungal Leaf Spot Complex in Major Cotton Growing Areas of Tamil Nadu

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Keywords: *Cotton, leaf spot complex.*

Introduction

Cotton (*Gossypium* sp.) is the most ancient and important commercial crop next to food grains. Sixty percentage of the clothing in India is made from cotton. In India, the area of cotton is 37.5% of the global share. The cotton growing area in Tamil Nadu is 1.28 lakh hectares with production of 6 lakh bales (2019-20). The full potential of cotton production has not been exploited due to several biotic and abiotic factors. The crop is affected by many fungal diseases, among which foliar diseases causes severe loss of yield. Indian cotton fields are previously reported to be affected with fungal foliar diseases caused by species *Alternaria*, *Cercospora*, *Myrothecium* and *Corynespora* (AICCIP 2013-2014). The major cotton growing areas in Tamil Nadu are to be surveyed for the incidence of fungal leaf spot diseases which will give inputs for researchers and also extension workers to concentrate on those areas where the incidence is predominant and to unravel the factors responsible for the incidence. Hence, a survey of major cotton growing areas in Tamil Nadu was surveyed and the observations are discussed in the paper

Methodology

A systemic field survey was carried out in different fields of various districts of Tamil Nadu to assess the severity of fungal leaf spot disease complex of cotton. The cotton fields were selected randomly. The plants in the field were selected at random by selecting atleast 50 plants and the severity of the leaf spot complex was recorded. Plant showing the leaf spot symptoms were scored as per the severity grade of 0-4 and the per cent disease index were calculated as per the methodology suggested by Sheo Raj (1988) and Kalloo (1995) using the following formula,

$$\text{Per cent Disease Index (PDI)} = \frac{\text{Sum of all individual ratings}}{\text{Total number of leaves observed}} \times \frac{100}{\text{Maximum grade obtained}}$$

Results and Discussion

The survey was conducted in different locations of cotton growing areas in Coimbatore, Dharapuram, Dindigul, Madurai and Virudhunagar districts of Tamil Nadu. The severity was assessed by using 0-4 disease score scale. The PDI ranged from 8.5-19.8 **(Table 1)**. The maximum disease was observed at Arasappapillaipatti (19.8 PDI) of Dindigul district and was followed by Srivilliputtur of Virudhunagar (16.5 PDI). Minimum PDI of 8.5 was documented at K. Kallampatti of Madurai district. Major disease symptoms observed were *Cercospora, Alternaria* and *Myrothecium.* The disease spread is major in Coimbatore and Virudhunagar were control measures must be taken to prevent further spread.

Table 1. Survey for the occurrence of fungal leaf spot complex in cotton crop from Tamil Nadu.

S. No.	District(s)	Village(s)	Percent Disease Index
1	Coimbatore	Thottipalayam	15.4
		Kondayampalayam	13.2
		TNAU Farm	15.5
2	Dharapuram	Varapalayam	10.8
		Vadaparuthiyur	12.5
3	Dindigul	Karisalpatti	9.4
		Tettupatti	10.2
		KoonurPirivu	8.9
		ReddiarSathiram	12.7
		Arasaappapillaipatti	19.8
		Virupatchi	10.1
4	Madurai	Kallupatti	9.7
		Kadaneri	10.2
		Melavalasai	11.3
		K. Kallampatti	8.5
5	Virudhunagar	Kalkurichi	10.8
		Srivilliputtur	16.5

Reference

Sheo Raj, 1988, Grading for cotton disease, CICR, Nagpur. Tech. Bull, pp. 1-7.

Kaloo, G. 1995. Disease management – Technical Programme 1995-96 Chapter II. Disease control. Annual report (1994-95) Vegetable Research. ICAR Publication Project, Directorate of vegetable Research, Varanasi.

Synergistic Toxicity of Macro Marine Algal Extracts with Azadirachtin and β -Asarone Mixtures Against a Cosmopolitan Pest, *Spodoptera litura* Fabricius

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Keywords: *Spodoptera litura, Macroalgae, Azadirachtin, β-asarone and Insecticidal action.*

Introduction

The indiscriminate use of synthetic pesticides causes hazards to the environment and serious ill effects to humans. Macroscopic marine algae, one of the important living resources of ocean with a unique source of chemical compounds. Azadirachtin and β-asarone, active principles of *Azadirachta indica* and *Acorus calamus*, respectively possess various biological activities including anti-feedent, larvicidal, insecticidal, insect growth regulator, nematicidal and antimicrobial that offer novel approaches in Integrated Pest Management. The objective of our study was to study the combination toxicity of Azadirachtin, β-asarone and Macro algal extracts, in a crude mixture, against *Spodoptera litura* (Fab.) (Noctuidae: Lepidoptera) under laboratory condition.

Methodology

Red algae (Rhodophyta) *Acanthopora spicifera, Amphiroa fragilissima, Gracilaria corticata and Liagora ceranoides* and Brown algae (Phaeophyceae) *Padina pavonica, Turbinaria conoides* and *Sargassum weightii,* were collected from shallow sea of Hare island, Tuticorin, Tamil Nadu, India. The samples were washed and shade dried. One hundred gram of each sample was powdered and soaked in 250ml methanol for 32 hours, stirred by magnetic stirrer and the solvent was evaporated using rotary cum vacuum evaporator and thus the crude extract was used. Azadirachtin with 12% Purity and β-asarone with 75% purity were used for evaluation. The prepared solutions were sprayed on Castor leaf disc of 4 cm diameter and shade dried (Dry film technique). Ten treated leaf discs were kept in each Petri plate and ten uniform aged (II instar); 4 hours pre-starved larvae of *S. litura* were allowed to feed along with control. Data on the mortality of larvae were recorded every 12 hours up to adult emergence. The treatments include Azadirachtin alone, β-asarone alone, Macro algal extracts alone, Azadiractin + β-asarone, Azadirachtin + Macro algal extracts, β-asarone + Macro algal extracts, and Azadirachtin + β-asarone + Macro algal extracts.

Results and Discussion

Azadirachtin, β-asarone and eight species of macro algae were evaluated individually and in combination and the results are furnished in Table 1. The Macro algae, *Amphiroa fragilissima* and *Sargassum weightii* were effective at 10000 ppm with 50.00 and 70.00 percent larvicidal action, respectively, at 24 hours of treatment. The same algal extracts (@10000 ppm) when combined with the selected concentration of azadirachtin (500 ppm) and β-asarone (1000 ppm) showed increased mortality up to 70.00 and 90.00 percent exhibiting synergism in toxicity.

Reference

Kannan, R. and K. Bharath Kumar. 2016. Bioefficacy of two sea weed's methanol extract on growth and development of *Spodoptera litura* (F.). Ann. Pl. Protec. Sci., 24 (1): 1-5

Sahayaraj, K and Y. Mary Jeeva. 2012. Nymphicidal and Ovipositional efficiency of seaweed *Sargassum tenerrimum* (J.Agardh) against *Dydercus cingulatus*(F.). Chilean J. Agric. Res., 72 (1): 152-156.

Table: 1. Toxicity of Azadirachtin, Beta asarone, Algal extracts and their combinations against *S. litura*

Name of the active compounds		Concentration (ppm)	Percent mortality (24 hrs)
a. Azadirachtin alone		500	50.00^{c} (45.00)
		550	50.00^{c} (45.00)
		600	60.00^{c} (50.77)
		650	60.00^{c} (50.77)
		700	80.00^{b} (63.43)
		750	80.00^{b} (63.437)
		800	100.00^{a} (87.13)
		SEd	4.9605
		CD (0.05)	10.6404
b. Beta asarone alone		1000	20.00^{c} (26.56)
		1500	20.00^{c} (26.56)
		1550	20.00^{c} (26.56)
		1600	20.00^{c} (26.56)
		1650	20.00^{c} (26.56)
		1700	40.00^{b} (39.23)
		1750	40.00^{b} (39.23)
		1800	40.00^{b} (39.23)
		1850	40.00^{b} (39.23)
		1900	100.00^{c} (87.13)
		1950	100.00^{c} (87.13)
		2000	100.00^{c} (87.13)
		SEd	5.7018
		CD (0.05)	11.9792
c. Algal extracts alone	*Acanthopora spicifera*	8000	0.00 (1.28)
		10000	20.00 (26.56)
	Amphiroa fragilissima	8000	20.00 (26.56)
		10000	50.00 (45.00)
	Gracilaria corticata	8000	10.00 (18.43)
		10000	40.00 (39.23)
	Liagora ceranoides	8000	0.00 (1.28)
		10000	30.00 (33.21)
	Padina pavonica	8000	0.00 (1.28)
		10000	30.00 (33.21)
	Sargassum weightii	8000	30.00 (33.21)
		10000	70.00 (56.78)
	Turbinaria conoides	8000	0.00 (1.28)
		10000	20.00 (26.56)

Combination of active compounds		Concentration (ppm)	Percent toxicity (24 hrs)
d. Azadirachtin + Beta asarone		500+1000	60.00^{c} (50.33)
		500 + 1650	60.00^{c} (50.33)
		550 + 1700	60.00^{c} (50.33)
		600 + 1750	70.00^{bc} (56.78)
		650 + 1800	70.00^{bc} (56.78)
		700 + 1850	70.00^{bc} (56.78)
		750 + 1900	80.00^{ab} (63.43)
		800 + 1950	90.00^{ab} (71.76)
		SEd	5.0403
		CD (0.05)	10.8114
e. Azadirachtin + Algal extracts	*Amphiroa fragillisima*	500 + 10000	60.00^{b} (50.77)
		550 + 10000	60.00^{b} (50.77)
		600 + 10000	70.00^{b} (56.78)
		650 + 10000	70.00^{b} (56.78)
		700 + 10000	90.00^{a} (71.76)
		750 + 10000	90.00^{a} (71.76)
		800 + 10000	90.00^{a} (71.76)
		SEd	7.4635
		CD (0.05)	16.0093
	Sargassum weightii	500 + 10000	70.00^{c} (56.78)
		550 + 10000	70.00^{c} (56.78)
		600 + 10000	80.00^{bc} (63.43)
		650 + 10000	80.00^{bc} (63.43)
		700 + 10000	90.00^{ab} (71.76)
		750 + 10000	90.00^{ab} (71.76)
		800 + 10000	100.00^{a} (87.13)
		SEd	6.7605
		CD (0.05)	14.5013
f. Beta asarone + Algal extracts	*Amphiroa fragillisima*	1000 + 10000	40.00^{b} (39.23)
		1650 + 10000	40.00^{b} (39.23)
		1700+ 10000	40.00^{b} (39.23)
		1750 + 10000	50.00^{b} (45.00)
		1800 + 10000	50.00^{b} (45.00)
		1850 + 10000	70.00^{a} (56.78)
		1900 + 10000	70.00^{a} (56.78)
		1950 + 10000	80.00^{a} (63.43)
		2000 + 10000	80.00^{a} (63.43)
		SEd	5.2113
		CD (0.05)	11.0476
	Sargassum weightii	1000 + 10000	50.00^{c} (45.00)
		1650 + 10000	50.00^{c} (45.00)
		1700+ 10000	50.00^{c} (45.00)
		1750 + 10000	60.00^{bc} (50.77)
		1800 + 10000	60.00^{bc} (50.77)
		1850 + 10000	80.00^{ab} (63.43)
		1900 + 10000	80.00^{ab} (63.43)
		1950 + 10000	90.00^{a} (71.76)
		2000 + 10000	90.00^{a} (71.76)
		SEd	6.6812
		CD (0.05)	14.1637
g. Azadirachtin + Beta asarone + Algal extracts	**Azadiractin + Beta asarone +** ***Amphiroa fragilissima***	500+1000+10000	70.00 (56.78)
	Azadiractin + Beta asarone + ***Sargassum weightii***	500+1000+10000	90.00 (71.76)

Values are the mean of three replicates; values enclosed in parantheses are arc sine transformed values; means followed by common alphabet are not significantly different at 5% level by LSD.

Synthesis and Evaluation of Colloidal Chitosan against Diamondback moth, *Plutella xylostella* L. (Lepidoptera: Plutellidae) on Cauliflower

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Keywords: Plutella xylostella, Colloidal Chitosan, Standardization, Characterization, Toxicity and Antifeedant

Introduction

Diamondback moth *Plutella xylostella* L.is an invasive and economically important pest of crucifers in Tamil Nadu, which cause 50 to 80% annual yield loss in crucifers (Gautam *et al.*, 2018). Farmers often resort to prophylactic and calendar based insecticides application, which lead to resurgence, resistance and residue problem in addition to environment pollution and destruction of natural enemies. With this view, research was carried out to find ecofriendly solution for this destructive pest. In this study, chitosan derivative was synthesized, characterized and evaluated for its toxicity against *P. xylostella*.

Methodology

The present investigation was conducted at Natural Pesticide Laboratory, Department of Agriculture Entomology, Agricultural College and Research Institute, Madurai during 2020-2021. Crude chitosan flakes (10g) were dissolved in 1500 ml of 0.2N Hydrochloric acid for one hour by intermittent stirring and digested overnight. After digestion, pH was adjusted to 5.5 by using 0.2 N NaOH and 0.1 N HCl. After neutralization, the chitosan was centrifuged (model: Velocity 14R) at 7000 rpm for 5 mins and sediment was collected and freeze dried in lyophilizer (model: Scan Vac) (Cruz *et al.*, 2004). This synthesized colloidal chitosan was standardized for its solubility, Degree of Deacetylation (DD), Water Binding Capacity (WBC) and Viscosity. The presence of reactive functional groups of chitosan and colloidal chitosan characterized by Fourier-transform infrared (FTIR) spectroscopy. To evaluate the effect of colloidal chitosan against second instar *P.xylostella* larva, leaf dip bioassay method was followed. Observation was recorded on larval mortality, feeding area at 24, 48 and 72 h after treatment, estimated per cent mortality and antifeedant index (Badawy and El- Aswad 2012).

Results and Discussion

The LC_{50} and LT_{50} value of colloidal chitosan was 8609.81 ppm and 45.70 h, respectively. It is concluded that colloidal chitosan is having toxicity and antifeedant effect against *P.xylostella*.

Table 1. Standardization of colloidal chitosan

S.No	Chitin Derivatives	Solubility (%)	DD (%)	WBC (%)	Viscosity
1	Chitosan	36.2	56	40	92
2	Colloidal Chitosan	87	85.3	724	452

Table 2. Toxicity and antifeedant effect of Colloidal chitosan on *Plutella xylostella*.

Treatment	Cumulative Mortality (%)*			Antifeedant Index (%)*		
	24 HAT	48 HAT	72 HAT	24 HAT	48 HAT	72 HAT
T1 – Colloidal chitosan 3000ppm	0.00 (0.66)e	6.70 (15.00)de	13.40 (21.47)c	34.56 (36.01)c	46.22 (42.83)b	47.49 (43.56)c
T2 – Colloidal chitosan 6000ppm	3.33 (10.51)d	13.40 (21.47)d	20.20 (26.70)c	40.53 (39.52)b	48.98 (44.42)b	51.10 (45.63)bc
T3 – Colloidal chitosan 8000ppm	13.33 (21.41)c	36.90 (37.40)c	50.50 (45.28)b	43.92 (41.50)b	48.43 (44.10)b	55.15 (47.96)b
T4 – Colloidal chitosan 10000ppm	26.67 (31.09)b	60.40 (51.00)b	74.07 (59.39)a	67.43 (55.20)a	72.38 (58.29)a	73.36 (58.92)a
T5 – Acetic acid 1%	0.00 (0.66)d	0.00 (0.66)e	0.00 (0.66)d	2.55 (9.19)d	2.17 (8.48)c	2.76 (9.57)d
T6 – Tween80 0.05%	0.00 (0.66)d	0.00 (0.66)e	0.00 (0.66)d	1.39 (6.77)d	1.29 (6.53)c	1.24 (6.41)d
T7 – Azadirachtin 700ppm	40.00 (39.21)a	70.47 (57.06)a	80.80 (64.01)a	66.02 (54.34)a	74.16 (59.84)a	74.76 (59.45)a
T8 – Control	0.00 (0.66)e	0.00 (0.66)e	0.00 (0.66)d	-	-	-
Sed	0.40	0.36	0.52	2.46	1.44	1.92

HAT – Hours After Treatment; Figures in parentheses are arc sine transformed values; Means in a column followed by the same letters are not significantly different (p = 0.05) by DMRT; *Mean of the three replications, SEd: Standard Error of the difference.

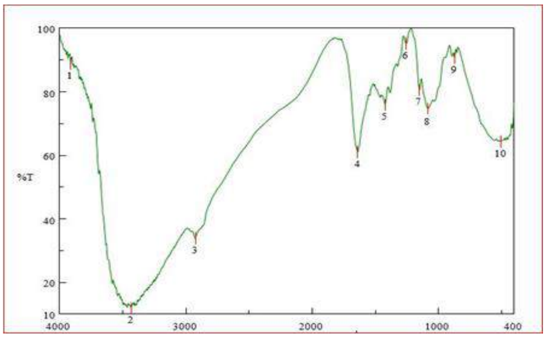

Fig 1. Fourier transform-infrared spectrometry of chitosan

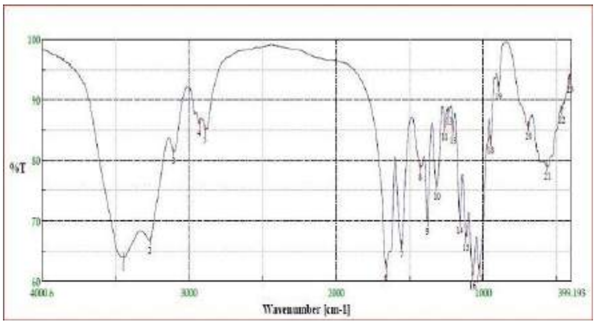

Fig .2. Fourier transform-infrared spectrometry of colloidal chitosan

Reference

Badawy M.E.I., El-Aswad A.F. (2012): Insecticidal activity of chitosan of different molecular weights and chitosan-metal complexes against cotton leafworm *Spodoptera littoralis* and oleander aphid *Aphis nerii*. Plant Protect. Sci., 48: 131–141.

Cruz C.R, Sanchez P. O, Rojas A. N.G, Gomez R.M, Rojas A. L.I. 2004. Chitosanase activity of *Bacillus thuringiensis*. *Folia Microbiologica*. 49 (1): 94-96.

Gautam, M.P, Hem Singh, Sushil Kumar, Vinod Kumar, Gajendra Singh and SN Singh.2018. Diamondback moth, *Plutella xylostella* (Linnaeus) (Insecta: Lepidoptera: Plutellidae) a major insect of cabbage in India. *Journal of Entomology and Zoology Studies*. 6(4): 1394-1399.

Synthesis of N Alkyl Chitosan and their Toxicity and Antifeedant Effect Against *Spodoptera frugiperda*

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Keywords: *Chitosan, N alkyl chitosan, Spodoptera frugiperda, Antifeedant, Toxicity*

Introduction

Chitosan was obtained by dealkylation of chitin and first produced in France during 1859 by Prof. Rouget and its production involves chemical process of raw shell of sea wastes by deproteination, demineralization and discoloration (Arbia *et al.*, 2013). Fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) is one of the most important pests of maize, suddenly appeared in India 2018 and other cereal crops. Quick dispersal of fall armyworm warranted frequent spraying of chemical pesticides in Indian subcontinent. With this background, synthesis of chitosan derivative was taken up and their antifeedant and toxicity effect was evaluated against *S. frugiperda*.

Methodology

This study The N- Alkyl chitosan derivative was synthesized adopting the method suggested by (Sahebzadeh *et al.*, 2017) with slight modification. The crude chitosan flakes (3g) mixed with glacial acetic acid (v/v) and then dimethyl amino benzaldehyde was added. Then aqueous Sodium borohydride (NaBH4) solution was added for reduced hydrolysis and stirred for 90 min. During this reaction, the yellow colour in the solution disappeared and became translucent. The N-alkyl derivative was precipitated by adjusting the pH of the solution to 10. Then the precipitate was washed with distilled water to remove the unreacted aldehyde.

Finally, the precipitate of N-alkyl derivative was extracted using ethyl alcohol-diethyl ether (1:1) (v/v) in Soxhlet apparatus for 48 hrs. Later, the residue was oven-dried overnight at 60°C. The resultant N-alkyl chitosan (NAC) was sieved and stored in refrigerator until further use for bioassay. Percent mortality of larvae were observed for all the treatments individually at 24, 48 and 72 hrs after release of larva (Abbott, 1925).

Results and Discussion

Mean per cent mortality of *S. frugiperda* larva was 64.84 per cent when treated with N alkyl chitosan at 5000 ppm, similar effect was recorded in Azadirachtin 1 % (73.33%). The next best treatment was 4000 ppm (48.10%) **(Table 1).** The data were subjected to Probit analysis and found that the LC_{50} and LC_{95} of N alkyl chitosan were 3702.18 and 5355.27 ppm respectively. Lethal time for causing 50 and 95 per cent mortality were 32.28 and 108.11 hours after treatment respectively (Table 2).

Table 1. Toxicity effect of N-alkyl chitosan derivative against first instar larva of fall armyworm, *S. frugiperda*

Treatments	Mean cumulative mortality (%)#			Mean (%)
	24 HAT	48 HAT*	72 HAT*	
T_1 - N-alkyl chitosan derivative - 1000 ppm	8.00 (16.42)^d	16.73 (24.13)^d	26.93 (31.25)^c	16.77 (24.17)^D
T_2 - N-alkyl chitosan derivative - 2000 ppm	12.00 (20.25)^{cd}	20.10 (26.62)^{cd}	33.67 (35.45)^c	21.25 (27.44)^D
T_3 - N-alkyl chitosan derivative - 3000 ppm	16.00 (23.56)^{bc}	30.20 (33.32)^c	50.00 (45.27)^b	32.45 (34.71)^{CD}
T_4 - N-alkyl chitosan derivative - 4000 ppm	30.00 (33.19)^b	50.33 (45.17)^b	63.97 (53.09)^{ab}	48.10 (43.89)^{BC}
T_5 - N-alkyl chitosan derivative - 5000 ppm	54.00 (47.27)^a	63.77 (52.97)^{ab}	77.44 (61.61)^a	64.84 (53.61)^{AB}
T_6 – Solvent (Aqueous glacial acetic acid 1 %)	4.00 (11.53)^d	3.33 (10.51)^e	3.36 (10.56)^e	4.45 (15.71)^E
T_7 – Surfactant (Tween 20 - 0.1%)	0.00 (0.66)^e	0.00 (0.66)^e	0.00 (0.66)^e	0.00 (0.66)^F
T_8 –Azadiractin 1%	63.33 (52.71)^a	73.80 (59.19)^a	84.17 (66.53)^a	73.73 (59.14)^A
T_9 – Untreated check	0.00 (0.66)^e	0.00 (0.66)^e	0.00 (0.66)^e	0.00 (0.66)^F
Mean (%)	16.5 (31.88)^C	23.05 (28.68)^B	31.92 (34.38)^A	
Sed	1.31	1.30	1.10	1.46
CD (0.05)	2.76	2.74	2.33	3.07

#Numeric data represent the mean value of five replications, HAT – Hours After Treatment. Figures in parentheses are arcsine transformed values. Mean values followed by the same alphabet in a column are not significantly different (P = 0.05) by LSD. *Abbotts corrected mortality.

Table 2. Dosage mortality response of first instar *S. frugiperda* larva to N-alkyl chitosan derivative

Test sample	χ^2	LC_{50} (ppm)	Fiducial Limits (50%)		LC_{95} (ppm)	Fiducial Limits (95%)	
			UL	LL		UL	LL
	7.81	3702.18	3506.10	3909.22	5355.27	4787.66	5990.17

Reference

Abbott WS (1925) A method of computing the effectiveness of an insecticide. Journal of Economic Entomology 18(2):265-267

Arbia W, Arbia L, Adour L, Amrane A (2013) Chitin extraction from crustacean shells using biological methods a review. Food Technology and Biotechnology 51(1):12-25.

Sahebzadeh N, Ghaffari-Moghaddam M, Sabagh SK (2017) Toxicity of N-alkyl Derivatives of Chitosan Obtained from Adult of *Chrotogonus trachypterus* (Orthoptera, Acrididae) against the Wheat, Cabbage and Oleander Aphid (Hemiptera: Aphididae) Species. Jordan Journal of Biological Sciences 10(1):45-55.

Viruses Harboring in Weed Hosts During the Cropping Season and Off-seasons in Brinjal Ecosystem

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Keywords: *Begomovirus, Cucumber mosaic virus, PCR, RT-PCR, Serology*

Introduction

Brinjal (*Solanum melongena* L.) is a *Solanaceae* vegetable crop grown in tropical and sub-tropical regions all over the world for its edible fruit and rich nutritive values. It is commonly known as eggplant, it belongs to Indian origin and India is the second largest producer in the world. The total cultivated area in India is around 0.7 million hectares with a production of 12.5 million tonnes and productivity of around 17 tonnes per hectare (https://www.indiastat.com).India contributes about 24.5% in global market (https://en.wikipedia.org/wiki/Eggplant). Apart from lossess caused by mollicutes, nowadays the crop is adversely affected by many viruses which are commonly infecting the Solanaceous crops / plants. The weed plants in and around the brinjal ecosystem play a principal role in harboring viruses both during the season and off-seasons of the crop. The research is focused on detection of viruses in weed hosts in brinjal ecosystem through serological and molecular techniques in order to find out the sources of inocula and to identify the collateral hosts of these viruses.

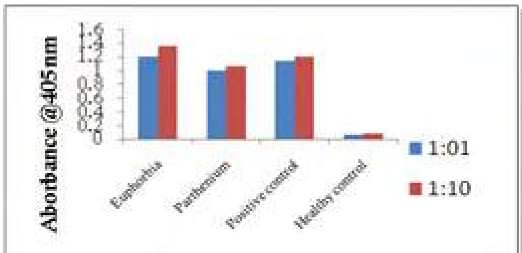
Methodology

Euphorbia spp. and *Parthenium hysterophorus* present in the brinjal ecosystem exhibited mosaic, mottling, curling and short internodes symptoms in Tamil Nadu. The leaf samples were collected from those plants. Protein from infected weed samples were extracted and subjected to DAC and DAS-ELISA for preliminary diagnostic evaluation of the viruses in these plants. Later, the total DNA and RNAs were extracted using CTAB and TRI reagent method for the identification of viruses from the infected weed samples. PCR and RT-PCR were performed using Begomovirus specific universal primers, PALIc 1960 5′ ACNGGNAARACNATGTGGGC 3′ and PALIr772 5′ GGNAARTHTGGATGGA3′ (Nagendran *et al*., 2016) and Cucumber mosaic virus coat protein specific primer pair, GK CMV CP F 5′GAGTTCTTCCGCGTCCCGCT; GK CMV CP R 5′ AAACCTAGGAGATGGTTTCA (Vinodhini *et al*., 2020). Positive amplicons were sequenced at M/s. Barcode Bioscience, Bangalore and the sequence were analyzed using NCBI and CLUSTALW. Multiple alignments of nucleotide and amino acid sequences were carried out using BioEdit sequence alignment editor version 7.0 by retrieving sequences from NCBI database. The phylogenetic tree was constructed by Neighbor-joining tree method with 1000 bootstrap replication using MEGA 7.0 software.

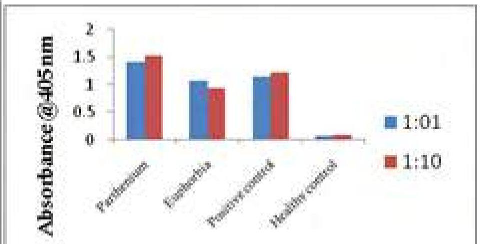
Results and Discussion

Cucumber mosaic virus was detected in DAC-ELISA in *Euphorbia* spp. and *Parthenium* samples. The *Euphorbia* sample showed high titre compared to *Parthenium* samples in DAC-ELISA. Similarly, in DAS-ELISA both the samples showed positive reaction for Begomovirus. *Parthenium* samples showed high titre compared to *Euphorbia*. In the RT-PCR for CMV, both the weed samples showed positive amplicon of ~1.1kb and the PCR for Begomovirus amplified around 1.2kb amplicon in both the samples. The CMV amlicons of *Euphorbia* and *Parthenium* were sequenced and upon sequence analysis, CMV showed 97 and 96 % identity with other CMV isolates of India infecting various vegetables crops, respectively. Similarly, the Begomovirus amplicons had 98 and 96% identity with other Indian isolates of ToLCNDV infecting vegetable crops in *Parthenium* and *Euphorbia* samples, respectively. On contrary, with brinjal isolates the CMV exhibited 95 and 94 % identity and ToLCNDV had 97 and 96 % identity in both

Euphorbia and *Parthenium*, respectively. Upon phylogenectic analysis of both CMV and Begomovirus sequences, they clustered along with brinjal isolates of Tamil Nadu and forms separate clade. Weed host play significant role in harboring many viruses and vectors both during the season and off-season of the cropping system. The results of the present study clearly indicates that the weed hosts acting as a major reservoir for the viruses and vectors. Susheel *et al.* (2016) reported *Parthenium* grows in the agriculture land of Lucknow was found to be infected with Tomato leaf curl virus (ToLCV) including the α and β-satellites of the virus and it acted as a natural reservoir host for ToLCV. Apart from Begomovirus, *Parthenium* was also found to be infected by other viruses *viz.*, GBNV (Vemana *et al.*, 2015), Potyvirus and Potexvirus (Cordeo *et al.*, 1983) and Tobacco streak virus (Sharma *et al.*, 2009). Apart from notorious, aggressive destructive weed in farming community, they started threatening, as reservoir for many plant viruses.



DAC-ELISA for detection of CMV in weed hosts



DAS-ELISA for detection of ToLCNDV in weed hosts

Reference

Gopal K, Muniyappa V, Jagadeeshwar R (2010) Weed and crop plants as reservoirs of viruses and its occurrence in South India. Archives of Phytopathology and Plant Protection 44(12): 1213-1224

Nagendran K, Satya V K, Mohankumar S and Karthikeyan G (2016). Molecular characterization of a distinct bipartite Begomovirus species infecting ivygourd (*Coccinia grandis* L.) in Tamil Nadu, India. Virus Genes 52: 146–151

Susheel K, Ashish S, Meraj J, Puneet S C and Raj S. K (2016). Molecular Characterization of a Begomovirus, α-Satellite, and β-Satellite Associated with Leaf Curl Disease of *Parthenium hysterophorus* in India. Plant Disease, 100: 2299-2305.

Vinodhini, J., Rajendran, L., Raveendran, M., Rajasree, V and Karthikeyan, G. 2020. Characterization of cucumber mosaic virus (CMV) subgroup IB infecting chilli in Tamil Nadu, India. 3 Biotech 10:500 1-10

Volatile Mediated Pest Management and Lactic Acid Bacteria Mediated Residue Management in Bhendi

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Keywords: *Volatile mediated, Lactic acid bacteria, residue management, Bhendi.*

Introduction

Sucking pest whiteflies, *Bemisia tabaci* limit the crop growth from the early stages, cause heavy yield loss in bhendi. Imidacloprid is the most commonly used insecticide for the management of sucking pests despite ecological implications. Plant volatiles have multiple ecological roles in plant-insect interactions as direct defense or indirect defense in pest control. With the above background the present study was undertaken to analyse the rate of pest and pesticide residue management by a milk-made lactic acid bacterial rich colloidal formulation - a bio-ameliorant referred as milkoid.

Methodology

The experiment was conducted at Anbil Dharmalingam Agricultural College and Research Institute. In field, bhendi plants raised were evaluated in a randomized block design (RBD) with seven treatments and three replications. Imidacloprid 17.8% SL was sprayed at 0.2 ml /litre of water. The lactic acid bacterial formulation, called milkoid, was prepared according to Elakkiya *et al*. (2019) and sprayed at 2.0 % with three controls. Whitefly was recorded in weekly intervals. Residue dissipated during vegetative was analysed for 15 days alternatively using HPLC. Plant volatiles were identified using GC-MS system.

Results and Discussion

The diseased plants by YMV were significantly less numerous in plots treated with imidacloprid / bleaching powder (14.17%), on par with imidacloprid (16.67%) (Table 1). The disease incidence was significantly moderate in plots treated with imidacloprid / milkoid (24.58%) and also has highest dissipation range (Table 2). Milkoid alone or in combination with imidacloprid treated leaves had produced valeric anhydride (Table.3) which is the major compound produced by *Lactobacillus* strains Nakae Elliot (1964). Malonic acid used in insect pest management (Beadle *et al*., 1997) was found in the leaves sprayed with bleaching powder. Benzoic acid obtained from both milkoid treated leaves, found to contain anti-fungal property Wang *et al*., 2012. Moreover, both LAB and bleaching powder are likely to influence host-finding by insects as well since microbial.

Table 1. *B. tabaci* transmitted YMV-infected plants after spraying imidacloprid, milkoid and bleaching powder in bhendi

Treatments	YMV-infected plants (%)		Mean
	Week 1	Week 2	
Imidacloprid 17.8% SL 2 ml / 10 Lit	22.50 (28.32)	10.83 (19.22)	16.67 (23.72)[a]
Imidacloprid 17.8% SL 2 ml / 10 Lit / Milkoid spray 2%	31.67 (34.24)	17.50 (24.73)	24.58 (29.34)[b]
Imidacloprid 17.8% SL 2 ml / 10 Lit/ Bleaching powder 1.0% spray	20.83 (27.16)	7.50 (15.89)	14.17 (21.50)[a]
Milkoid spray 2%	68.33 (55.76)	63.75 (52.98)	66.04 (54.39)[d]

Bleaching powder 1.0% spray	35.83 (36.77)	47.08 (43.33)	41.46 (40.03)c
Water spray	91.25 (72.79)	87.08 (68.94)	89.17 (71.06)e
Untreated control	95.00 (77.08)	90.00 (71.57)	92.50 (74.42)e
Mean	52.20 (46.26)	46.25 (42.85)	49.23 (44.56)
CD (P = 0.05)			4.46
SED			2.17

Mean of 3 replications; Figures in parenthesis are arc sin transformed values; Means followed by the same letter are not significantly different; YMV, yellow vein mosaic virus

Table 2. Volatile profiles analysed from milkoid using GC-MS

S. No.	Milkoid	Imidacloprid	Milkoid + Imidacloprid	Bleaching powder
1.	Benzoic acid	Oxalic acid	Trifluroacetic acid	Oxalic acid
2.	Ethanone	Trifuroacetic acid	Valeric anhydride	Malonic acid
3.	Valeric anhydride	Aziridine	Benzoic acid	Aziridine
4.	Oxalic acid	Ethanones	Oxalic acid	2-propene-1-amine
5.	2-propenamide	-	Ethanone	-

Reference

Wang H., Yan Y., Wang J., Zhang H., Qi W. (2012). Production and Characterization of Antifungal Compounds Produced by Lactobacillus plantarum IMAU10014. PLoS ONE, 7(1): 29452. doi:10.1371/journal.pone.0029452

Nakae, T, and JA Elliott. 1965. "Volatile fatty acids produced by some lactic acid bacteria. I. Factors influencing production of volatile fatty acids from casein hydrolysate." Journal of Dairy Science 48(3):287-292.

Volatilomes Mediated Antifungal Activity against *Fusarium oxysporum* f. sp. *lycopercisi* Infecting Tomato

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Keywords: *M. spicata, VOCs, Antifungal efficacy, Vermiculite ball*

Introduction

Tomato (*Lycopersicon esculentum*) is one of the most popular and high yielding versatile crops in India, because of its rich source in mineral, vitamins and organic acids. The wilt disease incited by *Fusarium oxysporum* f. sp. *lycopersici* (FOL) is a major devastating, hemi-bio trophic and soil inhabitant pathogens infecting tomato in major growing regions of world. For several years, application of fungicides and soil fumigants such as methyl bromide were the most practices control measures against soil borne fungal pathogens. A constant application of chemical fungicides adversely affects the soil microbial community and crop productivity in addition to environment pollution and residual toxicity to human being. Over the years, novel attempts are extensively used to manage the soil borne fungal pathogens in and integrated way. Use of natural volatile organic compounds (VOCs) produced by plants will have a greater stokehold directly or indirectly for the management of soil borne plant pathogens.

Methodology

The potential VOCs produced by the leaves of mint (*Mentha spicata*), lemongrass (*Cymbopogon citratus*), coleus (*Coleus amboinicus*), nochi (*Vitex negundo*), tulasi (*Ocimum tenuiflorum*), neem (*Azadirachta indica*) and vetiver (*Vetiveria zizanioides*) were screened for antifungal activity against *F. o.* f.sp. *lycospercisi*by sealed plate method as described by (Dennis and Webster, 1971)..Volatilomes produced by the leaves of plant sampled were were trapped and analyzed using air - entrainment technique with slight modification (Blight, 1990). The trapped volatilomes were immediately analyzed by HS-GCMS using Thermo GC injector coupled with Mass Spectrophotometer. The hexane extract of plant sample and the pure standard VOCs (Sigma Aldrich) were tested against the target pathogens using bipartite plate method.

Results and Discussion

Screening of Plant Volatilomes

The volatilomes produced by the leaves of *M. spicata* and*C. citratus* effectively inhibited the mycelial growth of *F. o.* f.sp. *lycospercisi* (**Table 1**). The sporulation behaviour of the pathogen was poorly infected on exposed to the volatilomes of *M. spicata.*

Collection and identification of VOCs

The volatiles emitted from the leaves of *M. spicata* and *C. citratus* were trapped and subjected to HS-GCMS analysis. It revealed the presence of 25 and 26 volatile organic compounds (VOCs) from the leaves of *M. spicata* and *C. citratus*, respectively. Among the diversified VOCs, carvone (MW: 150; 2.08 per cent area) from *M. spicata* and citronellol (MW: 156; 5.27 per cent area) from *C. citratus* leaves were identified as important VOCs
(Figure1)

Table 1. *In vitro* screening of plant volatilomes

Sample	Mycelial growth (mm)	%Inhibition over control (PI)
C. amboinicus	89.33d	0.74
O. tuniflorum	72.33c	19.63
M. spicata	52.30a	41.89
C. citratus	54.30a	39.67
V. negundo	59.00b	34.44
A. indica	90.00d	0.00
V. zizanioides	90.00d	0.00
Control	90.00d	0.00
CD (P = 0.05)	0.55	

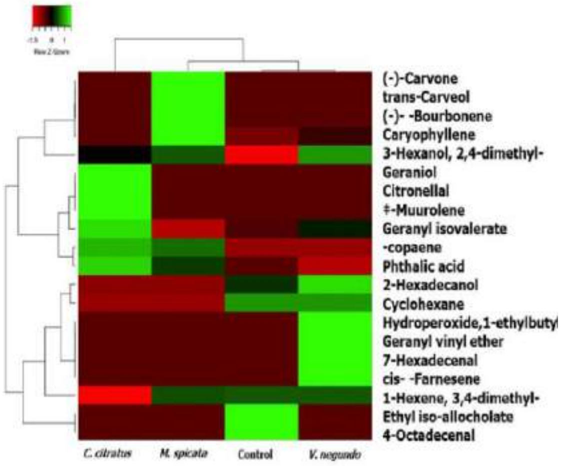

Figure 1. Heatmap on comparative analysis of plant volatilomes

Testing the effect of pure VOCs on pathogen suppression

The volatilomes exposed to*M. spicata* extract and carvone were found to be the highest inhibition against the pathogens. The mycelia of pathogens were floccose with sparse appearance with poor sporulation than white cottony thick mycelial growth in the unexposed control plate (**Figure 2 and 3).**

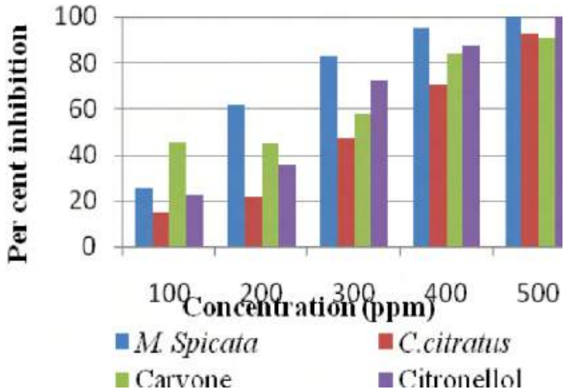

Figure 2. Effect of VOCs on pathogen

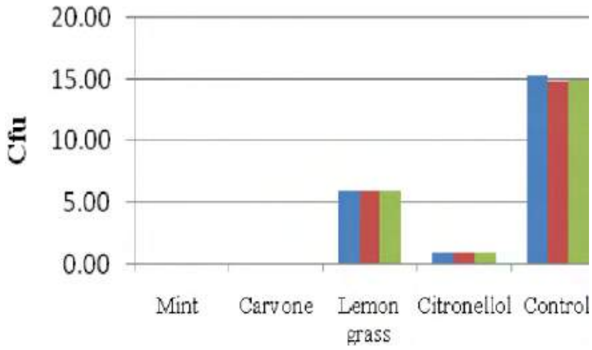

Figure 3. Effect of VOCs on sporulation behaviour of the pathogen

Reference

Dennis, C. and Webster, J. 1971. Antagonistic properties of species-groups of *Trichoderma*: II. Production of volatile antibiotics. ***Trans. Br. Mycol. Soc.***, 57(1):41–48.

Blight, M.M. 2019. Techniques for isolation and characterization of volatile semiochemicals of phytophagous insects. Chromatography and isolation of insect hormones and pheromones. New York (NY): ***Plenum Press,*** 281–288.

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THEME 04

Enhancing Sustainable Use of Natural Resources for Enhancing Food Production

Altering the Physiological Response of Compact Cotton by Application of Bio-Stimulants to Enhance Yield

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Keywords: *Cotton, bio-stimulants, physiology, yield*

Introduction

Cotton is the most important cash crop and has significant role in improving the agricultural economy of the country. Cotton production and consumption encounters major challenges and this fluctuation warrants new research and innovations to increase the cotton production substantially worldwide. Bio-stimulants can be an interesting alternative to formulate an efficient and eco-friendly strategy for the management of cotton crop. With this background, the present experiment was taken to study the impact of bio-stimulants on growth, physiology and yield in cotton.

Methodology

The present work was carried out during *Rabi* season, 2020 in Field No. 37 at Eastern block farm, Tamil Nadu Agricultural University, Coimbatore. The experiment was executed in a randomized block design with six replicates and seven treatments in the newly released compact cotton variety, CO 17. The treatments *viz.*, T1 - Control, T2 - *Enterobacter hormaechei* – 10 kg ha^{-1}, T3 - *Enterobacter hormaechei* – 20 kg ha^{-1}, T4 - *Glomus intraradices* –10 kg ha^{-1}, T5 - *Glomus intraradices* – 20 kg ha^{-1}, T6 - *Bacillus subtilis* – 10 kg ha^{-1} and T7 - Consortium of VAM with Vitamins and amino acids – 10 kg ha^{-1}. Cotton seedlings were treated with the above inoculants at 7 DAS (Days after sowing) and the crop was maintained under irrigated condition from sowing to harvest. During flowering stage, observations on leaf area (cm^2), chlorophyll index, Normalized Difference Vegetative Index (NDVI), photosynthetic rate (µmol CO_2 m^{-2} s^{-1}) and yield traits were recorded.

Results and discussion

Soil application of different bio-stimulants exhibited significant effect on growth, physiological and yield characters of cotton compared to control. Consortium of VAM with vitamins and amino acids at the rate of 10 kg ha^{-1} resulted on higher leaf area (2345.09 cm^2) which leads to the accumulation of more photosynthetic pigments. Likewise, the treatment T7 - Consortium of VAM with vitamins and amino acids yields higher chlorophyll index (42.1), Normalized Difference Vegetation Index (NDVI) values (0.83), photosynthetic rate (33.17 µmol CO_2 m^{-2} s^{-1}) and ascertained its supremacy by registering maximum boll weight (4.94 g) and seed cotton yield (651.73 kg ha^{-1}). These results are in accordance with Turhan *et al.* (2020) and Hassani *et al*., 2014. It can be concluded from the study that arbuscular mycorrhizal fungi (AMF) inoculated plants exhibited increased leaf area, photosynthetic pigments and rate of photosynthesis, which can contribute to significant yield increase (16.76 %) over control.

Fig.1. Effect of bio-stimulants on Leaf Area (cm^2) at flowering stage of compact cotton CO 17

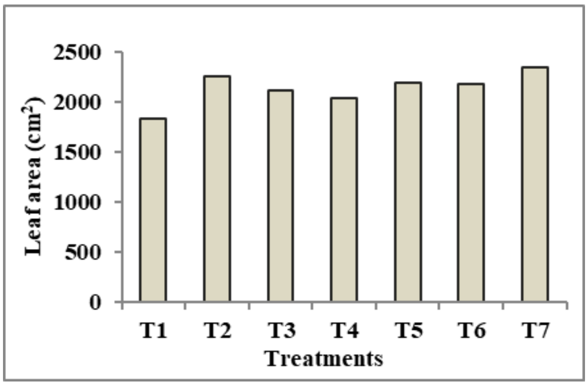
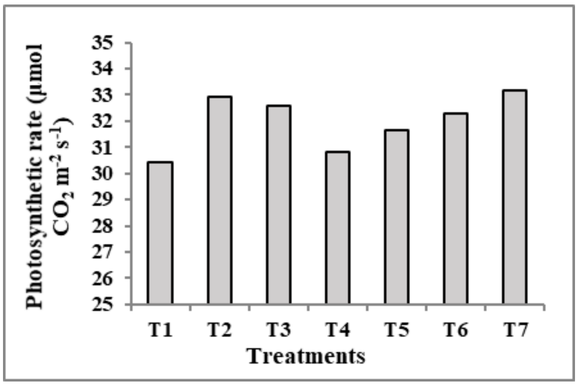


Fig.2. Effect of bio-stimulants on Photosynthetic rate (µmol CO_2 m^{-2} s^{-1}) at flowering stage of compact cotton CO 17



T1 - Control, T2 - *Enterobacter hormaechei* – 10 kg ha^{-1}, T3 - *Enterobacter hormaechei* – 20 kg ha^{-1}, T4 - *Glomus intraradices* –10 kg ha^{-1}, T5 - *Glomus intraradices* – 20 kg ha^{-1}, T6 - *Bacillus subtilis* – 10 kg ha^{-1} and T7 - Consortium of VAM with Vitamins and amino acids – 10 kg ha^{-1}.

Table 1. Effect of bio-stimulants on Chlorophyll index, NDVI and yield traits

Treatments	SPAD	NDVI	Boll weight (g)	Yield (kg/acre)
T1 - Control	39.2^{b}	0.77^{b}	4.08^{c}	558.19^{c}
T2 - *Enterobacter hormaechei* – 10 kg ha^{-1}	41.6^{ab}	0.82^{a}	4.61^{ab}	649.52^{a}
T3 - *Enterobacter hormaechei* – 20 kg ha^{-1}	41.2^{ab}	0.82^{a}	4.50^{bc}	636.62^{ab}
T4 - *Glomus intraradices* –10 kg ha^{-1}	42.0^{a}	0.83^{a}	4.33^{bc}	606.63^{b}
T5 - *Glomus intraradices* – 20 kg ha^{-1}	42.0^{a}	0.81^{a}	4.35^{bc}	625.35^{ab}
T6 - *Bacillus subtilis* – 10 kg ha^{-1}	42.6^{a}	0.82^{a}	4.92^{a}	640.13^{ab}
T7 - Consortium of VAM with Vitamins and amino acids – 10 kg ha^{-1}	42.1^{a}	0.83^{a}	4.94^{a}	651.73^{a}
Mean	41.5	0.81	4.53	624.02
SEd	1.09	1.46*	0.18**	15.81**
CD (*P*=0.05)	2.22	2.99	0.37	32.30

Values are mean of replicates; values followed by the same letter in each column are not significantly different from each other as determined by DMRT ($p \leq 0.05$).

References

Turhan, A. 2020. Interactive effects of boron stress and mycorrhizal (AMF) treatments on tomato growth, yield, leaf chlorophyll and boron accumulation, and fruit characteristics. *Archives of Agronomy and Soil Science.*, 22(3):1-12.

Hassani, F, Ardakani, M, Asgharzade, A, Paknezhad, F, Hamidi, A. 2014. Efficiency of mycorrhizal fungi and phosphate solubilizing bacteria on phosphorus uptake and chlorophyll index in potato plantlets. *International Journal of Biosciences.*, 4 (1): 244-251.

An Economic Analysis of Organic Farming Through Participatory Guarantee Scheme (PGS) in Coimbatore District

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Keywords: *Cost and returns, Economic efficiency, Data Envelopment, Organic Farming, Coconut cultivation*

Introduction

Paramparagat Krishi Vikas Yojana (PKVY) is a three-year continuous Central-State joint scheme to encourage organic farming under the National Mission for Sustainable Agriculture (NMSA). The scheme intends to promote organic farming by using a cluster approach for certification under the Participatory Guarantee System (PGS). In the first phase implemented from 2015-16, 50 clusters were constructed in 11 districts in the first phase, with a cost of Rs. 6.81 crore benefitting 2,272 farmers spanning 2,496 acres. During the second phase, fresh 150 clusters were developed in eight districts, and first-year activities were carried out at a cost of Rs.4.91 crore, encompassing 7,500 acres of organic farming. In 2019-20, second-year activities in 150 clusters were carried out at a cost of Rs.5.1 crore, of which Rs.3.89 crore has already been spent, benefiting 4,943 farmers.

Methodology

The respondents were chosen using a multistage sampling process. The primary data for analysis is land size, area under different crops, crop yields, farm produce prices, and so on in the Coimbatore district of Tamil Nadu for 2020-21. The district of Coimbatore was chosen for this study because the Participatory Guarantee Program (PGS) operates throughout the area and is seen as a prominent operator in this scheme. The second step included the purposeful selection of two blocks: (a) Thondamuthur and (b) Pollachi North. In the third stage, a Cluster Group of 20 farmers who practice PGS Organic Farming was purposefully chosen. The analytical tools employed in the study were estimation of cost and returns, Data envelopment analysis, Garette ranking method and Cobb- Douglas production function so on.

Results and Discussion

The total cost of cultivation shows the various fixed and variable costs that add up to the cost of cultivation of coconut farms, which is estimated to be Rs.82,216. It is evident that the cost for harvesting is highest compared to all other operational costs of the farm, i.e., Rs.17,800 and similarly the lowest cost accounted is for weeding (Rs.2,578) which was due to the several agronomical factors of the crop. The returns from the farms include both income earned by selling main and by products of coconuts. To estimate the returns from coconut products, the quantity used for personal consumption also valued so as to get actual rate of returns. Gross returns estimated for one hectare of coconut cultivation was Rs.3,38,913.

The net income over operational cost was Rs.2,95,888 and net income over total cost was Rs.2,56,697. The results of the linear regression indicate that the coconut yield responded significantly to inputs such as farmyard manure, bio – fertilizer and coconut cake. Similar results were obtained in organic turmeric where the farm yard manure, neem cake, jeevamirtham, vermicompost, panchakaviya and human labour contributed significantly on yield of turmeric (Amarnath and Sridhar, 2012). It was also evident that the response in coconut yield was relatively higher to the use of farm yard manure and bio- fertilizers, compared to all other organic inputs.

The results of farm efficiency analysis revealed that about 52.5 per cent of the farms are under the constant returns to scale condition operated with the efficiency level equal to 0.90 or higher. The average efficiency score was 0.92 indicating that 19 farms were inefficient. The farms showed an increased efficiency which can be attributed to the inclusion of scale efficiency. On assessing the scale of efficiency, 27 farms were performing at their best level or were operating near to the best level of efficiency. Further, 18 farms were found to be operating at an increasing return to scale and 9 farms under decreasing returns to scale. The production scale of these farms might be amplified by reducing the costs, because their performance is observed to be below the optimum production scale. Nearly, 32.5 per cent of the farms considered under study were found to be operating in constant returns to scale.

The results of the garette ranking technique showed that the most important marketing constraint faced by the farmers under organic farming was non – availability of labour (67.40) followed by price fluctuations (58.67), no exclusive market for organic produce (42.33) and incidence of pest and diseases (41.80) in the study area. Price instability of both inputs and vegetables put commercial farmers in risk of getting financial loss (Kamal *et.al.*, 2014).

In conclusion, organic coconut is found to be one of the best and sustainable crop options that can be taken up in Coimbatore district of Tamil Nadu. The increasing demands for organic produce have created new export opportunities and many developing countries have started to tap lucrative export market for organic products (Deshmukh and Nitin, 2015).

References

Raj Kumar Adhikari, (2009). Economics of organic vs inorganic carrot production in Nepal. *The Journal of Agriculture and Environment Vol:10, Jun.2009*

Amarnath, J. S., & Sridhar, V. (2012). An economic analysis of organic farming in Tamil Nadu, India. *Bangladesh Journal of Agricultural Economics, 35(454-2016-36346),33.*

Kamal Shrestha., Gautam Shrestha., & Pradyumna, R. Pandey. (2014). Economic Analysis of Commercial Organic and Conventional Vegetable Farming in Kathmandu Valley. *The Journal of Agriculture and Environment Vol:15, Jun.2014*

Deshmukh, M.S., & Babar, N. (2015). Present status and prospects of organic farming in India. *European Academic Research, 3(4), 4271-4287.*

Ranjan Kumar Biswas., (2016). An economic analysis of crop diversification under inorganic and organic farming in West Bengal. *International Journal of Bioresource Science, 3(1):25-30 June 2016*

AN ECONOMIC ANALYSIS OF GROUNDWATER MARKETS AND WATER USE EFFICIENCY IN HARD ROCK AREA OF HOSUR UNION KRISHNAGIRI DISTRICT OF TAMIL NADU

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Keywords: *Krishagiri, ground water, water use efficiency*

Introduction

The overall objective of the study was to analyse the structure, contact, estimate cost of water extraction and selling price and efficiency of groundwater use, and to suggest suitable policy options for realization of maximum gains from the groundwater exploitation in Hosur and Kveripatinam taluks of Krishagiri district, Tamil Nadu. The structure of groundwater market revealed that number of buyers increases as the farm size decreases, while the number of sellers increased with the increased in the size of the farm. The analysis of conduct of groundwater markets revealed that the seller-buyer concentration ratio was 1:1.13 in selected sample. The cropping intensity and irrigation intensity was highest (89.13 and 93.19 per cent) for self-user+seller category. The selling price of groundwater (Rs. 50 per tank) was marginally higher than the total cost of water extraction (Rs. 28.27 per tank) implying thereby the exploitative nature of groundwater markets. The Data envelopment analysis (DEA) resulted that the average water use of seller and control group is 25 to 20 per cent higher then buyer.

Methodology

Multistage random sampling procedure was followed to select four villages from from two taluks (Hosure and Kaveripatinam) and followed by the selection of 30 farmers from each village, totaling to a sample of 120 farmers. The selected farmers were classified as self-users (farmers having modern WEMs and irrigating their own land only),self-users + sellers (farmers having their own modern WEMs and also selling surplus water), self-users + buyers + sellers (farmers having modern WEMs and also buying and selling water),owner + seller (farmers having their own modern WEMs and sell water), and buyers (farmers buying water to irrigate their crops), Further, the selected farmers were also classified into three farm-size groups, *viz.*, marginal (up to 1 hectare), small (1to 2 hectares) and large (greater than 2 hectares), in order to capture the variations among the groups.

Irrigation Intensity

It is the ratio of gross irrigated area to net irrigated area and expressed in percentage.

Water Extracted per Annum per Well

Water extracted (in acre inches) = (Average number of days pumped in a year X Average number of hours pumped per day X Yield of the bore wells in gallons per hour) / 22611

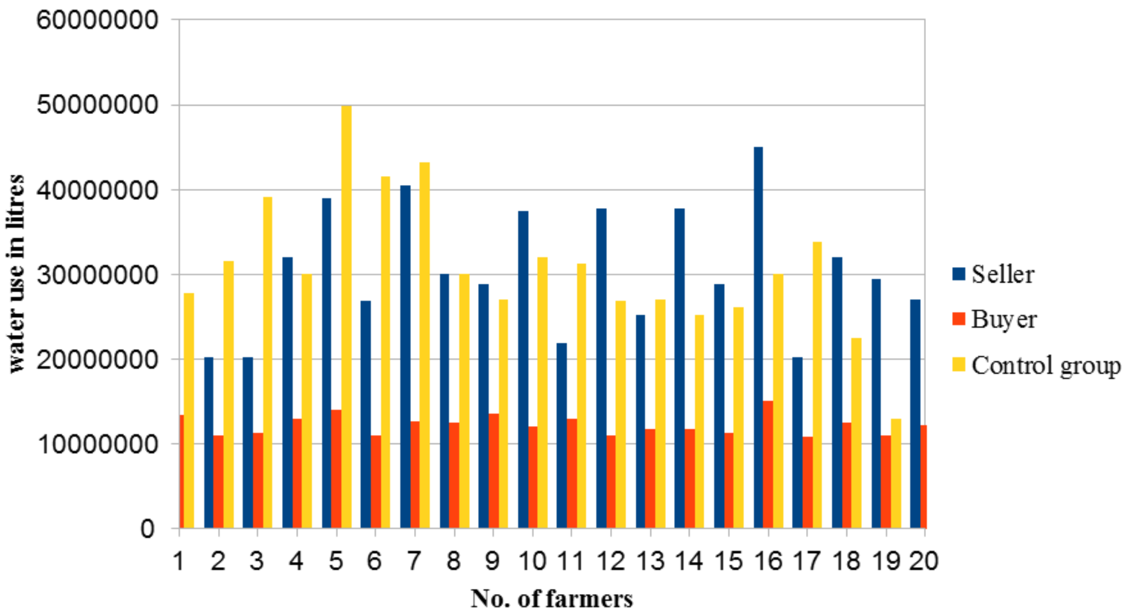
The DEA Model to Measure Efficiency

The methodology used for measuring the efficiencies in this study is Data Envelopment Analysis (DEA). DEA provides a straightforward approach for calculating the efficiency gap between the actions of individual producers and best practises, inferred from observations of the inputs used and the outputs generated by efficient firms.

Result and Discussion

The average water use of water sellers and control farmers is 25 per cent and 20 per cent higher than the use of water buyers. Water sellers and control farmers consume more water than water buyers because they have their own water source which provides them an easier access to water. Moreover as stated above, they also irrigate larger areas. Furthermore it would be logical that water buyers, who are the only ones who pay more than the extraction costs for water, use water more economically and efficiently than the other groups. To distinguish such relationship, a multidimensional measure such as the DEA efficiency measure is needed for the different groups that reveal if the water use efficiency between the group really differ in terms of the use of the use of the other inputs (labour, machines for land operations, manure and fertilizers) the water sellers have the highest mean usage followed by the control farmers shown in Figure 1. Study by Mukherji and Shah (2005), Polak and Yoder (2006) and Shah *et al*. (2008) also showed that the existence of groundwater markets offers these resource poor farmers access to increased agricultural productivity through irrigation. In this way the type of groundwater markets, based on private tube well development, which emerged in India has a different effect from the water markets in many other countries.

Fig. 1. Shows the Efficiency of Three Groups



Conclusion

Irrigation is one of the most important components in the transformation of agriculture which, in combination with technological breakthrough, has already been proved as a key determinant for success of Green Revolution during sixties. Importance of irrigation increases further for the country like India due to temporal and spatial variation of rainfall. Though the canal irrigation was dominant in the starting point of the irrigation development but its inefficiency and lack of reliability necessitated the policy makers to give more emphasis to ground water development which are more reliable and have comparatively better efficiency. As now agriculture is heavily dependent on groundwater irrigation. The ownership of private WEMs has, however, been confined mostly to the large farmers. The small and marginal farmers and even large farmers with fragmented holdings are to enter into informal transaction for buying of irrigation water from the neighboring WEM owners. This has led to spontaneous emergence of informal groundwater market.

References

Mukherji. (2014) Groundwater Markets in Ganga-Meghna-Brahmaputra Basin: Theory and Evidence. *Economics and political weekly*, **39**(31): 3514-3520.

Nasurideen, P., Pouchepparadjou, A and Swaminathan, N. (2003) Water Market in Pondicherry: A Policy Analysis. *Indian Journal of Agricultural Economics*, **58** (3): 490-491.

Assessment of Fluoride Contamination and its Relationship with Chemical Properties of Soil

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Keywords: *Fluoride, Soil, Contamination, water soluble fluoride, Dindigul district*

Introduction

Soil contamination due to fluoride has been growing at an alarming rate both by nature and anthropic influence. Currently, elevated fluoride in groundwater is the first problem in 25 countries and about 200 billion people in the world have to reckon on water containing excessive fluoride. Moreover, soils also contain approximately 300 ppm of fluoride to 1000 ppm wherein contaminated site-level exceeds 3500 ppm (Zhang *et al*., 2013). It occurs in soil as a single negatively charged fluoride ion or occasionally as a component of such complex anions as (BF^{-6}), $(AlF_6)^{3-}$ and $(SiF_6)^{2-}$. The harmful effect of soil fluoride is associated only with an available form where total fluoride content is not of great importance. The amount of fluoride content in soil is dependent on soil type, type of plant species, physical and chemical properties (Maitra *et al*., 2016). Soil fluoride is insoluble and tightly bound to particles by the advantage of having the same radius as hydroxide ion. Soil pH has a profound effect on the biogeochemistry of fluoride. High organic matter content increases the fluoride adsorption capacity of soils and controls immobilisation. In India, the Dindigul district of Tamilnadu contains the highest fluoride bearing minerals which in turn reflects soil with high fluoride concentrations. The present study was mainly focused on the analysis of water-soluble fluoride and working out the correlation with other chemical properties. The sample size is the Reddiyarchatram block of the Dindigul district where fluoride contamination in groundwater is a major problem.

Methodology

The entire block covering all 23 villages of Reddiyarchatram, Dindigul district was surveyed for collecting soil samples with the help of a handheld geographical positioning system covering 48 benchmark sites. Samples were collected at the depth 0-15cm according to standard procedures, dried and processed. Air-dried samples were analysed for pH, Electrical conductivity and TDS were analysed as suggested by (Jackson, 1973). Other parameters such as available nitrogen (alkaline potassium permanganate method), phosphorus (Watanabe and Olsen), potassium, sodium (Jackson, 1973), calcium and magnesium (Versanate titration) were analysed as per standard protocol. Fluoride content in soil is measured by the potentiometric method by using an ion analyser coupled with an ion-selective electrode using TISAB III buffer.

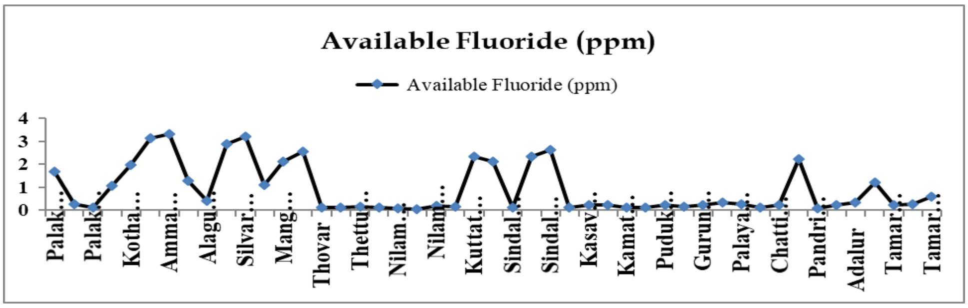
Results and discussion

Results showed that the soils of Reddiyarchatram are neutral to alkaline having moderate conductivity, medium status in organic matter. Also analysed parameters have information about the soil nutrient status. Fluoride concentration (water-soluble) varies from 0.98 ppm to 3.32 ppm where permissible is up to 2.64 ppm. High fluoride content is majorly present in the soils of Silvarpatti and Ammapatti villages that threats the danger of F accumulation in plants. Among the analysed chemical parameters, a correlation coefficient was worked out between water-soluble fluoride and other properties which are denoted by r. Water-soluble fluoride shows a positive correlation for soil pH, available nitrogen, potassium and sodium. This indicates that pH plays a prominent role in determining the solubility of fluoride and explains the relative information of specific adsorption of anions which is also observed by (Vijaya Lakshmi *et al*., 2019). The available fluoride shows a significantly negative correlation with soil available phosphorus which indicates that increasing F concentration leads to the formation of insoluble phosphorus compounds which is also reported by (Vijaya Lakshmi *et al*., 2019). Also, F negatively correlated with EC, TDS, organic carbon and available calcium. This gives an idea that increasing organic matter and calcium status causes immobilisation of fluoride.

Table 1. Range, mean value and Correlation coefficient (r) for soil chemical characteristics with water soluble fluoride

Soil properties	Range	Mean	Correlation with other characteristics	r value
pH	6.28-9.49	8.27	Water soluble fluoride vs pH	0.311**
EC (dSm^{-1})	0.04-1.17	0.12	Water soluble fluoride vs EC	-0.145
TDS (ppm)	25.6-1120	74.8	Water soluble fluoride vs TDS	-0.145
OC (%)	0.14-1.86	0.71	Water soluble fluoride vs organic carbon	-0.06*
Av.Nitrogen(kg ha^{-1})	156.8-436.8	311	Water soluble fluoride vs available nitrogen	0.094
Av.P_2O_5(kg ha^{-1})	11.6-38.3	22.5	Water soluble fluoride vs available P_2O_5	-0.213*
Av.K_2O(kg ha^{-1})	137-341	270	Water soluble fluoride vs available K_2O	0.215
Av.Na (meq100g^{-1})	1.52-7.56	2.19	Water soluble fluoride vs available Na	0.181
Av.Ca (meq100g^{-1})	2.24-5.71	4.21	Water soluble fluoride vs available Ca	-0.384
Av.Mg (meq100g^{-1})	0.32-2.34	1.32	Water soluble fluoride vs available Mg	-0.251

Figure 1 Available Fluoride content of the soil samples collected from different villages of Reddiyarchatram block



References

Jackson, M. L. (1973). Soil chemical analysis-advanced course: A manual of methods useful for instruction and research in soil chemistry, physical chemistry of soils, soil fertility, and soil genesis.

Mikkonen, H. G., van de Graaff, R., Mikkonen, A. T., Clarke, B. O., Dasika, R., Wallis, C. J., & Reichman, S. M. (2018). Environmental and anthropogenic influences on ambient background concentrations of fluoride in soil. *Environmental Pollution*, *242*, 1838-1849.

Vijaya Lakshmi, D., Rao, J., Ramprakash, T., & Reddy. (2019) A Relationship of Fluoride Content with Physico-Chemical and Chemical Properties of Soil.

Zhang, L., Li, Q., Ma, L., & Ruan, J. (2013). Characterization of fluoride uptake by roots of tea plants (Camellia sinensis (L.) O. Kuntze). *Plant and soil*, *366*(1-2), 659-669.

Assessment of Rhizosphere Microbiome in Reed Plants using Metagenomics

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Keywords: Reed plants, Rhizosphere microbiomics, Metagenomics, Alpha diversity

Introduction

Colocasia esculenta, Canna indica and *Typha domingensis* are the reed plants extensively used in the wastewater treatment. A large collection of mutualistic microbial population are present in the rhizosphere of the reeds. The co-metabolic activities of these microbes supports the growth and development of the host and associated organisms. The rhizosphere microbiomics of reeds play a major role in the treatment of wastewater and could be assessed by metagenomics. Therefore, metagenomic study could be used for enhancing the efficiency of native reeds for the biological treatment of wastewater.

Methodology

Determination of rhizosphere microbial population of reeds

Rhizosphere soil samples were collected by handshaking roots for 10 min in one litre of a sterile 0.9 % NaCl solution to remove the adhering soil (Barillot *et al.*, 2013).

Assessment of Microbial Diversity in the rhizosphere soil of Reeds

The rhizosphere soil samples of the above mentioned reeds were collected and the microbial diversity was assessed through metagenomics. The investigation of the presence and potential activity of microbes by the amplicon gene sequencing of conserved marker genes was done to determine the microbial diversity.

Purification of DNA from the rhizosphere soil

The were extracted using MACHEREY-NAGEL kit and PCR protocol was followed. The 5 µL of isolated DNA was added to 25 µL of PCR reaction solution (1.5 µL of Forward Primer and Reverse Primer, 5 µL of deionized water, and 12 µL of Taq Master Mix). Then, the PCR was performed using the following thermal cycling conditions. Denaturation, Annealing, Extension and Purification of PCR Production was done.

Sequencing protocol

Nanoporesequencing was performed by using 1µg of DNA template.

Results and Discussion

Microbial diversity in reeds rhizosphere

Table 1. Microbial Domain of reeds rhizosphere

Microbial Domain	*Colocasia esculenta*	*Typha domingensis*	*Canna indica*
Archaea (%)	0.00573	0.01182	0.0210
Bacteria (%)	99.51299	98.7073	99.548
Eukaryota (%)	0.09883	0.92614	0.0490
Unknown (%)	0.38244	0.35469	0.3813

The domain of the microbial diversity recorded in the rhizosphere of reeds namely, *Colocasia esculenta, Canna indica* and *Typha domingensis* are displayed in Table 1. The highest bacterial type was detected in the rhizosphere soil of *Canna indica* (99.54 per cent)

Microbial families (Operational Taxonomic Units) present in reeds rhizosphere

The rhizosphere soil of *Colocasia esculenta* was dominated by Unknown families (21.67 per cent) which indicated a highest value followed by Bacillaceae (6.507 per cent), Acidobacteriaceae (4.21 per cent), Pseudomonadaceae (4.15 per cent), Solibacteraceae (4.00 per cent, Clostridiaceae (3.19 per cent) and Chitinophagaceae (2.95 per cent) respectively

Beta diversity of microbial species in reeds rhizosphere

The beta diversity of microbial species in reeds rhizosphere soil are listed in Table 2. It revealed that the highest beta diversity (0.75) of rhizosphere microbial families was observed between the rhizosphere soil samples of *Typha domingensis* and *Canna indica*. The rhizosphere soil samples of *Colocasia esculenta* and *Canna indica* showed a reduced beta diversity (0.35) of rhizosphere microbial families.

Table 2 Beta diversity of microbial species in reeds rhizosphere

Rhizosphere soil samples	*Colocasia esculenta*	*Typha domingensis*	*Canna indica*
Colocasia esculenta	0	0.73	0.35
Typha domingensis	0.73	0	0.75
Canna indica	0.35	0.75	0

Conclusion

Hence metagenomics could be used to enhance the wastewater treatment by reed plants.

References

Barillot, Cindy D. C., Claude-Olivier Sarde, Valerie Bert, Eric Tarnaud, and Nelly Cochet. 2013. "A standardized method for the sampling of rhizosphere and rhizoplan soil bacteria associated to a herbaceous root system." ***Annals of microbiology*** 63 (2):471-476.

LeBlanc, Nicholas, Linda L Kinkel, and H Corby Kistler. 2015. "Soil fungal communities respond to grassland plant community richness and soil edaphics." ***Microbial ecology*** 70 (1):188-195.

Reinhold-Hurek, Barbara, Wiebke Bünger, Claudia Sofía Burbano, Mugdha Sabale, and Thomas Hurek. 2015. "Roots shaping their microbiome: global hotspots for microbial activity." ***Annual review of phytopathology*** 53:403-424.

BIOMASS BASED BIOCHAR FOR WASTEWATER TREATMENT

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Keywords: *Biochar; Vetiver; Pyrolysis; Tannery; Chromium*

Introduction

Pre-requisite for maintaining agricultural productivity in the cycle of intense climatic change is a stable agricultural production system. Atmospheric CO_2 concentration today is around 397 ppm, which is a significant increase over pre-industrial concentration of 280 ppm. The CO_2 production is predicted to double by the end of this century. The consequence of rising green house gas (GHG) pollution and heat retention in the earth's atmosphere contributes to global warming. Pollution of methane (CH_4) have risen by more than 150% since 1750, with the main source being agriculture. Therefore, the need for the hour is to synergize modern agricultural research with farmers indigenous wisdom to enhance Indian agriculture's resilience to the the process of changing climate.

Materials and Methods

Biochar is a product of combustion using biomass or organic matter through a pyrolysis process without or with limited oxygen availability at relatively low temperature. It can be used as an agent for soil improvement, improved resource use efficiency, remediation and/or protection against particular environmental pollution, controlling pest problem and as an avenue for greenhouse gas (GHG) mitigation. Biochar is carbon negative. It reduces atmospheric carbon dioxide by utilizing atmospheric carbon that is used to build plants and other organic materials and sequestering it in the ground.

Results and Discussion

Vetiver was grown in rhizoboxes with PWB and sand as medium. During the characterization of Prosopis wood biochar, The pH of the powdered Prosopis Wood biochar was alkaline pH (8.7) with an electrical conductivity of 1.49 dS m^{-1}. The pore space was recorded to be 30 per cent with particle size of 277 nm. The negative zeta potential of -24.4 mV was observed with cationic exchange capacity of 15.7 cmol (p^+) kg^{-1}. Proximate analysis revealed that Prosopis wood biochar exhibited 37.92% of fixed carbon with an ash content of 1.59% and volatile matter of 79.23% respectively. The ultimate analysis revealed that the carbon content in the biochar was highest with 81.54%. The FTIR studies revealed that the biochar contained functional groups at 481.15 cm^{-1} for alkyl halides, 988.31 cm^{-1} for alkenes, 1582.31 cm^{-1} for aromatic compounds and 2788.56 cm^{-1} for aldehyde groups respectively (Vikraman *et al.*, 2018)

Studies using rhizobox and floating bed technology revealed that compared to the individualistic effect of biochar and Vetiver alone, a coupled effect of biochar and Vetiver exhibited significantly higher degree of chromium removal from the ions. Between the samples collected from port 1 and 2, the removal of chromium in port 1 was recorded to be higher than that of port 2. Moreover, the removal of chromium ions from the spiked solution was stamped to be greater than the removal of chromium from the tannery effluent. In both the ports, the highest removal of chromium concentration was recorded in T_8 (Sand + Vetiver + Cr(III) @ 500 mg kg^{-1} +

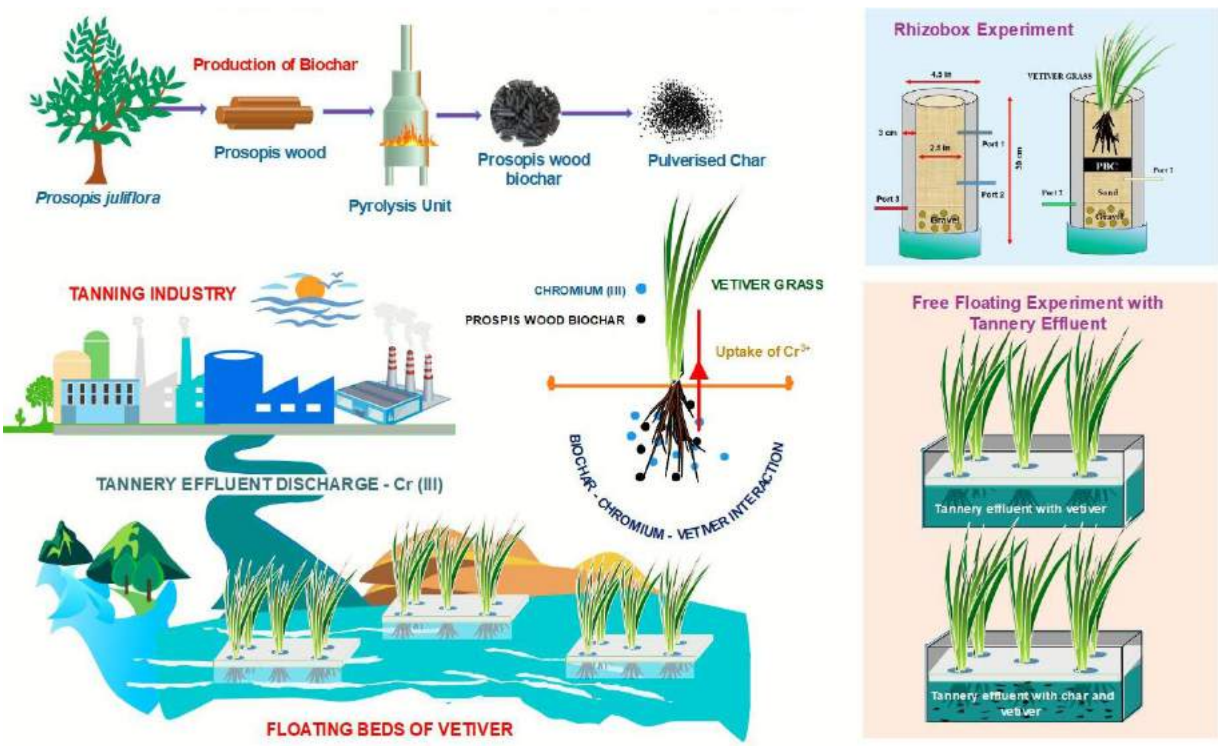
Biochar (PWB) @ 20 mg L^{-1}) The corresponding removal percent in port 1 and 2 was 20.74 and 11.28% respectively. The highest removal of chromium from tannery effluent was recorded in treatment T_9 (Sand + Vetiver + Tannery Effluent + Biochar (PWB) @ 20 mg L^{-1}). The corresponding removal per cent in port 1 and port 2 was 18.83 and 10.38 % respectively. The biochar and Vetiver association had the highest removal percentage in both the experiments. Keeping this in mind Vetiver and biochar based floating beds can be used to treat waterways contaminated with chromium.

References

Angalaeeswari, K, and S Kamaludeen (2017). "Production and characterization of coconut shell and mesquite wood biochar" *International Journal of Chemical Studies* 5 (4):442-446.

Shalini Ramesh, Pugalendhi Sundararaju, Kamaludeen Sara Parwin Banu, Subburamu Karthikeyan, Uma Doraiswamy and Kamaraj (2018). "Hydrothermal carbonization of arecanut husk biomass: fuel properties and sorption of metals". *Environmental Science and Pollution Research* 26.

V. Karuppasamy Vikraman, S. Pugalendhi, P. Subramanian,R. Angeeswaran and K. Chandrakumar (2018) "Experimental Study on Dual Air Supply Downdraft Gasifier for an Improved Producer Gas Quality". Madras Agric. J., 105 (1-3): 113-116,



Carbon Footprints in Agro Ecosystems of Nilgiri Hill Region in Southern Western Ghats – An insight to keep the Soils of Western Ghats Alive and to Combat Climate Change

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Keywords: *Organic Carbon, Bulk Density, Carbon Stock, Agro Ecosystems, Western ghats*

Introduction

Ever since the beginning of settled agriculture, soil and terrestrial ecosystem have been a source of atmospheric CO_2. Conversion of ecosystem from natural to agriculture has decreased the SOC pool by 30-75% in the last 100 years. It is an important factor to balance ecological and environmental sustainability of ecosystems (Srinivasarao *et al*., 2019). Amongst the most fragile ecosystems in the world, the Nilgiris in Tamil Nadu is bearing the brunt of climate change evident in the increasingly erratic rainfall and higher temperatures. The Nilgiris district, part of the 5,520 sq. km Nilgiris Biosphere Reserve, is a UNESCO World Heritage Site and a biodiversity hotspot. This region was mostly untouched till two centuries ago, but has witnessed large-scale destruction ever since. To mitigate the potential risks arising from atmospheric CO_2, delineation of carbon under major ecosystems is an essential prerequisite and hence this present study was conducted with an objective of assessing soil carbon stocks in agro ecosystem of Nilgiri hill region.

Methodology

A detailed soil survey to assess the SOC Stock and BD with geo coordinates was conducted in four blocks of the Nilgiri district situated between 11.4916° N, 76.7337° E and at elevations ranging between 2000 and 2400 m. The collected soil samples (50 samples per block) were air dried, powdered, sieved and analyzed for Bulk Density (Gupta and Dakshinamoorthy, 1980) and Organic Carbon (Walkley and Black method, 1934).

Soil Carbon Stock is calculated from the total soil organic carbon in % **(TOC)**, depth (cm) **(D)** and soil bulk density (Mgm^{-3}) **(BD)** for each ecosystem (Sisti *et al*.,2004) as per the formula - **Soil Carbon stock (t ha^{-1}) = TOC * D * BD**

Results and Discussion

Bulk Density – The mean values of BD ranged from 1.01 to 1.39 Mg m^{-3}. Bulk Density increased with soil depths in all blocks of Nilgiris (Figure 1). Continuous cultivation and poor organic matter turn over has decreased the pore volume with increase in Bulk Density.

Soil Organic Carbon - The organic carbon content ranged from 0.49 to 1.41. With less influence on parent material in all the blocks of Nilgiris, soil organic carbon was high in top 15 cm of soil surface and declined with increasing depth.

Soil Organic Carbon Stock - Irrespective of blocks SOC stocks decreased with increase in depth (Table 1). The soil organic carbon stock followed a similar trend of decline with increasing depth as that of soil organic carbon. The study revealed that the soil organic carbon decreases upon continued farming activities. Decrease in organic carbon with increase in depth may be due to minimum leaching of dissolved organic content and thus lower accumulation with depth.

Table 1. Carbon Stock distribution in different depths of Agro ecosystem in Nilgiris

Name of the Block	C Stock (t ha^{-1})			Mean
	0-15 cm	15-30 cm	30 - 45 cm	
Ooty	20.68	18.59	18.51	19.26
Coonoor	17.27	15.89	15.48	16.21
Kotagiri	22.85	22.45	22.20	22.50
Gudalur	14.70	14.18	13.93	14.27
Mean	18.87	17.77	17.53	18.06

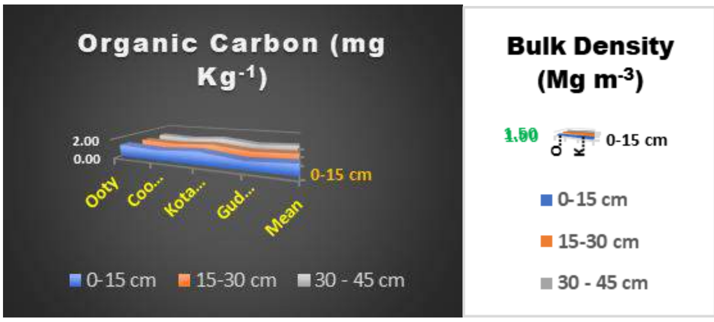

Figure 1. Mean Organic Carbon (mg kg^{-1}) and Bulk Density (Mg m^{-3}) in different depths of agro ecosystem in Nilgiris

Conclusion

It is evident that the Bulk Density increases with depth whereas the organic carbon content in soil decreases with increasing depth in all the blocks Nilgiris. Thus it indicates that carbon stocks in soils in agro ecosystem is governed by bulk density and organic carbon content. Therefore it is important to increase the carbon stock by prioritising appropriate land use statergy and practicing sustainable land management which was recognised under the United Nations Sustainable development Goal (SDG 15) in order to curb the menace of climate change events in Western Ghats .

References

Gupta, R., & Dakshinamoorthy, C. (1980). Procedures for physical analysis of soil and collection of agrometeorological data. *Indian Agricultural Research Institute*, New Delhi, 293.

Lal, R., Smith, P., Jungkunst, HF., Mitsch, W.J., Lehmann, J., Nair, NPR., McBratney, A.B., De Moraes, Sa JC., Schneider, J., Zinn, Y.L., LA.Skorupa, A., Zhang, HL., Ninasny, B., Srinivasarao, Ch., and RH. Ravindranath, NH., (2018). The carbon sequestration potential of terrestrial ecosystems. Journal of Soil and Water Conservation 73, 145A-152A.

Walkley, A., & Black, I. A. (1934). An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. Soil science, 37(1), 29-38.

Comparative Study of Epiphytic and Endophytic Bacteria Associated with Seeds of *Zea mays*.L

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Keywords: *maize seed, epiphytes and endophytes*

Introduction

Seed harbor diverse group of bacterial communities present on their surface (ephiphytes) and also reside inside the seed tissues (endophytes). These microorganisms are non-pathogenic and play a significant role in promoting the plant health and functioning. Maize (*Zea mays*.L) is a coarse cereal crop cultivated throughout the world with a production of 783 mt (Parihar *et al*., 2011). The present study was to identify the similarity and differences between the epiphytes and endophytes isolated from three different genotypes (Hybrid, male and female) of maize seeds and evaluating its colonization and morphological characteristics among the parental and hybrid lines.

Methodology

Maize seeds of three different genotypes Maize UMI-1230 (male), UMI-1200 (female), Maize COH6 (hybrid) were collected from Department of millets, Tamil Nadu Agricultural University, Coimbatore. The seed epiphytes and endophytes were isolated by serial dilution method. For epiphytes, the collected seeds were washed with detergent Phosphate buffer saline (PBS) and the epiphytes were suspended in the PBS wash. 1mL of the wash was used to make dilutions upto (10^{-4}) and was poured on different media for obtaining as much as possible isolates. For endophytes, the seeds were first surface sterilized with disinfectants sodium hypochlorite for 30 sec followed by 70% ethanol wash for 2-3 min and then the seeds were rinsed with sterile distilled water for 2-3 times. The surface sterilized seeds were macerated with phosphate buffer saline in sterile pestle and mortar and 1mL of the macerated wash is used to make dilutions upto (10^{-4}) using pour plate method.

The media used for isolation of epiphytes and endophytes were Nutrient Agar, Luria Bertani Agar, Tryptic Soy Agar, Reasoners 2 A agar, Soil Extract agar, Starch casein agar. The plates were incubated for 2 days at 28±2°C. After incubation, the plates were observed for colony development and the morphologically different colonies were picked and purified by repeated streaking on respected media.

Result and Discussion

The colony morphology and population count of epiphytes and endophytes revealed the existence of similarity and differences among the three different genotypes of maize seed. The population count expressed in colony forming units (cfu) per gram of seed shows epiphytes of seed microflora became more and the population decreased gradually inside the seeds (endophytes) (Santamaria and Bayman 2005). On comparing the male, female and hybrid seed microflora, majority of colony morphology of male and female seed microflora seems similar to the hybrid seed microflora. The microbial community transferred vertically through seed from parental line to the hybrid. The population count of epiphytes and endophytes of three genotypes of maize seed plated in different media was shown in (**Table 1 and Figure 1**)

Table 1: Epiphytic and Endophytic microflora of three different maize seed genotypes

Name of the sample	Medium and dilution	Epiphytes Population (cfu/g of seed)	Endophytes Population (cfu/g of seed)
Maize COH6 (Hybrid seed)	NA (X x10^5)	23.1 x10^5	5.5x10^5
	LB (X x10^5)	13.0 x10^5	2.3x10^5
	TSA (X x10^4)	8.3 x10^4	7x10^4
	SEA (X x10^3)	43.6 x10^3	10x10^3
	R2A (X x10^3)	17.4 x10^3	2x10^3
	SCA (X x10^3)	21.8 x10^3	2x10^3
Maize UMI-1230 (Male seed)	NA (X x10^4)	6.7 x10^4	4x10^4
	LB (X x10^4)	8.3 x10^4	3.3x10^4
	TSA (X x10^4)	11.5 x10^4	3.1x10^4
	R2A (X x10^3)	16.2 x10^3	9x10^3
Maize UMI-1200 (Female seed)	NA (X x10^3)	14.4 x10^3	12x10^3
	LB (X x10^3)	11.8 x10^3	5x10^3
	TSA (X x10^3)	9.6 x10^3	14x10^3
	R2A (X x10^3)	15.5 x10^3	11x10^3

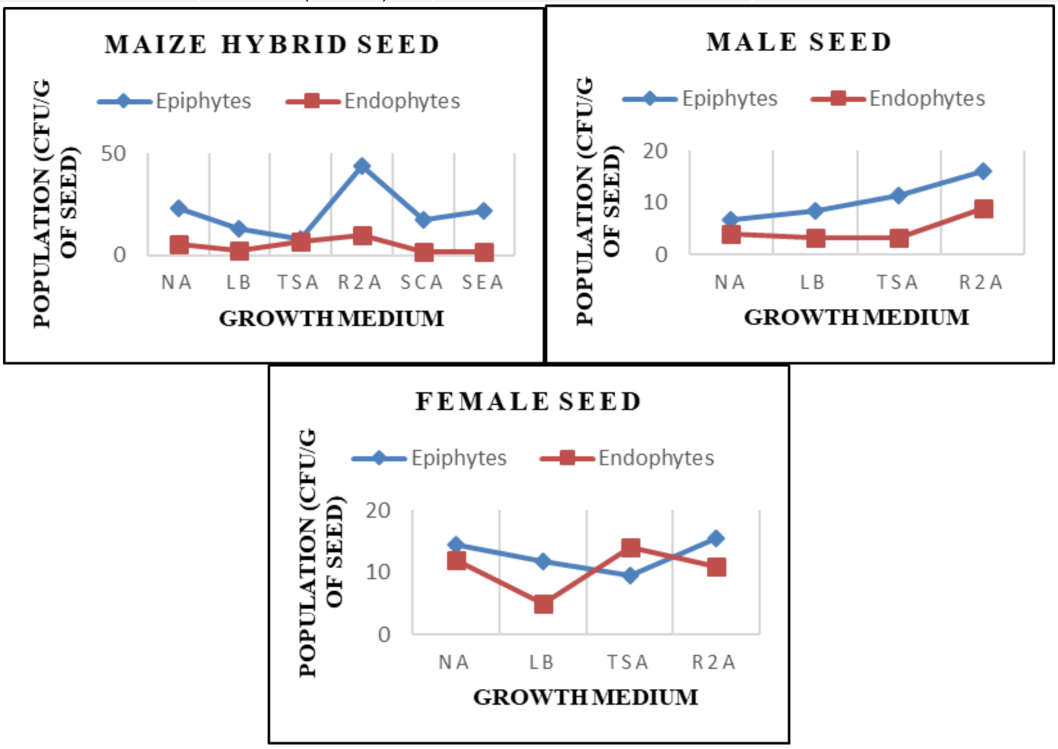

Figure 1: Colony forming units of bacterial isolates of male, female and hybrid seeds of maize

Reference

Parihar CM, Jat SL, Singh AK, Kumar RS, Hooda KS, Chikkappa GK, Singh DK (2011) Maize production technologies in India. ***DMR Technical bulletin***, *Directorate of maize research, Pusa Campus, New Delhi*, p 30

Santamaria J, Bayman P (2005) Fungal epiphytes and endophytes of coffee leaves (*Coffea arabica*). ***Microb Ecol*** 50:1–8

Comparative Study on Drying Kinetics of Small Cardamom (*Elettaria Cardamomum* Maton) Using Different Dryers

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Keywords: *Small cardamom, drying, moisture content, solar dryer, heat pump.*

Introduction

Cardamom, "Queen of Spices" belongs to the Zingiberaceae family. Cardamom capsules contain seeds, possessing a pleasant characteristic aroma and flavour. It is widely cultivated for its dried fruits (capsules). Small cardamom (Elettaria cardamomum Maton), the most popular commercial variety is also known for its medicinal properties. Immediate drying of capsules is necessary to retain the green color and to protect it from fungal attack. To increase the quality of the produce, pre-treatments and drying with optimum temperature are essential. The drying kinetics of cardamom using different dryers' is required to find a solution to the challenges that traditional drying methods confront.

Materials and Methods

Cardamom capsules of Njallani variety were subjected to pretreatment in 1, 2, 3 per cent sodium carbonate for 10 minutes (Purthi,1992). The moisture content was determined by the Dean and Stark distillation method according to the Indian Standard Specification- IS: 1797-1985. As a double and single layer, the treated samples were dried in solar and heat pump dryers on different base materials. Moisture ratio, drying rate were calculated to find the drying kinetics of cardamom at different set temperatures (40, 45 and 50°C) (Sahay and Singh, 1994). The colour of harvested and dried cardamom capsules was measured in colour flex meter (Make: Hunter Associates Laboratory, U.S.A & model: 65/10°). The water activity of cardamom capsules was analysed by an automated instrument (M/s Aqua lab, USA) model XT-2i. The essential oil was estimated as per the method described by AOAC (1975) using modified Clevenger apparatus. A model for the drying curve of cardamom was developed using SPSS 16.0 software.

Results and Discussion

Drying of Cardamom in Solar Dryer

A maximum drying occurred at a falling rate period irrespective of the thickness of the sample, pretreatments, and the base materials used. A faster drying rate was noticed in the steel tray as the base material in a single-layer. The moisture ratio reduction occurred from 1 to 0.02 in both the base materials. But the quality of the product is undesirable.

Drying of Cardamom in Heat pump Dryer

In a heat pump dryer, the pretreated cardamom at different levels in sodium carbonate was dried at a temperature of 40, 45, and 50°C. A Higher drying rate was observed as a single layer at 50°C. Single layered capsules, dried at 50°C took a minimum time of 12 h to reduce the moisture content from 455.5 per cent (d.b) to 10.01 per cent (d.b). The moisture ratio curve and drying rate curve of the capsules as a single layer in 2% Na_2CO_3 treatment using HPD dryer at 40, 45, and 50°C are given below. The higher drying rate was due to dehumidification in the heat pump dryer and with low relative humidity (Hii *et al.* 2012)

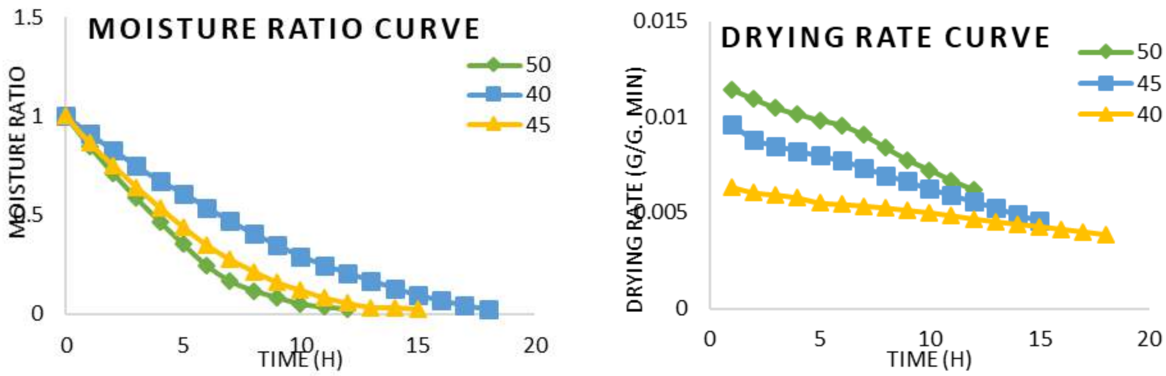

Figure 1. Moisture ratio curve and drying rate of dried cardamom as Single layer in 2% Na_2CO_3 using HPD dryer at 40, 45 and 50°C

The developed equation by considering the moisture ratio as the function of time was

$$MR = at^2 + bt + c$$

where, MR - Moisture ratio, a, b and c are constant and t – Time.

References

Hii, C.L., C.L. Law and S. Suzannah. 2012. Drying kinetics of the individual layer of cocoa beans during heat pump drying. ***Journal of Food Engineering***, 108: 276-282.

Pruthi, J.S. 1992. Post-harvest technology of spices. ***Journal of Spices and Aromatic Crops***, 1(1): 1–29.

Sahay, K.M and K.K. Singh. 1994. **Unit Operations of Agricultural Processing**. 2nd edition Publisher Vikas.

Crustacean Meal as a Fish Meal Replacement in Aquafeed for Improved Yields in Aquaculture

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Keywords: *Fish meal; Shrimp meal; Crab meal; Koi carp; Growth performance*

Introduction

Fish meal has remained as the primary protein source in any aqua feed to date. However, due to the declining fish catches, the demand and price of fish meal and fish oil have increased (Edwards et al., 2004). This rise in costs has, in turn, increased the cost of aquafeed production for fish farming. Many by-products have been identified as an alternate protein source for the aqua feed industry to overcome this problem. The waste produced from the fishery processing units is a cheap and good alternate for fish meal. These wastes primarily consist of crustacean wastes viz., shrimp shells, crab shells, and exoskeleton which are discarded as waste during their processing. These are available in large quantities and can be used as a feed ingredient in animal feed (Meyers, 1986). Hence, these wastes can be utilized as an alternative protein source to replace fish meal in the aquafeed. The total export of ornamental fish from India stood at around 42 tonnes, valued at around 8.4 crore (US $1.2 million) in 2017-18 (Gurvidhar, 2019). Koi and Goldfish accounts for nearly 45% of the ornamental fish trade in the world (Jonathan, 2021). Koi carp selected for the present study as an ornamental variant of East-Asian common carp. And koi is one major player in the market. It is famous for attractive colouration, body shape, and scale patterns. Ornamental farmers undertake rearing of koi for 2- 5 months, followed by sorting based on size, shape, and colour pattern based on which the price is fixed. Any improvement in quicker and better yield would boost the income of the ornamental fish farmers. Hence, the present study was planned to assess the performance of shrimp meal and crab meal wastes from processing units as an alternative to fish meal in the diet of koi carp.

Methodology

The experimental study was conducted with one control (C) and two treatments such as shrimp meal (T1) and crab meal (T2). Juvenile koi were reared in hapas (10X3X1 m), installed in an earthen pond. The animals 3.42 cm long and weighing 0.636 g were stocked at a stocking density of 3000/happa. Isoproteineous experimental diets with crude protein content of 35% were prepared by replacing fish meal up to 50% with shrimp meal (T1) and crab meal (T2). The koi carp diet was based on the formulation made by Nandeesha et al., (2002) (Table 1). Feeding was done once a day, once @ 5% of the biomass. Fortnightly sampling was carried out to record the growth performance and check the water quality parameters. The experiment was conducted for 60 days since which is the general culture duration of koi larval rearing before size and colour grading for sales.

Table 1. Experimental diet composition

Ingredient	Control	T1	T2
Fish meal	29.40	14.70	14.70
Shrimp meal	-	14.70	-
Crab meal	-	-	14.70
GNOC	29.40	29.40	29.40
Rice bran	24.70	24.70	24.70
Wheat flour	16.40	16.40	16.40
Vit & Min mix	0.10	0.10	0.10

Results and Discussions

Bio-growth parameters viz., length gain, weight gain, specific growth rate (SGR), food conversion ratio (FCR), feed efficiency ratio (FER), protein efficiency ratio (PER) and percentage length gain(PLG) were calculated to assess the growth performance given in table 2. Results indicate that the crab meal performs 14.04% better than control feed and

1.76% better than shrimp meal in terms of percent length gain (PLG). Both the treatment performed significantly better than the control animals. Hence, it could be concluded that both crustacean meals, Shrimp meal and crab meal can be efficiently used as an alternate to fish meal up to 50% in diet for better yields in koi carp farming.

Table 2. Bio-growth parameters of experimental fishes

Diet	Length gain(cm)	Weight gain(g)	FCR	FER	PER	SGR	PLG (%)
Control	1.70	1.43	1.88	0.53	1.55	2.88	49.70
T1	2.12	2.15	1.36	0.73	2.14	2.46	61.98
T2	2.18	2.29	1.31	0.76	2.26	2.54	63.74

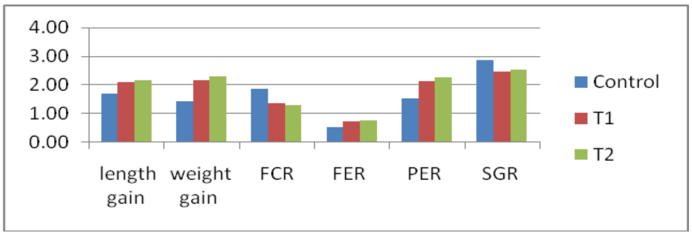

Fig 1. Bio-growth parameters of experimental fishes

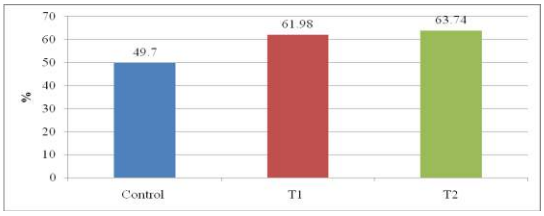

Fig 2. Percentage length gain of fishes

References

Edwards, P., Tuan, L.A. and Allan, G.L., 2004. A survey of marine trash fish and fish meal as aquaculture feed ingredients in Vietnam (No. 437-2016-33834).

Gurvidhar, S. 2019. Pretty lucrative – India's surge in ornamental fish farming. The Fish Site. https://thefishsite.com/articles/pretty-lucrative-indias-surge-in-ornamental-fish-farming

Jonathan P. 2021. Ornamental fish industry data.https://www.ofish.org/ornamental-fish-industry-data

Meyers, S.P., 1986. Utilization of shrimp processing wastes. Infofish Marketing Digest, 4/86: 18-19.

Nandeesha, M.C., Gangadhara, B. and Manissery, J.K., 2002. Further studies on the use of mixed feeding schedules with plant-and animal-based diets for common carp *Cyprinus carpio* (Linnaeus). Aquaculture Research, 33(14), pp.1157-1162

Effect of Continuous Fertilization and Intensive Cropping on Rhizosphere Phosphorus Dynamics on under sandy clay loam soil

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Keywords: *Available Phosphorus, Rhizhosphere, Long term fertilizer experiment*

Introduction

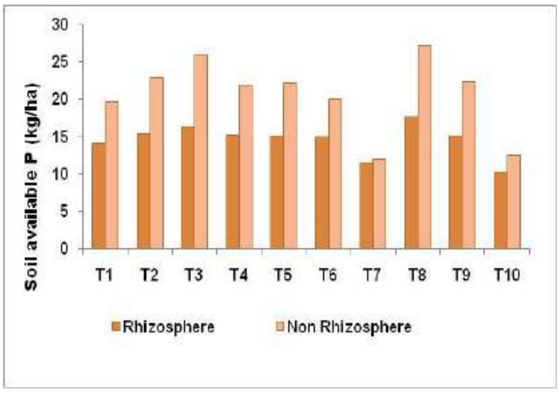
Phosphorus is the most important nutrient element (after nitrogen) limiting agricultural production in most regions of the world. Mineral fertilizer especially Phosphorus led to a substantial increase in agricultural yields and also to a spatial segregation between production and consumption (Gao *et al*., 2014). Looking at the global path of phosphorus from 'mine to fork' the efficiency seems low; only around one fifth of the phosphorus mined for fertiliser production is in the end, consumed by the human population (Cordell *et al*., 2009). Rhizosphere and non-rhizosphere soil are essential soil regions that connect the soil environment to plant root systems. Better understanding of P dynamics in soil/rhizhosphere plant continuum will provide the basis for sound management of soil and fertilizer P, to ensure its adequate P availability to plants and to reduce P losses to surface and groundwater.

Methodology

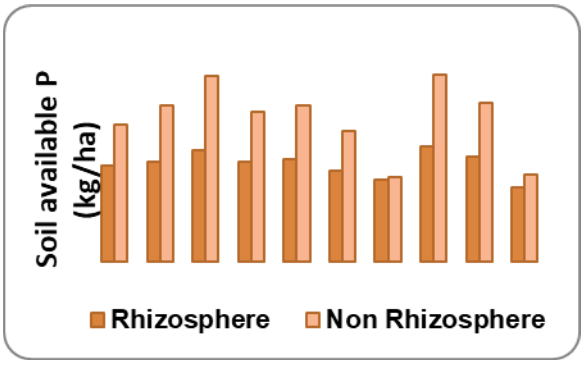
An ongoing Long-Term Fertilizer Experiment with Finger millet-Maize cropping sequence with sandy clay loam soil (Inceptisol) at Tamil Nadu Agricultural University, Coimbatore was chosen to study the effect of continuous manuring and fertiliser application on rhizospheric and non rhizospheric soil available phosphorus at various growth stages of maize during 2021. With maize as test crop, in a Randomized Block Design with ten treatment combinations *viz*., T_1-50% NPK, T_2-100% NPK, T_3-150% NPK, T_4-100% NPK + Hand Weeding, T_5-100% NPK + Zinc, T_6-100% NP, T_7-100% N, T_8-100% NPK + FYM, T_9-100% NPK (Sulphur free source), T_{10}-Control were imposed and replicated thrice. The phosphorus availability in rhizospheric and non rhizospheric soil were analysed at four growth stages *viz*., knee high stage, tasselling stage, milky stage and harvest stage.

Results and Discussion

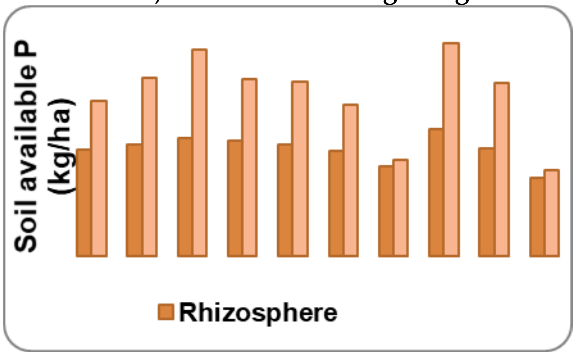
The study revealed that the P availability in the rhizospheric and non rhizospheric soil was significantly influenced by FYM along with 100% NPK application. The soil received graded levels of fertiliser from 50% to 150% increased the soil available phosphorus at the non rhizosphere and rhizosphere during critical stages of growth in maize. Comparing the treatments, the treatment which received 100% NPK + FYM recorded the highest available phosphorus in the non rhizospheric soil to that of rhizospheric soil during critical stages of growth in maize followed by 150% NPK. Remaining indexed order fertiliser treatments like 100% NPK, 100% NP and 100% NPK + Hand weeding, 100% NPK (S free) were on par with each other and the lowest value was recorded in control treatment.



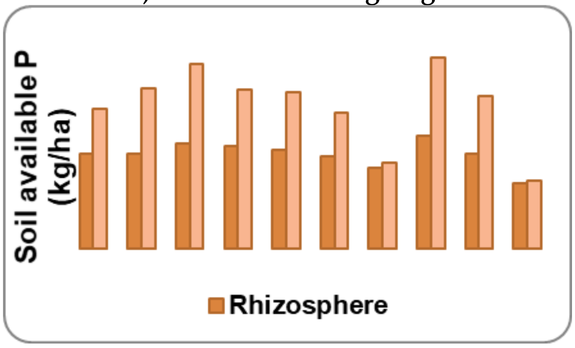
a) Maize - Knee high stage



b). Maize - Tasseling stage



c). Maize -milky stage



d). Maize - Harvest stage

Fig1. Soil available P (kg ha^{-1}) on rhizospheric and non-rhisopheric region at critical growth stages of maize

There were significant differences in the amounts of available P during the growth stages of maize. For the different treatments, it appeared that the contents available P was higher during the vegetative stage in both the rhizosphere and the non-rhizosphere soil. Both P types continued to decrease with plant growth until the harvesting period. This decrease in nutrients was probably due to uptake by the growing crop. The nutrient concentration in non-rhizosphere soil was significantly higher than that in rhizosphere soil.

References

Cordell, D., Neset, T.S.S., Drangert, J.O. and White, S. 2009. Preferred future phosphorus scenarios: A framework for meeting long-term phosphorus needs for global food demand, International Conference on Nutrient Recovery from Waste water Streams Vancouver, **In:** Don Mavinic, Ken Ashley, Fred Koch (Eds.). ISBN: 9781843392323.IWA Publishing, London, UK.

Gao, Y., He, N., Yu, G., Chen, W. and Wang, Q., 2014. Long-term effects of different land use types on C, N, and P stoichiometry and storage in subtropical ecosystems: A case study in China. Ecological engineering, 67: 171-181.

Effect of Different Source of Organic Manure and Bio Fertilizers on Phonological and Yield Characters of Tomato (*Solanum lycopersicum* L.)

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Key words: *Tomato, Organic manure, Bio fertilizers, Yield.*

Introduction

Tomato is known as protective food is being extensively grown all over the world both for fresh market and processing. There is a need to seek alternative nutrient sources which could be cheap and eco-friendly so that farmers may be able to reduce the investment made on fertilizer along with maintaining good soil environmental conditions leading to ecological sustainable farming. Organic fertilizer like vermicompost, compost, FYM and poultry manure are very popular among the farmers and can easily be produced. Bio fertilizers enhances the soil fertility and yield of crops by rendering unviable sources of primary nitrogen bound and phosphate into fixed and available form in order to help the plant for absorb the nutrients. At present, imprudent use of chemical fertilizer, pesticides and fungicides is responsible for deterioration of soil health and ultimately our green plant. Therefore, to maintain the soil fertility and to supply plant nutrients in balanced proportion for optimum growth, yield and quality of crop with integrated approach is to be practiced under specific agro-ecological situation by combined use of organic and bio-fertilizers of plant nutrients.

Methodology

A field experiment was carried out on tomato variety Laxmi at Dhanalakshmi Srinivasan Agriculture College, Perambalur, Tamil Nadu, India, during *Kharif* season, 2019. Nine treatments viz., T_1 Control (RDF 100:50:60 NPK kg/ha), T_2 FYM 15 t/ha, T_3 FYM 20 t/ha, T_4 FYM 25 t/ha ,T_5 FYM 30 t/ha, T_6 Vermicompost 2 t/ha ,T_7 Vermicompost 3 t/ha, T_8 Vermicompost 4 t/ha and T_9 Vermicompost 5 t/ha were tested in RCBD design with three replications. Recommended dose of 100 kg nitrogen, 50 kg phosphorus and 60 kg potassium were used as urea, single super phosphate and murate of potash, respectively in treatment T_1. Plants were transplanted in the month of august, 2019 at a spacing of 60 x 45 cm row to row and plant to plant respectively. There were 50 plants in a 3x4.5 sq.m.plot. Biometric observations (Phonological & yield characters) were recorded and interpreted in the table 1.The data was statistically analyzed by using SAS (2013).

Results and Discussion

Phonological characters

Phenological characters, the days to 50% flowering, days to 50 per cent fruit set, number of flowers per plant, number of fruits per plant and per cent of fruit set were studies in tomato (Table 1). Early 50 per cent flowering 47.58, 48.63 and 48.72 days were observed in treatments T_2, T_3 and T $_6$, respectively and which were at par with each other. Days to 50 per cent fruit set (62.28 and 61.23 days) were observed in treatments T_1 Control and T_9, respectively and which were at par with each other. This trait is useful for obtaining higher return. This trait can be utilized in the breeding programme. Similar findings have been reported (Kamal Shashi, *et al.,* 2008). Highest fruits per plant were recorded under the treatments T_1 Control and T_9 and which were at par with each other. The per cent of fruit set varied from 76.88 to 69.84%. Among the different treatments the significantly maximum per cent of fruit set was observed in treatment T_1 Control (76 . 88 %).

Yield characters

Yield characters, the fruit length, fruit weight and fruit yield per hectare were studies in tomato (Table1). Fruit length was significantly influenced by the various treatments.

Treatment T_6 was recorded highest fruit length followed by treatment T_7. This may be due to increased supply of major plant nutrients. Fruit weight of tomato responded significantly by the various treatments. The significantly maximum fruit weight was observed in the treatment T_6 followed by T_7, T_8 as compared to other treatments. Significantly maximum fruit yield of tomato were exhibited in the treatment T_6 and T_1 Control and which were at par with each other. The probable reason for enhanced fruit yield may be due to cumulative effects of nutrient (macro and micro) on vegetative growth which ultimately lead to more photosynthetic activities while, application of fertigation grade nitrogen levels enhance carbohydrate and nitrogen metabolism of pectic substances, as well as improve the water metabolism and water relation in the plants. Finding corroborates with their results obtained (Naidu *et al.*, 2002)

Conclusion

A significantly maximum marketable fruit yield of 254. 85 q/ ha was obtained in tomato hybrid Laxmi along cost benefit ratio 4 . 49 was obtained under treatment T_6 (Vermicompost 2 t/ha + Neem cake 2q/ha + PSB 2 kg + Azospirillum 2kg/ha) followed by T_1 Control (RDF 100:50:60 NPK kg/ha) gave fruit yield 227 . 59 q / ha with cost benefit ratio of Rs. 4.04. Similar results have been reported (Naidu *et al.*,2002, Patil *et al.*,2010) reported that the highest cost benefit ratio (1:2.02) was found due to application of *Azotobacter* and *Azospirillum* with recommended dose of NPK, in black clay soil of Perambalur district of Tamil Nadu.

Table. 1 Phonological and yield characters of tomato

Treat. Symb.	Treatments	Days to 5% flowering	Day to 50% Fruit set	No. of flower per plant	No. of fruit per plant	%of fruit set per plant	Fruit length (cm)	Fruit weight (g)	Fruit yield per hectare (q)	C: B ratio
T_1	Control (RDF)	54.30	62.28	125.40	96.47	76.88	4.78	91.93	227.59	1: 4.04
T_2	FYM 15 t/ha	47.58	54.30	103.53	72.47	69.84	3.60	75.93	119.47	1: 2.13
T_3	FYM 20 t/ha	48.63	55.40	106.80	78.27	73.19	3.97	81.53	135.27	1: 2.36
T_4	FYM 25 t/ha	49.60	57.47	109.40	79.80	72.56	4.23	82.87	150.34	1: 2.57
T_5	FYM 30 t/ha	51.70	59.65	112.93	82.80	73.29	4.48	88.13	176.57	1: 2.96
T_6	Vermicompost 2 t/ha	48.72	56.33	108.67	78.67	72.17	5.66	97.73	254.85	1: 4.49
T_7	Vermicompost 3 t/ha	50.30	58.46	111.27	80.73	72.00	5.06	91.60	221.68	1: 3.77
T_8	Vermicompost 4 t/ha	52.21	60.18	117.20	83.07	70.81	4.95	90.60	205.22	1: 3.38
T_9	Vermicompost 5 t/ha	53.17	61.23	119.87	87.93	73.25	4.58	84.40	160.73	1: 2.56
SE m ±		0.67	0.57	2.10	3.74	0.70	0.11	1.91	9.84	-
C.D. at 5% level		2.01	1.72	6.32	11.22	2.10	0.33	5.72	29.51	-

References

Kamal Shashi, Kumar Virender, Rana Sanjay, Singh M. P. (2008). Response of inoculation of biofertilizers on flowering, quality and yield of tomato (*Lycopersicon esculentum* Mill.). *Environment and Ecology*. 26 (4A): 1858- 1861.

Patil D. N., Bhalekar M. N., Dhumal S. S., Shinde U. S., Kshirsagar D. B. (2010). Effect of organic manures and biofertilizers on growth and yield of tomato. *Journal of Maharashtra Agricultural Universities*. 2010; 35 (3): 396- 399.

Effect of Integrated Plant Nutrition System on Yield, Response, Uptake by Barnyard Millet and Critical Levels of Soil Available N,P And K on Inceptisol

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***Keywords**: Barnyard millet; Critical levels; Inceptisol; Nutrient uptake; Response*

Introduction

The barnyard millet is one of the important small millets in Asia and also fourth most produced small millet to provide food security worldwide. India is the biggest producer of barnyard millet, both in terms of area (0.146 mha^{-1}) and production (0.147 mt) with average productivity of 1034 kg ha^{-1} during the last three years (IIMR, 2018). It was previously considered as poor man's crop. However, with high yielding varieties and its adaptability to perform in varied soil types, the present research has been undertaken to elucidate the effect of Integrated Plant Nutrition System (IPNS) on grain yield, response, nutrient uptake by barnyard millet on a mixed black calcareous soil (Vertic Ustropept – Perianaickenpalayam series) and to fix the critical levels for soil available N, P and K under NPK alone and NPK+IPNS.

Methodology

Field experiment was conducted at Eastern Block farm of Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu on a mixed black calcareous soil (Vertic Ustropept – Perianaickenpalayam series) and gradient experiment was performed by following Inductive approach (Ramamoorthy *et al.*,1967). The field was divided into three equal strips *viz.*, strip I ($N_0P_0K_0$), strip II ($N_1P_1K_1$) and strip III ($N_2P_2K_2$) and the graded of level fertilizer N, P_2O_5 & K_2O was applied and fodder sorghum was grown and harvested. The development of gradient in the fertility strips was confirmed through fodder yield, NPK uptake and post-harvest soil available N, P and K status. After confirming the development of gradient, each strip was divided into 24 plots totaling 72 plots in three strips. Pre-sowing surface soil samples were collected plot wise and analyzed for $KMnO_4$-N, Olsen-P and NH_4OAc-K. Again, across the strips, the three strips were split into three blocks and each block comprised of 24 plots and three levels of FYM (0, 6.25 and 12.5 t ha^{-1}) were applied. The 21 selected treatment combinations of N (0, 20, 40 and 60 kg ha^{-1}), P_2O_5 (0, 10, 20, 30 kg ha^{-1}) and K_2O (0, 20, 30, 40 kg ha^{-1}) with three controls were superimposed in each strip. The test crop barnyard millet was grown, the grain and straw yields were recorded and the response of barnyard millet to applied nutrients has been calculated. The grain and straw and samples were collected plot wise and analysed (Piper, 1966) and the total uptake of N, P and K by barnyard millet was computed. The critical levels of soil available N, P and K were fixed using the nomograms and it indicates the soil available N, P&K levels above which there was no requirement of fertilizer application (Randhawa and Velayutham, 1982).

Results and discussion

Grain yield

The grain yield in strip I ranged from 1.06 to 2.38 t ha^{-1} with a mean of 1.91 t ha^{-1}; 1.22 to 2.97 with a mean of 2.30 t ha^{-1} in strip II and from 1.35 to 2.94 t ha^{-1} with a mean of 2.43 t ha^{-1} in strip III. Strip II recorded a yield increase of 20.0 per cent over strip I; strip III recorded a yield increase of 26.8 and 5.70 per cent over strip I and strip II respectively. The nutrient uptake of barnyard millet was progressively increased from strip I to strip III.

Response of barnyard millet to different levels of fertiliser nutrients

Response to applied fertiliser nutrients is an important phenomenon to decide upon the optimisation of nutrients. The data on response for barnyard millet to different levels of fertiliser N, P_2O_5 and K_2O was computed and presented in Table 1. The response for N ranged from 222 in N_{20} to 765 kg ha^{-1} in N_{60}; for P_2O_5 the range was from 75 in P_{10} to 263 kg ha^{-1} in P_{30} and for K_2O the range was from 107 in K_{20} to 358 kg ha^{-1} in K_{60}. The results revealed that there was a progressive increase in response upto the highest level *i.e.,* 60:30:60 kg ha^{-1}, respectively for fertiliser N, P_2O_5 and K_2O.The highest response ratio (RR) recorded was 12.74, 9.42 and 5.96 kg kg^{-1} at N_{60}, P_{30} and K_{60}, respectively. A similar inclination of results was reported by Udayakumar and Santhi (2017) for pearl millet on Vertic Ustropept.

Table 1. Response of barnyard millet to different levels of fertiliser N, P_2O_5 and K_2O

S.No.	Nitrogen (N)			Phosphorus (P_2O_5)			Potassium (K_2O)		
	Level (kg ha^{-1})	Response (kg)	Response Ratio (kg kg^{-1})	Level (kg ha^{-1})	Response (kg)	Response Ratio (kg kg^{-1})	Level (kg ha^{-1})	Response (kg)	Response Ratio (kg kg^{-1})
1.	20	222	11.07	10	75.0	7.53	20	107	5.35
2.	40	465	11.61	20	157	7.85	40	220	5.49
3.	60	765	12.74	30	263	9.42	60	358	5.96

Critical levels

The critical levels of soil available N, P and K for barnyard millet were furnished in Table 2. The critical soil test values for all the major nutrients were low under IPNS treatments (NPK+12.5 FYM and NPK + FYM @6.25 t ha^{-1}) as compared to NPK alone. It is due to the supplement of nutrients through farmyard manure and resulted in saving of NPK fertilizers. Irrespective of treatments, higher yield targeting resulted in higher critical levels of nutrients in the soil. Though fertiliser application is not required above the critical level for specific yield target, maintenance dose (50% of the recommended dose) is prescribed to avoid mining of nutrients in soil over long run.

Table 2. Critical level of soil available N.P and K for barnyard millet using targeted yield model

Yield target	NPK alone (kg ha^{-1})			NPK + FYM @6.25 t ha^{-1} (kg ha^{-1})			NPK + FYM @12.5 t ha^{-1} (kg ha^{-1})		
t ha^{-1}	SN	SP	SK	SN	SP	SK	SN	SP	SK
2.50	278	43.9	835	254	38.8	739	229	33.7	643
2.75	306	48.3	919	281	43.2	822	257	38.1	726
3.00	334	52.7	1002	309	47.6	906	285	42.5	810

References

IIMR: (2018). *Annual Report 2017-18.* Hyderabad: Indian Institute of Millets Research.

Piper, C.S. 1966. Soil and plant analysis. Hans Publications, Bombay

Ramamoorthy, B., Narasimham, R.L., Dinesh, R.S. 1967. Fertilizer application for specific yield target of sonara-64 wheat. ***Indian Farming*, 17**:43-45.

Udayakumar, S. and Santhi, R. 2017. Soil test based integrated plant nutrition system for pearl millet on an Inceptisol. ***Res. on Crops*,18** (1): 21-28.

Effect of Long Term Fertilization on Soil Chemical Properties of Rice-Rice Cropping System, Aduthurai

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Keywords: long-term fertilization, Cropping system, chemical properties, correlation

Introduction

Rice (Oryza sativa L.), one of the world's most significant cereal crops, accounts for approximately 60% of global food production. To study changes in nutrient dynamics, variation in yield trends, assessing soil quality and system, nutrient dynamics and risk management, long-term fertilization experiments (LTFEs) are very useful.

Methodology

The Permanent manurial experiment (PME) in rice based cropping system viz., rice - rice was started at Tamil Nadu Rice Research Institute, Aduthurai (110 N altitude, 790 31' E longitude, 19.4 MSL) during June, 1992–93. The soil of the experimental site is fine montmorillonitic, isohyperthermic, Udorthentic Chromusterts with heavy clay texture belonging to Kalathur soil series. Chemical properties ie., Soil Reaction (pH) and Electrical Conductivity (EC) were analyzed by the standard procedure given by Jackson (1973). Organic Carbon (OC) was analysed by chromic acid wet digestion method by Walkley and Black (1934). Nitrogen (N) by Alkaline Permanganate Method given by Subbiah and Asijia (1956). Phosphorus (P) was analysed with 0.5M $NaHCO_3$ outlined by Olsen *et al.* (1954). Potassium by following 1N Neutral Ammonium Acetate given by Stanford and English (1949). Treatment details- FYM : Farmyard Manure- 12.5 t/ha ., GM : Green Manure - 6.25 t ha^{-1}., GYP: Gypsum -500 kg ha^{-1}., Weedicide : (Butachlor - 2.5 l ha^{-1})., CPC - Composted Coir pith -12.5 t ha^{-1}., Azos : Azospirillum - 2 kg ha^{-1}., BGA :Blue Green Algae - 10 kg ha^{-1}., $ZnSO_4$: 25 kg ha^{-1}.For Kharif N splits : 4 splits: Basal, 15 DAT, 30 DAT, 45 DAT - 25 % each. For Rabi N splits : 4 splits: Basal, 20 DAT, 40 DAT,60 DAT - 25 % each.

Results and Discussion

Soil reaction (pH) of the samples was almost neutral with highest in the Absolute control (7.58) and lowest in NPK +FYM+BGA (7.41) (Table.1). Similarly Electrical Conductivity (EC) ranged from 0.15-0.19 (dS m^{-1}). However, Organic Carbon of the samples ranges from 14.0 (NPK +FYM+GYP) to 5.90 (Absolute Control). Available nutrients were significantly different among the treatments. The overall available Nitrogen (N) was observed highest in NPK +FYM+GYP (254 kg ha^{-1}) and lowest in Absolute Control (172 kg ha^{-1}). Soil available Phosphorus (P) was noticed to vary from 58.4 kg ha^{-1} to 30.5 kg ha^{-1} in the treatment receiving NPK+FYM and Absolute Control respectively. Available Potassium oscillated between 304 kg ha^{-1} in NPK +FYM+GYP to 191 kg ha^{-1} in Absolute Control. Correlation study was also carried out and the results were given in Table.2.

Table.1 Effect of long term fertilization on soil chemical properties

Treatments	pH	EC (dS m-1)	OC (g kg-1)	Available nutrients (kg ha-1)		
				N	P	K
NP	7.40	0.19	8.20	225	57.0	241
NK	7.38	0.18	7.40	222	53.0	263
NPK	7.25	0.18	7.00	228	55.0	290
NK	7.38	0.15	7.40	244	52.0	278
NPK+FYM	7.48	0.15	12.10	250	58.4	295
NPK +FYM+BGA	7.41	0.17	13.30	241	57.9	222
NPK +FYM+GYP	7.46	0.18	14.00	254	58.2	304
NPK +$ZnSO_4$	7.50	0.18	9.40	232	51.7	265
NPK +Herbicide	7.52	0.18	6.60	235	54.8	281
NPK + GYP	7.48	0.16	9.40	247	54.5	275
NPK -75%	7.47	0.17	6.20	219	54.8	258
NPK + CCP	7.52	0.19	10.50	238	57.2	284
Absolute Control	7.58	0.18	5.90	172	30.6	191
CD	N/A	0.010	0.47	11.90	2.33	9.65
SE(d)	0.116	0.005	0.22	5.73	1.12	4.64

Table.2 Pearson Correlation matrix for the chemical properties under long term fertilization

	pH	EC	OC	N	P	K
pH	1					
EC	0.053	1				
OC	0.053	1.000**	1			
N	-0.264	.654*	.654*	1		
P	-0.407	0.528	0.528	.875**	1	
K	-0.269	0.29	0.29	.774**	.681*	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Conclusion

To conclude the present study carried out, there was a significant difference among all the treatments for all the parameters except soil reaction. There is a change in soil chemical parameters under long term experiment and continuous cropping. The practice of INM (NPK +FYM+GYP) displayed a favorable effect on Soil Health.

Reference

Jackson, ML. 1973. *Soil Chemical Analysis* Vol. 498. New Delhi: Prentice Hall of India Private Limited.

Stanford, G, L English, RE Comstock, HF Robinson, and PH Harvey. 1949. "Use of the flame photometer in rapid soil tests for K and Ca." *Agronomy Journal* 41 (9):446-447.

Subbiah, BV, and GL Asija. 1956. "Alkaline method for determination of mineralizable nitrogen." *Current Science* 25:259-260.

Walkley, Al, and IA Black. 1934. "An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method." *Soil science* 37 (1):29-38.

Effect of Muriate of Potash and Sulphate of Potash on Nutrient Uptake and Yield of Green Gram (*Vigna radiata* (L.) Wilczek) cv. VBN 2 Under Pot and Field Experiment

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Keywords: *Potassium, Greengram, Nutrient uptake, Grain yield*

Introduction

Greengram has been used to lower the glycemic index of other foods in combinations as it has its own glycemic index quite low and is recommended in the diet of diabetic, obese and consumers who desire to lose weight. Potassium is one of the essential plant nutrients playing a vital role in various physiological, biochemical activities and is required in high amounts to maintain adequate crop growth and sustainable crop production (Karthikeyan *et al.*,2009).

Methodology

A pot culture experiment followed by field experiment were conducted at pot culture yard, Annamalai University and at Thennavarayanallur, Thiruvarur Taluk, Thiruvarur District respectively.The treatments wereT1 - Absolute control, T2 - control N, P, (Without K), T3 - 10 kg of K_2O ha^{-1}, T4 - 20 kg of K_2O ha^{-1},T5 -30kg of K_2O ha^{-1},T6-40 kg of K_2O ha^{-1},T7-10 kg of K_2SO_4 ha^{-1},T8-20 kg of K_2SO_4 ha^{-1},T9 - 30 kg of K_2SO_4 ha^{-1}, T10 - 40 kg of K_2SO_4 ha^{-1}. The experiment was conducted in RBD and replicated thrice. The crop received all other nutrients except K as per Crop Production Guide, 2012

Nutrient uptake

N, P, K and S Nutrient uptake were calculated using following formula at harvest stage.

$$\text{Nutrient uptake by plant (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content \%}}{100} \quad \text{DMP}$$

Results and Discussion

Application of 40 Kg ha^{-1} of SOP effected maximum N, P, K and S uptake by grain at harvest (45.00, 3.80, 21.90 and 2.90 kg ha^{-1}) (Table 1). This increase in uptake by greengram grain and haulm may be ascribed to higher grain production due to K addition (Mengel and Kirkby, 2001). Grain yields were increased due to the soil application of SOP 40 kg ha^{-1} (12.00 g pot^{-1}and 1153 kg ha^{-1}) which were 34 and 42% higher compared to absolute control (7.90 g pot^{-1} and 670 kg ha^{-1}) in pot and field experiment. Application of SOP 40 kg ha^{-1} resulted in maximum haulm yields (Table 1). The effect of MOP and SOP are similar is varying doses as seen in table 1. Application of MOP @40 kg ha^{-1} is recommended for maximum returns to the farmer.

References

Karthikeyan, P.K., Ravichandran, M., Imas, P. and Assaraf, M., 2009. The effect of potassium on the yield and quality of turmeric (*Curcuma longa*). *Research Findings: e-ifc*, 21.

Mergel, K., and Kirkby, E.A. 2001. Principles of plant nutrition. *Annals of Botany*. **93(4):** 479-480.

Table.1 Effect of potassium on grain and haulm yields and N, P, K, S uptakes of grain in greengram VBN-2

Treatments	Yield (kg ha^{-1}) (Field)		Uptakes by grain (kg ha^{-1}) (Field)				Yield (kg ha^{-1}) (Pot)		Uptakes by grain (kg ha^{-1}) (Pot)				B:C
	Grain	Haulm	N	P	K	S	Grain	Haulm	N	P	K	S	
T_1- Absolute Control	670	806	16.80	1.50	6.70	1.30	7.90	10.20	221.00	20.50	75.80	12.60	1.23
T_2- Control N, P_2O_5 and (-K)	852	1093	27.44	2.37	12.43	1.90	9.45	13.63	316.42	27.25	117.81	19.16	1.52
T_3-10 kg of K_2O ha^{-1}	924	1207	31.67	2.71	14.73	2.14	10.06	15.00	354.37	29.94	134.52	21.77	1.64
T_4-20 kg of K_2O ha^{-1}	995	1319	35.81	3.05	16.95	2.38	10.66	16.34	391.59	32.57	150.92	24.33	1.76
T_5-30 kg of K_2O ha^{-1}	1066	1430	39.92	3.39	19.16	2.61	11.26	17.66	428.46	35.18	167.15	26.81	1.88
T_6-40 kg of K_2O ha^{-1}	1147	1558	44.68	3.77	21.73	2.88	11.95	19.20	471.11	38.20	185.93	29.80	2.02
T_7-10 kg of K_2SO_4 ha^{-1}	933	1221	34.19	2.76	14.99	2.17	10.14	15.17	359.07	30.27	136.59	22.10	1.63
T_8-20 kg of K_2SO_4 ha^{-1}	1002	1330	36.22	3.08	17.17	2.40	10.72	16.47	395.21	32.83	152.51	24.58	1.72
T_9-30 kg of K_2SO_4 ha^{-1}	1077	1447	40.57	3.44	19.51	2.65	11.36	17.87	434.24	35.59	169.69	27.27	1.81
T_{10}-40 kg of K_2SO_4 ha^{-1}	1153	1567	45.00	3.80	21.90	2.90	12.00	19.30	474.00	38.40	187.20	30.00	1.90
SEd	25.72	38.83	1.44	0.12	0.79	0.09	0.26	0.48	13.52	0.91	5.92	0.89	-
CD (0.05)	51.75	81.54	3.02	0.25	1.63	0.17	0.44	0.98	27.11	1.92	11.94	1.86	-

Urea = Rs 6/kg, SSP = Rs 9/kg, MOP = Rs 14/kg, SOP = Rs 70/kg

Effect of Nitrogen Sources, Micronutrients and Humic Acid on Growth and Yield of Paddy in an Alfisol of Tamiraparani Command Area

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Key words: *Nitrogenous fertilizers, Humic acid, Liquid micronutrients*

Introduction

Rice is the staple food of more than 60% of the world's population. In order to meet the growing demand for food, 1% of global rice production must be increased annually. The sustainability in attaining higher yield and intensification of rice cultivation are need of the hour to achieve this target. The nitrogen fertilizers play significant role in achieving higher grain production in rice. The type of nitrogenous fertiliser like urea (46% N) and ammonium sulphate nitrate (23% N) besides micronutrients also decides the yield and production. In addition, The present study was conducted to find out the effect of nitrogen fertilizer sources, humic acid and micronutrients on the growth and productivity of rice and soil properties in the Tamiraparani command area.

Methodology

The field experiment was conducted with 11 treatment combination, replicated thrice in a RBD with ASD 16 rice variety. The treatment were T1 – Control; T2 - STCR-IPNS N as Urea; T3 - STCR-IPNS N as Urea + Humic acid @ 2 kg ha^{-1}; T4 - STCR-IPNS N as Urea + Humic acid @ 4 kg ha^{-1}; T5 - STCR-IPNS N as ANAS; T6 - STCR-IPNS N as ANAS + Humic acid @ 2 kg ha^{-1}; T7 - STCR-IPNS N as ANAS + Humic acid @ 4 kg ha^{-1}; T8 - STCR-IPNS N as Urea + 1% Humic acid (FS); T9 - STCR-IPNS N as Urea + 1% Humic acid + 2% WSF (19:19:19) + 2% liquid micronutrients (FS); T10 - STCR-IPNS N as ANAS + 1% Humic acid (FS); T11- STCR-IPNS N as ANAS + 1% Humic acid + 2% WSF (19:19:19) + 2% liquid micronutrients (FS). The N fertilizers were applied as per the treatment in 4 split doses. All the treatments received uniform basal dose of P and 4 split doses of K as per the recommended schedule. The foliar spray was done twice viz. 30 and 40 DAT. The growth and yield attributes like plant height, number of productive tillers m^{-2} were recorded. The yield of grain and straw yield were recorded at harvest. The residual soil samples collected at harvest were analysed for available NPK.

Results and Discussion

Growth and Yield attributes

The results showed that the highest plant height (108 cm), number of productive tillers m^{-2} (378), grain yield (6618 kg ha^{-1}) and straw yield (8695 kg ha^{-1}) were recorded with the STCR-IPNS N as urea combined with foliar spay of 1% Humic acid + 2% WSF (19:19:19) + 2% liquid micronutrients. This might be due to the effective utilization of soil applied fertilizers in addition to the source to sink transport due to foliar spray of all macro and micronutrients. The humic acid also performed favourably in enhancing the yield of rice as stated by Ahmed *et al.*, 2011. The yield of rice was 17.1% higher than the STCR-IPNS N application of urea. The above treatment was followed by the soil application of STCR-IPNS N as Urea + Humic acid @ 4 kg ha^{-1} (13.2% increase in rice yield than the conventional practice). The residual soil available of N, P and K was significantly lowest in the control (T1) except available K.

Table 1 Effect of nitrogenous fertilizers, micronutrients and humic acid on grain and straw yield of rice (Variety ASD 16)

	Treatment details	Plant height (cm)	No. of productive tillers (m^{-2})	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
T1	Control	68.5	258	3301	3927	201	12.6	240
T2	STCR-IPNS N as Urea	95.6	320	5443	5593	248	15.9	245
T3	STCR-IPNS N as Urea + Humic acid @ 2 kg ha^{-1}	96.4	344	5767	6988	245	18.9	253
T4	STCR-IPNS N as Urea + Humic acid @ 4 kg ha^{-1}	105.3	369	6272	8142	254	19.6	272
T5	STCR-IPNS N as ANAS	98.9	291	5092	5264	244	16.2	252
T6	STCR-IPNS N as ANAS + Humic acid @ 2 kg ha^{-1}	92.8	342	5528	5718	253	16.3	251
T7	STCR-IPNS N as ANAS + Humic acid @ 4 kg ha^{-1}	95.7	351	5601	7121	248	18.8	260
T8	STCR-IPNS N as Urea + 1% Humic acid (FS)	98.2	345	5864	7902	237	17.4	252
T9	STCR-IPNS N as Urea + 1% Humic acid + 2% WSF (19:19:19) + 2% liquid micronutrients (FS)	108.1	378	6618	8695	255	20.0	282
T10	STCR-IPNS N as ANAS + 1% Humic acid (FS)	98.6	356	5444	7568	236	17.4	257
T11	STCR-IPNS N as ANAS + 1% Humic acid + 2% WSF (19:19:19) + 2% liquid micronutrients (FS)	98.2	347	6000	7912	239	19.0	255
	sEd	0.48	4.74	72.72	47.98	4.28	0.44	4.21
	CD (0.5)	1.0	9.9	151.7	100.1	8.9	0.9	9

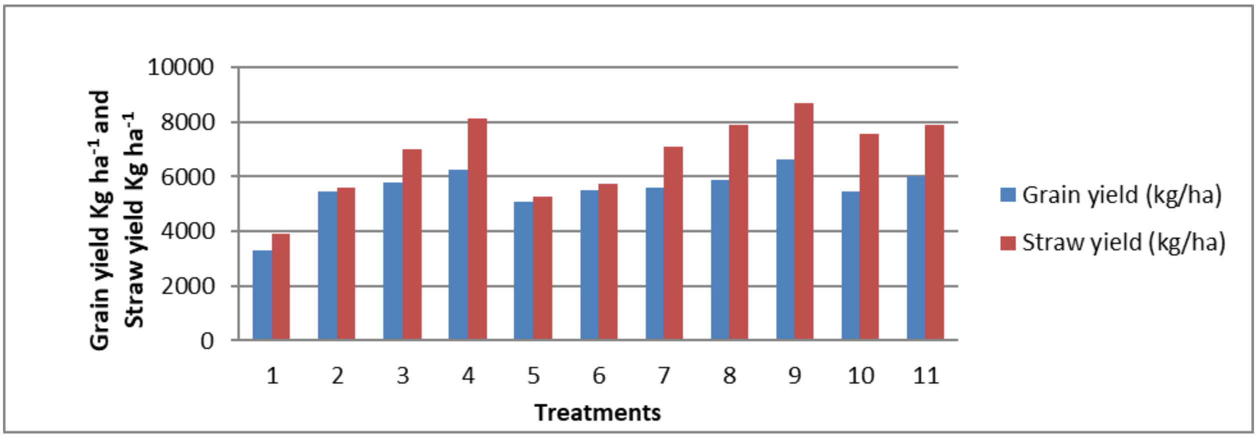

Fig 1 Effect of N source, micronutrients and humic acid on grain yield (kg ha^{-1}) and straw yield (kg ha^{-1})

Reference

Ahmed, Amal G., Tawfik , M.M. & Hassanein,M.S. (2011). Foliar Feeding of Potassium and Urea for Maximizing Wheat Productivity in Sandy Soil. *Australian J. Basic Appl. Sci.,* 5(5): 1197-1203.

Effect of Nutrient Ratios of Water Soluble Fertilizers on Growth of Tomato Crop Under Fertigation

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Keywords: *Fertigation, Water Soluble Fertilizer, Tomato, Growth Parameters*

Introduction

Poor understanding of the soil-plant relationships has led to the mismanagement of resources, especially fertilizers and water. This may end up in cascading effect on nature. Hence techniques that can pose minimal threat to the environment without compromising the plant growth, yield, and quality parameters needed to be adopted. Tomato is a crop that responds well to fertilizers and irrigation. The drip fertigation method has proved to be very significant in improving nutrient uptake which finally results in enhancement of growth and yield of tomato crop (Ankush *et al.*, 2017). So the drip fertigation method which supplies nutrients to the plant roots directly through irrigation can be utilized in tomato cultivation for betterment.

Methodology

A pot experiment was conducted at Department of Soil Science and Agricultural Chemistry with TNAU Tomato Hybrid CO-3 as a test crop. This experiment was laid in a Completely Randomized Design with nine treatment combinations *viz.*, absolute control without any fertilizers, control with solid fertilizers at the TNAU recommended dose of fertilizers, different nutrient ratios of N, P, K and N, P, K with Ca and B, and each treatment were replicated thrice. All the treatments were given nutrient supply through drip fertigation (except in the control treatments). Observations were made in different growth parameters like plant height and number of leaves at the critical stages of tomato plant growth *viz.*, vegetative, flowering, fruiting and harvesting stages.

Results and Discussion

The results indicated (Table 1) the trend observed in the plant height and number of leaves produced by the plants at critical stages. The plant height as well as the number of leaves were increased across the treatments at all stages of growth. Among the treatments, the significant differences were observed in the plant height as well as the number of leaves per plant at all the stages. The highest number of leaves and maximum plant height were observed in T5 (Fertigation NPK 2:1:1 (100% RDN)) followed by T6 (Fertigation NPK 1:1:1 + Ca (100% RDN)) and the least number of leaves and plant height were recorded in the absolute control.

The experimental results show that the application of NPK 2:1:1 (100% RDN) using 19:19:19 and urea through fertigation resulted in the maximum plant height and number of leaves. This may be attributed to the enhanced vegetative growth of those plants due to the increased supply of nitrogen, better availability and uptake of nitrogen, phosphorus and potassium through drip fertigation when compared to the conventional fertilizer application methods.

Table 1. Effect of varying nutrient ratios of water soluble fertilizers through fertigation on plant height and number of leaves at the critical stages

Treatment		Vegetative		Flowering		Fruiting		Harvest	
		Plant Height (cm)	No. of leaves	Plant Height (cm)	No. of leaves	Plant Height (cm)	No. of leaves	Plant Height (cm)	No. of leaves
T_1	Solid Fertilizers 200:250:250 kg/ha (100% RDF)	11.3	4	34.0	9	49.4	13	64.7	34
T_2	Fertigation + Basal P (Solid) (100% RDF)	12.2	5	41.1	12	51.7	12	66.0	38
T_3	Fertigation NPK 1:1:1 (100% RDN)	11.6	5	39.5	11	51.0	15	62.0	37
T_4	Fertigation NPK 1:2:1 (100% RDN)	10.7	5	34.7	12	51.6	15	63.3	38
T_5	Fertigation NPK 2:1:1 (100% RDN)	15.9	6	46.0	14	60.4	17	70.0	58
T_6	Fertigation NPK 1:1:1 + Ca (100% RDN)	13.8	5	42.0	13	59.4	15	68.3	43
T_7	Fertigation NPK 1:1:1 + B (100% RDN)	9.77	5	32.0	10	48.7	15	61.7	36
T_8	Fertigation NPK 1:1:1 + Ca + B (100 % RDN)	10.1	4	38.0	10	55.7	15	67.0	34
T_9	Absolute Control	8.60	4	29.0	7	44.3	10	55.0	30
Mean		11.5	4.63	37.4	10.9	52.5	14.3	64.2	38.7
SEd		0.40	0.16	0.80	0.38	1.17	0.57	1.45	0.93
CD (P=0.05)		0.85	0.33	1.69	0.80	2.46	1.19	3.04	1.95

*RDN: Recommended Dose of Nitrogen

References

Ankush, A., Singh, V., & Sharma, S. K. (2017). Response of tomato (Solanum lycopersicum L.) to fertigation by irrigation scheduling in drip irrigation system. ***Journal of Applied and Natural Science***, *9*(2), 1170-1175.

Gupta, A. and Shukla, V., 1977. Response of tomato (Lycopersicon esculentum Mill.) to plant spacing, nitrogen, phosphorus and potassium fertilization. ***Indian Journal of Horticulture***, *34*(3), pp.270-276.

Effect of Parallel Drain Subsurface System on Soil Characteristics of Waterlogged Paddy field

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Keywords: *parallel drain, pH, Electrical conductivity, Calcium, Magnesium, Sodium*

Introduction

In most of the command areas are commonly affected by waterlogging and salinity. Parallel drain subsurface system is the method used to lower the depth to groundwater level below the root zone to create a favorable environment for crop growth. This system consists of perforated PVC drain pipes and coir wrapped around the pipe as drain envelope. For alleviating water logging problems in paddy grown areas a pilot study has been conducted to study the effect of parallel drain subsurface system on soil characteristics.

Methodology

This experiment was conducted in waterlogged paddy field in Sembarai Village, Trichy District of Tamil Nadu, India. The subsurface drainage systems was installed in an area of 0.144 ha with different lateral drain spacing's and drain depths. Lateral drain spacing of parallel drain subsurface system was designed based on steady state Hooghoudt's equation and drain diameter was designed based on Wessling's equation. Field experiment was conducted with the combination of three lateral drain spacing (7.5, 10.0 and 12.5 m) and two drain depth (60 and 80 cm). The PVC perforated pipes 63 mm wrapped with coir envelope was laid as lateral drains at a grade 0.3 per cent. Inspection chambers connected with collector drains laid at a grade of 0.6 per cent. This experimental design consists of factorial randomized block with three replications. Details of treatments for the experiment are: (1) 7.5 m drain spacing with 60 cm depth of drain (S_1D_1), (2) 10 m drain spacing with 60 cm depth of drain (S_2D_1), (3) 12.5 m drain spacing with 60 cm depth of drain (S_3D_1), (4) 7.5 m drain spacing with 80 cm depth of drain (S_1D_2), (5) 10 m drain spacing with 80 cm depth of drain (S_2D_2), (6) 12.5 m drain spacing with 80 cm depth of drain (S_3D_2), (7) Control plot. The soil analysis of pH, EC, calcium, magnesium, sodium, potassium was calculated by standard procedures followed by Jackson (1969) and Saxena *et al.*, (1978).

Results and Discussion

Soil Characters

Impact of drain spacing and drain depth with different treatment combinations on soil characteristics (pH, EC, soil exchangeable cations and ESP were recorded before installation, 30 DAT, 60 DAT, 90 DAT, 120 DAT and after harvest (Fig 1-7). Soil pH, EC showed that the treatment of S_1D_2 (7.5 m drain spacing and 80 cm drain depth) has recorded lower soil pH and EC value of 8.18 and 0.35 dS/m respectively. The reduction of soil pH and EC was mainly due to the removal of some of the base forming cations from the soil by drain water and the elimination of sodium and bicarbonate ions through drain water. Soil exchangeable cations viz. calcium, magnesium, sodium and potassium (Ca^{2+}, Mg^{2+}, Na^{+} and K^{+}) has shown decreasing trend in S_1D_2 (7.5 m drain spacing and 80 cm drain depth) treatment over the period of crop growth when compared to undrained paddy field. Based on the results, parallel drain subsurface system at 7.5 m drain spacing and 80 cm drain depth has recorded considerable reduction in soil characteristcs, hence it is recommended in the study area.

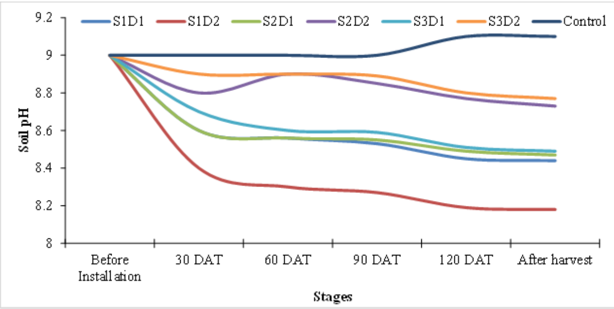

Fig 1 Impact of parallel drain SSD in Soil pH

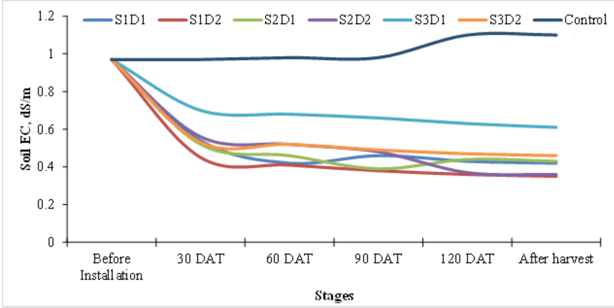

Fig 2 Impact of Parallel drain SSD in Soil EC

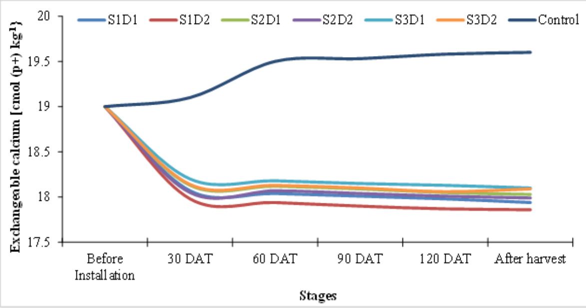

Fig 3 Impact of Parallel drain SSD in Calcium

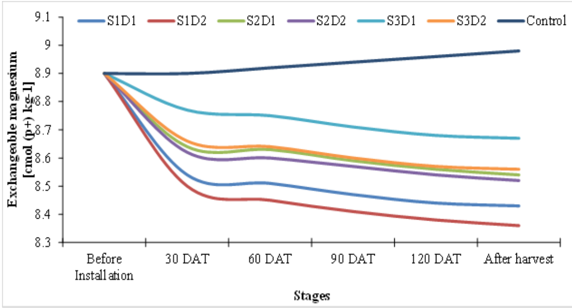

Fig 4 Impact of parallel drain SSD in magnesium

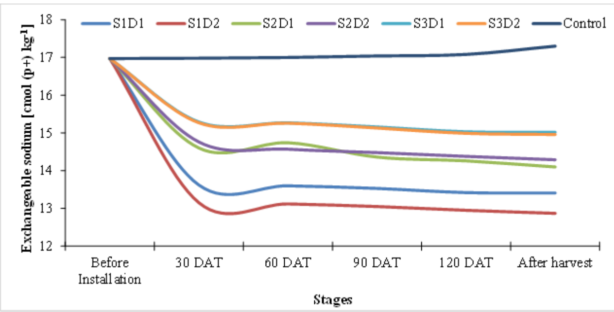

Fig 5 Impact of parallel drain SSD in magnesium

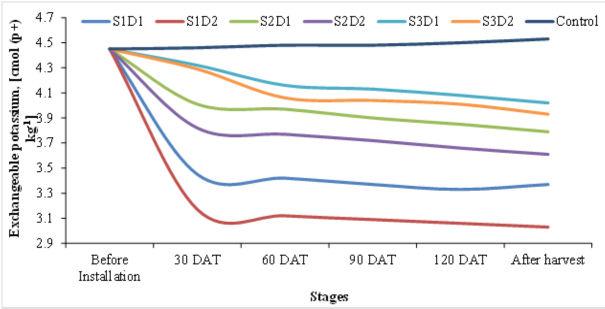

Fig 6 Impact of parallel drain SSD in sodium

References

Balusamy, Arumugam, Udayasoorian, C., & Jayabalakrishnan, R. 2019. Effect of Subsurface Drainage System on Maize Growth, Yield and Soil Quality. ***International Journal of Current Microbiology and Applied Sciences***, *8*(02), 1206–1215.

Jackson, M. L. (1969). *Soil Chemical Analysis - Advanced Course*.

Saxena, K.L., S.D. Makhijani and Ramakrishnan, S.K. 1978. Settling studies on pulp and paper mill wastewater. ***Indian Journal of environmental health.***, 20:273-283.

Effect of STCR-IPNS on Titratable Acidity and pH of Drip Fertigated Tomato in An Alfisol

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Keywords: STCR-IPNS, Tomato, Drip fertigation, Titratable acidity, pH

Introduction

Modern technologies in the field of agriculture escalated the usage of fertilizers which deteriorate the soil quality. STCR-IPNS approach safeguards the soil quality by utilizing the appropriate quantity of fertilizers that are required by the crop in addition to increased crop production. Tomato is a commonly consumed vegetable in a regular diet throughout the world cultivated mostly under drip fertigation. Hence research on the integrated approach of STCR-IPNS on drip fertigated tomato was conducted. In this paper, the pH and titratable acidity recorded in tomato fruit of various treatments of STCR-IPNS were compared.

Methodology

A field trial was laid out in the Western agro-climatic zone of Tamil Nadu on Palaviduthi soil series, Typic Rhodustalf during 2020-2021 at farmer's holding in Coimbatore district. The experiment was set up in Randomized Block Design (RBD) comprised of 15 treatments with three replications. Tomato seedlings were transplanted, fertilizers were given through drip fertigation and field operations were carried out as per the Crop production guide of TNAU 2020. The fruits were harvested at the full ripe stage from different treatments and analyzed for their titratable acidity (titration method) and pH (pH meter).

Results and Discussion

The titratable acidity was recorded the highest (0.49% citric acid) in treatment T_6: STCR-NPK + FYM @ 12.5 t ha^{-1} - 90 t ha^{-1} followed by T_{13}: STCR-NPK + Biocompost @ 5 t ha^{-1} - 90 t ha^{-1} and T_5: STCR-NPK + FYM @ 12.5 t ha^{-1} - 80 t ha^{-1} with the values of 0.48% citric acid. The highest titratable acidity recorded in these treatments was due to organic manures and increased potassium fertilization (Dimitrios Bilalis *et al.*, 2018). The least titratable acidity was found in T_{15}: Absolute control with 0.33% citric acid might be due to no organic or potassium fertilization. The titratable acidity indicates the amount of organic acids present in tomato fruit which contributes to the flavor of tomato. The organic acids in fruit increase with organic fertilization (Heeb *et al.*, 2006).
The pH was found to be highest (4.12) in T_{15}: Absolute control and the lowest pH was recorded in T_6: STCR-NPK + FYM @ 12.5 t ha^{-1} - 90 t ha^{-1} with a pH of 3.33. Since the pH of tomato fruit is below 4.4, it is not susceptible to thermophilic pathogens. There was a negative correlation between titratable acidity and pH. The decrease in titratable acidity was paralleled with an increase in pH (Anthon *et al.*, 2011). From the findings, it is evident that the highest titratable acidity recorded with treatment T_6: STCR-NPK + FYM @ 12.5 t ha^{-1} - 90 t ha^{-1} which also recorded the lowest pH whereas the lowest titratable acidity was recorded by the treatment T_{15} (Absolute control) recorded the highest titratable acidity.

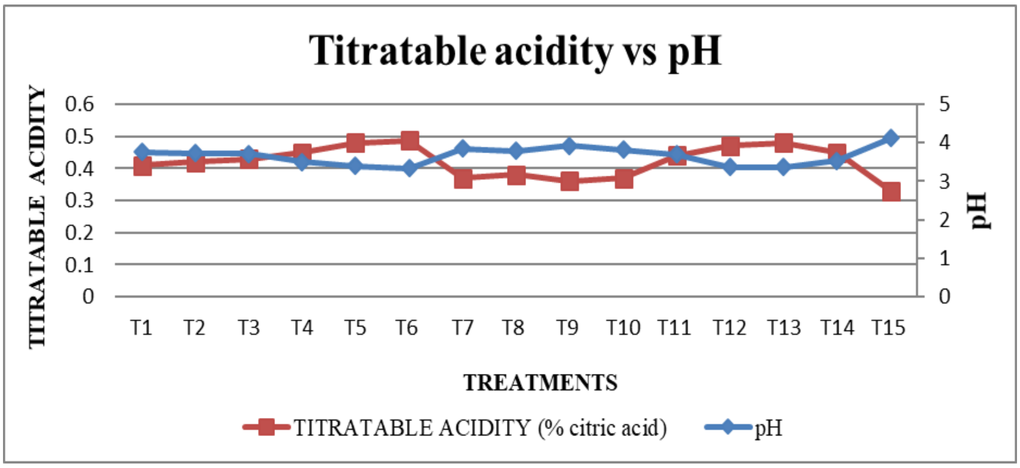

Fig.1 Relationship between pH and Titratable acidity in tomato fruit as affected by various treatments

References

Anthon, G. E., LeStrange, M., & Barrett, D. M. (2011). Changes in pH, acids, sugars and other quality parameters during extended vine holding of ripe processing tomatoes. ***Journal of the Science of Food and Agriculture***, *91*(7), 1175-1181.

Bilalis, D., Krokida, M., Roussis, I., Papastylianou, P., Travlos, I., Cheimona, N., & Dede, A. (2018). Effects of organic and inorganic fertilization on yield and quality of processing tomato (Lycopersicon esculentum Mill.). ***Folia Horticulturae***, *30*(2), 321-332.

Heeb, A., Lundegardh, B., Savage, G., & Ericsson, T. (2006). Impact of organic and inorganic fertilizers on yield, taste, and nutritional quality of tomatoes. ***Journal of Plant Nutrition and Soil Science***, *169*(4), 535-541.

Efficiency of Sunflower Seed Meal as a Partial Replacement for Groundnut Oil Cake in the Growth Performance of *Labeo rohita* under Nursery Phase

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Keywords: *Sunflower seed meal, rohu fry, groundnut oil cake*

Introduction

As the world population increases, the demand for a protein-based diet is also increasing. Three major sectors provide this protein-based food: agriculture, animal husbandry, and fisheries to nourish the global population. Among these three sectors, fisheries are the fastest growing sector. To uplift this sector for the long run, the demand and supply of feed for culture plays an important role. More than 70% of the total global aquaculture production depends on the supply of external feed inputs (Tacon and Metian, 2015). The high cost of feed is mainly due to the exorbitant price and scarcity of conventional feed ingredients (Apata and Ojo, 2000). This high cost and scarcity of feedstuffs, particularly the protein sources such as soybean cake, groundnut cake and fish meal, are the major factors militating against commercial production (Adeniji, 2007). There is a need to improve the scientific knowledge for utilizing locally available feed ingredients for feed preparations. As mentioned, to meet this demand, low cost and locally available agro-industrial by-products are the best solutions to overcomes all these problems with replacing conventional feed ingredients. The groundnut oil seeds and cakes are increasing annually because of governmental policy to export the raw oilseeds without processing. In addition to that, all of these circumstances and complicated situation require research efforts geared toward finding non-conventional protein sources available and cheap to utilise feed ingredients like sunflower seed meal.

Methodology

All three experimental trials and control were conducted in duplicate in happas measuring 10**x**3**x**1m in size and installed in the earthen ponds covered with bird fencing nets for 60 days. Rohu fry of 0.044g were stocked @100 per m^3 per happa. The feed ingredients used for the experiment were wheat flour, deoiled rice bran, vitamin-mineral premix and sunflower seed meal (SFM) with partial replacement of groundnut oil cake (GNOC) at (T1)30%, (T2)40%, (T3)50% and a basal diet (C). The ingredients and the percentage composition of the diet used in the experiment were given in Table 1. All the diets in the experimental trials were analyzed for their quality and proximate composition. Fishes were fed with basal diet at 5% of the bodyweight daily at 10.00 A.M. and 5:00 P.M., basic water quality parameters, were analyzed weekly. The fishes were sampled every 15 days to assess the growth performance.

Results and Discussion

Dietary sunflower seed meal had positive effect on fish growth compared with control. Weight gain was higher in T1 (2.54±0.18g) and followed by T2 treatment group (2.28±0.10g) there were no significant differences ($p>0.05$) observed in T3 (1.90±0.08 g) and control group (1.43±0.11g). And the survival percentage was more in T1 (42.42%) compared to other treatments like T2 (37.24%) and T3 (31.32%) and the control group (30.1%). The antinutritional factors such as phytic acid and trypsin inhibitor where responsible for lower acceptance of the sunflower seed meal and for decreasing of the survival percentage of rohu fry in the nursery phase.

Table 1. The experimental feed composition of Sunflower seed meal diets

Ingredients	C (0%)	T1 (30%)	T2 (40%)	T3 (50%)
GNOC	75	52.5	45	37.5
SFM	-	22.5	30	37.5
Wheat Flour	4	4	4	4
DORB	20	20	20	20
Vitamin Premix	0.5	0.5	0.5	0.5
Mineral Premix	0.5	0.5	0.5	0.5
Crude Protein (%)	31.57	30.86	30.23	29.37
Ether Extract (%)	5.28	5.00	4.73	5.29
Total Ash (%)	5.04	4.84	5.04	5.03
Moisture (%)	6.52	6.69	6.68	6.67

References

Tacon, A. G. and Metian, M. 2015. Feed matters: satisfying the feed demand of aquaculture. ***Reviews in Fisheries Science & Aquaculture***, 23(1): 1-10.

Apata, D. F., & Ojo, V. (2000, March). Efficacy of the Trichoderma viride enzyme complex in broiler starter fed cowpea Testa Based Diets. In *Proceedings of 25th* ***Annual Conference of Nigerian Society for Animal Production*** (pp. 132-134).

Adeniji, A. A. and Ehinmidu, O. M. (2007). Effect of feeding pullet chicks cotton seed cake with or without fish meal supplementation. ***International Journal of Poultry Science***. 6(1).

Gabriel, U. U., Akinrotimi, O. A., Bekibele, D. O., Onunkwo, D. N. and Anyanwu, P. E. (2007). Locally produced fish feed: potentials for aquaculture development in sub-Saharan Africa. ***Afr. J. Agr. Res.***, 2(7): 287-295.

Enhancing Growth and Physiological Attributes Through STCR – IPNS Approach for Aggregatum Onion Under Drip Fertigation

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Keywords: *Aggregatum onion, STCR – IPNS, Plant height, SCMR*

Introduction

Onion (*Allium cepa var aggregatum*), the Queen of kitchen being a shallow rooted and high nutrient requiring crop, optimum fertilization is an indispensable requisite to come up with desirable growth. In order to catch up with the rising demand, STCR – IPNS based fertilizer recommendation was embraced alongside with drip fertigation resulting in inflating efficiency. In this context, the aftermath of adopting STCR – IPNS approach under drip fertigation on growth and physiological attribute of aggregatum onion was deliberated.

Methodology

The field experiment was conducted with aggregatum onion (variety CO 4) in Palaviduthi soil series (Typic Rhodustalf) which is red, non-calcareous during rabi 2020. It was laid in randomized block design with three replications and 15 treatments viz., absolute control, blanket + FYM @ 12.5 t ha^{-1}, FYM @ 6.25, 12.5 t ha^{-1}, Biocompost @ 2.5, 5 t ha^{-1}, STCR – NPK alone, STCR – NPK + FYM @ 12.5 t ha^{-1} and STCR – NPK + Biocompost @ 5 t ha^{-1} for the targeted yield of 14,15,16 t ha^{-1}. Application of fertilizers was done as basal application for phosphorus and split application for N, K through drip fertigation based on the calculated doses from existing fertilizer prescription equations developed for conventional method of fertilizer application. Plant height was measured from ground portion to the tip of the top leaf and relative chlorophyll content was recorded using SPAD 502 Chlorophyll Meter (Minolta Camera Co. Ltd., Japan) to elucidate the effect of imposed treatments.

Results and discussion

Plant height

With the progression of days after sowing, plant height was increased ranging from 27.93 to 39.07 cm, 36.67 to 51.87 cm, 38.72 to 54.13 cm at critical growth stages viz., peak vegetative, bulb formation stage, bulb filled stage respectively (Fig 1). The worthwhile results were obtained in T_{10} – STCR - NPK + FYM @12.5 t – 16 t ha^{-1}. This may be due to the balanced application of nutrients based on crop requirement and nutrient supplied by soil, through drip fertigation which promoted better nutrient availability. Organic manure in the improvement of soil fertility, acknowledged for generations would help in plant metabolic activity through the supply of important nutrients besides micronutrients in promoting vigorous growth by slow and effective nutrient release (Anbarasi *et al.*, 2018).

SPAD chlorophyll meter reading (SCMR)

The relative chlorophyll content measured using SPAD meter was escalated up to bulb formation stage and decreased at the time of harvest. The decrease might be due to translocation of photosynthates from leaves to bulb (Fig 2). The greater SCMR reading was recorded in T_{10} – STCR - NPK + FYM @12.5 t – 16 t ha^{-1}. The reason was ample supply of nitrogen through fertilizers in splits making prolonged availability in the vicinity of root zone. All the treatments showed high SCMR reading over absolute control. It was noticed that SCMR reading had a direct correlation with nitrogen application since it is a constituent of chlorophyll ultimately showing enhanced vegetative growth (Rabari *et al.*, 2016).

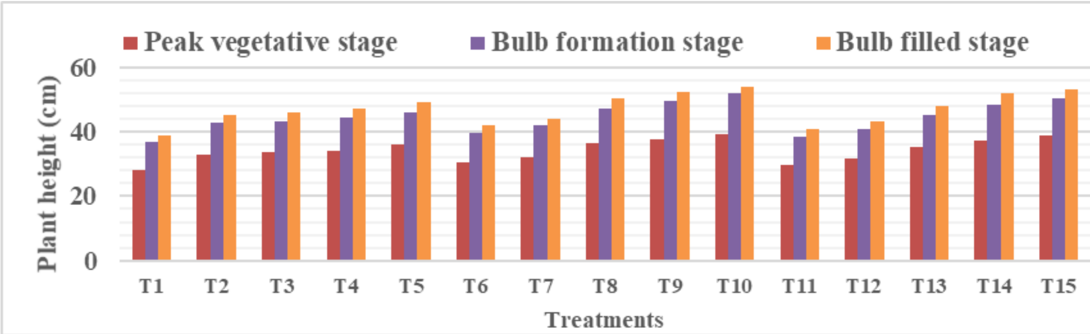

Fig 1 – Effect of different levels of NPK & IPNS on plant height (cm) of aggregatum onion

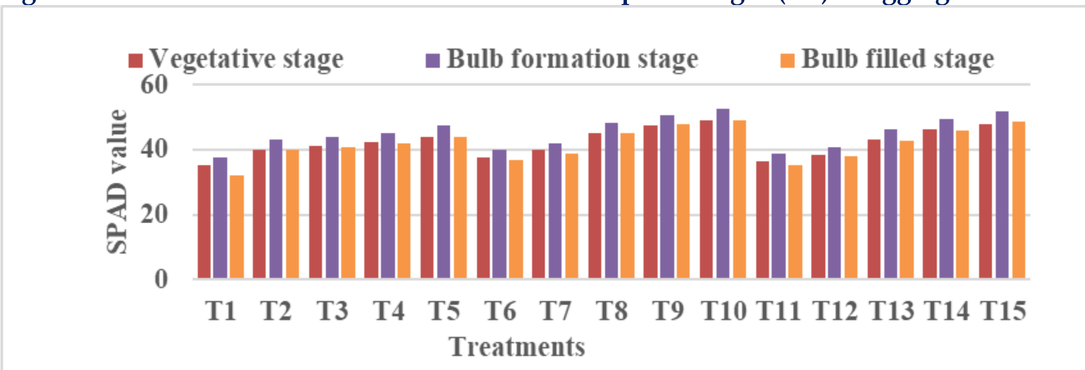

Fig 2 – Effect of different levels of NPK & IPNS on SCMR of aggregatum onion

T_{10} – STCR - NPK + FYM @12.5 t – 16 t ha^{-1} provide better results than all other treatments. By permitting balanced fertilization, STCR approach was pretended to be an apt option for desirable crop growth. Integrated nutrient management become a tactic by imparting superficial benefits. Thus, by merging this, adoption of STCR – IPNS might result in improved growth and physiological attributes.

References

Anbarasi, D, Haripriya, K, Sathappan, C.T, Stella, D. (2018). Response of an ideotype of cluster onion (Allium cepa var. aggregatum) to farm and animal wastes, *Journal of Phytology*, 10, 37-39.

Dhakad, R. K., Chudasama, V. R., Verma, J., Jalpa, G., & Dhaked, M. K. (2019). Effect of INM in Onion (Allium cepa L.) with respect to Growth and yield under North Gujarat Condition. *Int. J. Curr. Microbiol. App. Sci*, *8*(4), 1618-1622.

Rabari, K. V., Patel, M. V., & Umale, A. A. (2016). Effect of nutrient management on growth, TSS content, bulb yield and net realization from onion bulb (Allium cepa. L). *Biosciences Biotechnology Research Asia*, *13*(1), 557-559.

Santhi, R., Natesan, R., & Selvakumari, G. (2002). Soil test based fertilizer recommendation under IPNS for aggregatum onion in Inceptisols of Tamil Nadu. *Agropedology*, *12*, 141-147.

Estimation of Surface runoff From Sub-Catchments of Karamadai using SCS-CN Method and GIS Techniques

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Keywords: *Remote Sensing, Runoff, GIS, Antecedent Moisture Content (AMC), Curve number(CN)*

Introduction

Conventional methods of runoff estimation are expensive, time consuming and difficult process and these methods of runoff measurements are not easy for hilly and inaccessible terrains. Remote sensing technology can augment the conventional methods to a great extent in rainfall-runoff studies (Murmu and Biswas, 2012). In the present study SCS-CN method is used for estimating the runoff in Pare Pallam catchment of Karamadai block of Tamil Nadu State using geospatial techniques (Nagarajan N, and Poongothai, 2012).

Methodology

The watershed boundaries for the calculation of curve numbers as well as the area of the watershed was delineated using ArcGIS 10.3. The land use/land cover classification map of the study area was prepared from LISS III satellite imagery for the years 2006 and 2016 by using supervised classification. The soil map was obtained from the Department of Remote Sensing and GIS, TNAU, Coimbatore. The hydrologic soil groups (HSG) were identified based on the soil texture. The curve number was assigned based on land use as well as the HSG. The weighted curve number was calculated from the area under each land use. This was then used to calculate storm runoff. The SCS-CN method is used for estimating the runoff. The rainfall data was collected from the nearest gauging station, Mettuppalayam (Tamil Nadu Surface and Groundwater Data Centre, PWD, Taramani). The daily rainfall events come under the high, very high and extreme category were only considered for runoff estimation in order to reduce bias (Hawkins et al., 2009). There were 34 storm events in this category. The corresponding AMC group was identified for each event based on method proposed by Subramanya (2008).

Results and Discussion

For the Pare Pallam catchment, in the year 2006, the weighted CN number was calculated to be equal to 34.96 for AMC -I, 55.08 for AMC-II and 74.17 for AMC-III. The potential maximum soil moisture retention of soil is obtained from the CN value, viz., 472.497 mm for AMC-I, 207.1 mm for AMC-II and 88.45 mm for AMC-III. In the year 2016, the weighted CN number is calculated to be equal to 35.6 for AMC -I, 55.79 for AMC-II and 74.71 for AMC-III. The potential maximum soil moisture retention of soil is obtained from the CN value, viz., 459.3 mm for AMC-I, 201.25 mm for AMC-II and 85.93 mm for AMC-III. The decrease in maximum soil moisture retention in 2016 is primarily due to an increase in built-up land areas.

In the Pare Pallam catchment, the average annual rainfall that falls under heavy to extreme categories within the span of 20 years was 149.675 mm and the average runoff generated out of the same was 21.4 mm and a volume of 453228.79 m^3. The runoff generated strongly depends not only on rainfall, but also on the AMC condition as well as on the season of occurrence. It is very evident that in the year 2008, there were two rainfall events with AMCI and AMC II respectively that produces runoff of 12.12 mm out of 137.0 mm. But in the year 2009, 25.40 mm runoff were generated from 132.0 mm rainfall as it is generated out of two rainfall events with AMC I and AMC III respectively. The maximum runoff was generated is 60.35 mm during the year 2011 (Table 1).

Table 1. Annual runoff depth and volume at Pare Pallam catchment

Year	Rainfall (mm)	Runoff (mm)	Runoff volume(m^3)
2000	251.00	25.81	546913.90
2001	155.20	26.37	558780.30
2003	162.90	43.10	913289.00
2005	265.00	24.84	526359.60
2006	90.00	29.46	624257.40
2008	137.00	12.12	256822.80
2009	132.20	25.40	538226.00
2010	187.20	9.97	211264.30
2011	330.00	60.35	1278816.50
2012	141.40	13.63	288737.81
2014	194.30	36.28	768735.29
2015	217.60	48.45	1026680.91
2016	220.00	12.48	264451.20
2018	152.00	24.48	518753.79
2019	356.70	35.04	742487.04

References

Hawkins, R.H. (1993). Asymptotic determination of runoff curve numbers from data. ***J. Irrig. Drain. Eng***. 119(2):334–345.

Murmu, S. and Biswas, S. (2012). Application of Remote Sensing and GIS Technique in Runoff Estimation of a Catchment using SCS model. Proceeding of the Regional Conference of the International Network of Women Engineers & Scientists (INWES), New Delhi.

Nagarajan N and Poongothai (2012) Spatial Mapping of Runoff from a Watershed Using SCS-CN Method with Remote Sensing and GIS. ***Journal of Hydrologic Engineering, ASCE,*** 17 (11).

Subramanya, K. (2008). Engineering Hydrology, Publisher Tata McGraw Hill, 3rd edition, pp.139-195.

Evaluation of Dhaincha Genotypes Based on Seedling Biomass Yield

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***Keywords**: Dhaincha, Biomass yield, Green manure, Soil fertility*

Introduction

Dhaincha [*Sesbania* spp.] is one of the best sources of organic matter which improves the fertility of the nutrient deficit soil. Soil organic matter has come down to 0.3 - 0.4 per cent in the cultivable lands of India which leads the land to loss its fertility and becomes unproductive. Dhaincha has soft, tender stems which decomposes readily in soil but become woody at the later stage of growth i.e., 60 or more days after sowing. The objective of the present study is to screen out dhaincha genotypes based onseedling biomass yield at different days after sowing to improve the soil fertility.

Methodology

The experiment was conducted at department of Plant Breeding and Genetics, Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli. The experiment was laid out as a randomized block design with three replications. Seeds of four different genotypes namely Vellore local, Villupuram local, Sivagangai local and Pant dhaincha are sown in pots. 50 seeds were sown in each pot. The quantitative parameters such as germination percentage, root length, shoot length, fresh and dry weight of root & shoot, base diameter and green biomass per plant were recorded at ten days' interval till 60 days after sowing and analyzed.

Results and Discussion

Among the four different genotypes Sivagangai local showed 100% germination whereas other genotypes, Villupuram local recorded 94.67%, Pant Dhaincha showed 90.67%. Higher seed germination is a good indicator for quality seeds and healthy plants. The genotype Vellore local showed poor germination (20.0%). Plant height of four genotypes varies significantly and the longest genotype Sivagangai local recorded (14.41 cm) followed by Vellore local (11.69 cm) at 10DAS (**Table 1**). As the results showed that the height of genotype Sivagangai local is in increasing trend it performed better at both early and later growth stages

The longest root was found in Vellore local (5.73 cm) and shortest one in Pant dhaincha (3.93 cm) at 10DAS (**Table 2**).However, the longest root was found in Sivagangai local followed by Vellore local, Pant dhaincha, Villupuram local at 60 DAS. (**Table 2**).

The highest base diameter was found in Sivagangai local (1.02 cm and 1.04 cm) whereas lowest base diameter was observed in Vellore local (0.34 cm and 0.90 cm) at 10 DAS and 20 DAS respectively (**Table 3**). The base diameter of the Sivagangai local steadily increased from 30 to 60 DAS followed by Villupuram local, Vellore local and Pant dhaincha.

The highest total biomass yield was observed in Villupuram local and the lowest was recorded in Vellore local at 10 DAS (**Table 4**). On the other hand, Vellore local produced the highest biomass yield followed by Villupuram local, Sivagangai local and Pant dhaincha at 40 to 60 DAS. Among the four different genotypes Vellore local recorded high total biomass yield (2.3 g/ plant) followed by Villupuram local (1.2 g/plant), Sivagangai local (1.08 g/ plant) and Pant dhaincha (0.9 g/ plant) (**Table 4**). The higher biomass producing genotypes at later stages (40 to 60 DAS) will be more useful for green manure production and adds more nutrient to the follow up crops.

Conclusion

From the results it is concluded that Sivagangai localrecorded highest germination percentage, plant height, base diameter among all other genotypes. According to the biomass yield Vellore local produced more biomass when compared to other genotypes. Some studies revealed that there exists significant correlation between growth parameters and plant drymatter yield. Hence crossing can be attempted between Sivagangai localand Vellore local as Sivagangai local showed good growth parameters and Vellore local yielded high biomass per plant in order to produce good improved green manure varieties.

Table 1. Plant height (cm) of *Dhaincha*at different days after sowing (mean±Sd)

Genotype	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
Vellore local	11.69±0.30	16.54±1.47	28.68±3.34	37.06±3.44	40.62±5.04	41.97±1.51
Pant dhaincha	12.17±0.15	16.03±3.44	25.81±0.85	34.04±2.70	34.08±0.89	41.93±3.23
Sivagangai local	14.41±1.00	19.94±0.76	28.54±3.36	38.08±1.73	42.97±1.00	46.89±4.67
Villupuram local	13.46±1.03	19.23±2.84	29.32±0.29	36.09±2.26	39.73±2.95	45.67±6.48

Table 2. Root length (cm) of *Dhaincha*at different days after sowing (mean±Sd)

Genotype	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
Vellore local	5.73±0.45	7.00±0.43	11.38±4.26	12.10±0.76	13.76±0.66	14.40±0.50
Pant dhaincha	3.93±0.42	6.30±1.97	6.99±0.77	8.46±0.30	13.16±2.33	14.03±2.74
Sivagangai local	4.88±0.42	5.99±1.20	10.11±2.95	12.24±0.12	13.06±0.74	15.19±2.63
Villupuram local	5.31±0.23	6.01±0.79	10.16±0.45	10.22±0.64	12.30±0.41	13.90±1.16

Table 3. Base diameter(cm) of *Dhaincha* at different days after sowing (mean±Sd)

Genotype	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
Vellore local	0.34±0.44	0.90±0.05	0.95±0.04	0.99±0.01	1.01±0.01	1.14±0.04
Pant dhaincha	0.92±0.03	0.93±0.03	0.94±0.01	1.01±0.03	1.02±0.17	1.11±0.05
Sivagangai local	1.02±0.09	1.04±0.09	1.08±0.08	1.12±0.04	1.16±0.02	1.20±0.02
Villupuram local	0.91±0.01	0.93±0.01	1.04±0.04	1.06±0.04	1.08±0.08	1.13±0.05

Table 4. Biomass (g/ plant) of *Dhaincha* at different days after sowing (mean±Sd)

Genotype	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
Vellore local	0.003±0.014	0.017±0.009	0.037±0.012	0.714±0.130	1.713±0.951	2.303±1.029
Pant dhaincha	0.023±0.005	0.041±0.017	0.217±0.046	0.243±0.069	0.437±0.236	0.900±0.246
Sivagangai local	0.023±0.012	0.058±0.003	0.163±0.026	0.243±0.041	0.493±0.045	1.080±0.228
Villupuram local	0.029±0.007	0.030±0.008	0.153±0.021	0.337±0.127	0.383±0.059	1.210±0.016

References

Golam Sarwar, A.K.M., Hossain,M.A., Razzak, M.A., and Chanda, S.C. 2020. Biomass yield enhancement of Dhaincha (*Sesbania* species) through cultural practices. *Agronomic research in Moldavia*. 53(2): 160-176

Joshi-Saha, A., and Gopalakrishna, T. 2007. Agromorphological and molecular variability in the genus Dhaincha. *Genetic Resources and Crop Evolution*. 54(8): 1727–1736

Mandal, U.K., Singh, G., and Victor, U.S. 2003. Green manuring: its effect on soil properties and crop growth under rice-wheat cropping system. *Eur J Agron*, 19:225–237

Evaluation of Nitrogen Use Efficiency of Rice Varieties Under Tropical Condition of Tamil Nadu

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Keywords: *Rice, Nitrogen, controlled release fertilizers, nitrogen use efficiency, response ratio*

Introduction

Rice is a staple food for almost half of the world's population, and it is farmed in over 90 nations. It supports the livelihoods of more people for many years than any other cereal (Fageria *et al*. 2013). Nitrogen is necessary for rice production, and it is typically the most yield-limiting nutrient in irrigated rice production around the world (Samonte *et al*., 2006). Coated fertilisers and the usage of N inhibitors are examples of fertilisers that release nitrogen slowly, allowing for efficient and optimal nitrogen utilisation. The most promising technique for increasing N use efficiency is likely to be synchronisation between crop N demand and N supply from soil plus applied N fertiliser.

Methodology

The field experiment was conducted in Agricultural College and Research Institute, Killikulam which is located in a semi-arid tropical agro-climatic region. The experiment layout was designed in split plot design with the treatments replicated thrice. The treatments included were three different rice varieties (main plot) viz., V_1-ASD 16, V_2-Co 45 and V_3-ADT 47 and eight treatments (sub plot) viz., N_0 -Absolute control, N_1 – N management based on crop production guide (CPG) @ 150 kg N ha^{-1}, N_2 – N management based on leaf colour chart (LCC), N_3 – Neem coated urea @ 150 kg N ha^{-1} (1:5), N_4 – Sand incubated urea 150 kg N ha^{-1} (1:1), N_5 – Charcoal coated urea @ 100 kg N ha^{-1} (1:1), N_6 – Charcoal coated urea @ 150 kg N ha^{-1} (1:1), N_7 – Charcoal coated urea @ 200 kg N ha^{-1} (1:1). Urea was applied as both basal (25%) and top dressing at tillering at 30 DAT (25%), active tillering at 45 DAT (25 %) and panicle initiation at 60 DAT (25 %).

Results and Discussion

The nitrogen use efficiency has been assessed through partial factor productivity, agronomic efficiency, physiological efficiency and recovery efficiency. The rice variety ASD-16 had high partial factor productivity in neem oil coated urea treatment varied from 23.4 to 50.0 kg (kg N)$^{-1}$. The physiological efficiency varied from 10.5 to 24.5 kg (kg N)$^{-1}$. The higher physiological efficiency was recorded Co-45 variety in neem oil coated urea treated plot and the lower physiological efficiency was recorded in ASD-16 variety in charcoal coated urea @ 100 kg N ha^{-1}. The value of agronomic efficiency ranged from 6 to 28 kg (kg N)$^{-1}$. The highest agronomic efficiency of 27.08 kg (kg N)$^{-1}$ was registered by ASD-16 variety under the application of neem oil coated urea @ 150 kg N ha^{-1} followed by Co-45 (24.28 kg (kg N)$^{-1}$) and ADT-47 (25.00 kg (kg N)$^{-1}$). The recovery efficiency ranged from 12 to 75 %. Application of neem oil coated urea @ 150 kg N ha^{-1} treatment had highest RE (74.3 %) in ASD 16 variety than Co-45 (61.3 %) and ADT 47 (65.6 %). Dinesh Kumar *et al*. (2010) reported that, neem oil coated urea resulted in significantly higher agronomic efficiency and apparent nitrogen recovery over prilled urea and this may be due to the increased uptake of nitrogen coupled with increased yield. Coating of prilled urea with different neem products slows down the availability of N from prilled urea since neem products act as nitrification inhibitors, which results in increased nitrogen use efficiency in different crops (Prasad, 2005). The rice variety ASD-16 had high response ratio followed by ADT-47 and Co-45 varieties. The neem oil coated urea treated plots had high response ratio compared to all the treatments this might be due to the controlled releasing pattern of coated urea.

Conclusion

This experiment concluded that, the neem oil coated urea performed best compared to all the treatments and the variety ASD-16 had high nitrogen use efficiency and response ratio compared to all the varieties.

Table 1. N use efficiencies of rice as influenced by the variety and N management under SRI

	ASD-16				Co-45				ADT-47			
Treatments	**PFP**	**AE**	**PE**	**RE**	**PFP**	**AE**	**PE**	**RE**	**PFP**	**AE**	**PE**	**RE**
N_0 control	-	-	-	-	-	-	-	-	-	-	-	-
N_1 CPG-N	41.7	18.7	20.7	45.6	38.2	18.0	23.2	40.3	41.7	19.4	22.5	42.7
N_2 LCC-N	45.1	16.4	18.0	35.5	43.5	18.3	21.5	38.2	44.3	16.5	19.4	30.3
N_3 NCU	50.0	27.0	22.7	74.3	44.4	24.2	24.5	61.3	47.2	25	22.8	65.6
N_4 SMU(1:1)	36.8	13.8	17.1	36.1	36.8	16.6	21.9	38.4	38.2	15.9	18.8	41.2
N_5 CCU 100 kg N ha^{-1}	44.8	10.4	10.5	31.8	43.9	13.6	15.8	30.0	45.8	12.5	14.5	20.2
N_6 - CCU 150 kg N ha^{-1}	45.8	22.9	21.7	60.4	41.7	21.5	23.7	53.2	43.8	21.5	22.4	52.4
N_7 – CCU 200 kg N	25.5	8.3	16.2	17.5	24.0	8.8	19.3	17.6	23.4	6.78	15.0	12.4

PFP - Partial factor productivity (kg (kg N)$^{-1}$) PE - Physiological efficiency (kg (kg N)$^{-1}$)

AE - Agronomic efficiency (kg (kg N)$^{-1}$) RE - Recovery efficiency (%)

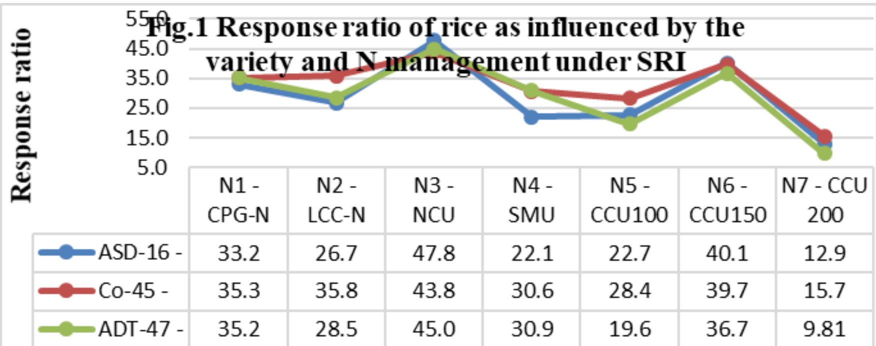

Fig.1 Response ratio of rice as influenced by the variety and N management under SRI

References

Fageria, N. K., & Knupp, A. M. (2013). Upland rice phenology and nutrient uptake in tropical climate. *Journal of plant nutrition*, *36*(1), 1-14.

Samonte, S. O. P. B., L. T. Wilson, A. M. McClung, and L. Tarpley. (2001). Seasonal dynamics of nonstructural carbohydrate partitioning in fifteen diverse rice (Oryza sativa L.) genotypes. Crop Sci. 41 : 902-909.

Prasad, R. (2005). Rice-wheat cropping systems. *Adv. Agron*., 86: 255-339.

Dinesh Kumar, C. Devakumar, Rajesh Kumar, Aurovinda Das, P. Panneerselvam and Y. S. Shivay. (2010). Effect of neem-oil coated prilled urea with varying thickness of Neem-oil coating and nitrogen rates on productivity and nitrogen-use efficiency of lowland irrigated rice under indo-gangetic plains. *J. Plant Nutr.*,33:1939 – 1959, 2010.

Generation of Soil Fertility Map of Gudalur Village of Perambalur District, Tamil Nadu using GIS

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Keywords: *cadastral map, soil fertility, Perambalur, GIS*

Introduction

Geospatial innovations have emerged in the 21st century as a very useful and efficient tool in various applications and have been found to be beneficial for mapping over traditional soil survey methods. A soil fertility map for a specific area will prove highly useful in guiding farmers and planners to decide the requirements of different fertilizers as a seasonal basis each year and to make predictions for increased requirements on the basis of crop pattern and intensity. Furthermore, NPK map can be used to apply fertilizer to an area, where there is a low nutrient availability and also for efficient fertilizer management (Ismail and Junusi, 2009).In the present study cadastral level soil nutrient map of Gudalur village in Alathur block of Perambalur district was generated.

Methodology

The study area chosen for this research is Gudalur village of Alathur block of Perambalur district of Tamil Nadu. Alathur block has 38 revenue villages. The required topographic map at 1:5000 scale covering the study area was collected from Survey of India and utilised for the study. The Geographic information system (GIS) with Arc GIS 10.6 software was used for database creation and for creating the union of various soil nutrient maps. Geocoding of the nutrient database was done with survey points of Alathur block. The cadastral level soil nutrient maps of the village were generated for available N, available P and available K using the technique of geostatistical analysis (Kriging). The maps were reclassified based on ratings of respective nutrients.

Results and Discussion

Gudalur village in Alathur block recorded the available nitrogen values that ranged from 131 to 150 Kgha^{-1} (Fig.1).The soil available phosphorus values were recorded to be high (24.0 to 27.0 kg ha^{-1}) (Fig.2). The high status of phosphorus in the soils of study area may be due to alkaline condition, calcareousness and various agronomic practices. The available K values ranged from 140 to 199 Kgha^{-1} (Table 1) (Fig.3).The information thus generated through the cadastral level nutrient maps can be used to arrive meaningful and workable land management practices and alternative land use plan for the Gudalur village of Alathur block of Perambalur district for sustainable agriculture as reported by Nalina *et al.* (2016).

Table 1.Fertility properties of Gudalur village of Perambalur district

Sl.No.	Latitude	Longitude	Available N (Kg ha^{-1})	Available P (Kg ha^{-1})	Available K (Kg ha^{-1})
1.	11.1536 N	79.9934 E	137.4	25	144.0
2.	11.1462 N	78.9908 E	139.6	27.0	175.6
3.	11.1441 N	78.9941 E	131.0	24.0	165.0
4.	11.1416 N	78.9985 E	150.0	25.6	199.0

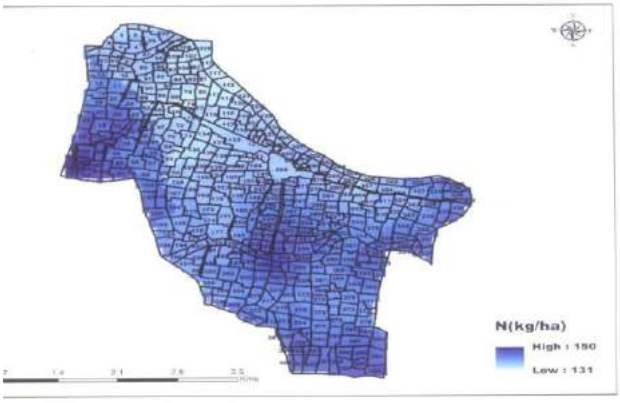

Fig.1.Nitrogen status of Gudalur village

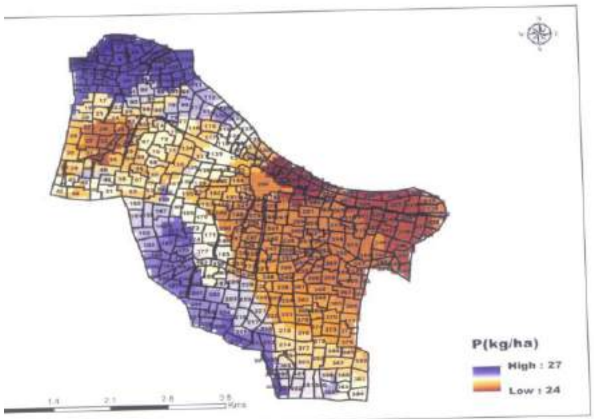

Fig.2.Phosphorus status of Gudalur village

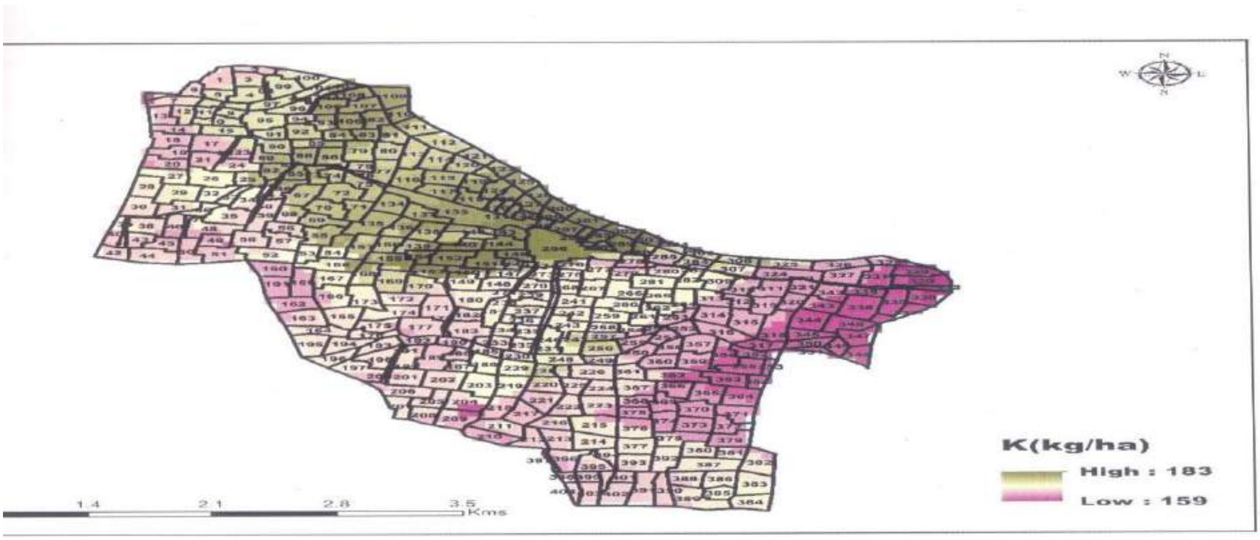

Fig.3.Potassium status of Gudalur village

References

Ismail,M.H. and R.M.Juinusi, 2009 Determining and mapping soil nutrient content using geoststistical technique in a Durian orchard in Malaysia.**Journal of Agricultural Science. 1(1):**86.

NalinaC.K.Kumar.M.Chandrakala,S.S.Rani.K. Sujata.K.Shree, R.Hegde and S.Singh. Soil nutrient status mapping of Nagenahalli micro-watershed under eastern dry zone of Karnataka by remote sensing, detailed soil survey and GIS technique. **Indian Journal of Agricultural Research.** 50 (5):389 -397.

Impact of Crop Geometry and Nitrogen Levels on Physiology of Multicut Fodder Sorghum Based Intercropping System

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Keywords: Fodder sorghum, crop geometry, paired row system, intercrop

Introduction

The gap between the demand and supply of green and dry fodder in India is rising constantly. The production has to be increased This additional production has to come from existing land of cultivated area (143.8 m ha). The only option available is time and space utilization in agriculture through intercropping (Sankaran and Rangasamy, 1990). There is ample inter-space in widely spaced crops like grain maize, sorghum, bajra, hybrid cotton, red gram *etc*., which can be advantageously used to raise short duration pulse crops such as fodder cowpea or multi-cut fodder crops without much reduction in the main crop yields.

Methodology

The field experiment was conducted in central farm, Agricultural College and Research Institute, Madurai during *kharif* 2018. Multicut fodder sorghum variety Co-31 and fodder cowpea variety Co(FC)-8 were used for the experiment. The experiment was laid out in split plot design with three replications, keeping the different crop geometry in main plot and nitrogen levels in sub plot. The treatment details are given below

Mainplot

S_1-130 × 15 cm: sole fodder sorghum, S2- 45 × 15 cm: sole fodder sorghum

S3- (45+15) ×15 cm: fodder sorghum and fodder cowpea under paired row system, S4- (60+30) ×15 cm: fodder sorghum and fodder cowpea under paired row system

Sub plot

N1- 75 % N of RDF, N2- 100 % N of RDF, N3- 125 % N of RDF

Results and Discussion

The interaction effect was significant for number of leaves in all cuttings. The combination of 45×15 cm sole fodder sorghum with 125 per cent RDF of nitrogen noted higher number of leaves in first and second cutting. In the third cutting, (60+30) ×15 cm paired row system with intercrop of cowpea and 125 per cent RDF of nitrogen recorded more number of sorghum leaves. More number of tillers per plant under intercropped condition significantly improved the number of leaves. Related results were recorded by Pradhan and Mohapatra (1995).

Higher number of leaves was recorded higher at 125 per cent RDF of nitrogen. This might be attributable to the positive influence of nitrogen on vegetative growth resulting in higher plant height, number of tillers thereby increasing the number of leaves. Similar results were noted by Kumar and Sharma (2002).

Significant interaction effect was found for crop growth rate. In the first and second cuttings, 45×15 cm sole fodder sorghum and 125 per cent RDF of nitrogen recorded higher crop growth rate of 7.89 and 10.54 g m^{-2} day^{-1} at first and second cutting respectively. In the subsequent third cutting, (60+30)×15 cm paired row system with intercrop and 125 per cent RDF of nitrogen recorded more crop growth rate of 10.26 g m^{-2} day^{-1}. In the third cutting, fodder sorghum intercropped with fodder cowpea exerted higher crop growth rate. This was due to the legume effect which complements the growth of main crop by supplying additional nitrogen from biological nitrogen fixation. This was in agreement with the results of Rathore *et al*. (2012). The nitrogen level at 125 per cent RDF of nitrogen recorded highest crop growth rate. This might be owing to more nitrogen availability leading to better absorption, enhanced source to sink relationship and thereby increased accumulation of dry matter resulting in higher crop growth rate. Related outcomes were recorded by Nirmal *et al*. (2016) also.

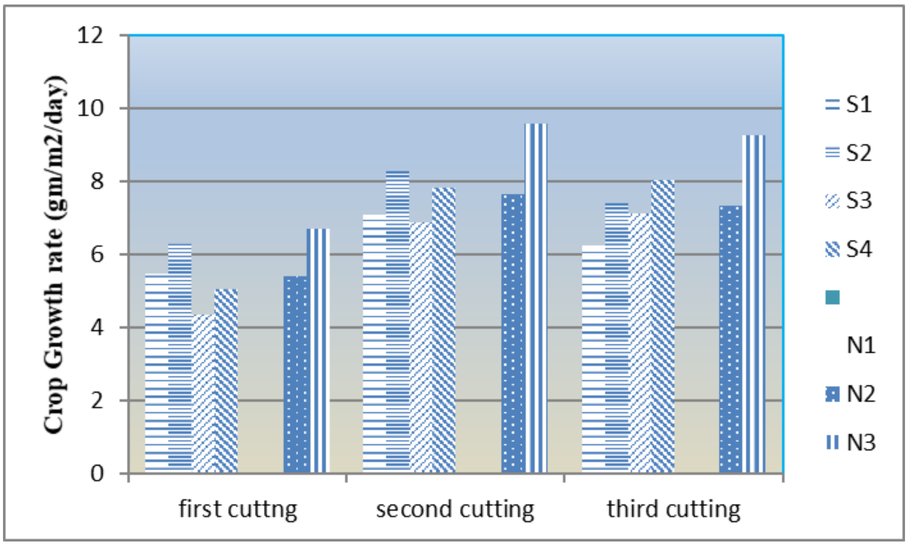

Fig 1. Effect of crop geometry and nitrogen levels on crop growth rate under sole and intercropping condition

References

Nirmal, SS., D.D. Dudhade, A.V. Solanke., S.R. Gadakh, B.D. Bhakare, R.R. Hasure, and S.B. Gore. 2016. "Effect of nitrogen levels on growth and yield of forage sorghum [*Sorghum bicolor* (L.) Moench] varieties."

Kumar, S., and B.L. Sharma. 2002. "Effect of FYM, nitrogen and Azospirillum inoculation on yield and quality of fodder sorghum." *Forage research* 28 (3):165-168.

Pradhan, L., and B.K. Mohapatra. 1995. "Growth analysis and yield of fodder oat in relation to cutting management, row spacing and levels of nitrogen." *Annals of Agricultural Research* 16 (3):273-277.

Rathore, R.S., D.D. Nawange, R.S. Solanki, and R.P. Singh. 2012. "Identification of Suitable Ideotypes of Blackgram (*Vigna mungo* L. Hepper) for Intercropping with Sorghum (*Sorghum bicolor* L. Moench)." *Legume Research-An International Journal* 35 (1):72-74.

Sankaran, S., and A. Rangaswamy. 1990. "Farming Systems Research: In Agronomic Research towards Sustainable Agriculture (edited by Singh KN and Singh, RP)." *Indian Society of Agronomy, Division of Agronomy, IARI, New Delhi*:69-80.

Impact of Targeted Yield Model Based Fertiliser Prescription on Physiological Attributes of Pearl Millet (*Var.* Co 10) in an Inceptisol

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Keywords : *Pearl millet, Targeted yield model, Inceptisol, SCMR, Crop Growth Rate*

Introduction

To meet the food demand of the growing population, it is essential to maintain and sustain the soil fertility along with enhanced crop productivity. In STCR-IPNS technology, the fertiliser doses are framed to the requirements of specific yield levels of crop taking into account the contribution of nutrients from soil, fertilisers and organic manure. Keeping the above facts, the targeted yield model based fertiliser prescription equation (FPE's) developed for pearl millet (*var.* CO 10) in an Inceptisol has been validated and the effect of fertiliser prescription equations (FPE's) on physiological parameters of pearl millet such as SCMR (SPAD Chlorophyll Meter Reading) and Crop Growth Rate (CGR) was interpreted.

Methodology

The field experiment was conducted at Eastern Block, TNAU, Coimbatore with pearl millet (*var.* CO 10) during Kharif 2019 on Periyanaickenpalayam soil series, taxonomically termed as Vertic Ustropept, which is mixed black calcareous soil and was laid out in Randomized Block Design (RBD) consisted of ten treatments and replicated thrice. The relative chlorophyll content of leaves was determined using SPAD chlorophyll meter. Crop Growth Rate (CGR) is expressed as g cm^{-2} day^{-1}.

CGR = W2 – W1 / P (T2 – T1)

Where, W2 and W1 = Dry weight of whole plant at time T2 and T1; P = Spacing in m^2;

T2 – T1 = Time interval

Regression equation

SPAD = 26.935 + 0.126X

Where, X is Applied Nitrogen level

Results and Discussion

SPAD Chlorophyll Meter Reading (SCMR)

The balanced nitrogen dosage had a great impact on chloropyll content which further leads to higher crop growth rate. The SPAD chlorophyll meter reading (SCMR) ranged from 23.8 to 37.1, 32.9 to 46.3, 34.1 to 48.6 and 26.1 to 43.9 at vegetative, panicle initiation, grain filling and harvest stages, respectively. The relationship between the applied nitrogen dosage and SCMR was analysed using SPSS statistical software (Fig. 1). At all the crop growth stages, the highest SPAD chlorophyll meter reading was reported by T_6 (STCR-IPNS 3.5 t ha^{-1}) which was parallel with T_3 (STCR-NPK alone - 3.5 t ha^{-1}) irrespective of stages. The superiority of STCR-IPNS treatment is due to the application of organic manures such as FYM @ 12.5 t ha^{-1} along with inorganic fertilizers which renders easy availability and higher uptake of nutrients which enhances the development of new tissues resulted in higher chlorophyll content throughout the crop growth stages (Bamboriya *et al.,* 2017).

Crop Growth Rate (CGR)

The crop growth rate was increased progressively from the stages of VG to GF with the rise of crop growth (Fig. 2). T_6 (STCR – IPNS – 3.5 t ha^{-1}) had recorded significantly higher crop growth rate which was on par with T_3 (STCR – NPK alone - 3.5 t ha^{-1}); T_{10} (Absolute control) reported relatively lower crop growth rate in all the stages. The plants under STCR-IPNS treatments recorded higher value than STCR-NPK alone treatments among the same yield targets. The sufficient supply of all the nutrients especially nitrogen improves the vegetative growth and resulted in higher growth rate. All the STCR treatments and blanket + FYM @ 12.5 t ha^{-1} reported its superiority over blanket (100% RDF alone), farmer's practice and absolute control. With increase in fertiliser dosage, there was an increase in the crop growth rate. The findings were in accordance with Saini *et al.* (2018).

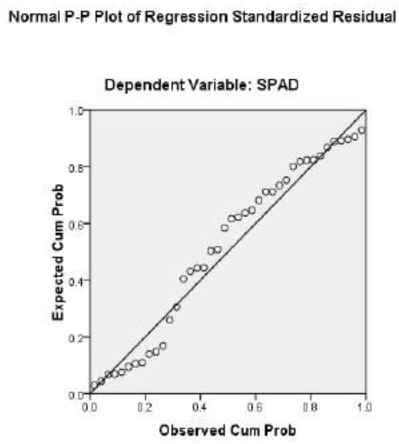

Fig. 1. Regression graph of applied nitrogen dose and SPAD chlorophyll meter reading

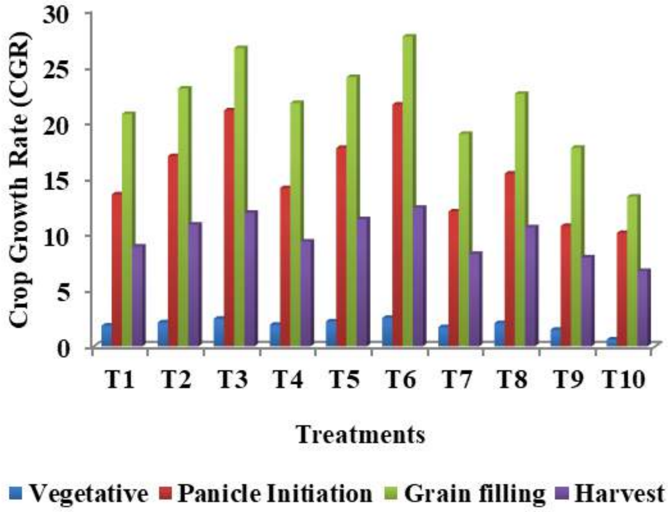

Fig. 2. Effect of varying doses of NPK and IPNS on CGR of Pearl millet

References

Bamboriya, S.D., R.S. Bana, V. Pooniya, K.S. Rana, and Y.V. Singh. 2017. "Planting density and nitrogen management effects on productivity, quality and water-use efficiency of rainfed pearlmillet (Pennisetum glaucum) under conservation agriculture."*Indian Journal of Agronomy* 62 (3):363-366.

Ramamoorthy, B., and M. Velayutham. 2011. "The" Law of Optimum" and soil test based fertiliser use for targeted yield of crops and soil fertility management for sustainable agriculture." *Madras Agricultural Journal* 98 (10/12):295-307.

Saini, A.K., A.M. Patel, P.P. Chaudhary, and L.H. Saini. 2018. "Impact assessment of irrigation, fertility and hydrogel levels on growth attributes, yield and economics of summer pearl millet (Pennisetum glaucum L.) under North Gujarat conditions."*Journal of Pharmacognosy and Phytochem*istry 7:2914-2918.

Influence of Nipping and Crop Geometry on the Growth Parameters of Rainfed Horsegram

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Keywords: Nipping, spacing, mepiquat chloride, chlormequat chloride

Introduction

Horse gram (*Macrotyloma uniflorum*) is an under exploited legume which is an important food and feed crop that traditionally grown in arid, tropical and subtropical regions of the world. Due to wider adaptability of horse gram to different climatic conditions, it is grown in various places of India. Horse gram being a rainfed crop undergoes many biotic and abiotic stresses which leads to poorer yields. Therefore, there is a need to standardize the agronomic practices for realizing the yield potential in horse gram. Since, horse gram is indeterminate in growth and twining in nature, the plant height has to be reduced so that, the lateral productive branches can be produced. Hence, Nipping is found to be an effective method to improve the productivity of horse gram.

Methodology

The field experiment was conducted in Eastern Block farm of Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore. The experimental site comes under western zone of Tamil Nadu. It is located at a latitude of 11.01^0 N, longitude of 76.93^0 E and 426.7 meters above the mean sea level (MSL). The experiment is done to investigate the influence of nipping on the productivity of rainfed horsegram under altered crop geometry for a variety of Paiyur 2 in factorial randomized block design with two factors and two replications. First factor consisted of three crop geometries *i.e.,* broadcasting, line sowing with 30 cm × 10 cm spacing and line sowing with 30 cm × 20 cm spacing. Second factor involved manual nipping, mepiquat chloride 125 ppm, mepiquat chloride 250 ppm, chlormequat chloride 125 ppm, chlormequat chloride 250 ppm and no nipping.

Observations on growth parameters such as dry matter production was calculated. Dry matter accumulation is the main factor that determines the growth of a plant. The efficient utilization of available resources is reflected by the dry matter production of a crop. Though total dry matter production in a plant represents its potentiality for yield, mobilization of TDM towards grain development is a prime factor for achieving the economic yield. Randomly five plants were collected from each plot by pulling out the plants carefully. The plants were first air dried followed by oven drying at 700C until the constant weight was obtained. Later the plants were weighed by using electronic top pan balance and expressed in kg ha^{-1}. Dry matter production was carried out at 30, 60, 90 DAS and at harvest.

Results and discussion

Influence of crop geometry and nipping on dry matter production is depicted in Fig 1. Among the different crop geometries, the line sowing at 30 cm × 10 cm recorded the higher total dry matter production with 3041 kg ha^{-1} at harvest, respectively which was followed by broadcasting, which might be because of the higher population and higher accumulation of nutrients per unit area over wider spacing. This result is in line with the findings of Vijayakumar *et al.* (2006), Sathyamoorthi *et al.* (2008) and Kumar *et al.* (2017). With respect to method of nipping, considerably higher dry matter production was recorded with mepiquat chloride 250 ppm with 3667 kg ha^{-1} at harvest followed by chlormequat chloride 250 ppm). The increased dry matter production might be due to better carbon partitioning between source and sink. This result is in line with Paikra *et al.* (2018). Evidently, lesser dry matter production was observed with no nipping. The interaction between crop geometry and nipping failed to produce a significant influence on the dry matter production.

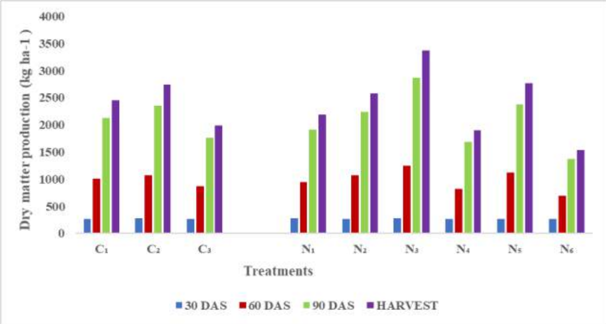

Fig. 1. Influence of crop geometry and nipping on dry matter production (kg ha^{-1}) of horsegram

References

Kumar, S., N. Durairaj, and V. Kannan. 2017. "Effect of crop geometry and foliar nutrition on growth and yield of irrigated blackgram (Vigna mungo L.) " International Journal of Current Microbiology and Applied Sciences 6 (11):4084-4094.

Paikra, V., I. Paikra, and R. Lakpale. 2018. "Effect of different doses of cyclanilide+ mepiquat chloride on crop growth and quality of soybean (Glycine max L.)." International Journal of Chemical Studies:1812. 6(1): 2167-2170

Influence of Soil Test Crop Response Based Integrated Plant Nutrient Management on Quality of Okra [*Abelmoschus Esculentus* (L.) Monech]

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Keywords: *productivity, soil health, STCR, IPNS, improve, sustainable*

Introduction

Food security, environmental quality and soil health are among the major challenge in the 21st century faced by agriculturists. In contrast to the increasing food demand, the factor productivity and rate of response of crops to applied fertilizers under intensive cropping system are reducing continuously. Okra is a short duration vegetable crop and its growth, yield and quality is highly influenced by fertilizer application. Integrated Plant-Nutrient System (IPNS) involving combined use of fertilizers, organic manures and biofertilizers not only helps in improving the productivity of the major crops but also helps in maintenance of better soil health on cost effective basis.

Methodology

A field experiment was conducted during the *Kharif* season of 2018 in Karikalampakkam village in Nettapakkam commune of Pondicherry district, U.T of Puducherry. The experiment was carried out with ten treatments *viz*., farmer's practice, FYM alone @ 12.5 t ha^{-1}, blanket recommendation, STCR-NPK alone @ 160, 170 and 180 q ha^{-1} and STCR-IPNS @ 160, 170 and 180 q ha^{-1} and control each replicated thrice. The representative fruit sample from each plot was collected at 5th, 12th and 19th picking and analyzed for quality parameters *viz*., content of mucilage, protein and crude fibre content.

Results and Discussion

Mucilage content

The content of mucilage was found to be the highest in the treatment that received FYM (12.5 t ha^{-1}) alone i.e., (4.65 per cent), and was non significant to the treatments that received STCR+IPNS combination, farmer's practice and blanket recommendation treatments (**Table 1**). The lowest was recorded in control (2.92 per cent).

Protein content

The protein content of fresh fruit was numerically higher (1.84 per cent) in the plot that received STCR + IPNS – 180 q ha^{-1}. The lowest protein content (1.42 per cent) was observed in control followed by STCR-NPK alone treatment (**Figure 1**).

Crude fibre

The content of crude fibre was significantly higher in the fruits harvested in the control plot (15.63 per cent) followed by STCR-NPK alone treatment and least in the plots that received STCR+IPNS treatments followed by FYM (12.5 t ha^{-1}) alone treatment (**Figure 2**)

Table 1.Effect of different treatments on mucilage content (per cent)

Treatments	5th picking	12th picking	19th picking	Treatment Mean
T_1-Control	2.86	3.00	2.90	2.92
T_2- FYM (12.5 t ha^{-1}) alone	4.60	4.72	4.64	4.65
T_3-Farmer's Practice	4.38	4.56	4.44	4.44
T_4-Blanket Recommendation	4.42	4.50	4.46	4.46
T_5-STCR-NPK alone-160 q ha^{-1}	3.43	3.62	3.58	3.54
T_6-STCR-NPK alone-170 q ha^{-1}	3.62	3.82	3.68	3.70

Treatments	5th picking	12th picking	19th picking	Treatment Mean
T_7-STCR-NPK alone-180 q ha^{-1}	3.87	4.20	3.97	4.01
T_8-STCR+IPNS-160 q ha^{-1}	4.45	4.52	4.42	4.46
T_9-STCR+IPNS-170 q ha^{-1}	4.48	4.59	4.48	4.51
T_{10}-STCR+IPNS-180 q ha^{-1}	4.48	4.62	4.52	4.54
Days Mean	4.05	4.21	4.10	
	T	**D**	**T X D**	
S.Ed	0.19	0.10	0.33	
C.D(0.05)	0.38	NS	NS	

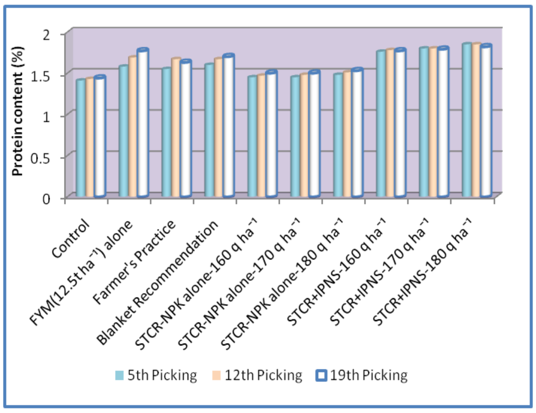

Figure.1 Effect of different fertilizer doses of NPK and STCR- IPNS on protein content (%)

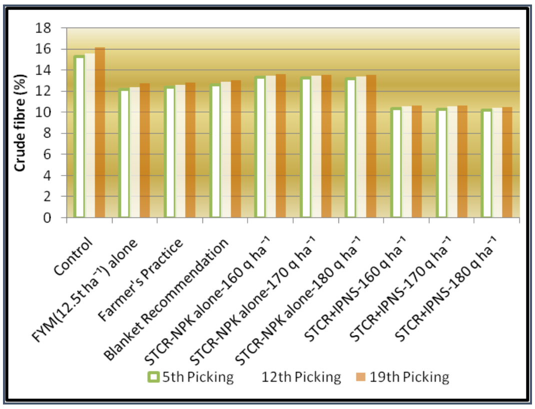

Figure.2 Effect of different fertilizer doses of NPK and STCR- IPNS on crude fibre content (%)

References

Akande, M.O., F.I. Oluwatoyinbo, E.A. Makinde, A.S. Adepojuand I.S. Adepoju. 2010. Response of okra to organic and inorganic fertilization. ***J. Nat. and Sci.,*** 8(11): 261-266.

Asha K. Raj and V.L. Geetha Kumari. 2001. Effect of organic manure and Azospirillum inoculation on yield and quality of okra. ***Veg, Sci.,*** 28: 179-181

Pavan Yadave, P. Sing and R.L. Yadave. 2006. Effect of organic manures and nitrogen levels in growth yield and quality of okra. ***Indian Journal of Horticulture.,*** 63: 215-217

Interaction Effect of Vesicular Arbuscular Mycorrhiza with Different Amendments on Increasing Phosphorus Uptake

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Keywords: *Phosphorus, VAM, FYM, P uptake.*

Introduction

Phosphorus (P) nutrition of plants has rightly been regarded as the "key to human hunger" because of its pivotal role in the normal growth of plants but, it is often the most limiting nutrient in soil-plant systems. In alkaline soils, the abundance of calcium causes phosphorus fixation in the soil and unavailability to the crop. The application of right combination of amendments can improve the uptake of native as well as the applied phosphorus by crop.

Methodology

A pot experiment was carried out with maize as test crop, in a factorial completely randomized block design with five treatment combinations *viz*., Control (no P), P alone, P with FYM, EFYM and P with Humic acid and all the five treatments were tried with and without VAM and the experiment was replicated four times. The phosphorus concentration in soil was analysed in four growth stages *viz*., knee high stage, tasselling stage, milky stage and harvest stage. Total plant P concentration in grain and stover was analysed during the harvest stage to study the P uptake under different treatments.

Results and Discussion

Effect of VAM with different amendments on soil available P

The Soil phosphorus content showed a decreasing trend along the crop growth stages. The application of P with FYM and as EFYM recorded significantly higher available P in all the stages (Figure 1 and 2)

Effect of VAM with different amendments on plant P content and P uptake

The highest plant P concentration was also recorded in P and FYM with VAM treatment (Table 1). The grain P uptake and stover uptake was also found to be higher in the application of P and FYM with VAM (Table 1).The application of phosphorus with FYM along with VAM showed the highest soil P and plant P concentration. The P uptake was also found to be higher in the same treatment. VAM has mobilised the available P in soil and thereby the P uptake was higher.

Table 1. Effect of VAM and different amendments on P content (%) and uptake (g pot^{-1})

Treatments	TOTAL P (%)						P UPTAKE (g pot^{-1})								
	GRAIN			STOVER			GRAIN			STOVER			TOTAL		
	V_0	V_1	Mean	V_0	V_1	Mean	V_0	V_1	Mean	V_0	V_1	Mean	V_0	V_1	Mean
T_1- Control	0.206	0.274	**0.240**	0.180	0.188	**0.184**	0.07	0.11	**0.09**	0.06	0.08	**0.07**	0.12	0.19	**0.16**
T_2- P alone	0.279	0.321	**0.300**	0.182	0.189	**0.186**	0.07	0.10	**0.08**	0.05	0.06	**0.06**	0.13	0.16	**0.14**
T_3- P + FYM	0.314	0.372	**0.343**	0.190	0.197	**0.194**	0.13	0.15	**0.14**	0.09	0.10	**0.10**	0.22	0.25	**0.24**
T_4- EFYM	0.294	0.366	**0.330**	0.192	0.195	**0.194**	0.09	0.14	**0.11**	0.07	0.09	**0.08**	0.16	0.23	**0.20**
T_5-P + Humic acid	0.214	0.300	**0.257**	0.184	0.189	**0.187**	0.07	0.11	**0.09**	0.09	0.08	**0.09**	0.16	0.19	**0.18**
MEAN	**0.261**	**0.327**	**0.294**	**0.186**	**0.192**	**0.189**	**0.08**	**0.12**	**0.10**	**0.07**	**0.08**	**0.08**	**0.16**	**0.20**	**0.18**
VARIABLES	**SEd**	**CD(5%)**		**SEd**	**CD (5%)**		**SEd**	**CD (5%)**		**SEd**	**CD (5%)**		**SEd**	**CD (5%)**	
Fertiliser (F)	0.003	0.006		0.001	0.003		0.001	0.002		0.001	0.001		0.002	0.004	
VAM(V)	0.002	0.004		0.001	0.002		0.001	0.001		0.001	0.001		0.001	0.002	
F X V	0.004	0.009		0.002	NS		0.002	0.003		0.001	0.002		0.003	0.006	

V_0- Without VAM ; V_1- With VAM

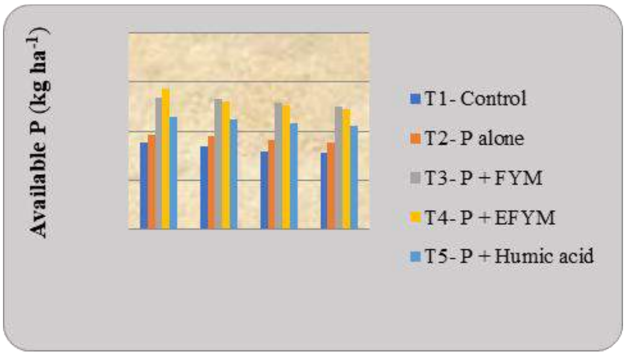

Figure 1. Effect of different amendments on soil available P

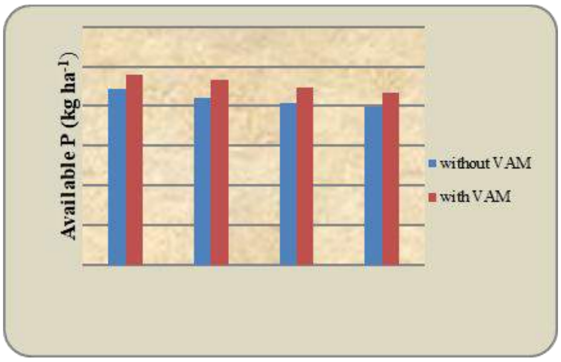

Figure 2. Effect of VAM on soil available P

References

Ali, A., M. Sharif, F. Wahid, Z. Zhang, S. N. M. Shah, R. S. Zaheer, F. Khan, and F. Rehman. 2014. "Effect of composted rock phosphate with organic materials on yield and phosphorus uptake of berseem and maize." *American Journal of Plant Sciences* 5 (07):975.

Cavagnaro, T. R., S. F. Bender, H. R. Asghari, and M. G. van der Heijden. 2015. "The role of arbuscular mycorrhizas in reducing soil nutrient loss." *Trends in Plant Science* 20 (5):283 290.

Tirupathirao, H., R. Subhash, S. Sumathi, and S. Jayamma. 2013. "Influence of FYM and VAM on yield, nutrient content and antioxidant activity of spinach (*Beta vulgaris*)." *Journal of Pollution Research* 32 (4):833–836.

Irrigation and yield parameters of Sorghum as Influenced by Irrigation Practices in Sodic Soil Irrigated with Alkali Water

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Keywords: *Sorghum, sodic soil, alkali water, irrigation practices, relative yield difference.*

Introduction

Sorghum is an important crop for grain and fodder purpose owing to its assured production under adverse conditions of poor quality land and water. The area under the sodic soil in India and Tamil Nadu is 574 thousand hectares and 0.4 million ha respectively (Levy and Shainberg, 2005 and Jayakumar *et al.,* 2012). Improper germination followed by affect on crop stand and growth ultimately leading to reduction in yield is found due to irrigation with poor quality water which is dominant in these areas (Kumar, 2016). This study was conducted to find suitable irrigation practices to manage the productivity and profitability of sorghum cultivated under the sodic soils using poor quality ground water for irrigation.

Methodology

Field experiment was conducted at Anbil Dharmalingam Agricultural College and Research Institute, Tamil Nadu Agricultural Research Institute, Tiruchirapalli, Tamil Nadu during Kharif 2018. The site is located at 10°45′15″ N latitude, 78°36′01″ E longitude with 85m above mean sea level. Amount of rainfall during the crop growth period was 202 mm. The experiment was laid out in Factorial Randomized Block Design (FRBD) with two factors Viz., Method of irrigation (M_1- All furrow, M_2- Alternate furrow and M_3- Check basin) and IW: CPE ratio based scheduling of irrigation (I_1- 0.40, I_2- 0.55, I_3- 0.70, I_4- 0.85 and I_5- 1.00) consisting fifteen treatments. The standard guidelines were followed for crop production as recommended by Tamil Nadu Agricultural University. Irrigation treatments were given by summing up the daily evaporation values by using USWB class A pan evaporimeter along with consideration of rainfall contribution. Sorghum yield under normal conditions was observed. The crop growth and yield data was analysed statistically and recorded.

Results and Discussion

The number of irrigations and water requirement of sorghum increased with increase in IW: CPE ratios. Among different methods of irrigation alternate furrow has utilized half the amount of water when compared to all furrow and check basin for the same number of irrigations. The interaction effect for different methods showed higher yield for T_4, T_{10} and T_{13} and lower yield reduction (%) than sorghum grown under normal conditions. Furrow irrigation and higher water availability under high IW: CPE ratios might have reduced the ill effects of the alkali water and sodic soil along with enhanced translocation of photosynthates towards economic parts which might have contributed for higher yields. Depending on the water availability and suitability of the location different irrigation practices may be adopted.

Table 1: Effect of method and scheduling of irrigation on the relative yield difference (%) of sorghum

Treatments	Yield obtained (Kg ha^{-1})	Percent relative yield difference (%)	Reduction in yield (%)
Sorghum yield under normal conditions	2680.02		
M_1I_1	915	34.2	65.8
M_1I_2	1166	43.5	56.5
M_1I_3	1388	51.8	48.2
M_1I_4	1486	55.5	44.5
M_1I_5	1295	48.3	51.7
M_2I_1	706	26.3	73.7
M_2I_2	917	34.2	65.8
M_2I_3	1085	40.5	59.5
M_2I_4	1218	45.4	54.6
M_2I_5	1281	47.8	52.2
M_3I_1	617	23.0	77.0
M_3I_2	771	28.8	71.2
M_3I_3	825	30.0	69.2
M_3I_4	778	29.0	71.0
M_3I_5	646	24.1	75.9

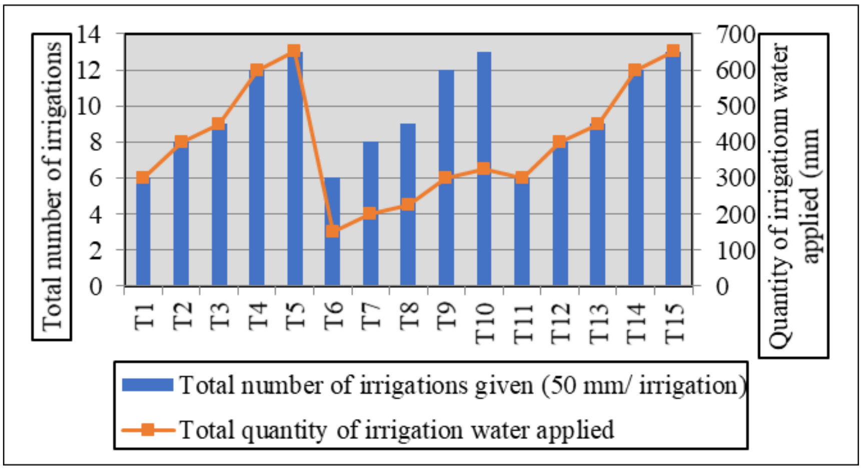

Fig. 1: Total number of irrigations and total quantity of water (mm)

References

Jayakumar M., Balasubramanian V. and T.S. Manickam. 2012. Characterization of Sodic Soils of North Western Zone of Tamil Nadu. *Madras Agriculture Journal*, *99* (10-12): 707-710.

Kumar and Kodary Avil. 2016. Growth, yield and water productivity of sorghum influenced by saline water irrigation and management practices. *International journal of innovative research and development*. 5(3): 188-193.

Levy G.J. and I. Shainberg. 2005. Sodic soils. The Volcani Center, Bet Dagan, Israel; 504-513.

Kinetics of Nitrogen in Sodic Soil Under Different Amendments

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Key words: *Distillery spent wash, nitrogen, sodic soil, amendments, incubation*

Introduction

Large extent of land in India is affected by sodicity due to major degradation processes like sodification, water logging, chemical impairment and desertification (Dagar and Singh, 1994). Sodic soils can be reclaimed by different amendments. Reclamation of sodic soils involves the replacement of exchangeable sodium with a favourable cation like calcium (Richards, 1954). Distillery spent wash is one of the by-product from sugar industry which is highly acidic and contains good amount of essential plant nutrients. Application of distillery spent wash to the air dried non-saline sodic soil, followed by two or three leaching with water could effectively reclaim sodic soil (Rajukannu *et al*., 1996).The nitrogen supplying capacity and its transformation under sodic soil is important to attain optimum yield in rice. Hence the study is carried out to study about the Dynamics of nitrogen in sodic soil under different amendments.

Methodology

The incubation experiment was conducted with eight treatments and three replications. the treatments includes control (T_1),gypsum + green manure @ 6.25 t ha^{-1} (T_2), green leaf manure @ 12.5 t ha^{-1} (T_3), Distillery spent wash @ 5lakh liters ha^{-1} (T_4), Nitrogen alone @ 75 kg ha^{-1}(T_5), Gypsum + Green manure @ 6.25 t ha^{-1} + Nitrogen @ 75 kg ha^{-1}(T_6), Green leafmanure@12.5 t ha^{-1} + Nitrogen @ 75 kg ha^{-1}(T_7), DSW @ 5 lakh liters ha^{-1}+ Nitrogen @ 75 kg ha^{-1}(T_8). The soils were incubated at saturated condition for 60 days and were analysed for pysico- chemical properties *viz*., pH, EC, ESP. The incubated soils were collected at 15 days intervals (15, 30, 45, 60) and analysed for Available nitrogen, Ammonical nitrogen, and Nitrate nitrogen.

Result and Discussion

Physico-chemical properties

The results of the incubation study revealed that application of amendments decreased the pH of the soil. Maximum reduction in soil pH was recorded in DSW applied treatments. The soluble salt concentration was found to be slightly increased in the DSW applied pots. Soil ESP was significantly reduced on reclamation to the level of 13.1, 13.5 and 24.2 per cent on account of application of DSW, Gypsum + GM, and Green leaf manure.

Available nitrogen, Nitrate nitrogen and Ammonical nitrogen

The influence of different amendments and levels of nitrogen on available nitrogen, ammonical nitrogen and nitrate nitrogen content of soil collected at different intervals during incubation period was showed in the Figure 1. The highest amount of available nitrogen, ammonical nitrogen and nitrate nitrogen were registered in the treatment T_8 (DSW @ 5 lakh liters ha^{-1}+ Nitrogen @ 75 kg ha^{-1}) for the samples collected at 15, 30, 45 and 60 days after incubation (DAI).

Higher N availability in DSW applied soil could be due to the direct contribution of nitrogen as well as increased microbial activity due to the added organic matter. The organic form of N supplied by the application of DSW might have been slowly released into the available pool and steadily increased the available N content. This is in line with the findings of Devarajan *et al*., (1996) and Satisha (2000).

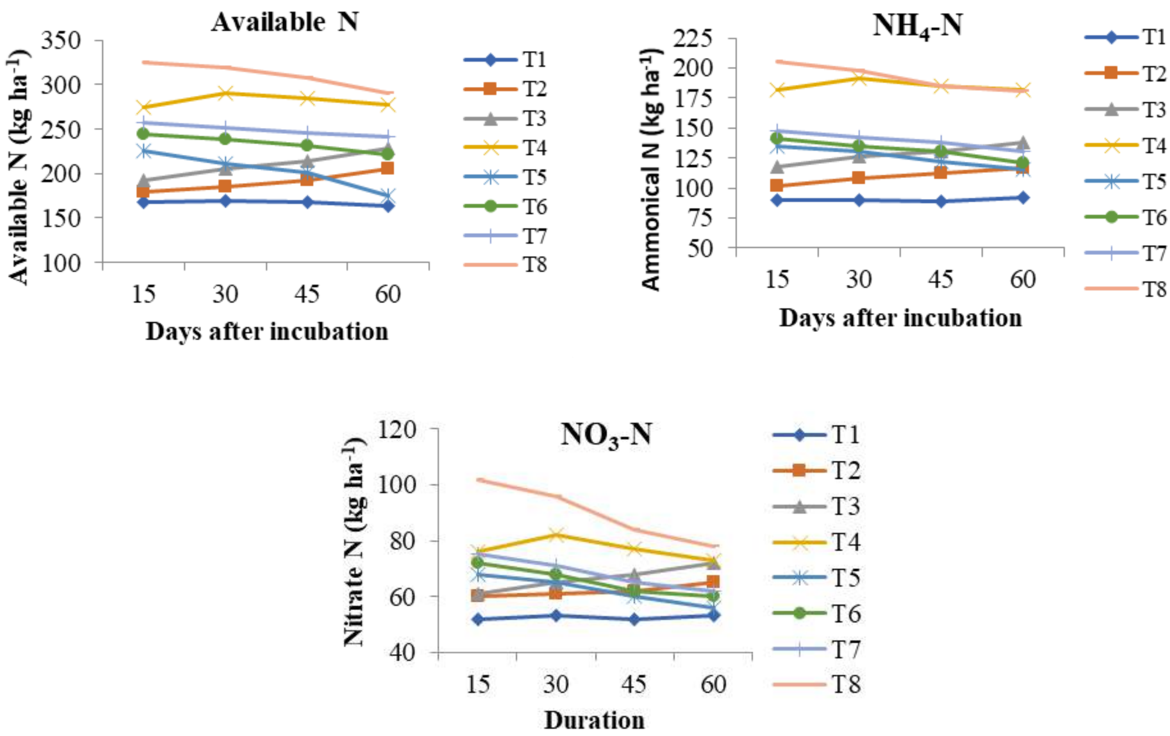

Fig.1 Influence of amendments and nitrogen on available nitrogen, nitrate nitrogen and ammonical nitrogen of soil at different incubation period

References

Dagar, JC, and NT Singh. 1994. "Agroforestry options in the reclamation of problem soils." *Trees and tree farming*: 65-103.

Devarajan, L, G. Ramanathan, and G. Oblisami. 1996. Effect of bio-earth composts on yield and quality of sugarcane. In: Proceedings of national seminar on use of distillery waste on agriculture, held at ADAC&RI,TNAU,Tiruchirapalli, Oct. 28-29, 171-175.

Rajukannu, K, and TS Manickam. 1996. "Use of distillery and sugar industry wastes in agriculture—problems and prospects." National symposium on use of distillery and sugar industry wastes in agriculture.

Richards, L.A. 1954. Diagnosis and Improvement of Saline and Alkali Soils. Handbook, No.60. United States Department of Agriculture, Washington DC, 275.

Satisha.G.C. 2000. Bioconversion of sugar industrial effluent wastes into enriched compost and its effect on soils and crops. *Ph. D. Thesis.* Tamil Nadu Agricultural University, Coimbatore.

Microbiome and their Metabolits for Plant Growth Promotion and Drought Tolerance in Little Millet (*Panicum sumatrense* L.)

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Keywords: *Abiotic stress, Induced systemic tolerance, Plant growth promotion, Seed exudates.*

Introduction

Little millet (*Panicum sumatrense* L.) is one of the important small millets indigenous to Indian subcontinent. It is cultivated both in the tropics and sub-tropics and even at an altitude of 7000 ft above MSL. Little millet is the much needed food grain among the tribal and is staple food for millions in many parts of the world. Although little millet is well known for its drought tolerance and is considered as one of the least water demanding crops, the plant associated bacteria can help the crop by many ways which includes mitigation of abiotic stress through induced systemic tolerance (IST).

Methodology

The present study was carried out in little millet seeds of ATL -1variety for their ability to tolerate drought by creating artificial osmotic stress using PEG 6000. Seeds were able to tolerate osmotic stress about 10 bars. Bacterial, fungal and actinobacterial isolates were isolated from seeds of little millet plants grown under stressed conditions. A total of 15 endophytic bacterial isolates, 4 fungal isolates and 2 actinobacterial isolates were selected based on their ability to tolerate drought up to 64 bars on PEG infused agar plates. The potential microbes of strain number LSB2, LSB6, LSF4, and LSF7 were further screened for P, K and Zn solublization, IAA production, ACC deaminase activity, siderophore production, exopolysachride production, and biofilm activity. The isolate LSB4 and LSB6 were screened as potential candidates. Laboratory level germination experiments were carried out for production of seed exudates of variety ATL-1 and the changes occurring in germination during stressed and non-stressed conditions under microbial inoculant treated seeds were recorded at periodic intervals.

Results and Discussion

In vitro efficacy of different isolates for induced drougt tolerance

Among the 21 isolates, LSB2, LSB6, LSF4, and LSF7 significantly recorded high drought tolerant capacity of 64 bars. Based on PGP traits the isolate LSB4 and LSB6 were screened as potential candidates. **(Table 1)**

Seed metabolites

Fumaric acid, oleic acid, hexadecanoic acid, 1-octanol,2-butyl, L-ascorbic acid and sitosterol, Myristin etc are the metabolites profiled during seed germination.Apart from fatty acid synthesis, proponoate metabolism over represented.**(Figure 1)**

Table 1. Solublization efficiency of different isolates

Isolation	P			K			Zn		
	Culture dia (cm)	Solublization zone (cm)	SE (%)	Culture dia (cm)	Solublization zone (cm)	SE (%)	Culture dia (cm)	Solublization zone (cm)	SE (%)
LSB2	0.5	0.8	160	0.5	1.3	260	0.5	1.6	320
LSB6	0.5	0.9	180	0.5	1.2	240	0.5	2.0	400
LSF4	0.5	0.9	180	0.5	1.4	280	0.5	2.0	400
LSF7	0.5	0.6	120	0.5	-	-	0.5	1.0	200

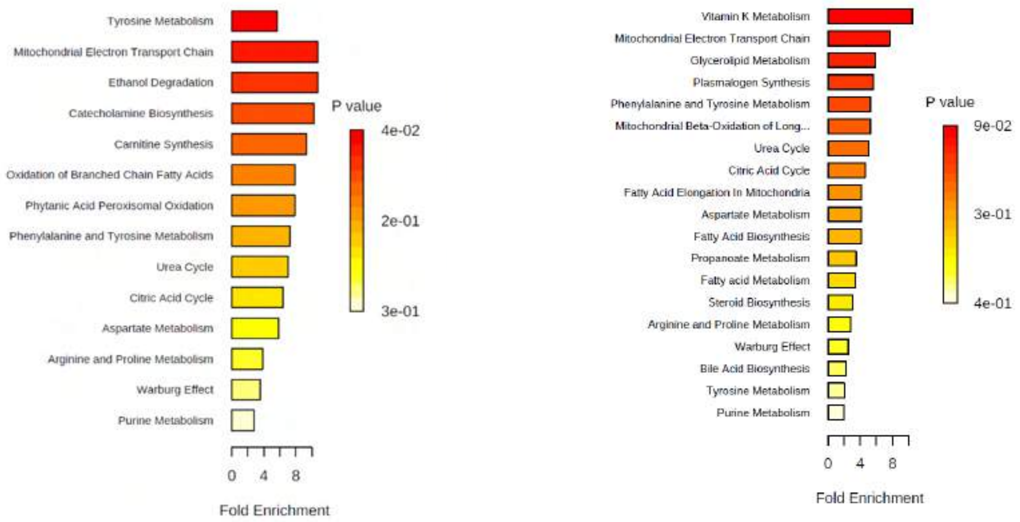

Figure 1. Over representation analysis of Seed Metabolome under Stress

References

Manavalan, Lakshmi P, Satish. Guttikonda, Lam-Son Phan Tran, and Henry T. Nguyen. 2009. Physiological and molecular approaches to improve drought resistance in soybean. *Plant and cell physiology* 50 (7): 1260-1276.

Meena, Kamlesh K, Ajay M, Utkarsh M. Bitla, Khushboo Choudhary, Priyanka Gupta, Ashwani Pareek, Dhananjaya P. Singh.2017. Abiotic stress responses and microbe-mediated mitigation in plants: the omics strategies. *Frontiers in plant science* 8:172.

Ngumbi, Esther, and Joseph Kloepper. 2016.Bacterial-mediated drought tolerance: current and future prospects. *Applied Soil Ecology* 105: 109-125.

Nutrient Use Efficiencies of Hybrid Sunflower in Response to Sulphur and Zinc Fertilization in Tambirabarani Tract

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Key words: *Sulphur, Zinc Sulphate, Nutrient Use Efficiency, Hybrid Sunflower*

Introduction

Sunflower (*Helianthus annuus L.*) accounts the fourth place among the vegetable oilseeds ensuing to soybean, oil palm and canola within the world. Nowadays, the world zone under sunflower is 27.29 million ha with an annual production and productivity of 49.56 million tons and 1820 kg ha^{-1}, respectively (NSA, 2019). In India, it is cultivated over an area of approximately 0.39 million ha with a production of 0.34 million tons and productivity of 842 kg ha^{-1} (USDA, 2018). The optimization of the nutrients is the key to achieve the productivity of sunflower, as it has very high nutrient requirement. The recently released high yielding hybrid varieties remove more nutrients from the soil, so proper management of nutrient is essential for sustainable production. Despite its considerable importance, little work has been done on sunflower with particular reference to its ability to grow well in Rabi season in the southern regions of Tambirabarani tract. With the above background, the present investigation was carried out to study the effect of soil and foliar applications of S and Zn along with NPK fertilizers on sunflower seed yield, nutrient uptake and nutrient use efficiencies.

Methodology

A field experiment was conducted at Agricultural College and Research Institute, Killikulam, Thoothukudi during *Rabi* season between November - February on 2015-16 to 2016- 17. The experiment consisted of eight treatments *viz.* T_1- Control, T_2- 60:90:60 kg of NPK ha^{-1} + S @ 25 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1}, T_3- 60:90:60 kg of NPK ha^{-1}+ S @ 12.5 kg ha^{-1} + $ZnSO_4$@ 0.5 % foliar spray, T_4- 60:90:60 kg of NPK ha^{-1} + S @ 25 kg ha^{-1} + $ZnSO_4$@ 0.5 % foliar spray, T_5- 60:90:60 kg of NPK ha^{-1}+ S @ 37.5 kg ha^{-1} + $ZnSO_4$@ 0.5 % foliar spray, T_6 - 60:90:60 kg of NPK ha^{-1}+ $ZnSO_4$@ 12.5 kg ha^{-1} + S @ 0.2 % foliar spray, T_7- 60:90:60 kg of NPK ha^{-1}+ $ZnSO_4$ @ 25 kg ha^{-1} + S @ 0.2 % foliar spray and T_8 - 60:90:60 kg of NPK ha^{-1}+ $ZnSO_4$ @ 37.5 kg ha^{-1} + S @ 0.2 % foliar spray was carried out in randomized block design (RBD) with three replication.

Indices for Assessment of Nutrient Efficiencies

Agronomic Efficiency (AE):

AE = {(Seed yield in fertilized plot (kg ha^{-1}) – Seed yield in unfertilized plot (kg ha^{-1}) / Quantity of nutrient applied (kg ha^{-1})}

Physiological Efficiency (PE) :

The physiological efficiency is the seed yield obtained per unit of nutrients absorbed. It was computed as follows (Yoshida, 1981).

PE = [Seed yield in fertilized plot (kg ha^{-1}) – Seed yield in unfertilized plot (kg ha^{-1}) / Nutrient uptake in fertilized plot (kg ha^{-1}) – Nutrient uptake in unfertilized plot (kg ha^{-1})]

Result and Discussion

Seed Yield and Nutrient Use Efficiencies

Application of S and Zn micronutrient had a remarkable influence on efficiencies of sunflower. Among the treatments, treatment T_2- 60:90:60 kg of NPK ha^{-1} + S @ 25 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} registered the higher seed yield (2101 kg ha^{-1}), agronomic efficiency of 12.28 kg N, 8.19 kg P_2O_5 and 2.95 kg of K_2O,58.96 kg of S and 245.67 kg of Zn and physiological efficiency of 34.43, 139.45, 41.70, 141.19 and 6639.6 kg of N, P_2O_5, K_2O, S and Zn respectively of rabi irrigated sunflower crop. In view of the above results it is concluded that hybrid sunflower is highly responsive crop to Zn and S micronutrient fertilization and have positive effects on the uptake and utilization of major nutrients at the whole plant level and it may improve efficiency parameters. The present results supported the observations of Hawkesford *et al.* (2014).

Table 1. Effect of treatments on Seed yield and Nutrient use efficiency

Treatment	Seed yield (Kg ha^{-1})	Agronomic efficiency					Physiological efficiency				
		N	P	K	S	Zn	N	P	K	S	Zn
T_1- Control	975	-	-	-	-	-	-	-	-	-	-
T_2- 60:90:60 kg of NPK ha^{-1} + S @ 25 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1}	2101	18.77	12.51	9.43	45.04	45.04	8.81	33.33	13.36	37.53	2458.5
T_3- 60:90:60 kg of NPK ha^{-1} + S @ 12.5 kg ha^{-1} + $ZnSO_4$ @ 0.5 % foliar spray	1712	12.28	8.19	2.95	58.96	245.67	34.43	139.45	41.70	141.19	6639.6
T_4- 60:90:60 kg of NPK ha^{-1} + S @ 25 kg ha^{-1} + $ZnSO_4$ @ 0.5 % foliar spray	1801	13.77	9.18	4.43	33.04	275.33	13.45	55.48	16.79	42.49	3344.1
T_5- 60:90:60 kg of NPK ha^{-1} + S @ 37.5 kg ha^{-1} + $ZnSO_4$ @ 0.5 % foliar spray	1892	15.28	10.19	5.95	24.45	305.67	10.91	40.44	14.11	30.63	3026.4
T_6- 60:90:60 kg of NPK ha^{-1} + $ZnSO_4$ @ 12.5 kg ha^{-1} + S @ 0.2 % foliar spray	1757	13.03	8.69	3.70	651.67	62.56	17.41	101.39	27.41	92.32	3969.5
T_7- 60:90:60 kg of NPK ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} + S @ 0.2 % foliar spray	1813	13.97	9.31	4.63	698.33	33.52	12.20	49.13	15.45	51.16	2415.0
T_8- 60:90:60 kg of NPK ha^{-1} + $ZnSO_4$ @ 37.5 kg ha^{-1} + S @ 0.2 % foliar spray	1980	16.75	11.17	7.42	837.50	26.80	9.77	38.05	14.04	47.58	2233.3
SEd	43.16										
CD (P=0.05)	92.58										

Conclusion

From the present investigation it is concluded that 60 kg N, 90 kg P_2O_5 and 60 kg K_2O ha^{-1} along with soil application of S @ 25 kg ha^{-1} $ZnSO_4$ @ 25 kg ha^{-1} was the optimal agronomic nutrient management treatment for obtaining maximum seed yield, maximum nutrient use efficiencies, agronomic efficiency and physiological efficiency of irrigated hybrid sunflower crop.

References

Hawkesford, M.J.; Stanislav, K. and Kok, L.J.D. (2014). Nutrient use efficiency in plants: concepts and approaches. Springer, Int. Pub., Switzerland, 279.

NSA, (2019). World Supply and Disappearance, National Sunflower Association, https://www.sunflowernsa.com/stats/world-supply/

USDA. (2018). India Oilseeds and Products Update. USDA Foregin agricultural Service.

Yoshida, S. (1981). Fundamentals of rice crop science. IRRI, Los Banos, Philippines.

Plant Growth Promoting Characteristics of Maize Apoplastic Fluid Bacteria

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Keywords: *Apoplastic fluid, maize, Plant growth promotion, bacteria*

Introduction

Plants constantly interact with numerous beneficial and deleterious microorganisms. Beneficial microbes seek great attention because of their role in improving plant growth and health. Especially, bacterial endophytes provide much more benefits and are able to improve host tolerance and/or resistance to various biotic and abiotic stresses. Plant apoplast is considered as one of the main reservoirs of bacterial endophytes. The apoplast is the space outside the plasma membrane which contains free diffusing metabolites and proteins. These solutes play an important role in plant physiology by controlling biotic and abiotic stresses. The apoplastic fluid endophytes positively enhance the plant growth through improved nutrition (nitrogen, phosphate, zinc and potassium) and phytostimulants production (indole acetic acid and gibberellic acid) production. Maize (*Zea mays*), the third most important cereal crop in India after rice and wheat, has been planted on about 80 lakh hectares (Romero et al., 2019). In this context, the aim of current study was to evaluate the plant growth promoting potential of apoplastic fluid isolated bacteria in maize.

Methodology

Root apopalstic fluid isolation

The apoplastic fluid was recovered from excised roots samples of 45 days old maize (COH6) grown in millet farm, Tamil Nadu Agricultural University (TNAU), Coimbatore according to the procedure of Dragisic Maksimovica et al.. 2014

Estimation of mineral solubilisation efficiency

For estimating nutrient solubilizing index, the bacterial cultures were grown on Pikovskaya, Aleksandrov, Bunt and Rovira media for phosphate, potassium and zinc respectively. After incubation, the halo zone formed around the colonies was measured.

Indole acetic acid (IAA) and Gibberllic acid (GA)

IAA production of isolated apoplastic fluid bacteria was determined using Salkowaski reagent following the procedure of Patel and Saraf, 2017. GA was estimated according to the method of Chakdar et al., 2018

Siderophore production

Chrome azurol succinic acid medium was used for qualitative assay for siderophore production, positive result showed yellow zone around the bacterial colonies. For quantitative assessment of isolates, 48 h old cultures grown in succinic acid broth were centrifuged at 10,000g for 10 min. One ml of supernatant and 1 ml of CAS dye was added and absorbance was taken at 630 nm in spectrophotometer

Result and Discussion

Of the 6 isolates, RAF5 produced significantly (P=0.0001, df =30, Table. 1) higher amount of IAA (58.04 ±0.07 µg ml^{-1}) and GA (30.61 µg ml^{-1}) than other bacterial isolates. The potential mineral solubilizing endophytes were selected based on the solubilisation index (SI). Only 4 endophytic isolates (RAF3, RAF4, RAF5, and RAF6) solubilized all the three inorganic minerals. Among them, RAF5 showed significantly (P=0.001, df =12, Table. 1) higher degree of mineral solubilisation. All the isolated apoplastic fluid bacteria exhibited positive results for siderophore. Of the 6 isolates, RAF2 (12.29±0.04%) recorded maximum siderophore production. Nivitha et al., 2019 also reported the growth promoting characteristics of apolastic fluid bacteria in rice

Table 1. Plant growth promotion characteristics of maize root apoplastic fluid bacterial isolates

Isolates	Mineral solubilisation index			IAA ($\mu g\ ml^{-1}$)	GA ($\mu g\ ml^{-1}$)	Siderophore (%)
	Phosphate	Zinc	Potassium			
RAF1	2.95 ± 0.02^{e}	nd	5.05 ± 0.28^{a}	14.42 ± 0.05^{d}	19.22 ± 0.02^{d}	1.22 ± 0.01^{d}
RAF2	3.45 ± 0.02^{d}	2.60 ± 0.02^{c}	nd	40.59 ± 0.21^{b}	20.01 ± 0.02^{d}	12.29 ± 0.04^{a}
RAF3	5.05 ± 0.02^{b}	2.67 ± 0.02^{b}	2.24 ± 0.01^{e}	1.83 ± 0.12^{e}	21.46 ± 0.03^{c}	2.68 ± 0.03^{c}
RAF4	3.35 ± 0.08^{d}	2.31 ± 0.02^{d}	2.44 ± 0.01^{d}	27.15 ± 0.03^{c}	21.89 ± 0.01^{c}	2.93 ± 0.00^{d}
RAF5	10.75 ± 0.14^{a}	3.51 ± 0.05^{a}	4.95 ± 0.03^{b}	58.04 ± 0.07^{a}	30.61 ± 0.02^{a}	10.07 ± 0.08^{b}
RAF6	3.60 ± 0.23^{c}	2.66 ± 0.03^{b}	2.75 ± 0.03^{c}	1.87 ± 0.05^{e}	26.25 ± 0.01^{b}	1.14 ± 0.14^{d}

* Note: Values are the mean ± standard deviation of experimental data in triplicate. Values with different letters are significantly different according to Duncan's test; $P \leq 0.05$. Abbreviation: RAF, root apoplastic fluid; nd, no detected activities.

References

Chakdar, H., Dastager, S. G., Khire, J. M., Rane, D., Dharne, M. S. (2018). Characterization of mineral phosphate solubilizing and plant growth promoting bacteria from termite soil of arid region. ***3 Biotech***, 8(2): 1-1.

Maksimovic, J. J., Zivanovic, B. D., Maksimovic, V. M., Mojovic, M. D., Nikolic, M. T., Vucinic, Z. B. 2014. Filter strip as a method of choice for apoplastic fluid extraction from maize roots. ***Plant Sci***, 223:49-58.

Nivitha, G., Bowya, T., Kalaiselvi, T., Sivakumar, U. (2019). Screening of rice apoplast associated endophytic bacterial isolates for moisture stress tolerance and plant growth promoting traits. ***Madras Agricultural Journal***, 106*:* 1-3.

Patel, T., Saraf, M. (2017). Biosynthesis of phytohormones from novel rhizobacterial isolates and their in vitro plant growth-promoting efficacy. ***J. Plant Interact***, 12: 480-7.

Romero, F. M., Rossi, F.R., Garriz, A., Carrasco, P., Ruíz, O.A. (2019). A bacterial endophyte from apoplast fluids protects canola plants from different phytopathogens via antibiosis and induction of host resistance. ***Phytopathology***,109:375-83.

Pollinators Diversity in *Moringa Oleifera* Lam. Ecosystem in the Red Sand Dunes of Thoothukudi District of Tamilnadu

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Keywords: *Apis mellifera*, Pollination, Moringa, Diversity, Pollination efficiency

Introduction

Pollinators are needed to provide 15–30 percent of the world's food supply (Greenleaf and Kremen, 2006). Moringa is a highly cross pollinated and entomophilous crop (Sharma, 2019). The most numerous and plentiful pollinators were hymenopterans, with *Apis cerana indica* F. being one of the most common species among the floral visitors.

Materials and methods

The field studies were conducted in a Moringa orchard with 5 year old trees located at Kayamozhi, Thoothukudi district of Tamilnadu during July 2021. Five trees were chosen at random and marked. Five inflorescences/ tree were chosen at random. to examine the pollinator diversity (FAO, 2008). During peak flowering, the number of insect visitors was monitored for ten days and counted. The two diversity indices namely, Shannon's H and Simpson's D were calculated.

$H = - \sum_{i=0}^{S} pi \ln pi \qquad D = \frac{1}{\sum_{i=1}^{S} pi^2}$

The Pollination efficiency Index is generally calculated using the formula as follows:

Pollination efficiency index = PS of LP x PS of PA

Where PS of LP = $\frac{LPi}{\sum_{i=1}^{n} LPi}$ and PS of PA = $\frac{PAi}{\sum_{i=1}^{n} PAi}$

Results and Discussion

Among the insect pollinators observed, *Apis mellifera* was the dominant pollinator found in the moringa orchard with 3.63/ 25 inflorescences/ 5mins in the morning hours of the day and this was followed by *Apis cerana indica* with population 2.97/ 25 inflorescences/ 5mins in the morning meanwhile *A. cerana indica* was dominant in the afternoon hours compared to the former. Dipterans were least abundant in both the sessions. (Table 1). The diversity was not much differing in both the sessions. The pollination efficiency index was highest in *Xylocopa* sp. with the score of 7.0 *A. mellifera* was the second most efficient pollinator (Table 2.). Our results were in concurrence with Sowmiya *et al*., (2018). *A. mellifera* and *A. cerana indica* can be used for managing pollination in moringa as *Xylocopa* sp. cannot be reared.

Table1. Diversity of pollinators at different time of the day (Kayamozhi, July, 2021)

Sl. No.	Species / Session of a day	Pollinator population in 25 inflorescence / 5 min*		Mean
		Morning	Afternoon	
1	*Apis cerana indica*	2.97	1.87	2.42
2	*Apis mellifera*	3.62	1.77	2.69
3	*Apis dorsata*	1.57	1.13	1.35
4	*Apis florea*	0.15	0.07	0.11
5	Non-Apis Hymenopteran	1.08	1.18	1.13
6	Dipteran	1.00	0.83	0.92
7	Lepidopteran	1.83	1.12	1.48
Mean		1.75	1.14	
SD		1.20	0.60	
Diversity indices				
Simpson's D		5.0	5.6	
Shannon's H		1.02	0.99	

*mean of 6 observations taken at hourly intervals.

Table 2. Pollination Efficiency Index (PEI) of different floral visitors of moringa at Kayamozhi, Thoothukudi on July 2021

Insect species	Loose pollen adhering to the body		Pollinator abundance		Pollinator efficiency index LP pi x PA pi	Pollinator rank
	Number (LP)x1000 *	Performance score (LP pi)	No. of insects (PA)**	Performance score (PA pi)		
Xylocopa sp.	130 (11.41) [a]	0.382	2.60 (1.73) [b]	0.18	7.0	1
Apis mellifera	68 (8.24) [bc]	0.200	4.40 (2.21) [a]	0.31	6.2	2
A. cerana indica	60 (7.75) [cd]	0.176	4.40 (2.20) [a]	0.31	5.5	3
A. dorsata	82 (9.07) [b]	0.241	2.80 (1.81) [b]	0.20	4.8	4
CD (0.05)	1.06		0.29			

*Mean of five observations under compound microscope. Values in parentheses are square root $(\sqrt{x+0.5})$ transformed. In a column figures followed by a common alphabet are not significantly different by LSD (p=0.05)
**Number of pollinators for 25 min / 5 inflorescences (Mean of five observations)

References

FAO. 2008. Rapid assessment of pollinator's status. FAO, Rome, Italy.

Greenleaf, Sarah S and Claire Kremen. 2006. Wild bees enhance honey bees' pollination of hybrid sunflower. Proceedings of the National Academy of Sciences 103: 13890-13895.

Sharma, Devinder. 2019. *Moringa oleifera* Lam.: The Honey Bee Heaven Plant in Jammu and Kashmir. ***Bee World***, 96: 120-122.

Sowmiya, C, MR Srinivasan and PA Saravanan. 2018. Diversity of Pollinators in Drumstick, *Moringa oleifera* Lam. Ecosystem. ***Madras Agric. J.***, 105: 1

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Production and Characterization of Polyhydroxybutyrate (PHB) from *Bacillus siamensis* PHB01

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Keywords: PHB, Bioplastic, FTIR, Bacillus siamensis

Introduction

Polyhydroxybutrate (PHB) is considerably of human interest due to their unique properties and effectively replacing the plastic produced by petroleum. PHB are secondary macromolecules synthesized by micro-organisms under excess carbon and nutrient limited conditions. Both Gram positive and negative bacteria produce PHB. This polymer (PHB) is accumulated during growth phase.

Materials and Methods

Twenty-five bacterial isolates were obtained from soil samples and seven among them exhibited positive staining for sudan black thus indicating the presence of PHB. Culture conditions for organisms were optimized by changing the parameters, *viz*., incubation time, pH, carbon source and nitrogen source. At optimized conditions, 7 isolates exhibited significant PHB yields, thus showing a potential for further exploitation.

Results and Discussion

Present study indicates that production of PHB from soil bacteria. The bacterial isolate (PHB1) were isolated from termite mound soil yields about 3.58g/L PHB. The microscopic analysis confirmed that the lipid globules present intracellularly in the bacterial cell. One of the isolates, PHB01, which showed rapid growth and good polymer yield, was molecularly identified as *Bacillus siamensis* (MW440618). In addition to that FTIR analysis reveals that, the extracted PHB possesses the same pattern of functional groups as that of the standard PHB i.e. the characteristics presence of –OH and –C=O stretching. The wave numbers 1631.48 and 1089.58 cm-1 indicates the presence of lipid storage products which is primarily of lipid and fatty acids. The present results is matching with the Mustafa Kansiz,2000. The C-O group were evidenced by the bands and the wave number corresponds to 1027.87 cm^{-1}. The typical polymeric structure of PHB's are represented by the peaks of ester, methylene and terminal hydroxyl groups (Apparao and Krishnaswamy, 2015).

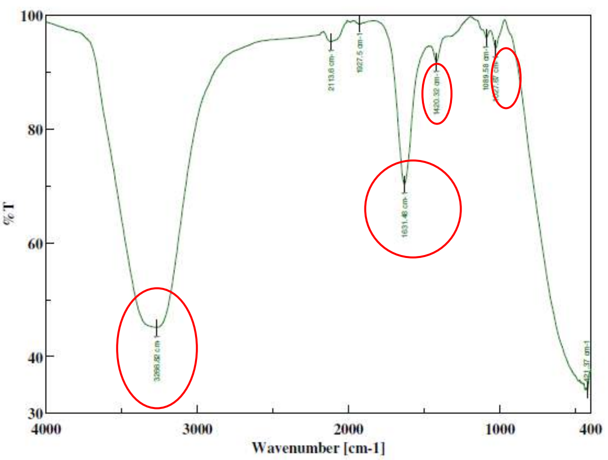

Fig 1: FTIR Spectra of Extracted PHB

Wavenumber	Corresponding Group
3266.82 cm^{-1}	-OH group
1631.48 cm^{-1}	C=O group
1420.32 cm^{-1}	CH_3 group
1027.87 cm^{-1}	C- O Stretch

Table 1: Corresponding group of Extracted PHB

Conclusion

Thus, the bacterial mediated PHB synthesis can be used as a better alternative to deal with the currently available practices of plastic use and its gradually increasing pollution level.

References

Mustafa Kansiz, Helen Billman-Jacobe and Don Mcnaughton 2000. Quantitative Determination of the Biodegradable Polymer Poly(b-hydroxybutyrate) in a Recombinant *Escherichia coli* Strain by Use of Mid-Infrared Spectroscopy and Multivariative Statistics. Applied and Environmental Microbiology, 3415–3420.

Apparao, U., & Krishnaswamy, V. G. (2015). Production of polyhydroxyalkanoate (PHA) by a moderately halotolerant bacterium *Klebsiella pneumonia* isolated from rubber plantation area. *Int J Environ Bioremed Biodegrad*, 54-61.

Production Potential of Bed Planted Chickpea (*Cicer Arietinum* L.) as Influenced by Different Intercropping Systems

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Key words: *Bed planted chickpea, Chickpea equivalent yield, Intercropping system, Productivity*

Introduction

Chickpea (*Cicer arietinum* L.) is a foremost pulse crop of semi-arid tropics and grown as winter *rabi* pulse crop in India. Bed planting in chickpea is a new concept in the cultivation of chickpea. Sowing of chickpea on the bed and intercrops in the ditches will not only protect the chickpea from excess moisture during heavy rains or irrigated conditions but will also decrease the competition between the two crops if any, because of their different rooting depths. Chickpea plays an important role in the cropping systems of subsistence farmers due to its ability to grow under abrasive edaphic factors and arid environments when provided with better low inputs. The performance of intercrops may differ due to their different phenology, growth behaviour and duration of crops. No systematic research and adequate technologies have been reported in Punjab on intercropping of different crops in chickpea. So, keeping in view the above information, the present study has been conducted for two years.

Methodology

Field experiment was conducted during *rabi* season of 2017 and 2018 at Students' Research Farm, Department of Agronomy, Punjab Agricultural University, Ludhiana. The experiment was laid out in randomised block design in four replications with thirteen treatments. The plant population of chickpea was kept same in all the treatments. The varieties taken for sowing were PBG 7 of chickpea, OL 10 of oats fodder, LC 2063 of linseed, PL 807 of barley and GSC 6 of oilseed rape. Wheat bed planter was used for 67.5 cm apart spaced bed preparation (bed width was 37.5 cm and furrow width was 30 cm). Sowing of two rows of chickpea was done on the top of each bed and intercrops was sown in the furrows under 2:1 row ratio, whereas four rows of chickpea was sown on two beds and one row of intercrops was sown in furrows after two beds under 4:1 row ratio. All cultural practices were followed as per recommended procedures. The chickpea equivalent yield was computed by converting the yield of intercrop to chickpea yield, based on their market prices. The critical difference (CD) values at 5% level of probability were computed for making comparison between treatments.

Results and Discussion

Seed yield of chickpea: Sole chickpea recorded significantly higher seed yield (19.2 q/ha) which might be due to no competition effect, higher number of pods per plant and higher 1000-seed weight as compared to other treatments. This system was statistically at par with the seed yield of chickpea obtained under chickpea + oats fodder (2:1), chickpea + oats fodder (4:1) and chickpea + linseed (4:1) systems during both the cropping seasons. The lowest seed yield was recorded under chickpea + oilseed rape in 2:1 row ratio (5.1 q/ha) and followed by chickpea + oilseed rape in 4:1 row ratio (8.6 q/ha) which might be due to the reason that chickpea crop was suppressed by the oilseed rape plants and resulted in less production of pods per plant and shrivelled grains(Table 1).

Chickpea Equivalent Yield (CEY), System productivity and Production efficiency: Among all the different intercropping systems, chickpea + oats fodder in 2:1 row ratio recorded maximum chickpea equivalent yield (24.4 q/ha) and maximum production efficiency (432.3 Rs/ha/day) during both the cropping seasons, respectively (Table 1). Higher CEY, system productivity and production efficiency under chickpea + oats fodder system was due to the fact that oats fodder is a short duration crop and three cuttings was taken for fodder, result showed less competition with chickpea that resulted in comparatively higher seed yield of chickpea.

Table 1: Seed yield of chickpea, intercrop yield, chickpea equivalent yield, system productivity and production efficiency as influenced by different intercropping systems.

S. No.	Treatment	Seed yield (q/ha)	Intercrop yield(q/ha)	CEY (q/ha)	System productivity (kg/ha/day)	Production efficiency (Rs/ha/day)
		Pooled	Pooled	Pooled	Mean	Mean
1.	Chickpea + oats fodder (2:1)	18.2	224.4	24.4	15.78	432.3
2.	Chickpea + oats fodder (4:1)	19.1	152.0	23.3	15.07	402.4
3.	Chickpea + linseed (2:1)	13.1	10.7	22.8	14.75	388.1
4.	Chickpea + linseed (4:1)	17.4	5.8	22.7	14.62	384.3
5.	Chickpea + barley (2:1)	11.4	18.3	17.2	11.07	245.9
6.	Chickpea + barley (4:1)	16.7	10.3	19.9	12.85	329.6
7.	Chickpea + oilseed rape (2:1)	5.1	13.2	17.1	11.06	245.9
8.	Chickpea + oilseed rape (4:1)	8.6	10.0	17.6	11.37	264.4
9.	Sole chickpea	19.2	0.0	19.2	12.42	318.2
10.	Sole oats fodder	-	615.0	17.0	12.19	308.6
11.	Sole linseed	-	16.9	15.4	9.93	244.7
12.	Sole barley	-	38.1	12.0	8.66	217.7
13.	Sole oilseed rape	-	19.3	17.6	11.85	296.7
14.	CD (P=0.05)	2.1	-	2.4	-	-

CEY = Chickpea Equivalent Yield

References

Meena, H. and B.L. Kumar. 2017. Production potential of gram based intercropping systems under rainfed conditions. ***Adv Res J Crop Improv.,*** 8: 95-98.

Sekhon, F.S., T. Singh and K.S. Saini. 2019. Production potential and economic returns of pigeonpea (*Cajanus cajan* L.) based intercropping system as influenced by planting pattern and nutrients levels. ***Legume Res.,*** 42: 533-37.

Torkaman. M., B. Mirshekari, F. Farahvash, M. Yarnia, and A.A. Jafari. 2018. Effect of sowing date and different intercropping patterns on yield and yield components of rapeseed (*Brassica napus* L.) and chickpea (*Cicer arietinum* L.). ***Legume Res.,*** 41: 578-83.

Repellency and Toxicity of Different Plant Derived Compounds against Cigarette Beetle

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Key words: *Percent repellency, Citral, Citronellol, Cinnamaldehyde, Eucalyptol, Geraniol*

Introduction

The cigarette beetle, *Lasioderma serricorne* (Fabricius) ranks as one of the most serious pests of stored products in the world (Kim *et al*. 2003). Use of phosphine for decades has disrupted biological control and led to the development of resistance, undesirable effects on non-target organisms and environmental and human health concerns (White and Leesch, 1995). Therefore, it is extremely important to develop ecofriendly methods with low toxicity to nontarget insects.

Materials and Methods

Different plant derived compounds (Citral, Citronellol, Cinnamaldehyde, Eucalyptol, Geraniol, Myrecene, Thymol) were used to study the insecticidal and repellent activity against *L. serricorne.* The behavioral response of *L. serricorne* adults to different plant derived compounds was evaluated by using the area preference method at 0.01, 0.05, 0.1, 0.15 and 0.2 % concentrations as given by Lu and Liu (2016). Percent repellency (PR) of the essential oil compound was calculated. The negative values of percentage repellency represent the attractiveness. An aliquot of 0.5 µL dilution of different concentrations (0.1%, 0.2%, 0.3%, 0.4% and 0.5%) was applied topically to the dorsal thorax of insects as direct application. Different concentrations (1%, 2%, 3%, 4% and 5%) of different plant derived compounds were used to study the contact toxicity (surface treatment) and fumigant toxicity against egg, grub and adult stages of cigarette beetle as described by Liu and Ho (1999). Mortality was recorded at 48 h. The LC_{50} and LC_{95} values were calculated by using probit analysis.

Results and Discussion

Behavioural response of *L. serricorne* adults to citral and citronellol showed attractiveness towards the adults of cigarette beetle at very low concentrations and attractiveness decreased with the increase in concentration. Cinnamaldehyde, eucalyptol and myrecene showed strong repellent effect whereas geraniol and thymol exhibited medium repellent effect towards adults of cigarette beetle at all test concentrations for 2 h, 4 h and 8 h exposure periods. But the repellent effect of all plant derived compounds at different concentrations were decreased after exposing for 24 h. Cinnamaldehyde exhibited highest contact and fumigant toxicity with least LC50 values when tested against grubs and adults of cigarette beetle. There was no effect of surface treatment and fumigation of different plant derived compounds against eggs.
Each cell represents the percent repellency (±s.e.) of four replicates. Means within a column followed by the same superscript letters are not significantly different.

References

Kim, S., Park, C., Ohh, M.H., Cho, H.C. and Ahn, Y.J. 2003. Contact and fumigant activity of aromatic plant extracts and essential oils against *Lasioderma serricorne* (Coleoptera: Anobiidae). **Journal of Stored Products Research,** 39:11-19.

Liu, Z.L. and Ho, S.H. 1999. Bioactivity of the essential oil extracted from *Evodia rutaecarpa* Hook F. Et Thomas against the grain storage insects, *Sitophilus zeamais* Motsch. and *Tribolium castaneum* (Herbst). **Journal of Stored Products Research**, 35: 317–328.

Lu, J and Liu, S. 2016. The behavioral response of *Lasioderma serricorne* (Coleoptera: Anobiidae) to citronellal, citral, and rutin. **SpringerPlus,** 5:798. DOI 10.1186/s40064-016-2553-2.

White, N.D.G. and Leesch, J.G. 1995. Chemical control. In: Subramanyam, B. and Hagstrum, D.W. (Eds.), Integrated Management of Insects in Stored Products. Marcel Dekker, New York, 287-330.

Table 1 Behavioral response of *L. serricorne* adults to different plant derived compounds at concentrations of 0.01, 0.05, 0.1, 0.15 and 0.2 % after 1, 2, 8 and 24 h exposure period.

Cinnamaldehyde	Exposure time			
	2hrs	4 hrs	8 hrs	24 hrs
0.01	65.00 ± 11.87^{a}	72.50 ± 10.00^{a}	60.00 ± 4.35^{a}	27.50 ± 10.00^{a}
0.05	70.00 ± 10.64^{a}	77.50 ± 8.65^{a}	67.50 ± 3.84^{ab}	45.00 ± 5.64^{a}
0.1	82.50 ± 10.53^{a}	87.50 ± 8.73^{a}	65.00 ± 5.19^{a}	55.00 ± 5.09^{a}
0.15	90.00 ± 8.04^{a}	90.00 ± 8.04^{a}	85.00 ± 7.18^{bc}	60.00 ± 12.75^{a}
0.2	100.00 ± 0.00^{a}	100.00 ± 0.00^{a}	87.50 ± 6.26^{c}	77.50 ± 9.26^{a}
Citral	Exposure time			
	2hrs	4 hrs	8 hrs	24 hrs
0.01	-22.5 ± 6.26^{ab}	-20 ± 9.33^{a}	-17.5 ± 8.22^{a}	-27.5 ± 5.11^{a}
0.05	-12.5 ± 9.34^{a}	0 ± 7.53^{a}	-5 ± 10.04^{a}	-17.5 ± 8.22^{a}
0.1	7.5 ± 10.08^{a}	2.5 ± 8.83^{a}	-5 ± 10.04^{a}	2.5 ± 18.79^{a}
0.15	32.5 ± 5.71^{ab}	15 ± 13.70^{a}	17.5 ± 17.52^{a}	-7.5 ± 15.13^{a}
0.2	50 ± 6.53^{c}	32.5 ± 3.84^{a}	22.5 ± 16.88^{a}	10 ± 15.09^{a}
Citronellol	Exposure time			
	2hrs	4 hrs	8 hrs	24 hrs
0.01	-30 ± 15.68^{bc}	-32.5 ± 5.72^{b}	-52.5± 5.02^{a}	-62.5 ± 2.83^{b}
0.05	-27.5 ± 10.99^{ab}	-12.5 ± 21.39^{b}	-15 ± 14.87^{a}	-5 ± 13.55^{a}
0.1	0 ± 7.53^{a}	-2.5 ± 4.61^{a}	-12.5 ± 13.54^{a}	-12.5 ± 9.34^{a}
0.15	57.5 ± 6.66^{c}	52.5 ± 12.51^{b}	5 ± 15.27^{a}	-20 ± 14.34^{a}
0.2	67.5 ± 4.64^{c}	60 ± 4.35^{b}	15 ± 13.03^{a}	-2.5 ± 14.32^{a}

Resource Management Strategies and its Implications on Farmers Well-being

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Key words: Resource, Management, Strategies, Well-being

Introduction

Agriculture enterprise is a way of life of Indian farmers. In an increasing crowded world, conservation and management of resources is vital to sustain life support system on earth. The farmers always need new knowledge, new skills and more modern concept than their traditionalism. The wealth of a nation depends on the richness of the natural resources it is blessed with. Fortunately, India is favoured with such varied resources viz., climate, soil, fauna and flora for production of all types of crops and tree species. As a result, Indian agriculture is seen with diversified farming situations with wide physiographic, geological and climatic features and influenced by varied socio-economic characteristics of farm families. The serious concern of declining land man ratio, production, employment and income becoming the dictating strategy components as well as investment decisions. Though Indian agriculture was successful in attaining food self sufficiency, the degrading trend of natural and other resources emerged as a serious problem. All the agricultural resources can be classified into two ways as fixed and variable resources. The factors of production can be broadly categorised into land, labour, capital and management. The fact remains that all farmers, including small and subsistence farmers, make use of management factor as it is an integral part of production on their farms. Better management of resources can increase the farmers' income and thereby their well being.

Methodology

Focus group discussion – is a structured discussion used to obtain in-depth information (qualitative data - insight) from a group of people about a particular topic. The purpose of a focus group is to collect information about peoplesopinios, belifs, attitudes, perceptions, not to come to consensus or make a decision. The study was conducted in a BhootanaHosuru village of Mandya district. Focus group discussion method was employed to collect the in-depth information about the resource management in their fields. Nearly 10 farmers were participated in the discussion. And SWOT technique was used to analyse the results of focus group discussion.

Results of the study

Strength

✓ Traditional knowledge for cultivation of crop. ✓ Experience in management. ✓ Co-operative activities certainly encouraged this system. ✓ Availability of technical personnel. ✓ Co-operative societies encourage the NRM among the farmers. ✓ There is availability of law and regulations related to Natural resource management viz., soil and water protection, land-use planning, natural resource protection.

Weaknesses

➢ Poor quality of water. ➢ Sensitivity for climate change. ➢ Increasing pollution rates of soil and water resources due to agricultural, industrial activities and energy requirements. ➢ Lack of reliable data on soil and water resources to protect the sustainable use of these resources. ➢ Lack of coordination and integration efforts between public, academic, private, governmental and nongovernmental organizations for sustainable planning of natural and human resources.

Opportunities

Better suitability under the soil, water and climate of district. ▪ Healthy available market ▪ Finance can be easily available through bank ▪ A very young farmer population that can better understand and accept environmental issues ▪ Collaboration between research institutes and community groups Threats

❖ Labour intensive harvesting, labour problem during peak seasons. ❖ Fluctuating in market price may affect the sustainability. ❖ Poor financial capacity ❖ Increase in immigration rates and social-economic and cultural problems caused by the reduction of natural resources

Conclusion

In India depleting natural resources base-like ground water and rapid urbanization decreases agricultural land, increase in indebtedness of farmers, migration of farmers and frequent crop failure posing major threats to agriculture. Under the light of current situation, SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis are to be performed to recommend the strategies for overcoming the weakness and possible threats on sustainable resource management and to enhance the wellbeing of farmers. Strategies such as overcoming existing insufficient and unreliable databases of natural resources in terms of monitoring resource degradation and climate change processes, supplying of the coordination and integration among governmental, academic, private, nongovernmental organizations and farmers and dissemination of environmentally sound management practices are recommended. The sustainable resource management must be ecologically, economically, politically and socially integrated in to the fragile ecosystems like India to overcome the prevailing conditions.

References

Akemach Yohannes, 2019, Indigenous soil and water management practice, characteristics and extent of adaptation in Ethiopia.(Un pub), Debremarkos university, College of agriculture and natural resources department of natural resource management program integrated watershed management (IWM), Debremarkos, Ethiopia.

Jerome Kimaro, 2019, A review on managing agroecosystems for improved water use efficiency in the face of changing climate in Tanzania.Hindawi advances in Meteorology, 1: 1-12

Response of Phosphorus Addition With Mycorrhizae on Enzymatic Activity and Nutrient Use Efficiency of Groundnut Varieties in Acid Soil

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Keywords: *phosphorus, mycorrhizae, phosphatase, groundnut*

Introduction

Groundnut is the important oilseed crop in India. It contribute 27% of the total oilseed production of the country. Groundnut suffers deficiency of phosphorus in acid soils due to the diversified soil properties like pH, organic carbon, native total phosphorus (P) and oxides and ions of iron and aluminium. There is a significant need of phosphorus for groundnut roles involves root growth, Biological fixation of nitrogen, pod formation and also increases the nutrient use efficiency of crop.

Methodology

The experimental soil was acidic in reaction with a pH of 5.8 ,low in organic carbon 2.6g kg^{-1}, low in available N(196 kg ha^{-1}), P(9.5 kg ha^{-1}) and medium in K(232 kg ha^{-1}). The soil sandy loam in texture comes under the series of *Typic haplustalf*. Field experiment, four P levels (0, 25, 50 &75 kg P ha^{-1}) were evaluated in the presence and absence of AM fungi. Groundnut varieties VRI2 and G-5 used as a test crop.

Result and discussion

Among the different levels of P addition, P_0V_1 recorded the significantly maximal Acid phosphatase (AcP) activity in 30 and 60 days after sowing and it was followed by P_0 V_0. The lowest AcP activity were recorded in $P_{75}V_0$ treatment combination. The AcP activity were higher in P deprived treatment (control) and its gradually decreases with increases in P supply. The main source AcP secreted by host plant root, AM fungi and other rhizosphere microbes. The secretion of acid phosphatase in P deprived condition is in order to hydrolyse the organic phosphorus compound in the rhizosphere in high plant shoot P condition reduces the host plant AcP secretion. There is a decrement in mycorrhizal colonization with increase in inorganic phosphorus activity which leads to reduction of AcP secretion (Yadav and Tarafdar, 2001).

Regarding nutrient use efficiencies like Agronomic efficiency, Apparent nutrient recovery, partial factor productivity recorded higher in $P_{50}V_1$ treatment combination and it was followed by $P_{75}V_0$ treatment. The highest NUE due to the elevated yield of groundnut by the support of applied phosphorus and AM fungi. Applied phosphorus and AM fungal increases the uptake of nutrients like Nitrogen, Phosphorus and Zinc by increase the nutrient absorbing area of the root (40 times) and also explores the area which could not be explored by thin roots (Smith , 2008). Increase in pod yield is the indirect measure of the efficiency of applied nutrients. Phosphorus application increases the activation of metabolic process namely building block of phospholipids and nucleic acids particularly increases the pod filling and also increases nutrient use efficiency by biological N fixation. The results were coincide with the results of Doley and Jite, (2012).

Conclusion

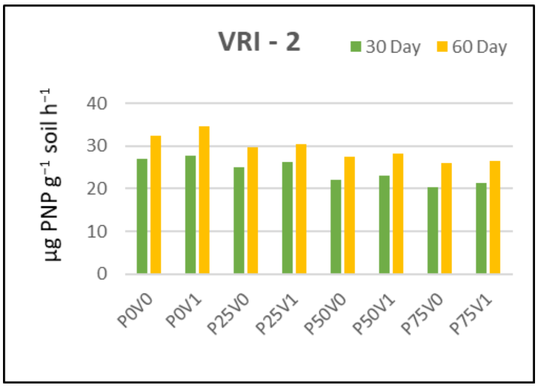
The Nutrient Use Efficiency of groundnut genotypes were higher in both Phosphorus (50 kg ha^{-1}) and AM fungi applied plot. Increase in P above 50 kg ha^{-1} reduces the NUE and at the same time, the enzymatic activities were declined with increase in phosphorus levels.

Table 1. Effect of Phosphorus addition with mycorrhizae on Nutrient Use Efficiency of groundnut VRI-2

Treatments	Agronomic Efficiency (Kg Kg-1)			Apparent Nutrient Recovery (Kg Kg-1)			Partial factor productivity (Kg Kg-1)		
	N	P	K	N	P	K	N	P	K
T1 - P_0V_0	-	-	-	-	-	-	108.8	-	34.2
T2 - P_0V_1	9.47	0.00	2.98	0.48	0.00	0.07	118.2	-	37.2
T3 - $P_{25}V_0$	15.47	10.52	4.87	0.90	0.09	0.16	124.2	84.5	39.1
T4 - $P_{25}V_1$	26.06	17.72	8.20	1.49	0.13	0.25	134.8	91.7	42.4
T5 - $P_{50}V_0$	37.00	12.58	11.65	2.07	0.10	0.33	145.8	49.6	45.9
T6 - $P_{50}V_1$	56.00	19.04	17.63	3.12	0.17	0.48	164.8	56.0	51.9
T7 - $P_{75}V_0$	40.18	9.11	12.65	2.32	0.07	0.37	148.9	33.8	46.9
T8 - $P_{75}V_1$	46.65	10.57	14.69	2.62	0.08	0.41	155.4	35.2	48.9

Table 2. Effect of Phosphorus addition with mycorrhizae on Nutrient Use Efficiency of groundnut G-5

Treatments	Agronomic Efficiency (Kg Kg-1)			Apparent Nutrient Recovery (Kg Kg-1)			Partial factor productivity (Kg Kg-1)		
	N	P	K	N	P	K	N	P	K
T1 - P_0V_0	-	-	-	-	-	-	94.7	-	29.8
T2 - P_0V_1	10.00	0.00	3.15	0.50	0.00	0.07	104.7	-	33.0
T3 - $P_{25}V_0$	15.18	10.32	4.78	0.79	0.07	0.13	109.9	74.7	34.6
T4 - $P_{25}V_1$	23.41	15.92	7.37	1.24	0.10	0.19	118.1	80.3	37.2
T5 - $P_{50}V_0$	35.94	12.22	11.31	1.83	0.08	0.24	130.6	44.4	41.1
T6 - $P_{50}V_1$	58.12	19.76	18.30	3.09	0.15	0.45	152.8	52.0	48.1
T7 - $P_{75}V_0$	39.47	8.95	12.43	2.11	0.06	0.30	134.2	30.4	42.2
T8 - $P_{75}V_1$	43.41	9.84	13.67	2.21	0.06	0.29	138.1	31.3	43.5



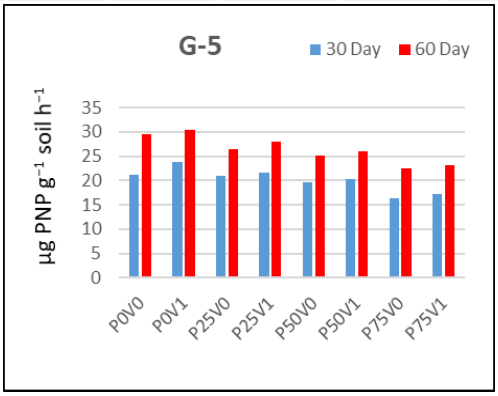


Fig. 1 Effect of Phosphorus addition with mycorrhizae on Acid phosphatase activity of groundnut varieties

References

Doley, K., and Jite, P. K. 2012. Response of groundnut ('JL-24') cultivar to mycorrhiza inoculation and phosphorous application. *Notulae Scientia Biologicae*, 4(3), 118-125.

Smith, S.E. and D.J. Read .2008. Mycorrhizal Symbiosis. 3rd Edn., Academic Press, London, UK

Yadav, R., and Tarafdar, J.2001. Influence of organic and inorganic phosphorus supply on the maximum secretion of acid phosphatase by plants. *Biology and Fertility of soils*, *34*(3), 140-143

Salt Stress Alleviation in Groundnut by Use of Rhizobial and Non- Rhizobial Endophytes

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Keywords: Salinity, Screening, Salt tolerant endophyte, PGPR.

Introduction

Salinity is one of the major threat faced by agriculture ecosystem which affects the plant growth. Groundnut is one of the important oilseed crop, its yield is reduced due to salinity. In order to overcome the effect of salinity by an eco-friendly approach, microorganisms could play a significant role, if we exploit their unique properties such as tolerance to saline conditions, nutrient solubilisation, siderophore production, synthesis of compatible solutes, anti-oxidant activity and their interaction with crop plants.

Methodology

Screening of salt tolerant PGPR endophytes

Among the 98 bacterial endophytes isolated from nodules of groundnut about 10 bacterial isolates were selected of which four were rhizobial endophytes and six were non-rhizobial endophytes. All the isolates were screened for their salt tolerance capacity ranging from 0-15% NaCl concentration and the isolates were tested for their PGPR activities like IAA production, ACCD activity, nutrient solubilisation (P, Zn, &Si), siderophore, biofilm, and EPS production under normal and salt stressed condition following the standard protocol. Bacteria under salt stress produced compatible osmolytes *viz.*, proline, glycine betaine and trehalose and were estimated under control, 3% and 5% NaCl salt stressed conditions.
Further morphological characterization of the endophytes cultured in normal and salt stressed condition was analysed using the Transmission Electron Microscope (Piuri *et al.*, 2005). Root exudate pattern of endophytes treated groundnut grown under saline condition was analysed using Funnel-flask experiment and GC-MS. Nodulation assay was performed in Leonard Jar for groundnut seeds treated with rhizobial and non-rhizobial endophytes.

Pot culture study

Pot culture study was conducted to analyse the effect of combined inoculation of rhizobial and non- rhizobial endophytes on plant growth promotion in groundnut cv., VRI 8 under saline condition. Biometric observations were measured at particular intervals, compatible solutes, physiological and biochemical assays (Sumanta *et al*., 2014) was estimated as per the standard protocol. Finally, yield was recored at physiological maturity.

Result and Discussion`

All the tested endophytes were able to grow upto 5% NaCl concentration. Based on the results of screening and PGPR activities at 3% and 5% salt stress, four best endophytes were selected of which each two rhizobial and two non- rhizobial endophytes. Treatments were designed and used for application studies. Anti-oxidant enzyme activity estimation revealed that plants treated with *Rhizobium pusense* S6R2 and *Bacillus tequilensis* NBB13 registered the maximum catalase, whereas *Rhizobium pusense* S6R2 and *Pantoea dispersa* YBB19B treated plants showed maximum super oxide dismutase activity and *Pantoea dispersa* YBB19B inoculated plants recorded the highest ascorbate peroxidase activity (Table 1). From all the studies conducted, plants co-inoculated with *Rhizobium pusense* S6R2 and *Pantoea dispersa* YBB19B showed significant impact on salt stress alleviation in groundnut.

Table 1. Effect of co-inoculation of rhizobial and non-rhizobial nodule endophytes on anti-oxidant enzymes activities in groundnut under saline soil.

Treatment	Details	Catalase (µM min^{-1} g^{-1} FW)	Superoxide dismutase (µM min^{-1} g^{-1} FW)	Ascorbate peroxidase (µM min^{-1} g^{-1} FW)
T1	*Rhizobium phaseoli* S18	44.25±2.45^{gh}	124.16±15.46^{abc}	5.89±0.30^{b}
T2	*Rhizobium pusense* S6R2	61.32±2.80^{efg}	151.54±14.85^{a}	8.03±0.92^{a}
T3	*Pantoea dispersa* YBB19B	102.9±2.38^{abc}	90.78±3.15^{bcd}	6.42±0.61^{b}
T4	*Bacillus tequilensis* NBB13	113.7±8.80^{ab}	132.7±4.16^{ab}	9.10±1.54^{a}
T5	*Rhizobium phaseoli* S18+ *Pantoea dispersa* YBB19B	85.37±5.40^{bcd}	82.30±3.05^{bcd}	10.10±0.30^{a}
T6	*Rhizobium phaseoli* S18 + *Bacillus tequilensis* NBB13	95.23±8.89^{abc}	97.10±3.10^{bc}	5.35±0.61^{b}
T7	*Rhizobium pusense* S6R2 + *Pantoea dispersa* YBB19B	71.66±8.60^{def}	104.0±3.66^{abc}	6.35±0.41^{b}
T8	*Rhizobium pusense* S6R2 + *Bacillus tequilensis* NBB13	124.3±8.95^{a}	39.54±5.63^{d}	5.89±0.20^{b}
T9	Control	37.03±4.34^{h}	78.19±2.23^{cd}	4.82±0.20^{b}

Values in each column are mean of three replications ± SE (standard error). Mean values in each column followed by same letter(s) are not significantly different at 5% level. F.W- Fresh weight

Conclusion

Halotolerant effective nodule endophytic bacteria can be used as bio-inoculant in groundnut for the effective plant growth after conducting field experiments under saline conditions.

References

Piuri, M., C. Sanchez-Rivas, and S.M. Ruzal. 2005. "Cell wall modifications during osmotic stress in *Lactobacillus casei*." *Journal of applied microbiology* 98 (1):84-95.

Sumanta, N., C.I. Haque, J. Nishika, and R. Suprakash. 2014. "Spectrophotometric analysis of chlorophylls and carotenoids from commonly grown fern species by using various extracting solvents." *Res J Chem Sci* 2231:606X.

Study on Grain Filling Rate in Rice (*Oryza sativa* L.) Advanced Cultures

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Keywords: *rice, grain filling rate, grain weight*

Introduction

Rice (*Oryza sativa* L.) is important staple food crop grown in India under diverse ecological conditions. To ensure national food security, there is a need to increase the grain yield of rice. Grain yield is controlled by four basic components, including number of panicles per plant, number of spikelets per panicle, the seed setting rate, and the grain weight. (Xing and Zhang, 2010).Grain weight which influences the yield is determined by grain filling. Grain filling is the process of accumulation of starch which is governed by the balance between sink and source (Okamura *et al*, 2018). High grain filling rate is associated with high yield in super rice and super hybrid rice (Chang *et al,* 2020). Considering the importance of grain filling rate, this study was carried out to evaluate the grain filling rate of advanced rice cultures.

Methodology

A study was conducted on 10 medium duration advanced rice cultures and one variety at the research fields of Anbil Dharmalingam Agricultural College and Research Institute, Trichy during the late samba season of the year 2020. The spikelets from 15 panicles were marked with red colour permanent marker pen, on the day of flowering. The marked spikelets were collected at 7, 14, 21, 28, 35 days after flowering and dried in a hot air oven at 75^{o}C for 8 hours. The 10 randomly selected dried grains at each stage were weighed with precision up to 0.001gram and used to estimate the single grain weight. In view of the grain size variations among the rice genotypes, the final single grain weight of the rice culture, estimated from 100 grain weight was considered as 100% grain filling and the grain weight taken at five stages after flowering were partitioned as the percent of grain filling at the interval of 7 days. The bar chart (Fig. 1) exhibit the partitioned percent of grain filling in five stages.

Results and Discussion

The rice genotypes TRY 3 (96.7%) and TR 15021(92.9%) showed rapid grain filling that exceeds 90 percent of its single grain weight by 14 days after flowering (DAF). The genotypes TR 15055, TR 15052, TR15025, and TR 15008 ranged between 82.3 and 84.3 % for its single grain weight by 14 DAF. The genotype TR 13075 (44.1%) recorded lowest grain filling at 14 DAF (Table. 1, Figure. 1). In this study, TRY 3 and TR 15021 were identified to exhibit maximum grain filling at 14 DAF. Hence, these rice genotypes could be utilized in breeding programmes as parental lines for introgression of high grain filling rate trait in evolving improved variety and elite parental lines for producing superior hybrid rice.

Table 1. Single rice grain weight (in mg) at five stages

S. No.	Genotypes	7DAF	14DAF	21DAF	28DAF	35DAF
1	TR 13075	3.90	8.60	18.23	18.90	19.57
2	TR 15002	7.60	15.93	18.60	19.70	20.50
3	TR 15008	8.23	15.93	17.70	18.47	18.90
4	TR 15021	5.10	17.47	17.90	18.50	18.80
5	TR 15025	4.20	14.97	17.10	17.63	18.20
6	TR 15029	7.70	16.07	20.53	21.20	21.80
7	TR 15031	8.70	14.47	19.73	20.10	21.30
8	TR 15040	6.60	13.00	16.90	17.13	17.90
9	TR 15052	4.77	14.30	16.17	16.27	16.97
10	TR 15055	5.03	16.80	18.27	19.60	20.30
11	TRY 3	7.43	24.00	24.90	25.00	25.57

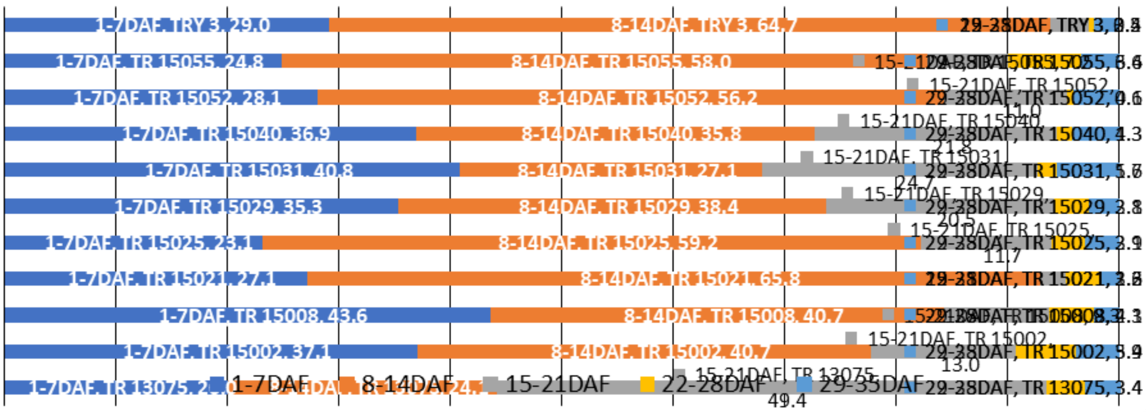

Figure 1. Grain filling rate in terms of percentage at five stages

References

Chang, S., Chang, T., Song, Q., Wu, J., Luo, Y., Chen, X., & Deng, Q. (2020).Architectural and Physiological Features to Gain High Yield in an Elite Rice Line YLY1. *Rice*, *13*(1), 1-16.

Okamura, M., Arai-Sanoh, Y., Yoshida, H., Mukouyama, T., Adachi, S., Yabe, S., & Kondo, M. (2018).Characterization of high-yielding rice cultivars with different grain-filling properties to clarify limiting factors for improving grain yield. *Field Crops Research*, *219*, 139-147.

Xing, Y., & Zhang, Q. (2010). Genetic and molecular bases of rice yield. *Annual review of plant biology*, *61*, 421-442

Study on Variability, Heritability and Genetic Advances in Wild Rice Magic Population for Yield and Yield Related Traits Under Sodic Soils

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Keywords: Wild rice, MAGIC population, variability, sodic soil

Introduction

Salinity is one of the most important abiotic stress, which seriously affects rice production. Hence, useful adaptation of wild relatives as it contribute more to total diversity and development of salt-tolerant rice varieties is the most economic option to safeguard rice production in salt-affected regions and enhancement of yield. Studies on genetic variability of yield and yield contributing traits in wild rice MAGIC population under sodic soil condition helps to assess variability and identify salt tolerant lines.

Methodology

The present study was carried out using 98 wild rice MAGIC population under sodic soil condition (EC 1.5 dSm^{-1}, pH 8.75 and ESP 42.4) at Anbil Dharmalingam Agricultural College and Research Institute, Trichy during November, 2020. The experiment was laid out in randomized block design with three replications. Observations on 12 morphological traits were recorded as per descriptor of Bioversity International. The statistical analysis was carried out using TNAUSTAT software.

Results and Discussion

In any crop breeding program, knowledge on genetic parameters like phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and genetic advance of traits is of paramount importance to decide on breeding strategies to be adopted for crop improvement. The estimation of mean, range, phenotypic coefficient of variation, genotypic coefficient of variation, heritability, genetic advance as percent of mean for 12 characters have been presented in **Table1**. For all the traits the estimates for PCV was higher than GCV which indicated preponderance of environmental effect over their inheritance. However for the traits days to 50 % flowering, 100 grain weight and grain yield per plant, the difference between PCV and GCV was narrow suggesting better genetic influence in expression of these traits and hence selection based on these traits could be effective. High heritability coupled with high genetic advance was recorded for traits *viz.*, days to 50% flowering, plant height, flag leaf length, number of productive tillers, number of grains per panicle, flag leaf area and grain yield per plant suggesting preponderance of additive gene effect and hence selection method of breeding could be employed for improvement of these traits.

Table 1: Variability parameters for morphological traits in Rice MAGIC lines

Character	Mean	Maximum	Minimum	Coefficient of variation		h^2 (%)	GAM (%)
				PCV (%)	GCV (%)		
Spad meter reading	36.46	48.13(WRM 10)	27.53(WRM 109)	13.68	7.94	33.67	9.49
Days to 50% flowering	104.81	131.00(WRM 22)	81.67(WRM 27)	14.75	14.50	96.62	29.37
Plant height (cm)	119.23	161.33(WRM 29)	71.67(WRM 80)	14.51	12.97	79.86	23.88
Flag leaf length (cm)	41.11	74.67(WRM 17)	18.00(WRM 80)	29.37	20.99	51.08	30.91
Flag leaf breadth(cm)	1.31	2.30(WRM 105)	0.80(WRM 25)	24.37	12.25	25.27	12.68
Number of productive tillers	11.99	22.00(WRM 85)	2.33(WRM 30)	38.17	34.60	82.16	64.61
Panicle length(cm)	26.07	35.83(WRM 1)	14.33(WRM 80)	16.12	11.65	52.22	17.35
Panicle breadth(cm)	1.22	1.93(WRM 21)	0.77(WRM 80)	24.19	14.66	36.73	18.30
Number of grains per panicle(g)	128.58	324.67(WRM 10)	73.33(WRM 25)	30.40	28.24	86.24	54.02
100 grain weight(g)	2.93	3.71(WRM 6)	1.87(WRM 60)	9.80	8.98	83.98	16.95
Flag leaf area cm^2	34.93	66.63(WRM 22)	11.53(WRM 55)	55.78	52.78	89.87	103.08
Grain yield per plant (g)	16.92	69.00(WRM 10)	3.33(WRM 80)	28.70	28.70	46.38	40.26

Reference

Manju, S., Thirumurugan, T., Subramanian, A., Nithila, S., Rajammal, S. J. T and Jeyaprakash, P. 2021. Study on genetic variability and heritability in rice landraces (*Oryza sativa.* L.) under sodicity. *International Journal of Current Microbiology and Applied Science* 10(01): 709-715

Zhang, Y., Kimberly, S. P., Meng, L., Chakraborty, R., Zhao, Q., Guo, L., Gao, Z., Leng, Y and Ye, G (2020). QTL identifcation for salt tolerance related traits at the seedling stage in indica rice using a multi-parent advanced generation intercross (MAGIC) population. *Plant Growth Regulation* 92:365–373

Synthesis and Characterization of Various Iron Chelates Using Organic and Amino Acids as a Chelating Agents

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Keywords: *Iron chelates, Nutrient availability, FT-IR and Iron content*

Introduction

A chelate refers to a ring system that results when a metal ion combines with two or more electron donor groups of a single molecule. The compound with these characters are very much useful in agriculture. By addition of some micronutrient fertilizers, there is a chance of getting conversion of form that is unable to utilize by the plants. This is said to be plant unavailable form. But by application of micronutrient fertilizers in chelated forms will be the solution for available form in plants (Nurchi *et al.*, 2020).

Methodology

The lab experiment was carried out to study the synthesis of Fe chelates by using organic and amino acids based chelating agents. The Fe chelates was synthesized based on 2:1 molar ratio of chelating agents and metal ions. Those iron chelates are ferrous aspartic acid, ferrous asparagine, ferrous alanine, ferrous arginine, ferrous citrate, ferrous cysteine, ferrous cystine, ferrous DTPA, ferrous EDTA, ferrous glycinate, ferrous histidine, ferrous leucine, ferrous lysine, ferrous malate, ferrous malonic acid, ferrous oxalic acid, ferrous proline, ferrous succinate and ferrous valine. The pH, EC, FT-IR, Colour, Hygroscopic, Solubility and iron content were characterized.

Results and Discussion

The results shows that Fe glycine and Fe proline highly hygroscopicity was observed and the others were non hygroscopic. The colour varies from white to black including yellow, pink and among chelates (Table 1). The pH of the chelates range from 3.51 to 9.01 and electrical conductivity varies from 0.39 to 2.02 dSm^{-1} in 1:10 aqueous solution. The iron content was as low as 8.6 per cent in Fe leucine and Fe histidine and highest value of 18.2 per cent in Fe succinate.

Among the iron chelates ferrous glycinate, ferrous citrate and Fe – EDTA were found to be good due their solubility, lower cost of preparation and iron contents.

Table 1. Properties of synthesized iron chelates

Chelate Name	Solubility in water (%)	Hygroscopy	Colour	pH (1:5 ratio)	EC (dSm^{-1}) (1:5 ratio)	Fe – content (%)	Cost (100g)
Fe- Glycine	100	Hygroscopic	Brown	5.35	1.47	15.2	95
Fe- Citrate	100	Non hygroscopic	White	3.65	1.32	14.4	25
Fe- EDTA	100	Non hygroscopic	Yellow	4.27	1.05	8.53	81
Fe- DTPA	100	Non hygroscopic	White	3.51	2.02	13.3	210
Fe- Malate	100	Non hygroscopic	White	3.57	0.56	14.6	120
Fe- Oxalate	80	Non hygroscopic	Yellow	3.59	1.10	6.67	255
Fe- Succinate	80	Non hygroscopic	Pink	4.01	1.13	18.2	155
Fe- Cysteine	100	Non hygroscopic	White	5.35	0.60	12.5	290
Fe- Arginine	100	Non hygroscopic	Black	9.01	0.75	13.5	300
Fe- Alanine	100	Non hygroscopic	Black	4.11	0.39	10.1	1100
Fe- Aspartic	100	Non hygroscopic	Yellow	3.85	0.75	11.6	700

Chelate Name	Solubility in water (%)	Hygroscopy	Colour	pH (1:5 ratio)	EC (dSm^{-1}) (1:5 ratio)	Fe – content (%)	Cost (100g)
acid							
Fe- Proline	100	Hygroscopic	Yellow	5.64	1.21	14.2	315
Fe- Lysine	100	Non hygroscopic	Black	3.55	1.23	9.6	450
Fe- Valine	100	Non hygroscopic	Brown	4.01	0.68	8.4	1125
Fe- Malonoic acid	100	Non hygroscopic	White	3.58	0.98	12.2	325
Fe- Leucine	100	Non hygroscopic	White	3.55	0.67	8.6	870
Fe- Histidine	100	Non hygroscopic	Yellow	6.78	0.54	8.6	885
Fe- Humic acid	100	Non hygroscopic	Black	5.86	1.01	12.4	155
Fe- Aspragine	100	Hygroscopic	Yellow	5.95	0.84	10.5	170
Fe- Cystine	100	Non hygroscopic	White	5.29	0.58	11.6	150

Reference

Nurchi, Valeria Marina, Rosita Cappai, Guido Crisponi, Gavino Sanna, Giancarla Alberti, Raffaela Biesuz, and Sofia Gama. "Chelating Agents in Soil Remediation: A New Method for a Pragmatic Choice of the Right Chelator." *Frontiers in chemistry* 8 (2020): 991.

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Termite Mound Soil as an Alternative Soil Amendment for Enhancing Food Production

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Keywords: *Termite mound soil, Adjacent field soil, Physico-chemical properties, Soil enzymes*

Introduction

Termite mound soil has idiosyncratic range of soil enzymes resulting in diverse physico-chemical properties than the adjacent field soil. Termites have been reported to be the common biological agents that produce significant physical and chemical modifications in soils they inhabit (Semhi *et al*., 2008). It has been suggested that, termite activity in the soil, increases the organic matter content in the soils, which is used for the construction of nests. In spite of the advanced soil studies, the basic analytical studies have not been focused in termite mound soil.

Methodology

The soil sample from the surface of the inhabited termite mound and its adjacent soil was collected 2m away surrounding the mound and was pooled into a single sample representing the whole of adjacent soil. Soil physico-chemical properties such as pH, EC, Available NPK, Organic carbon content, Bulk density, Particle density and Porosity was RECORDED for all the 20 samples using standard analytics. Dehydrogenase activity was determined by the method proposed by Cassida, 1977. Urease activity was estimated by colorimertric indophenol blue method. Phosphatase activity was calculated by the method proposed by Tabatabai and Bremner, 1967. Principal component analysis has been carried out to correlate the soil enzymes and soil physicochemical properties of termite mound soil and adjacent field soil.

Results and Discussion

Soil physico-chemical properties

Termite mound soil samples T1, T2 and T3 showed decreased pH when compared to the surrounding adjacent soil. Contrarily, all the other samples exhibited increased pH in termite mound soil in comparison with adjacent soil. Soil porosity analysis showed that there was a gradual variation in termite mound till 2m radius from the mound base and there was no relation apart from the secured perimeter. Influence of Bulk density was the direct relation for the variation in porosity **(Table 1)**. The organic carbon content of the soil ranged from 0.182 – 1.259 per cent with an average of 0.721 per cent.

Soil Enzymes

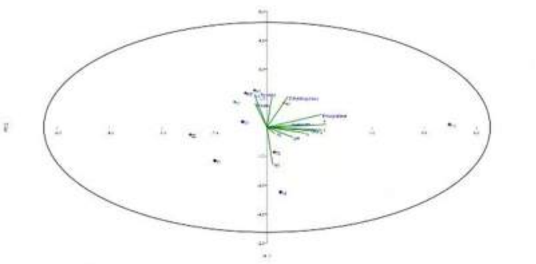
Protease activity in termite mound soil was same as that of normal soils. Dehydrogenase activity ranged from 1.14 – 2.02µg TPF g^{-1} d.wt of soil h^{-1}which is higher when compared to the dehydrogenase activity in normal soils. Urease activity in termite mound soil ranged from 151.33–237.09 µg NH_4 - N g^{-1} d.wt of soil h^{-1}which is comparatively higher in termite mound soil. Phosphatase activity is another indirect measure of the proliferating microbes in the soil. The maximum phosphatase activity in termite mound soil was found to be 122.04 µg g^{-1} d.wt of soil h^{-1}in sample T5.

Statistical analysis

The scree plot conveyed the eigen values from the largest to smallest. Eigenvalues >1 are selected as principal components for the construction of PCA biplot. The ideal pattern obtained was a steep curve, followed by a bend, and then a straight line. From the trend it was clear that there exist 9 components in both termite mound soil and adjacent field soil. **(Figure 1)**.

Table 1: Physical properties of Termite mound soil (TMS) and its Adjacent Field soil (AFS)

Sample	pH		EC (dS m-1)		Bulk density (mg m-3)		Particle density (mg m-3)		Porosity (%)	
	TMS	AFS	TMS	AFS	TMS	AFS	TMS	AFS	TMS	AFS
T_1 – Thanjavur	7.0	7.2	0.023	0.021	1.33	1.11	2.00	2	33.33	44.44
T_2 – Thanjavur	5.9	6.3	0.124	0.103	1.11	1.05	2.86	1.82	61.11	42.11
T_3 – Thanjavur	8.7	7.9	0.076	0.078	1.18	1.14	2.5	1.54	52.94	25.71
T_4 – Thanjavur	8.4	8.1	0.108	0.102	1.82	1.25	3.33	2.5	45.45	50
T_5 – Thanjavur	8.1	7.5	0.143	0.15	1.25	1.25	2.50	2.5	50.00	50
S_1 - Dindigul	7.3	7.5	0.379	0.344	1.18	1.05	2.86	1.54	58.82	31.58
S_2 - Dindigul	7.6	7.2	0.290	0.271	1.25	1.11	2.22	2.5	43.75	55.56
N_1 – Coimbatore	7.7	7.1	0.302	0.268	1.00	1.05	2.86	1.33	65.00	21.05
N_2 – Coimbatore	8.3	7.7	0.351	0.339	1.053	1.05	2.22	1.54	52.63	31.58
N_3 – Coimbatore	7.5	7.4	0.502	0.521	1.053	1.05	2.50	1.54	57.89	31.58



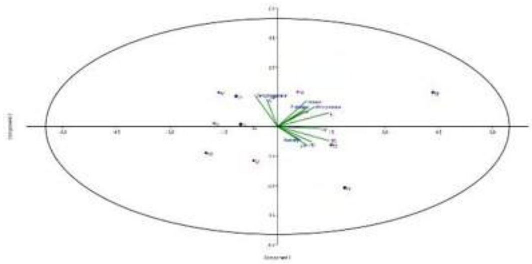


Figure 1: PCA biplot of soil enzymes and physico-chemical properties of (a) Termite mound soil (TMS) (b) Adjacent field soil (AFS)

References

Cassida, L. E. (1977). Microbial metabolic activity in soil as measured by dehydrogenase determination. *Applied and Environmental Microbiology*, 34(6), 630-636.

Semhi, K., Chaudhuri, S., Clauer, N., & Boeglin, J. L. (2008). Impact of termite activity on soil environment: A perspective from their soluble chemical components. *International Journal of Environmental Science & Technology*, *5*(4), 431–444.

Tabatabai, M., Bremner, J. (1967). Use of p-nitrophenyl phosphate for assay of soil phosphatase activity. *Soil Biology and Biochemistry*. *1*(4), 301–307.

Traditional Knowledge Adopted by the Tribal Farmers of the Nilgiris District in Animal Husbandry

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Keywords: *ITK, animal husbandry, livestock, poultry, awareness, adoption*

Introduction

Indigenous technical knowledge (ITK) is the accumulated skill, technology of a locality or a community and has been passed on from one generation to another generation. There is wide spread revival of studies on indigenous knowledge system with different synonyms. The present study is an effort to gather indigenous technical knowledge that is being followed by tribal farmers of the Nilgiris district. The data were collected through both personal interview method and participatory techniques. The study revealed that many of the indigenous practices are still in vogue and meet the farmers' needs. A total of 11 practices were used by the respondent farmers for animal husbandry. Out of these, two practices were used for poultry and nine practices were used for livestock. A vast majority of the respondents were seen with high level of awareness and adoption of the rational ITK viz. Turmeric is used to cure 'Bumblefoot' in chicken with 96.67% and 92.22% respectively. A notable majority of the respondents had awareness and adoption (95.56% and 86.11% respectively) in the rational ITK viz. when a cow is suffered from indigestion or gastric problems, 10 betel leaves and 10 g each of pepper and garlic were ground together, diluted in hot water and administered to suffering animal.

Methodology

The study was carried out in the Nilgiris district of Tamil Nadu. Kotagiri and Udhagamandalam blocks were purposively selected because the percentage of selected tribal population is high. Three villages from each block were selected randomly for the study thus making a total of six villages. From each village, 60 respondents comprising of three primitive tribal communities *viz*. Todas, Kotas and Irulas were selected thus constituting 180 respondents as sample size for the study using Multistage Random Sampling method. To assess the extent of adoption of each of the indigenous practices in animal husbandry, an individual farmer was asked to mention those practices in the check list, which he/ she was practicing during the last five years. The ITKs which were found to be adopted by less than 20 % and more than 80 % of the tribal farmers were eliminated from the analysis.

Results and Discussion

Awareness and adoption of the ITKs related to poultry management

Table 1 indicates that an overwhelming majority of the respondents (96.67%) were very much aware about the usage of turmeric for curing the swelling foot in lower legs in chicks which is called the 'Bumblefoot' because of its antiseptic and anti-inflammatory properties. As regard to the adoption of technologies, little more than ninety percentage of the respondents (92.22%) have followed the practice of using turmeric to treat 'Bumblefoot' disease in chicks as it has antiseptic and anti-inflammatory properties. This is in line with the findings of (Ponnusamy, 2007).

Awareness and adoption of the ITKs related to livestock

An overwhelming majority of the respondents (95.56%) were very much aware about the practice of treating the cow suffering from indigestion and gastric problems with the extract of 10 betel leaves and 10 g of pepper and garlic each ground together, and diluted in hot water. It is an appreciable fact that a good majority of the respondents were very much aware about all the listed out rationalized technologies. With regard to the adoption of rationalized technologies, most of the respondents (86.11%) were found adopting the same practice. This is in line with the findings of Senanayake (2006).

Table 1. Awareness and adoption of the rationalized ITKs in Animal Husbandry (n=180)

S.No	Rational Technologies	Awareness		Adoption	
		No	%	No	%
I	**Poultry**				
1.	Turmeric is used to cure 'Bumblefoot' in chicken	174	96.67	166	92.22
2.	Cinnamon is widely used as a form of oral medicine with a feed	141	78.33	127	70.56
II	**Livestock**				
1.	Feed the animal with 2:1 ratio of wheat straw and soaked oil cake	169	93.89	146	81.11
2.	Tulasi leaves (100 g) are boiled in water then extracted juice is mixed with 1 teaspoon honey and fed to the animal	125	69.44	107	59.44
3.	Leaves and bark of neem along with cucumber seeds (100g) are given for 3 days in intestinal worms.	158	87.78	140	77.78
4.	Ground fresh leaves of henna leaf (1kg), add salt (100g) and sour butter milk, mix it well and apply to the body of cattle	125	69.44	112	62.22
5.	When a cow is suffered from indigestion or gastric problems, 10 betel leaves and 10 g each of pepper and garlic were ground together, diluted in hot water and administered to suffering animal.	172	95.56	155	86.11
6.	Foot and mouth disease, an important viral disease of animals was prevented by feeding them with the flour of ragi.	133	73.89	119	66.11
7.	Drumstick seed at 50g was crushed and mixed with water and given to buffaloes. This helped in solving the urinary problems by removing the stones.	158	87.78	137	76.11
8.	Mixture of salt and water was applied on the body of buffaloes infested with ticks.	144	80.00	134	74.44
9.	Ground coriander seeds with water are fed to animals for indigestion	161	89.44	140	77.78

Conclusion

The results of the study highlighted the important indigenous practices which were practiced by different proportion of tribal farmers for animal husbandry. The study leads to the conclusion that proper identification, documentation and scientific analysis of the age old practices of tribal farmers would provide us a greater scope to think about eco-friendly practices in animal husbandry. Indigenous practices are thus excellent alternatives to the costly chemicals in conjunction with other organic-based components.

References

Ponnusamy, K, J.Gupta and R.Nagarajan. 2007. Indigenous Technical Knowledge (ITK) in dairy enterprise in Coastal Tamil Nadu. Indian Journal of Traditional Knowledge. 8(2):206-211.

Senanayake, S.G.J.N. 2006. Indigenous Knowledge as a Key to Sustainable Development. The Journal of Agricultural Sciences. 2(1).

Usability of Monthly ERFS to predict Maize Yield Using DSSAT model over Erode District of Tamil Nadu

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Key words: *ERFS, DSSAT, Rainfall, Rice Yield, Tamil Nadu*

Introduction

Extended range forecast (ERF; ~10-15 days in advance) of rainfall and temperature are of great importance due to its widespread applications in agriculture, water management, urban planning, energy sector etc. Decision Support System for Agrotechnology Transfer (DSSAT) is a collection of software programs used to simulate the growth of agricultural crops. In this context, the study was taken to downscale and validate the extended range of weather forecast issued for Tamil Nadu state to district level and integrating with DSSAT model for the yield prediction of Maize over Erode district of Tamilnadu.

Methodology

The extended range weather forecasts of rainfall issued for Tamil Nadu were single values and should be disaggregated and validated for observed Southwest monsoon rainfall of Erode district by correlation analysis using MATLAB scripts was used for disaggregation purpose (Sofi *et al.*, 2015). After disaggregation process, the data were uploaded to DSSAT for yield prediction and outputs were obtained. The model output yields are compared with actual yield data of Erode district. Percent deviation was worked out between model obtained yields and yield data.

Results and Discussion

Comparison of disaggregated monthly observed data and forecasted data

The monthly rainfall frequency was highly correlated with the observed for the month of June (0.93) and July (0.92) but for August (0.57), the correlation was average and below average in September (0.36) (Fig 1a). In total rainfall, the correlation was high for all the months with the r value more than 0.99 (Fig. 1b).

The frequency of rainfall of the Erode district was highly correlated with the forecast for June and July months with the r values 0.93 and 0.92, respectively. During August and September, the correlation was reduced into 0.57 and 0.37, respectively. Dhekale *et al.*, (2017) also found that the skill for ERFS forecast is lower and may be because of the fact that the forecasts are prepared by considering the climate situations four months ahead.

Performance of Predicted yields using DSSAT Crop Simulation Model

The average per cent deviation between the yields of observed weather and the disaggregated one was found to be -15.7 per cent and the average deviation between the yields of ERF forecasted weather data and actual yield was very high as -29.7 per cent for Erode. The average per cent deviation between the yields of observed weather and the actual yield was -14.7 per cent. The studies related to CERES Maize yield simulation indicated that, under Indian conditions the date of tasselling and grain yield predicted by CERES-Maize model showed good agreement with the observed values. But the model poorly predicted the biomass yield and harvest index of maize (Karthikeyan and Balasubramaniyan, 2005).

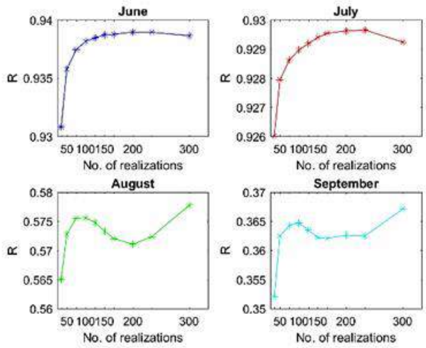

Fig. 1a Rainfall Frequency

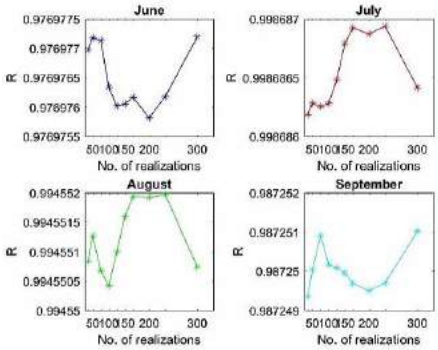

Fig. 1b Total Monthly Rainfall

References

Dhekale, B. S., P. K. Sahu, K. P. Vishwajith, and P. Mishra. 2017. "Analysis of growth, instability, modelling and forecasting of cotton production scenario in India." *Indian Journal of Economics and Development* 13 (2a):211-216.

Karthikeyan, R., and T. N. Balasubramanian. 2005. "Evaluation of DSSAT v3. 5 CERES-Maize model for western zone of Tamilnadu." Journal of Agrometeorology 7 (2):190-198.

Volatilization Loss of Nitrogen Under Various Coated Urea in Rice Under Tamiraparani River Basin

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Keywords: Volatilization, Ammonia, Coated Urea, Nitrogen loss, Rice

Introduction

Rice is an important world food security crop that relies more on chemical fertilizer to sustain higher yields. Among the fertilizers, nitrogen fertilizer is a critical component, currently accounting for over 50% of the world's production. However, already stated 50% nitrogen losses from the applied N-fertilizers is around 50% and it contributes significantly to low nitrogen use efficiency. Ammonia volatilization is the major pathway of nitrogen loss. Urea is the most commonly used N fertilizer in India and about 31 million metric tons of urea is currently consumed which accounts to 83% of total N fertilizer consumption in the country. Thus custom made urea based coated fertilizers such as KCl coated, sulphur coated, iron pyrites coated, gypsum coated, and fly ash coated urea are used to improve N use efficiency and yield of rice by reducing ammonia volatilization.

Methodology

Efficiency of different coated materials with urea was studied under both field and laboratory conditions to evaluate ammonia volatilization in Pishanam season during 2020 in manakkarai series under Tamiraparani river basin. Field experiment was laid out in Split plot design with nitrogen doses as main plot and coated materials as sub plot replicated twice. The N fertilizers were applied as per the recommended methods in 4 split doses. All the treatments received uniform basal dose of P and 4 split doses of K. Soil and plant samples were collected at active tillering, panicle initiation, maturity and after harvest for analysis of physico-chemical and biological properties of soil by following standard procedures. Biometric observations of various stages and yield parameters were recorded. Incubation study was also conducted to measure the ammonia volatilization from different coated and uncoated urea (Kenney and Nelson, 1982).

Results and Discussion

Effect of nitrogen rates and coated fertilizers on grain yield

The results showed that the higher nitrogen rate recorded enhanced grain yield in Rice. Highest grain yield of 6358 kg/ha was obtained from 100% STCR recommended rate which was on par with STCR 75% recommended rate. Among the coated urea fly ash produced higher grain yield of 6106 kg/ha. This might be due to the high podzalonic properties and rich in nutrients such as P, K, Ca, Mg, S, Zn, Cu, Mn which are essential for better plant growth as observed in this experiment. This findings in line with the reported work of Dong et al. (2016) **(Table 1).**

Ammonia volatilization from different coated and uncoated urea

In the laboratory experiment, the mean ammonia volatilization loss was around 49 mg/kg of soil for the entire incubation period. Highest ammonia volatilization loss was observed under uncoated urea (55 mg/kg) and the lowest was in iron pyrite and flyash coated urea **(Figure 1).**

Table 1: Ammonia volatilization as influenced by nitrogen rates and coated fertilizers on grain yield

	Uncoated Urea	Kcl Coated Urea	Sulphur Coated Urea	Iron pyrites Coated Urea	Gypsum Coated urea	Flyash Coated urea	Mean
No Urea	3515	4387	4455	4026	3898	4746	4171[c]
50% STCR Recommended Urea	4962	5623	5730	5426	5060	6073	5479[b]
75% STCR Recommended Urea	5635	5900	6023	5902	5714	6576	5958[ab]
100% STCR Recommended Urea	6388	6833	6387	6143	5392	7008	6358[a]
Mean	5125[c]	5686[b]	5648[b]	5374[bc]	5016[c]	6101[a]	5491
	N		**A**		**N at A**	**A at N**	
SEd	185.8		184.7		385.1	369.5	
CD (p=0.05)	591.4		385.4		901.8	770.9	

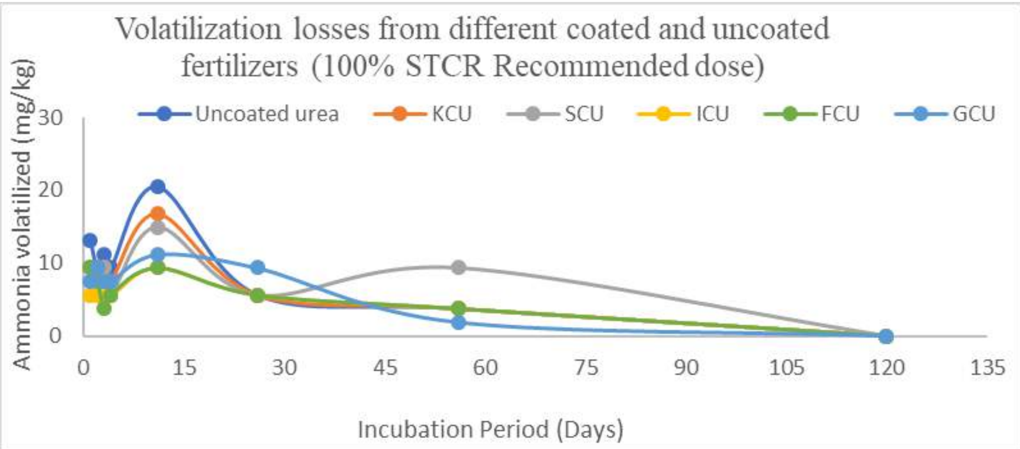

Figure 1: Volatilization losses from different coated and uncoated fertilizers

References

Dong, YJ, MR He, ZL Wang, WF Chen, J Hou, XK Qiu, and JW Zhang. "Effects of New Coated Release Fertilizer on the Growth of Maize." *Journal of soil science and plant nutrition* 16, no. 3 (2016): 637-49.

Kenney, DR, and DW Nelson. "Inorganic Nitrogen." *Methods of soil analysis. Part* 2 (1982): 643-98.

THEME 05

Horticulture for Unswerving and Optimized Food Production

A Study on Extension Contact of Coconut Growers for Enhancing Coconut Production of East Godavari District of Andhra Pradesh

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Keywords: *Extension Agencies, Awareness, Enhanced production, Coconut growers*

Introduction

The coconut palm, botanically known as *"Cocus nucifera"* and commonly recognized as KALPAVRISHA, is economically very important horticultural plantation crop as it provides a variety of products like copra, tender nuts, coconut water, coir, shell-based products, fuel, toddy, coconut leaf for roofing and thatching purposes in rural areas. Globally India ranks third in the area of coconut after Indonesia and Philippines and first in production and productivity. In India more than 90% of the total coconut production is from four major coconut growing southern states *i.e.,* Kerala, Tamil Nadu, Karnataka and Andhra Pradesh. Coconut is an important commercial plantation crop in India. In this context it is stated that coconut is an important cash crop as well as crucial in shaping social livelihood of people of India and Andhra Pradesh. Adoption of new and advanced techniques can improve the production and productivity of any crop. Extension agencies play a pivotal role in the dissemination of information and technology which provide great helps in increasing the adoption of new and more scientific methods as recommended for the farmers. The variable extension contact during the present study was used to determine the extent of awareness of the respondent towards different extension agencies and also the frequency of contact with them. Hence this research paper provides the pattern of extension contact in procuring recommendations that can enhance the production of coconut.

Methodology

Andhra Pradesh occupies fourth place in area and production but supersedes the top three states in productivity. Among the major coconut growing districts in Andhra Pradesh, East Godavari district stands first in area and production. Coconut is an important cash crop as well as crucial in shaping the social livelihood of people of East Godavari district, the present study elucidates the pattern of extension contact followed by the growers to obtain timely suggestions which enhances the production. An ex-post facto design was adopted for the study. Ainivilli and I.Polavaram mandals from East Godavari district were purposively selected as they possess highest production and largest area under coconut. Four villages namely Chintana Lanka, Madupalle, Yedurulanka, Pasuvullanka were identified for the study. A total of 100 respondents, 25 respondents from each village constituted the sample. A well-prepared interview schedule was used for data collection through personal interview mode. Frequency and percentage were worked out to analyze the data.

Results and Discussion

In the study, it was found that the majority of the selected respondents were fully aware of their fellow farmers who were involved in coconut cultivation followed by horticultural officer and agricultural field officer who were visiting the villages regularly and KVK, located at Kalavacherla, Rajahmundry was also known to maximum number of respondents as a viable source for getting valuable information and the respondents were fully aware about. With regard to the frequency of contact, fellow farmers were very often contacted by the respondents followed by agricultural field officer and horticultural officer. The selected respondents were also aware and made contact with other agencies like agricultural college, under Acharya N.G. Ranga Agricultural University, Rajahmundry and horticultural college under Dr. Y.S Rajasekhar Reddy Horticultural University at Venkataramannagudem, members of coconut board, Vijayawada and various other NGOs in enhancing the adoption of new cultivation practices and provide help in rendering the suitable advices. The respondents were given scores based on their extent of awareness and frequency of contact of extension agencies and were further categorized into three categories viz., low, medium and high according to their extension contact. Table 1 shows the distribution of respondents according to their extension contact.

From persual of the table it was found that majority of the respondents i.e., 68% were having medium level of extension contact followed by 17% with high level of extension contact and 15% with low level of contact. The proposed suggestions should be considered by the government and extension personnel to get enhanced production and profits. The results were in line with the findings of Aunndhkar *et al.* (2013), Sasane (2010), Dhulipalla (2004).

Table 1. Suggestions given by the Coconut growers

Category	Ainivilli mandal		I. Polavaram mandal		Total
	Chintana Lanka f (%)	Madupalle f (%)	Yedurulanka f (%)	Pasuvullanka f (%)	
Low	7 (28%)	2 (8%)	3 (12%)	3 (12%)	**15**
Medium	17 (68%)	15 (60%)	20 (80%)	16 (64%)	**68**
High	1 (4%)	8 (32%)	2 (8%)	6 (24%)	**17**

Mean: 45.56; S.D: 5.79

Reference

Aunndhkar, R. S., Deshmukh, A. N., Tale, S. G., and Shinde, P. P. (2013). "A study adoption of drip irrigation on technologies by sweet orange grower", Chandur bazaar, Amravati district. (M.S.). Agric. Update 2 (4):620-622

Dhulipalla, R. P. (2004). "Participation of partners in agricultural research extension and farmers linkage mechanisms in Kirhsna-Godavari Zone of Andhra Pradesh". Ph.D. Thesis (Unpublished), Acharya N G Ranga Agricultural University, Hyderabad, India.

Sasane M.S. (2010). "Knowledge and adoption of recommended production technology by cauliflower growers", M.Sc. (Agri.) Thesis (Unpublished), MAU, Parbhani (M.S.).

Analysis of Variability in F_2 Generation of Tomato (*Solanum lycopersicum* L.) Cross EC177824 X LE27 under Drought Stress

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Keywords: *Tomato, Drought, PCV, GCV, Heritability and GAM*

Introduction

Worldwide, tomatoes are being cultivated in tropical and temperate regions with varied amount of precipitation. However, most of the tomatoes were sensitive to stress particularly to drought stress. Water shortage affects the crop to a greater extent and reduces the yield potential of tomato. Hence breeding tomato for drought tolerance is of prime concern as it plays a significant role in the economy of the farmers in our country (Prakash *et al.*, 2019).

Methodology

The experiment was carried out at college orchard, Department of Vegetable Science, HC&RI, Coimbatore. The seeds obtained from the EC177824 X LE 27 was sown along with their parents in protray. The main field was prepared to a fine tilth and FYM at 25 t/ha was applied at the time of last ploughing. The 25 days old seedlings were transplanted in the main field at a spacing of 60 cm X 60 cm. After 7 days of transplanting, gap filling was done. After 15 days of transplanting drought stress was imposed by restricting irrigation for seven days. To maintain the crop stand adequately, uniform cultural practices were followed at regular intervals. More than 150 plants were maintained in the field per cross.

Results and Discussion

The cross EC 177824 X LE 27, high PCV and high GCV were recorded for number of fruits per plant, fruit yield per plant, nitrate reductase activity and peroxidase activity. There is considerable variation for the above characters and hence selection based on phenotypic would be done for further improvement of these traits. The traits such as root length, number of flowers per cluster, individual fruit weight, proline, chlorophyll stability index and relative water content, were observed with moderate PCV and moderate GCV specifying that there is a little scope for phenotypic selection. Low PCV and low GCV where recorded for days to first flowering and catalase activity. The character plant height was seen with moderate PCV and low GCV. The direct phenotypic selection for above character could not made and the population size must be increased for further improvement (Rai *et al.*, 2016).

High heritability with high genetic advance as percent of mean were observed for the traits such as number of fruits per plant, root length, number of flowers per cluster, individual fruit weight, chlorophyll stability index, proline, relative water content, nitrate reductase activity, and peroxidase activity that specifies that their inheritance are governed by the additive gene effects. The phenotypic selection for the improvement of these characters could be achieved by simple breeding methods. The traits including plant height and catalase activity recorded high heritability and moderate genetic advance as percent of mean indicating the preponderance of additive gene action and furthermore these traits could be surpassed upon pure line selection. Days to first flowering recorded with high heritability coupled with low genetic advance as percent of mean. These traits are governed by non-additive gene action and selection based on phenotypic appearance is not effective (Table 1).

Table 1. Variability analysis of cross EC177824 X LE27 under drought stress

Characters	Co-efficient of Variation		Heritability (BS)	GA	GAM
	Phenotypic	Genotypic			
Plant height (cm)	10.40	9.64	85.90	11.08	18.40
Days to first flowering (days)	5.65	4.56	65.29	1.93	7.59
Root length (cm)	12.36	11.02	79.37	5.19	20.22
Number of flowers per cluster	15.06	14.05	87.04	1.25	27.01
Individual fruit weight (g)	19.09	16.80	77.41	9.51	30.44
Number of fruits per plant	28.74	25.16	76.63	8.64	45.37
Fruit yield per plant (g)	38.44	36.83	91.78	436.2	72.68
Relative water content (%)	12.80	12.80	92.52	14.66	25.36
Chlorophyll stability index (%)	13.00	13.00	89.68	15.31	25.37
Proline (μ/g fresh weight)	12.06	12.06	76.89	71.30	21.78
Nitrate reductase (μg NO_2/g/h)	21.47	21.47	93.30	52.76	42.73
Peroxidase (changes in OD/min/g leaves)	37.94	37.94	80.05	1.53	69.93
Catalase (μg of H_2O_2 /g/min)	9.28	9.28	76.03	1.14	16.68

Reference

Prakash, G., M.L. Chavan, Ramachandra R.K, A.S. Gowda, and M.B. Doddamani. 2019. "Screening of tomato genotypes for various morphological and yield parameters under controlled deficit irrigations in northern dry zone of Karnataka." *International Journal of Chemical Studies* 7 (1):2003-2006.

Rai, A.K., A. Vikram, and A. Pandav. 2016. "Genetic variability studies in tomato (*Solanum lycopersicum* L.) for yield and quality traits." International Journal of Agriculture, *Environment and Biotechnology* 9 (5):739.

Biochemical Responses of Capsicum Hybrids to Iron (Fe) and Zinc (Zn) Fertilisation

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Keywords: *Zinc and Iron fertilisation, Enzymatic activities, Micronutrient content, Capsicum.*

Introduction

Micronutrients particularly iron (Fe) and Zinc (Zn) play vital roles in growth and development of plants due to their catalytic effect on many metabolic processes. However, the biochemical responses to the applied micronutrients vary with cultivars. Capsicum being grown on large scale as an off-season vegetable crop and its consumption in India is increasing day by day due to increase in demand by urban consumers but surprisingly there are little studies on optimum micronutrient recommendations and their enrichment aspects of capsicum production.

Methodology

A screening experiment was conducted during to evaluate the biochemical responses of six capsicum hybrids to iron and zinc fertilisation in grow bags under shade net condition. The experiment consists of three treatments *viz.*, control, 50 kg $FeSO_4$ and 37.5 kg $ZnSO_4$ application ha^{-1} and the biochemical responses was tested with six capsicum hybrids *viz.*, Indra, Priyanka, Inspiration, Massilia, Bachata and local green. The experiment was laid out in a Randomised Block Design with three replications. The fruit and leaf samples were collected and analysed for biochemical constituents such as titrable acidity, total soluble solids (TSS) and ascorbic acid content. In the leave samples the super oxide dismutase (SOD) (Beau-Champ and Fridovich, 1971) and peroxidase (POD) (Sadasivam and Manickam, 1992) enzyme activities were determined besides assessing the Zn and Fe content.

Results and Discussion

Application of ferrous sulphate and zinc sulphate to capsicum hybrids increased the biochemical constituents in fruits and enzyme activities in leaves. Out of the six genotypes tested, higher ascorbic acid content (9.20 mg 100 g^{-1} fresh weight), acidity (6.0) and TSS (6.1 ^{0}Brix) was observed with Indra followed by Inspiration and Bachata (Fig.1). The increased acidity in fruit juice might be due to the metabolic transformation of sugar into organic acids by the addition of Zn and Fe (Brahmachari *et al.*, 1997). Increased ascorbic acid content with the application of zinc might be due to higher synthesis of auxins, which has been reported to increase the accumulation of ascorbic acid content (Nawaz *et al.*, 2008). The SOD (6.70 units mg^{-1} protein) and POD (6.90 units g^{-1} fresh weight) activities in the leaves was also higher with Indra > Inspiation > Bachata. Zinc and iron content in the fruit was higher in Indra (20.8, 43.6 mg kg^{-1}) > Inspiration (19.6, 42.8 mg kg^{-1}) > Bachata (18.4, 41.5 mg kg^{-1}) > Masilia (17.8, 40.3 mg kg^{-1}) > Piyanka (17.3, 40.7 mg kg^{-1}) > local green (17.1, 40.4 mg kg^{-1}).

It can be concluded that application of Zn and Fe enhanced the respective nutrient content and quality of fruits and the genotype Indra was identified as Zn/ Fe efficient genotype having better Zn and Fe transport and accumulation which in turn improved the fruit quality.

Table 1. Effect of Zn and Fe fertilization on zinc and iron content in capsicum fruits

	Fruit Zn content (mg kg^{-1})				Fruit Fe content(mg kg^{-1})			
	Control	$ZnSO_4$	Fe SO_4	Mean	Control	$ZnSO_4$	Fe SO_4	Mean
Indra	18.3	20.8	19.7	19.6	39.6	39.9	43.6	41.0
Inspiration	16.4	20.2	19.1	18.6	39.1	39.4	42.8	40.4
Bachata	15.8	19.8	19.1	18.2	39.0	39.2	41.8	40.0
Masilia	15.7	19.7	18.0	17.8	38.5	38.8	41.3	39.5
Priyanka	15.1	19.1	17.8	17.3	37.8	38.5	40.7	39.0
Local green	14.8	18.2	17.1	16.7	34.8	38.4	40.4	37.9
Mean	16.0	19.6	18.5		38.1	39.0	41.8	
	G	T	G x T		G	T	G x T	
CD	0.546	0.386	NS		0.847	0.599	1.467	
SEd	0.268	0.189	0.463		0.415	0.293	0.719	

***G- Genotypes; T- Treatments; CD- Critical deference; SEd – standard error of difference**

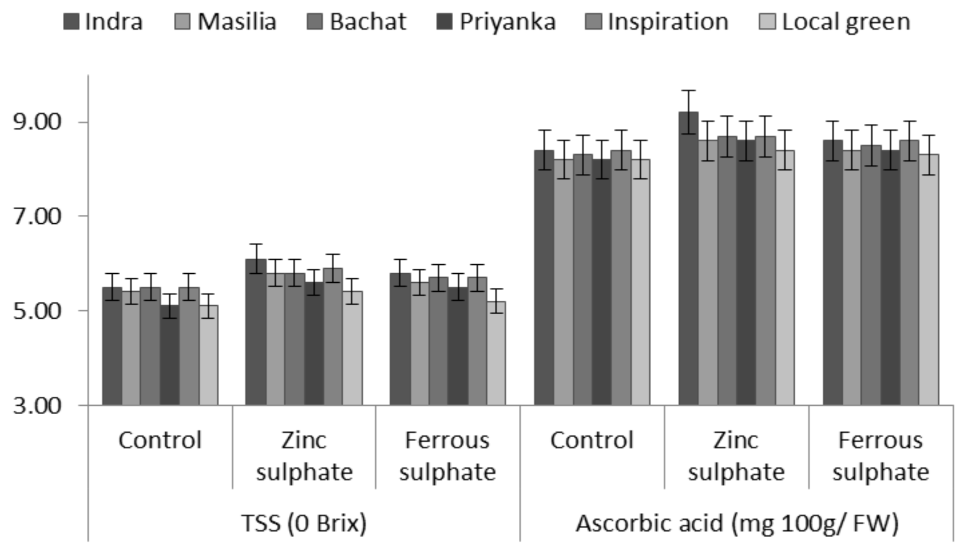

Fig 1. Effect of iron and zinc fertilisation on biochemical constituents in capsicum fruit.

Reference

Beauchamp, C. O and I. Fridovich. 1971. Superoxide dismutase: improved assays and an assay applicable to acrylamide gels. *Anal Biochem* 44:493–502.

Brahmachari, V.S., G. S. Yadav, K. Naresh. 1997. Effect of feeding of calcium, zinc and boron on yield and quality attributes of litchi (Litchi chinensis Sonn.). *Orissa Journal of Horticulture*. 25(1):49-52.

Nawaz, M. A., W. Ahmad, S. Ahmad, M. M. Khan. 2008. Role of growth regulators on pre harvest fruit drop, yield and quality in Kinnow mandarin. Pakistan *Journal of Botany*. 40:1971-1981.

Sadasivam, S. and A. Manickam. 1992. In :Biochemical Methods for Agricultural Sciennces, Willey Eastern Ltd, New Delhi, pp. 185-186.

Biochemical Responses of Cocoa Accessions for Water Deficit Conditions

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Keywords: *Cocoa, accessions, drought and biochemical*

Introduction

Cocoa (*Theobroma cacao* L) belongs to Malvaceae family is one of the important beverage crop followed by tea and coffee (Alverson *et al.,* 1999). Climate change and limitations in availability of water in several regions of the world, pose a serious threat to plantation industry, especially cocoa as the crop is drought sensitive and productivity is greatly affected in the areas receiving erratic rainfall. Thus, screening the accessions for drought tolerance based on their response to biochemical parameters are major objectives in cocoa crop improvement programme.

Methodology

A study was conducted from 2018-2019 at Coconut Farm, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu. Survey has been conducted in Coimbatore regions (Vedapatti and Thondamuthur) of Tamil Nadu and based on the yield potential, a total of 35 plus trees were identified and the pods collected from identified plus trees have been used for the present study. Mature pods were harvested during August 2018 from identified plus trees and the seeds were sown in the polybags containing potting mixture at the rate of one per bag and regularly irrigated. After five months, seedlings from identified 35 plus trees were subjected to two different irrigation regimes (100 and 50 per cent field capacity) through gravimetric method (Sivakumar, 2013). After imposing the treatments, biochemical parameters like total phenol, proline content, nitrate reductase activity and catalase activity were recorded and the results of the experiments are statistically analysed by SPSS method. This study was conducted using Factorial Completely Randomized Design with three replications.

Results and Discussion

Among the 35 plus trees, Tc (Vedapatti) 88 was recorded maximum proline content (509.17µg/g), catalase activity (14.12 µg of H_2O_2/g/min) and total phenol (17.93 mg/g) and Tc (Vedapatti) 85 registered the highest nitrate reductase activity (395.93 µmol/NO_2 $g^{-1}h^{-1}$) whereas, the lowest (62.37 µmol/NO_2 $g^{-1}h^{-1}$) was recorded in Tc (Vedapatti) 40 under water deficit condition (Table 1 to 4). In this study, wider variation was observed among the thirty-five plus trees for biochemical parameters. These variations can be used further to develop hybrids for drought tolerance.

Reference

Alverson, WS, BA Whitlock, R Nyffeler, C Bayer and DA Baum. 1999. "Phylogeny of the core Malvales: evidence from ndhF sequence data." *American journal of Botany* 86 (10):1474-1486.

Sivakumar, R. 2013. "Studies on physiological, biochemical and molecular basis of drought tolerance in tomato (*Lycopersicon esculentum* Mill.)." Ph.D. (Agri.) Thesis., Tamil Nadu Agricultural University, Coimbatore.

Table 1. Effect of different irrigation regimes on catalase activity (µg H_2O_2/g/min) on the seedlings of identified plus tree

S. No.	Catalase activity (µg H_2O_2/g/min) Irrigation regime 100% FC	Catalase activity (µg H_2O_2/g/min) Irrigation regime 50% FC	Mean 100% FC
Average	4.68	6.16	5.42
Maximum	3.8188	14.12 Tc (Vedapatti) 88	8.97 Tc (Vedapatti) 88
Minimum	1.01 Tc (Vedapatti) 72	1.11 Tc (Vedapatti) 76	2.68 Tc (Vedapatti) 42
	P	I	PxI
SE(d)	0.091	0.021	0.129
CD (P=0.05)	0.180**	0.043**	0.255**

Table 2. Effect of different irrigation regimes on total phenol (mg/g) on the seedlings of identified plus trees

S. No.	Phenol (mg/g) Irrigation regime 100% FC	Phenol (mg/g) Irrigation regime 50% FC	Mean
Average	11.99	12.32	12.16
Maximum	20.88 Tc (Vedapatti) 121	17.93 Tc (Vedapatti) 88	17.77 Tc (Vedapatti) 121
Minimum	5.09 Tc (Vedapatti) 45	5.23 Tc (Vedapatti) 72	5.63 Tc (Vedapatti) 45
	P	I	PxI
SE(d)	0.190	0.046	0.270
CD (P=0.05)	0.377**	0.090**	0.533**

Table 3. Effect of different irrigation regimes on proline content (µg/g) on the seedlings of identified plus trees

S. No.	Proline content (µg/g) Irrigation regime 100% FC	Proline content (µg/g) Irrigation regime 50% FC	Mean
Average	381.38	295.10	**338.24**
Maximum	1047.50 Tc (Vedapatti) 64	509.17 Tc (Vedapatti) 88	**613.75 Tc (Vedapatti) 64**
Minimum	103.33 Tc (Vedapatti) 67	100.00 Tc (Vedapatti) 72	**133.75 Tc (Vedapatti) 67**
	P	I	**PxI**
SE(d)	6.702	1.602	**9.477**
CD (P=0.05)	13.249**	3.167**	**18.737****

Table 4. Effect of different irrigation regimes on nitrate reductase activity (µmol/NO_2/g/h) on the seedlings of identified plus trees

S. No.	NRase activity(µ mol/NO_2/g/hour) Irrigation regime 100% FC	NRase activity(µ mol/NO_2/g/hour) Irrigation regime 50% FC	Mean
Average	173.00	172.12	172.56
Maximum	815.54 Tc (Vedapatti) 75	395.93 Tc (Vedapatti) 85	587.26 Tc (Vedapatti) 75
Minimum	56.76 Tc (Vedapatti) 48	62.37 Tc (Vedapatti) 40	83.55 Tc (Vedapatti) 40
	P	I	PxI
SE(d)	3.280	0.784	4.638
CD (P=0.05)	6.484**	1.550**	9.170**

Comparative Performance of Mint in Different Hydroponics Systems

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Keywords: *NFT, Vertical A, Horizontal type, Yield*

Introduction

Population is increasing day by day and decline in cultivated area by 38.10 percent is also witnessed. There is a need for remunerate productivity shift towards new technology of soilless culture like NFT (nutrient film technique). Vertical A type and horizontal models are the technique of raising plants with nutrient solutions along with media such as clay pebbles, coir dust etc, that provides mechanical support for plant growth. This system is especially useful is areas prone to biotic stresses *viz.*, cold, dessert, heat etc. If this cultivation is done under protected environment the Crops which are grown under these systems are not subjective to climate change and hence cultivation of vegetables year-round and off season can be done which fetches high market price (Manzocco *et al.*, 2011).

Methodology

The trial was laid out with Factorial Randomized Block Design (FRBD) in two systems Horizontal type(NFT)-S_1 ,Vertical A type(NFT)-S_2, and with three nutrient treatments *viz.*,T_1-NPK@ 40:65:40 per hectare ,T_2--NPK @ 50:75:50per hectare,T_3--NPK @ 60:85:60 per hectare. The nutrient quantities were calculated for the required volume of water (100 liter tank) and given through fertigation. These nutrient solutions were circulated around the clock directly to plant dangling roots by maintaining the optimum pH range of 5.5 -6.5by altering either acid or base as per the recommendations of Wang *et al.* 2017.

Results and Discussion

Performance of mint was studied in two systems and in various nutrient combinations. It was inferred that among the two systems the vertical A type is the best. Among the nutrient combinations studied highest plant height and yield was obtained in the treatment T1 with NPK @ 40:65:40 per hectare **(Figure 1 & 2).**

Reference

Manzocco, Lara, Martina Foschia, Nicola Tomasi, Michela Maifreni, Luisa Dalla Costa, Marilena Marino, Giovanni Cortella, and Stefano Cesco. "Influence of hydroponic and soil cultivation on quality and shelf life of ready-to-eat lamb's lettuce (Valerianella locusta L. Laterr)." *Journal of the Science of Food and Agriculture* 91, no. 8 (2011): 1373-1380.

Wang, Lichun, Xiaoli Chen, Wenzhong Guo, Yinkun Li, Hua Yan, and XuzhangXue. "Yield and Nutritional Quality of Water Spinach (Ipomoea aquatica) as Influenced by Hydroponic Nutrient Solutions with Different pH Adjustments." *International Journal of Agriculture & Biology* 19, no. 4 (2017).

Table 1. Comparative performance of mint in two hydroponics systems

Treatments	Plant height(cm)	Crop growth rate at 45th day($gm^{-2}day^{-1}$)	Crop growth rate at 60th day($gm^{-2}day^{-1}$)
Horizontal type-S_1			
S_1T_1	44.1	0.02	0.04
S_1T_2	39.4	0.01	0.03
S_1T_3	36	0.005	0.01
Vertical type-S_2			
S_2T_1	84.3	0.04	0.06
S_2T_2	52.6	0.02	0.05
S_2T_3	56.6	0.03	0.034

Fig 1. Effect of different system on plant height

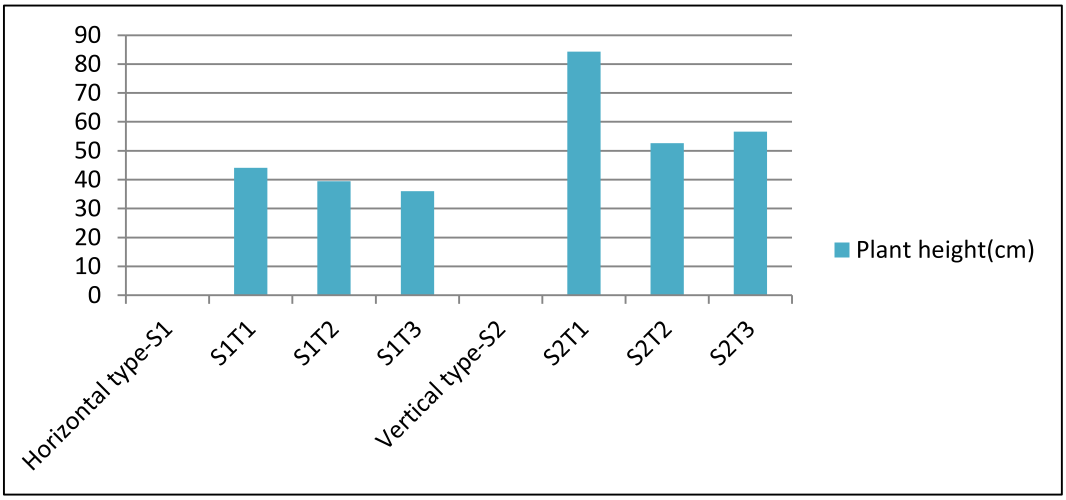
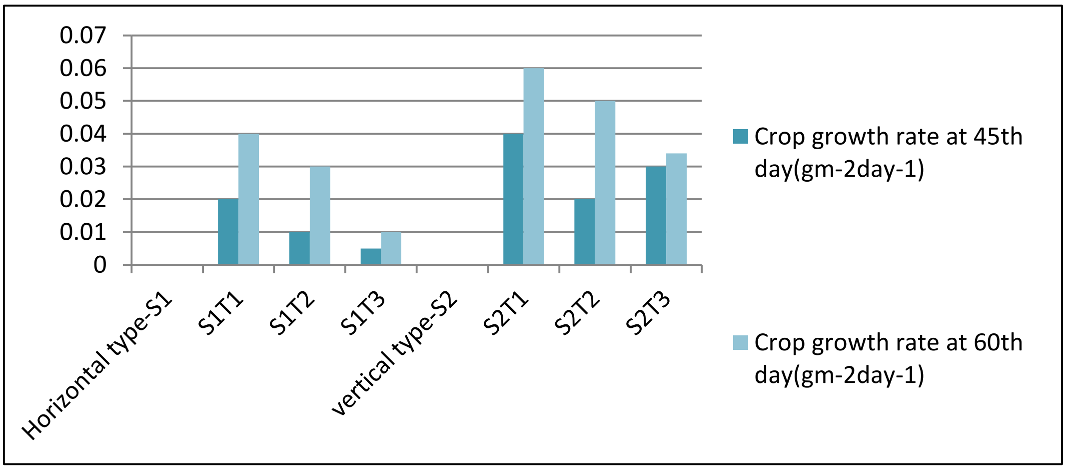


Fig 2. Effect of different systems on crop growth rate



Comparative studies on seed germination (%) of ajowan (*Trachyspermum ammi* L.) genotypes under lab and field condition

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Keywords: *Ajowan, germination, petridish, field level*

Introduction

Ajowan (*Trachyspermum ammi* L.) is indigenous to India and Egypt (Sayre, 2001). It is a herbaceous annual plant, 2n = 18 belonging to the family Apiaceae (Bentley and Trimen, 1983). Ajowan is exported from India in raw and processed form *viz.,* ajowan oil. The objective of this study, identify the germination behavior of different ajowan genotypes under laboratory and field condition.

Methodology

The experiment was conducted at the Dept. of Spices and Plantation Crops, HC&RI, TNAU, Periyakulam, Theni District. The experimental materials include twenty ajowan genotypes obtained from Tamil Nadu (6 Nos.), Gujarat (12 Nos.) and Andhra Pradesh (2 Nos.). The details of the seed germination method and analytical procedures followed during the investigation are furnished below.

Seed germination in lab test and field level (Schelin *et al*., 2003)

Germination percentage = No. of seeds germinated/ No. of seeds sown x 100

Results and Discussion

Seed germination (%) in petridish method and field condition

Per se performance of germination percentage in petridish method ranged from 30. 00 % (JA-172) to 74.00 % (GA-1) with a general mean of 48.33 % (Fig1). The highest germination percentage in petridish method was recorded by the genotype GA-1 (74.00 %). It was followed by the genotype Acc. No.3 (72.00 %), LTa-26, JA-177 (58.00 %) and Acc. No. 5 (56.00 %). In the present study confirmed with (Seghal, 1966) highest seed germination in *Ammi majus* (77%) and lowest in *Cuminum cyminum* (15%). *Per se* performance of seed germination percentage at field level ranged from 40.52 % (Acc. No.9) to 82.42% (Acc. No.3) with a general mean of 65.45% (Fig.1). The highest seed germination percentage at field level was recorded by the genotype Acc. No.3 (82.42%). It was followed by the genotype JA-114 (79.21 %), Acc. No.13 (77.32 %) and JA-212 (76.67 %). Similar kinds of results were obtained by Moniruzzaman *et al.* (2013) evaluated coriander genotypes and reported the highest germination percentage in coriander. Islam *et al.* (2004) obtained germination (%) in 14 genotypes in the range of 68.25 to 78.25% which was very close to the most of the coriander genotypes. The genotype JA-172 recorded the lowest germination percentage in petridish method (30. 00 %) and it was followed by the genotype JA-176 (34.00 %), JA-114, JA-145, Acc. No.9 (36.00 per cent) and Acc. No.11 (38.00 per cent). While, the genotype Acc. No.9 recorded the lowest seed germination percentage at field level (40.52) and it was followed by the genotype JA-190 (47.84 per cent) and Acc. No.14 (52.29 per cent). In the Umbelliferous species, having poor germination is mainly due to abortive seeds lacking of endosperm and embryo, seeds with normal endosperm but without embryo and seeds with rudimentary, dormant or defective embryos (Seghal, 1966). In this study, the genotypic and phenotypic correlation of all the traits studied except seed germination in petriplate method (-0.009) and (-0.025) had negative association with seed yield per hectare. The path analysis revealed that the traits seed yield per plant (1.146), seed germination percentage in petridish method (0.145) and seed germination percentage in field level (0.080) had the high positive direct effect on seed yield per hectare. The results suggest that the above characters play a major role influencing the seed yield per hectare both directly as well as indirectly through other yield parameters also. Hence, selection based on such characters would be effective in ajowan (Fig. 1).

Based on the *per se* performance of the ajowan genotypes, highest seed germination percentage in petridish method was recorded by the genotype GA-1 (74.00 per cent) and seed germination percentage at field level was recorded by the genotype Acc. No. (82.42) respectively.

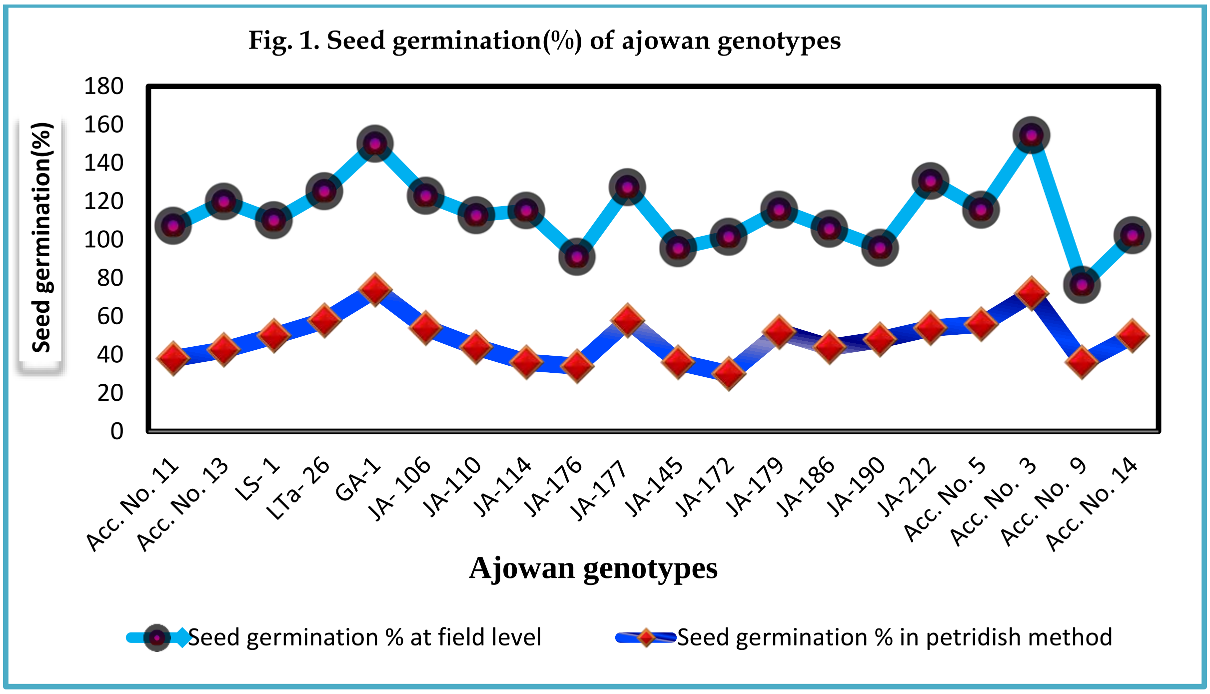

Fig 1. Seed germination (%) of ajowan genotypes

Reference

Bentley, R. and H. Trimen. 1983. Medicinal plants, Ist Ed. Delhi (INDIA): Asiatic Publisher.

Moniruzzaman, M., M. M. Rahman, M. M. Hossain, A. J. M. Sirajul Karim and Q. A. Khaliq.2013. Evaluation of coriander (*Coriandrum sativum* L.) genotypes for seed yield and yield contributing characters. *Bangladesh J. Agril. Res.*, 38(2): 189-202.

Islam, M. S., M. A. Rahman Mazumder, M. M. Hossain. R. Kundu and M. A. J. Bhuyan. 2004. Performance of some coriander genotypes for grain yield and its attributes. *Bangladesh J. Agril. Res.*, 29 (1): 59-66.

Sehgal, C.B. (1966). Studies relating to seed – set and germination in Umbeliferous. *Proc. natn. Inst. Sci. India.* 34(B): 60-70.

Comparision of Biochemical Attributes of Pickling Mango (Vadumangai) with Commercial Cultivars

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Keywords: Pickling Mango, Vadumangai, Local genotypes, Whole-fruit pickle

Introduction

Mango (*Mangifera indica* L.) is a major fruit crop in the Anacardiaceae family and it comprises 69 Mangifera species, which are dispersed across the world. Good mango fruit contains a TSS of 20° Brix, 0.2-0.5% acid, and 1% protein. Mango fruits can be consumed as a dessert fruit or some other value-added forms like mango chutney, pickles, jam, squashes, slice, and pulp, etc,. out of which pickle is an important by-product made from Mango. The Western Ghats is known for tropical fruit diversity, some wild pickling mango genotypes (popularly called Vadumangai in Tamil and Appemidi in Karnataka) were collected and these fruits were compared with commercial cultivars of mango to estimate fruit and biochemical characters to check the suitability of table or pickle making purpose.

Methodology

The present experiment was carried out in Horticultural College and Research Institute, Peiyakulam, during the year 2020-21 using a completely randomized design. Surveys were made to collect wild pickling mango fruits in different local areas and foot hills of Western Ghats, and forest areas, river dams, etc. Fruits from pickling mango trees are randomly chosen and these fruits are compared to traditional commercial mango varieties like Neelum, Bangalora, Alphonso, Sendhura, and Mulgoa for assessing the quality characteristics. Ten fruits of different cultivars were compared with three pickling mango genotypes to measure Acidity, ascorbic acid, Total Soluble Solids, Total carotenoids, total sugars, reducing sugars and non-reducing sugars, crude fiber content (Ranganna,1986). This experiment has been carried out using a Completely Randomized Design (CRD) with eight treatments and three replications. Data were analyzed by the method of Gomez and Gomez (1984).

Results and Discussion

Fruit Characteristics

Fruit length and perimeter of different cultivars ranged from 6.82cm to 13.89 cm and 3.85 cm to 12.52 cm respectively. Maximum and minimum fruit length and girth were recorded in fruits of Bangalora (13.89 cm and 12.52 cm) and vadumangai 01 (6.82 cm and 3.85 cm) local pickling mango genotypes. Cultivar Bangalora recorded a maximum stone weight of 97.15g followed by Mulgoa (74.56 grams). The lowest stone weight 18.70 grams was recorded in local pickling mango fruits (vadumangai 03). Maximum pulp weight was noticed in cultivar Bangalora (265.54 grams) followed by the cultivar Mulgoa (181.56) and the minimum pulp weight was observed in Vadumangai 02 (32.68 grams) followed by Sendhura (119.46 grams). The Peel weight of listed cultivars ranged between 16.45 grams (Vadumangai 01) to 32.19 grams (Bangalora). Cultivar Neelum and Sendhura had almost similar results for peel weight. Cultivar Alphonso recorded a maximum pulp: stone ratio (3.26) followed by Neelum (2.96). Minimum pulp: stone ratio 1.59 was recorded on local mango (vadumangai 02) followed by Mulgoa (2.44).

Quality characteristics

Cultivar which recorded maximum total soluble solids content was Neelum (17.89 ^{0}Brix) followed by Alphonso (17.58^0 Brix) and minimum was noticed in Vadumangai 03 (09.25^0 Brix). Total sugars present in fruit pulp were also high in Alphonso (15.93%), and low in Vadumangai (5.30%) genotypes. Local genotype Vadumangai 03 recorded maximum acidity (3.55%) and the minimum was found in cultivar Mulgoa (0.27%). Among different cultivars and local genotypes, ascorbic acid content was maximum in Vadumangai 03 (47.34 mg/100g) followed by Alphonso (24.32mg/100g) and minimum in cultivar Neelum (16.86mg/100g) followed by Bangalora (19.46mg/100g). Carotenoid content of screened mango cultivars and local genotypes ranged between 2.60 to 6.85mg/100g, out of six cultivars carotenoid content was lower (2.60 mg/100g) in local pickling mango (Vadumangai 02) genotypes and higher in Neelum (6.85mg/100g) cultivar followed by Alphonso. Crude fiber content was maximum in local pickling mango genotypes (1.94%) followed by Sendhura (0.98%) and minimum in Mulgoa (0.42%) followed by Neelum (0.45%).

Due to its small size, fiberness, high raw mango flavor, latex flow, and different biochemical characteristics like high acidity, high fiber content, low level of total sugars, this genotype may not be suitable for table uses. It is a genotype exclusively suitable for pickle industries.

Table 1. Biochemical attributes of pickling mango (Vadumangai) with commercial cultivars

Varieties	Acidity (%)	Ascorbic acid (mg/100g)	TSS (°Brix)	Total sugars (%)	Carotenoids (mg/100g)	Crude fiber (%)
Vadumangai 01	2.63	35.42	11.91	6.52	2.78	1.55
Vadumangai 02	2.67	32.85	10.60	5.94	2.60	1.78
Vadumangai 03	3.55	47.34	9.25	5.30	3.25	1.94
Alphonso	0.32	24.32	17.58	15.93	5.80	0.65
Neelum	0.38	16.86	17.89	14.54	6.85	0.45
Bangalora	0.32	19.46	16.88	13.81	5.73	0.58
Sendura	0.29	19.75	17.35	13.86	5.65	0.98
Mulgoa	0.27	20.16	16.50	12.29	4.98	0.42
Mean	1.38	27.02	14.74	11.02	4.70	1.08
SEd	0.32	0.50	0.29	0.24	0.12	0.02
cd at 0.05 %	0.68	1.06	0.62	0.51	0.25	0.05

Reference

Abirami, K., Nacheggowda, V. and Reddy Y T N. (2004). Physicochemical attributes of certain polyembryonic varieties of mango. *South Indian Hort*., 52(1/6): 291-296

C. Vasugi, K. Sekar, MR Dinesh, ER Swesh (2008) Evaluation of Unique mango accessions for whole fruit pickle. *Journal of Horticultural Sciences* 3(2), 156-160.

MN Hoda, Sanja Singh, Jayant Singh (2003), Evaluation of mango (*Mangifera indica* L.) cultivars for quality attributes. *Indian journal of Agricultural Science* 73(9), 504-506.

Correlation and Path Coefficient Analysis in Ash Gourd [*Benincasa hispida* (Thunb) cogn.] for Yield and Yield Related Traits

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Keywords: *Ash gourd, Correlation coefficient, Direct and Indirect effects, Yield per vine*

Introduction

Ash gourd (*Benincasa hispida*) (Thunb.) (Cogn.) is an important tropical and sub-tropical cucurbitaceous vegetable grown in India, China, Philippines and in some parts of Asia. There are varieties and hybrids of ash gourd possessing different attributes rampant in India, especially in southern parts of India. A study of correlation between yield its components and their relative contribution to the yield have a great importance in planning effective breeding programme and selection of hybrids and parents. Path coefficient analysis is also an important tool for the better understanding of the crop inheritance in respect of yield. It gives specific measures on the direct and indirect effect of each component character on yield.

Methodology

The present investigation was carried out at the College Orchard, Department of Horticulture, Agricultural College and Research Institute, Madurai during Rabi 2018–19. The current experiment consisted of thirteen genotypes of ash gourd viz., G-1, G-2, G-3, G-4, G-5, G-6, G-7, G-8, G-9, G-10, G-11, G-12 and G-13. The experiment was laid out in a randomized block design with two replications. The net area of the experimental plot was 520m^2. Five plants were randomly selected in each genotype from each replication and evaluated for the quantitative characters viz., vine length, internodal length, number of internodes, number of branches, node number to first male and female flower, number of days to first male and female flowering, number of days for 50% flowering, sex ratio (male/female), number of fruits per vine, fruit length, fruit girth, fruit weight, yield per plant, yield per plot and yield per hectare and the mean values of the data recorded were analysed statistically by using the method suggested by Panse and Sukhatme (1985) Correlation co-efficient for yield and other traits in all 13 genotypes were worked out as suggested by Johnson *et al*., (1955).

Results and Discussion

Correlation between fruit yield per vine and other attributes

Inter nodal length (0.694), fruits per vine (0.611), fruit length (0.591), average fruit weight (0.557) and fruit girth (0.537) exhibited positive significant association with fruit yield per vine, similar results were reported by Manikandan *et al*., (2017) in ash gourd.

Inter correlation among yield attributes

Vine length showed significant positive association with inter nodal length (0.725), for other attributes such as number of branches (0.220), sex ratio (0.030) and average fruit weight (0.002), similar results were reported by Manikandan *et al.,* (2017) in ash gourd, Kattula Nagaraju *et al.,* (2016) in ash gourd, Resmi and Sreelathakumary (2011) in ash gourd.

Path coefficient analysis

Among the thirteen attributes subjected to path analysis, node for first male flower (2.7060), fruit length (2.5949), days to first male flower (1.5527), vine length (1.1183) had a very high positive direct effect with yield per vine. Whereas the attributes such as fruit girth (0.4284), days to first female flower (0.3661) had a high positive direct effect with yield per vine and sex ratio (0.2113) had a moderate positive direct effect with yield per vine.

Table 1. Genotypic correlation coefficient between yield and yield attributes

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.00	0.22	0.72**	0.19	-0.16	-0.03	0.14	0.04	0.03	-0.09	0.00	-0.095	0.15	0.50
2		1.00	0.27	0.09	-0.00	0.72**	0.018	0.21	0.00	-0.04	0.00	-0.148	0.05	-0.30
3			1.00	0.01	-0.08	0.21	0.01	0.11	0.08	0.08	-0.02	0.277	0.21	0.69**
4				1.00	0.86**	0.58*	0.27	0.08	0.26	0.13	-0.21	-0.288	-0.21	-0.54*
5					1.00	0.43	0.41	0.10	0.04	-0.19	-0.11	0.047	0.09	0.45
6						1.00	0.27	0.48	0.38	0.21	-0.32	-0.284	-0.21	-0.24
7							1.00	0.44	0.19	-0.38	0.35	0.253	0.44	-0.57*
8								1.00	0.02	0.04	-0.11	-0.235	0.12	0.27
9									1.00	0.75**	0.76**	-0.545*	0.87**	0.15
10										1.00	0.97**	0.571*	0.94**	0.61*
11											1.00	0.743**	0.98**	0.55*
12												1.000	0.78**	0.59*
13													1.00	0.53*
14														1.00

** Significant at 1 percent level; * Significant at 5 percent level

1.Vine length; 2. Number of branches; 3. Internodal length 4. Node for first male flower; 5. Node for first female flower 6. Days to first male flower; 7. Days to first female flower; 8. Days for fifty percent flowering; 9. Sex ratio; 10. Number of fruits per vine; 11. Average fruit weight; 12. Fruit length; 13. Fruit girth; 14. Yield per plant.

Reference

Johnson., Herbert, W., H.F. Robinson., and R Comstock, Ev. 1955. "Genotypic and phenotypic correlations in soybeans and their implications in selection."*Agronomy journal* 47 (10):477-483.

Manikandan, M., G.M. Yassin., V. Kanthaswamy., and S. Kamaladevi. 2017. "Correlation and path coefficient analysis in ash gourd [*Benincasa hispida* (Thunb.) Cogn.] for yield and yield attributing traits." *Chemical Science Review Letters* 6 (23):1399-1403.

Panse, V.G., and P.V. Sukhatme. 1985. "Statical methods for Agricultural workers. ICAR." *New Delhi*.

Tindall, H.D. 1986. "Vegetables in the Tropics: Mac-Millan Education Ltd. Houndmills." *Hampshire* 533.

Walters., W. Terrence, Deckers., and Deena S. 1989. "Systematic re-evaluation of *Benincasa hispida* (Cucurbitaceae)." *Economic Botany* 43 (2):274-278.

Correlation Studies for Bulb Yield and Yield Contributing Characters Among Aggregatum Onion (*Allium cepa* L.. *aggregatum* Don.) Genotypes

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Keywords: *Aggregatum onion, correlation, yield*

Introduction

Onion is one of the important vegetable crops of Alliaceae family which has been cultivated for the last 5000 years around the world. Common onion and aggregatum onion are commonly cultivated in India. Multiplier onion produces small sized bulbs, many in number to form an aggregated cluster. Association of several component character of yield with other characters helps to improve these characters. Hence association between yield and other components have been estimated by correlation coefficient.

Methodology

The seed bulbs of twenty genotypes collected from different district of Tamil Nadu were used as seed materials. The field experiment was laid out in a Randomized Block Design with two replications. Growth characters such as plant height, number of leaves per plant. Leaf length, number of tillers per plant, leaf girth, bulb length, bulb diameter, number of bulbs per clump, root length, biochemical characters such as total soluble solids, ascorbic acid, pyruvic acid, protein content, chlorophyll content and yield characters such as fresh weight of bulb, dry weight of bulb, curing percentage and yield per plot were recorded.

Results and Discussion

Association analysis of 20 genotypes of aggregatum onion exhibited genotypic significance and positive association between yield per plot and chlorophyll content, fresh weight of bulb, dry weight of bulb. Phenotypic significance exhibited positive association between fresh weight of bulb and dry weight of bulb. (Fig 1&2).

Reference

Degewione, A., A. Sentayehu and T. Getachew. 2011. Genetic variability and association of bulb yield and related traits in Shallot (*Allium cepa* var. *aggregatum* Don.) in Ethiopia. Int. J. Agric. Res. pp. 1816-4897.

Dewey, D. R and K. H. Lu. 1959. A correlation and path analysis or components of crested wheat grass seed production. Agron. J., 51: 521-523.

Dhotre, M t. allolli, T.B. athani, S.J and Halemani, I.C. 2010. Genetic variability, character association and path analysis studies in Kharif onion (Allium cepa var. cepa L.) .The Asian Journal of Horticulture. 5(1):143-146.

Kaloo, Pandey, V.C., Lal., S. and Pandita, M.L., 1982, Correlation and path analysis studies in garlic (*Allium sativum* L.). Haryana Journal of Horticultural Sciences, 11: 97-101.

Figure 1. Genotypic correlation coefficient

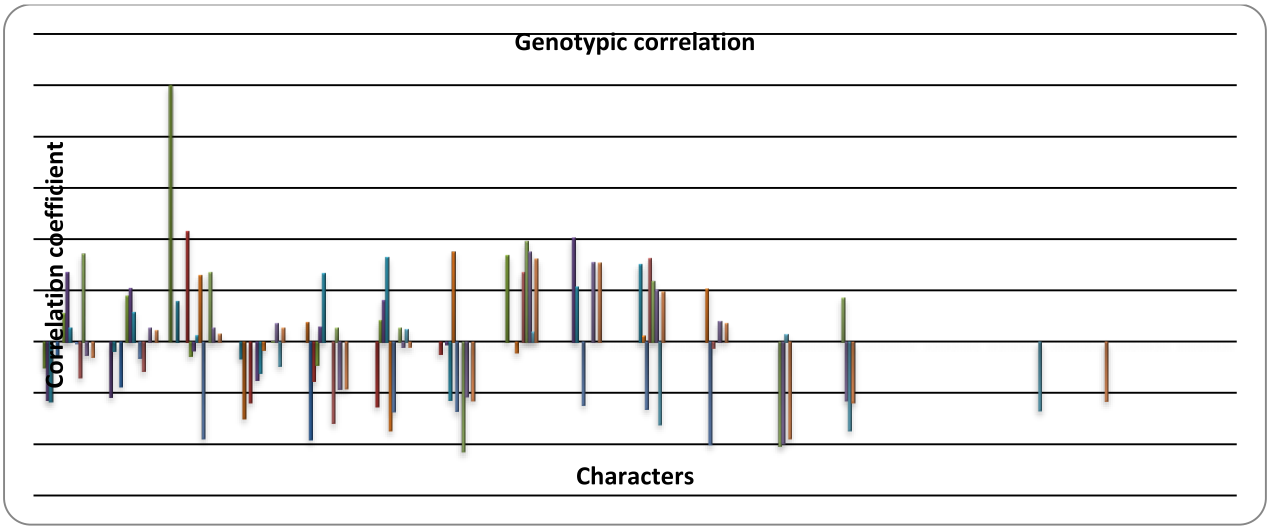
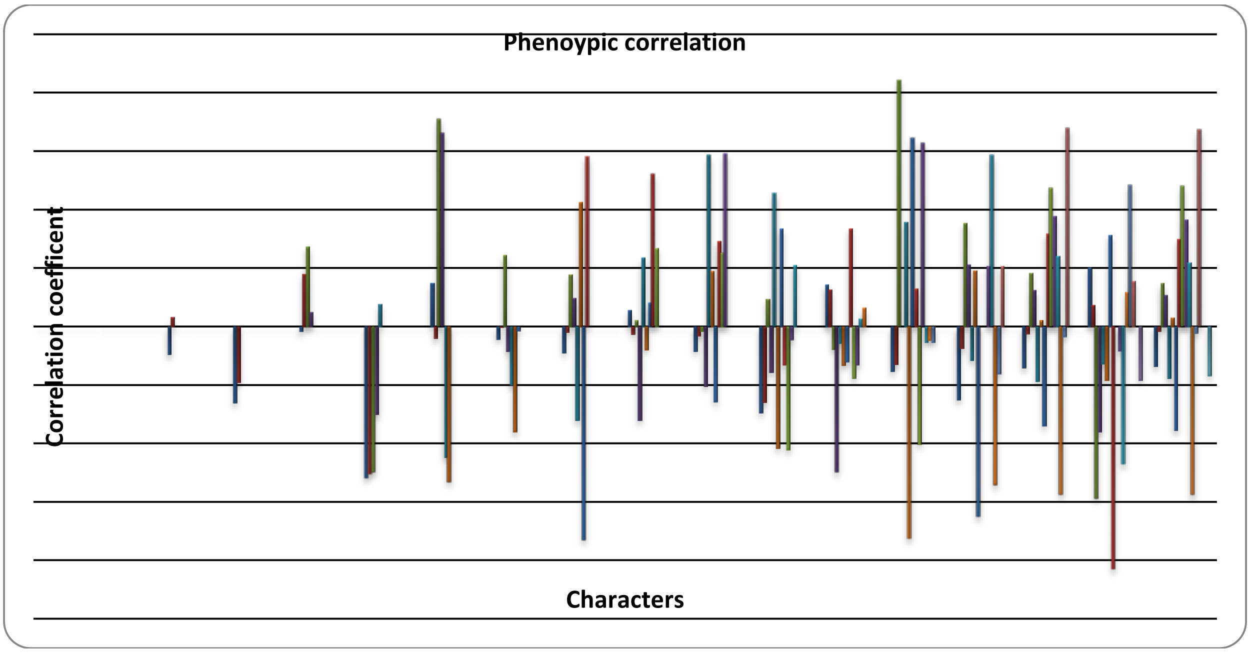


Figure 2. Phenotypic correlation coefficient



1. Plant height
2. Leaf length
3. Number of leaves
4. Number of tillers
5. Leaf girth
6. *Bulb length*
7. Bulb diameter
8. Number of bulbs per clump
9. Root length
10. Total soluble solids(TSS)
11. Ascorbic acid
12. Pyruvic acid
13. Protein content
14. Chlorophyll content
15. Fresh weight of bulb
16. Dry weight of bulb
17. Curing percentage
18. Yield per plot

Determination of Absorption Dose in Chemical Mutagenesis in Acidlime Var. PKM 1

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Keywords: *Mutation breeding, EMS, LD_{50}, Acid lime var. PKM 1*

Introduction

Acid lime (*Citrus aurantifolia* Swingle) belongs to the family Rutaceae, with chromosome number (2n=18) and sub family Aurantioideae and is commercially grown in tropical and subtropical regions of India. Acidlime var. PKM 1 is the most popular cultivar in Tamil Nadu. It is a selection from kadayam type of Tirunelveli district of Tamilnadu. Mutations are characterized as heritable alterations in an organism's genetic material and in turn in its characters that are not derived from genetic segregation (Van Harten, 1998). In induced mutation, mutagens *viz.*, physical (gamma rays) and chemicals such as ethyl methane sulphonate (EMS) and methyl methane sulphonate (MMS) are most frequently used. Chemical mutagens are alkylating compounds that can be used to induce mutations. Chemical mutations are more stable and unique to a specific gene than physical mutations. On the above facts, the objective was to determine on LD_{50} dose in Acidlime var. PKM 1 for inducing mutations to produce viable mutants.

Methodology

The present investigation was undertaken at Department of Fruit Science, Horticultural College and Research Institute, Periyakulam, TNAU during 2019-2021. The experiment was laid out in Completely Randomized Block Design with six treatments and three replications and conducted for a period of 4 months. Acidlime seeds of variety PKM 1 were obtained from HC&RI, Periyakulam. For chemical mutagenesis, healthy and uniform sized seeds were treated with different concentrations (0.2 %, 0.4 %, 0.6 %, 0.8% and 1.00 %) of ethyl methane sulphonate (EMS). The aqueous solution of different concentrations of EMS was prepared using Phosphate Buffer (pH 7.0). Measured the leaf area(cm^2) through graphical method. Total phenol content of the leaves were determined according to Malik *et al.*,1980.

Results and Discussion

Germination percentage

With increasing doses of ethyl methane sulphonate, the number of days required for germination and the percentage of seeds that germinated were significantly influenced. With an increase in ethyl methane sulphonate dosage, the number of days required for germination increased while the germination percentage reduced. The seed germinated in 19.2 days in the control group, with 89.3 percent of the seed germinated (Table1and Fig.1).

Survival rate (%)

Seedling survival per cent on 45th day after sowing is presented in. The survival percentage ranged from 60.00 (0.2% EMS) to 6.00 (1.0% EMS) (Table 1 and Fig 2). All the treatments showed lower survival rates than the control. Lokesh and his co-workers (2017) revealed that there was a gradual and significant reduction in survival of nodal segments, with increase in dose of the mutagens.

Dosage of mutagens

LD50, value was 0.4% EMS in acidlime. With increasing mutagen concentrations, a gradual decline in germination percent was detected, reaching more than 50% mortality at 0.4 percent EMS in acidlime var. PKM 1 of 90 days old seedlings (Table 1 and Fig.2). Similar results were reported by Dhatt *et al.* (2000) for Kinnow seed with EMS 0.4 percent.

Table 1. Effect of Ethyl Methane Sulphonate on Biological Parameter of Acid lime var. PKM 1

Treatment	Days taken for germination	Seed germination%	Seedling height (cm)	Internodal length(cm)	Leaf number	Leaf area (mm2)	Root length	Survival rate (%)
0.0%	19.2	89.3	17.4	2.2	7.2	485.7	27.9	87
0.2%	23.7	63.7	16.4	1.9	6.1	438.9	23.7	60
0.4%	27.0	59.3	15.1	1.5	5.3	365.1	19.9	51
0.6%	31.3	53.3	13.5	1.2	4.4	298.4	17.1	45
0.8%	36.2	35.3	12.6	0.9	4.1	247.4	14.2	25
1.0%	48.6	10.3	11.5	0.5	4.0	145.1	12.5	06
CD(P=5%)	1.6	10.7	0.7	0.5	0.7	17.6	0.8	2.9

Reference

Dhatt, A S, Rattanpal H S, Khokhar R and Singh S N. 2000.Standardising LD_{50} doseof gamma rays and EMS in kinnowSeeds. *Journal of Research Punjab AgriculturalUniversity*37(3–4): 194–7.

Malik E.P., Singh M.B., 1980. Plant Enzymology and Hittoenzymology (1st Edn.) Kalyani Publishers: New Delhi; 286

Lokesh Bora, RM Vijayakumar, and M Ganga (2017) Mutagenic effect of ethyl-methyl sulphonate on in vitro nodal segments of acid lime cv. PKM-1. International Journal of Chemical Studies 2017; 5(6): 429-432.

Effect of Drying Methods on Moringa PKM1 Leaf Powder for Retention of Nutritional Quality

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Keywords: *Moringa powder, shade drying, cabinet drying, solar tunnel drying, nutritional quality.*

Introduction

Moringa oleifera is an eternal tree indigenous to India but now it is globally popularized and acclimate transversely everywhere to the tropics and subtropics. Due to its great nutritional value, moringa have played an important role in reduction of malnutrition, especially among infants and breast-feeding mothers. The leaf of miracle tree is eaten up freshly and it can be stored as dried powder for months. The medicinal wellness of moringa- value added products is projected to the growth of many industries. Moringa leaf powder can be used in many forms such as raw intake, as moringa powder that used in food additions, tea and oil. The best nutritional quality of moringa leaf powder indicate the colour, odour, texture and nutrivie composition. To enhance the standard, quality of powder, enforcement of proper drying method is applicable.

Methodology

Moringa PKM 1 variety fresh leaves were collected from the organic Moringa leaf production field in the Department of vegetable science at Horticultural College and research institute, Periyakulam, Tamilnadu.The harvested fresh moringa leaves were subjected to processing because processing will destroyed the pathogen and microbes in the moringa leaf and also it might increases the shelf life of the product, after that Stripping of leaflets from freshly harvested leaves were carried out and leaves are washed in tap water. The fresh moringa leaves are dried using three methods includes shade drying, cabinet drying with temperature of 45-50°C for 5 hours and solar tunnel dryer as 40-42°C for 4 hrs for drying. The dehydrated moringa leaves with 7-8% moisture content were blended into fine powder using pulverizer and the freshly prepared moringa leaf powder were packed air tightly in polythene bag having thickness of 200 guage. The packed powder then stored in ambient and cold storage with at 4°C. The samples were drawn at 30 days interval and the stored powder were interpreted for endowment specification.

Results and Discussion

Effect of different drying methods on nutritional parameters

Among different drying methods the solar tunnel drying retains maximum nutrient contents of moringa PKM 1 variety leaf powder after 30 days of storage. The highest nutrient of protein (26.39mg/100g), crude fibre (13.2-12.7%), Vitamin A (13.02 -12.83 mg/100g) and Ascorbic acid (17.0-16.0 mg/100g) contents were recorded in solar dried leaf powder stored under both the storage conditions and other drying methods was observed with minimum nutrient contents (Table 1).

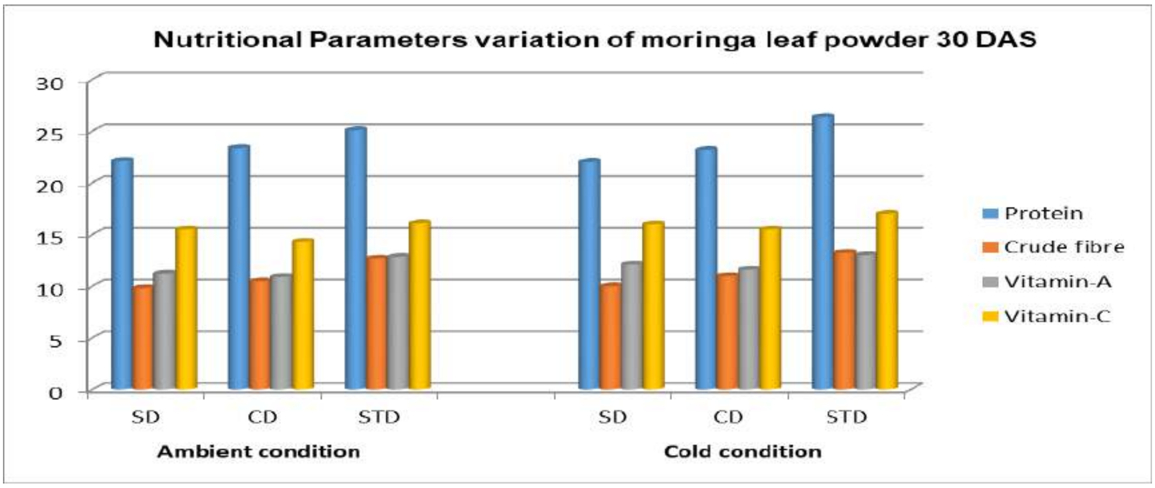
The solar tunnel dryer have maintained the ideal temperature and endowing with efficient intensity maintain perfect quality, texture with good aroma of leaf powder during 4 hours of drying at 40°C. Therefore, the performances of solar tunnel dryer is best for moringa when compared to the other methods of drying.

Table 1. Nutritional Parameters of Moringa leaf powder at 30 days of after storage

Drying kinetics	Protein (mg/100g)	Crude fibre (%)	Vitamin-A (mg/100g)	Vitamin-C (mg/100g)
Ambient condition				
Shade drying	22.10	9.8	11.2	15.5
Cabinet drying	23.38	10.5	10.9	14.3
Solar tunnel drying	25.10	12.7	12.83	16.1
Ambient condition				
Shade drying	22.02	10.0	12.1	16.0
Cabinet drying	23.18	11.0	11.6	15.5
Solar tunnel drying	26.39	13.2	13.02	17.0
S CD(0.05)	0.66691NS	0.19231*	0.33603NS	0.41960*
P CD(0.05)	0.81680*	0.23553**	0.41155*	0.51391*
S×M CD(0.05)	1.15512NS	0.33309NS	0.58202NS	0.72677NS

*** - Significant ** - Highly significant NS - Non significant S*- Storage condition M*-Drying methods**

Fig 1. Comparison of nutritive value with drying methods during storage condition



Reference

Kinetics study on dried *Moringa oleifera* leaves during sun drying, multi commodity solar tunnel dryer drying and oven drying. Malaysian Journal of Halal Research 2(1):2616-1923.

Suzauddula, M.D., M. Moeen Miah., Nasima Akter Mukta., Najia Kamrul., M.D., Bellal Hossain.2019. Tropical leafy vegetables. Food chemistry, 53, 375-379.

Vijay Venkata Raman, S., S. Iniyan., & R. Goic. 2012. A review of solar drying technologies. Renewable and Sustainable Energy Reviews, 16(5): 2652-2670.

Effect of Integrated Nutrient Management on Yield and Cost Economics of Nerium (*Nerium oleander* L.)

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Keywords: *Biofertilisers, Yield, Cost economics, BC ratio, Nerium*

Introduction

Nerium is an evergreen flowering perennial shrub, highly opted for commercial loose flower cultivation owing to its wider adaptability and sinecure horticultural practices. The production share of floriculture among all horticulture crops in India is only around 1 to 1.2 %. However, there is an increase in area and production of flowers since the year 2003- 04, in addition to the landscape uses of ornamental plants (Horticultural Statistics at a Glance, 2018). Tamil Nadu state holds the first position in the loose flower production in the country and the nerium cultivation occupies an area around 1400 hectares with an annual production of 33,780 tonnes with the highest productivity of 24.00 t/ha, among other loose flower crops.

Methodology

Three nerium cultivars (Red, White and Pink) of one year old plants were pruned to equal height *i.e.*, 60 cm from the base and subjected to ten different fertilizer combinations with inorganic, organic and biofertilizers depending on the fertilizer requirement (Vijai and Rameshkumar, 2012). The fertilizer level adopted by the farmer's in nerium cultivation was taken as the control. The fertilizers were applied in the small furrow taken up 20 cm from the main stem after pruning and watered regularly. The morphological, flowering and yield characters of the plants were recorded at 30, 60, 90, 120, 150 days after pruning.

Results and Discussion

The maximum flower yield per plant was observed in T_7 (NPK @ 120:160:160 g /plant/year + Farm Yard Manure + Azospirillum + Phosphobacteria) with the yield of 4.14 kg) followed by the treatment T_9 (NPK @ 120:160:160 g/plant/year + Vermicompost + Azospirillum + Phosphobacteria) which was on par with the treatment T_3 (NPK @ 150:200:200 g/plant/year) with the flower yield of 3.6 and 3.5 kg respectively, whereas the minimum flower yield per plant (1.3 kg) was interpreted in T_{10} (NPK @ 85:85:85 g/plant/year) as mentioned in **Table 1**. The economic analysis for cultivation of nerium plants for one hectare was calculated for the treatments individually and revealed that the maximum net returns (Rs.6,82,545.00) with cost-benefit ratio (3.06) was identified in the treatment T_7.

Cost economics plays a pivotal role in any crop production practice from the farmer's point of view, where the ultimate goal is to make the grower to get more profit with lesser input. The profit margin from the crop will be more during the course of maturation of the plants. The present study results of higher benefit cost ratio supports the values of (Patel *et al*., 2017) in *Rosa hybrida* L. cv. Gladiator and (Angadi, 2014) in garland chrysanthemum in which the combination of organic, inorganic and biofertilizers yielded economically adoptable and valuable outcome from the flower yield.

In entirety, it was observed that the combined application of inorganic fertilizers along with organic manures and biofertilizers significantly influenced the growth, yield and net return of the crop.

Table 1. Effect of integrated nutrient management on yield attributes and cost economics of nerium (*Nerium oleander* L.)

Treatments	Flower yield (g/plant)	Flower yield (t/ha)	Net returns (Rs.)*	B:C ratio
T_1 - NPK @ 90:120:120 g/plant/year	2.27	5.68	2,96,015	1.5
T_2 - NPK @ 120:160:160 g/plant/year	2.96	7.39	4,38,995	2.1
T_3 - NPK @ 150:200:200 g/plant/year	3.51	8.77	5,52,400	2.6
T_4 - T_1 (NPK @ 90:120:120 g/plant/year) through Nutri-pellets	2.23	5.57	2,86,550	1.4
T_5 - T_2 through Nutri-pellets	3.08	7.69	4,66,544	2.3
T_6 - T_1 + Farm Yard Manure + Azospirillum+ Phosphobacteria	3.23	8.07	4,90,652	2.3
T_7 – T_2 + Farm Yard Manure + Azospirillum + Phosphobacteria	4.14	10.35	6,82,545	3.1
T_8 - T_1 + Vermicompost + Azospirillum + Phosphobacteria	3.26	8.15	4,87,565	2.2
T_9 – T_2 + Vermicompost + Azospirillum + Phosphobacteria	3.64	9.11	5,64,220	2.4
T_{10} (Control) - NPK @ 85-85-85 g/plant/year	1.33	3.33	2,22,750	1.1
SE.d	0.0683	0.146	-	-
CD (0.05 %)	0.143	0.307	-	-

*(Cost for 1 kg of nerium flower is applied as Rs. 50)

Reference

Angadi, A. P. 2014. Effect of integrated nutrient management on yield, economics and nutrient uptake of garland chrysanthemum (*Chrysanthemum coronarium* L.). The Asian J. Horticulture, 9(1), 132-135.

Patel, V. S., Malam, V. R., Nurbhanej, K. H., Vihol, A. N. and Chavada, J. R. 2017. Effect of organic manures and biofertilizers on growth, flowering and flower yield of rose (*Rosa hybrida* L.) cv. Gladiator. International Journal of Chemical Studies, 5(5), 1924-1927.

Vijai, A. and Rameshkumar, S. 2012. Effect of different levels of pruning along with NPK on growth and yield of Nerium (*Nerium oleander* L.). International Journal of Current Agricultural Sciences, 2, 13-16.

Effect of Organic Manure over the Growth and Yield of Amaranthus for Sustainable Agriculture (*Amaranthus dubius*)

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Keywords: *Amaranthus, organic and inorganic manures, yield and quality components*

Introduction

Amaranthus is an old cultivated leaf vegetable of South India. It belongs to the family Amaranthaceae.. It is rich in vitamins especially vitamin A and other vitamins like as iron and calcium. It also has higher grain protein (13-19 per cent) and leaf protein (23-25per cent) with high lysine and sulphur containing amino acids which are limiting in other conventional crops (Tognett *et al.*, 2008). Provision of a sustainable environment in the soil by amending with organic inputs can improve the quality and acceptability of crop. The use of inorganic fertilizer to increase yield has been found to be effective only within few years, demanding consistent use on long term basis (Sajirani *et al.,* 2012). There is a need to determine the independent influence of organic manures and inorganic fertilizer such as N,P, K on the growth and yield of fast growing vegetables like amaranthus species as to justify the continuous mixture of both or otherwise (Vipitha and Geethakumari, 2016).

Methodology

The field experiment on Amaranthus was conducted under open field conditions at the Department of Horticulture, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal. Amaranthus variety used in this study was CO1 (Mulaikeerai and Thandukeerai). The crop was raised under Randomized Block Design (RBD) with eighteen treatments and two replications. The seeds were sown in lines under raised bed (2m X 1m). RBD Thinning was done once after 15 days after sowing (DAS) and observation were recorded. Fifteen days after first thinning, the crop was ready for harvesting. The growth, yield and quality parameter were recorded and subjected for analysis.

Results and Discussion

Among the eighteen treatments evaluated, the treatment T_{10} Vermicompost (7.5 t ha^{-1}) + 75 per cent Recommended Dose of Fertilizer (75 kg ha^{-1} N: 25 kg$ha^{-1}K_2O$)was found superior than other treatments by recording maximum values for plant height (54.09 cm), leaf length (11.48 cm), number of leaves (67.10) and the leaf breadth (7.23 cm) was maximum in the treatment T_{13} (Poultry Manure 5 t ha^{-1} + 75per cent RDF) than control. Study on comparative effect of organic and inorganic fertilizers on plant growth characters of amaranthus revealed that organic fertilizer produced higher effects on all the parameters investigated when compared with inorganic fertilizer. Organic manures activate many species of living organisms which release phytohormones and may stimulate the plant growth and nutrients (Arisha *et al*., 2003) and such organisms need nitrogen for multiplication (Ouda and Mahadeen, 2008). Organic manures like cattle manure have been reported to release both micro and macro nutrients slowly resulting in subsequent promotion of vegetable growth Also the treatment, Vermicompost (7.5t ha^{-1}) along with inorganic fertilizer (75per cent RDF75 kg ha^{-1} N: 25 kg ha^{-1} K_2O) showed superior performance for yield attributing characters by recording maximum values for leaf weight (14.90 g), shoot weight (22.30 g), yield plot^{-1} (2.78 kg) and yield ha^{-1} (13.87 t) than control leaf weight (3.74 g), shoot weight (5.70 g), yield plot^{-1} (1 kg) and yield ha^{-1} (5t). This was in line with Ahirwar and Hussain (2015) because the mineralization of organic matter, decrease of soil pH by organic acids produced in vermicompost and increases micronutrient complexes formation.

Table 1 Mean performance of plant height (cm) influenced by different levels of Organic and inorganic manures

Treatments	Storage period (days)		
	1*	2*	3*
T_1	4.93	10.53	17.46
T_2	4.51	9.13	15.85
T_3	4.51	9.52	15.84
T_4	4.6	10.6	17.7
T_5	4.56	9.33	15.02
T_6	4.59	11.3	18.6
T_7	4.82	19.96	26.01
T_8	8.57	20.41	26.05
SEd	0.1399	0.4025	0.3236
CD(0.05)	0.2967	0.8534	0.6860

Reference

Sajirani, E.B., M.J. Shakouri and S. Mafakheri. 2012. Response of spinach (*Spinacia oleracea*) yield and nutrient uptake to urea and manure*Indian J. of Sci. and Technology***5**(1):2121-2123.

Tognetti, C., M.J. Mazzarino, F. Laos. 2008. Compost of municipal organic waste: Effects of different management practices on degradability and nutrient release capacity. *Soil Biol. Biochem.***40**:2290-2296.

Vipitha, V.P., and V.L. Geethakumari. 2016. Evaluation of different organic manure mixtures in vegetable amaranth cultivation *J. Hortl. Sci.,***9**(1):86-89.

Effect of Post-Harvest Treatments on Shelf Life and Quality of Okra (*Abelmoschus esculentus* (L.) Moench)

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Keywords: *Okra, Citric acid, Ascorbic acid, Cysteine, quality*

Introduction

Okra (*Abelmoschus esculentus* (L.) Moench) is an important tropical vegetable cultivated and consumed widely in Asian, African and European continents. Improper postharvest handling of okra also has an impact on appearance of fruits by causing blackening of ridges which results in reduced consumer acceptance. About 50-70% of postharvest loss occurs due to ridge blackening in okra (Kanwal *et al.*, 2020). Organic acids and amino acids like, citric acid and cysteine (Sohail *et al.*, 2021) are widely recognized as safe for consumption and use and also efficient in maintaining postharvest qualities of fruits and vegetables during storage.

Methodology

Okra *cv.* Bhendi Hybrid CO 4 was harvested from Western Farm, Horticultural College and Research Institute, HC&RI, Periyakulam. Eight batches of okra fruits were separated for dipping treatments. The treatments included T_1- 250 ppm citric acid, T_2 - 500 ppm citric acid, T_3- 0.5% Ascorbic acid, T_4- 1% Ascorbic acid, T_5- 0.5% Cysteine, T_6- 1% Cysteine, T_7- distilled water and T_8- Untreated okra (control). The okra fruits in each treatment were divided into three replicates and kept at room temperature (27±2^{0}C and 60 ±10% RH) in plastic trays. The experimental design used was Completely Randomized Design. The mean values were compared using Duncan's Multiple Range Test. All the observations were recorded once in 24 hours throughout the storage period.

Results and Discussion

Physiological Loss in Weight

Throughout the storage period, the weight loss percentage increased gradually. There was a significant difference among the treatments in physiological loss in weight throughout the storage period. Okra fruits treated with (T_5) cysteine 0.5% (15.02%) showed least loss in weight at the end of storage period and the highest weight loss percentage was recorded in control (T_8) (26.05%) (Table 1). The loss in weight is due to transpiration losses occurs due to respiration which results in moisture loss from the produce, Adetuyi *et al.* (2008).

Chlorophyll

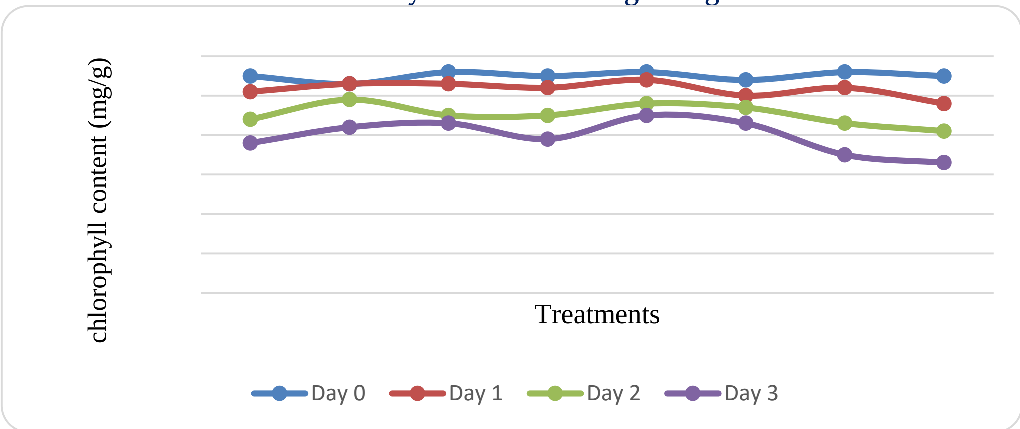
The postharvest treatments significantly influenced the chlorophyll content of okra fruits. Higher chlorophyll retention was observed in okra fruits treated with Cysteine 0.5% (T_5) (0.51 mg/g) followed by ascorbic acid 0.5% (T_3) and Cysteine 1% (T_6) (0.49mg/g) at the end of the storage period and the lowest chlorophyll content was recorded in control (T_8) (0.44mg/g) The chlorophyll generally degrades with the progression of storage period due to breakdown of chlorophyll pigment (Rai *et al.* (2009).

The results also showed that cysteine at 0.5% was the best treatment in preserving the qualities of okra with minimum loss in firmness (5.06 kg/cm^2), less fiber formation (10.17%) and bacteria (1.33× 10^4 CFU/g) and also had extended shelf life of four days compared to untreated control fruits.

Table 1. Effect of postharvest treatments on Physiological Loss in Weight (%) of Okra *cv.* Bhendi Hybrid CO 4 during storage

Treatments	Storage period (days)		
	1*	2*	3*
T_1	4.93	10.53	17.46
T_2	4.51	9.13	15.85
T_3	4.51	9.52	15.84
T_4	4.6	10.6	17.7
T_5	4.56	9.33	15.02
T_6	4.59	11.3	18.6
T_7	4.82	19.96	26.01
T_8	8.57	20.41	26.05
SEd	0.1399	0.4025	0.3236
CD(0.05)	0.2967	0.8534	0.6860

Fig 1. Effect of antioxidants and amino acids dipping on chlorophyll content (mg/g) of Okra *cv.* Bhendi Hybrid CO 4 during storage



Reference

Adetuyi, F.O., Osagie, A.U., Adekunle, A.T. 2008. Effect ofpostharvest storage techniques on the nutritional properties ofbenin indigenous okra (*Abelmoschusesculentus*. L) moench. *Pakistan J. Nutr.* 7, 625–657.

Kanwal, R., H. Ashraf, M. Sultan, I. Babu, Z. Yasmin, M. Nadeem, M. Asghar, R. R. Shamshiri, S.M. Ibrahim, N. Ahmad, M. A. Imran, Y. Zhou and R. Ahmad. 2020. Effect of 1-Methyl Cyclopropane and Modified Atmosphere Packaging on the Storage of Okra (*Abelmoschus esculentus* L.): Theory and Experiments *Sustainability*, 12, 7547.

Rai, D. R., Narsaiah, K., Bharati, D. K., Reddy, P. M. K. and Brar, S. S. (2009). Modified atmosphere packaging of minimal processing and storage of shredded cabbage. *J. Food Sci. Technol.*, 46(5):436-439.

Sohail, M., R. B. H. Wills, M. C. Bowyer and P. Pristijono. 2021. Impact of exogenous arginine, cysteine and methionine on the postharvest senescence of six green leafy vegetables *Journal of Horticulture and Postharvest Research*, VOL. 4(3), 253-262.

Effect of Seed Treatments on Seed Germination and Seedling Parameters in F_2 Crosses of Mundu Chilli (*Capsicum annum* L.)

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Keywords: *Mundu chilli, Seed treatment, Germination, seed vigour index*

Introduction

Chilli (*Capsicum annuum* L.), a member of the Solanaceae family, is well known for its aromatic flavour, pungency, and strong food colouring potential. Chilli is grown in area of 10,61,000 hectares in India, with an annual production of 57.93 lakh tones, yielding an annual yield of 2.59 MT ha–1. In Tamilnadu is covered area of 64,25 with 27.46 lakh tones of production (NHB, 2020). India being largest producer and exporting chilli production of elite seedling is essential. Delayed seedling emergence, irregular seedling growth results in low seedling vigour and non-uniform seedling for production (Demir and okcu 2004). Furthermore, chilli seedlings are susceptible to damping-off disease, which is caused by *Rhizoctionia solani* and necessitates the use of pre-sowing seed treatments. For high-quality seedling production, especially among transplanted vegetables, rapid and uniform seedling emergence is a must. Pre-sowing seed treatments can be beneficial for achieving faster, more synchronized germination and seedling emergence for enhanced performance, but also for protecting seedlings against seed or soil-borne diseases.

Methodology

Four Mundu chilli (*Capsicum annuum* L.) F_2 crosses *viz.*, PKM CA 20 X PKM CA 08 (C_1), PKM CA 32 X PKM CA 33 (C_2), PKM CA 32 X PKM CA 20 (C_3), PKM CA 38 X PKM CA 33 (C_4) were obtained genetically pure and fresh seed from the Department of Vegetable Science, Horticultural College and Research Institute, TNAU, Periyakulam, Tamil Nadu, and used foe the study. Seven treatments were used, are as follows: T_0 - Control, T_1 - Seed treatment with KNO_3 (0.5% solution), T_2 - Seed treatment GA_3 (50 ppm solution), T_3 - Seed treatment with NAA (100 ppm solution), T_4 - Hot water seed treatment at 60^o C for 15 minutes, T_5 - Seed treatment with cow urine (1: 1 w/v), T_6 - Seed treatment with *Trichoderma viride*. Seeds were soaked in an equal volume of each concentration of solution. The treated seeds were sown in Protray filled with low EC, neutral P^H coir pith media and kept under mist chamber. Data on percent seed germination, root length, shoot length and seed vigour index were recorded. The experiment was carried out using a Factorial Completely Randomized Design (FCRD). Each treatment was replicated three times. The obtained data on various factors was statistically evaluated as per the method described by Panse *et al.* (1954).

Results and Discussion

Effect of seed treatment on seed germination in F_2 crosses of mundu chilli

The factors, seed treatment (T) and F_2 crosses (C) differed significantly in seed germination, but there was no significant difference in interaction between seed treatment (T) and progenies (C). Mean value of treatment should be mentioned (Table 1). Among the different seed treatments, the seeds treated with GA_3 50 ppm (T_2) had higher germination percentage of 69 % followed by KNO_3 0.5 % treatment (68.00 %) and the lowest germination was observed in control treatment (T_1) with the germination percentage of 57.00 %. Comparing the different F_2 crosses, there was significant difference among the F_2 crosses with respect to seed treatment. Higher germination was recorded in the crosses C_4 (63.85 %) which was on par with C_2 (63.32 %) and C_1 (63.28 %). Among the interaction effect of F_2 crosses and seed treatments, there was no significant difference among the crosses with respect to seed treatment. The interaction C_1T_2 (69.00 %) registered the highest germination which was on par with C_1T_1 and C_2T_2. The lowest germination percentage was recorded in C_1T_4 (61.00 %). The better seed germination by GA_3 treatment resulted in maximum germination is due to the that, GA_3 induced enzymes that digest the endosperm quickly and efficiently, reducing the mechanical restraints of endosperm, thus providing energy to start and sustain embryo growth, which occurred quickly during the early stages of germination. Similarly, a high germination percentage was reported by Reddy and khan (2001, Natesh *et al* (2005), Yogananda et *al* (2004) in bell pepper.

Table 1. Effect of seed treatment on seed germination in F_2 crosses of mundu chilli

Treatments	C_1	C_2	C_3	C_4	Mean
T_0	57.00	59.00	54.00	58.00	57.00
T_1	68.00	67.00	64.00	67.00	66.50
T_2	69.00	68.00	66.00	68.00	67.75
T_3	62.00	63.00	62.00	65.00	63.00
T_4	61.00	62.00	60.00	64.00	61.75
T_5	63.00	64.00	63.00	63.00	63.25
T_6	63.00	60.00	61.00	62.00	61.50
Mean	63.28	63.32	61.43	63.85	440.75
Source	SEd		CD 5%		
F_2 crosses	0.49		0.99		
Treatment	0.65		1.31		
Interaction	1.31		2.62		

Reference

Demir, I. and Okeu, G. (2004). Aerated hydration treatment for improved germination and seedling growth in aubergine (*Solanum melongena* L.) and pepper (*Capsicum annuum* L.). Annals of Applied Biology, 144, 121–123.

Natesh, N. Vyakaranahal, B. S. Gouda, M. S. and Deshpande, V. K. (2005) Influence of growth regulators on growth, seed yield and quality of chilli cv. ByadagiKaddi. Karnataka J Agric Sci 18: 36-38.

NHB. Online statistical database. National Horticultural Board, Ministry of Agriculture, Govt. of India, 2020.

Reddy, Y. T. N. and Khan, M. M. (2001) Effect of osmo priming on germination, seedling growth and vigour of khirni (*Mimusops hexandra*) seeds. Seed Res 29:24-27.

Yogananda, D. K. Vyakarnahal, B. S. and Shekhargouda, M. (2004) Effect of seed invigoration with growth regulations and micronutrients on germination and seedling vigour of bell pepper cv. California Wonder. Karnataka J Agric Sci 17: 811-13.

Evaluation of Acid Lime (*Citrus aurantifolia* Swingle) Cultivars for Yield Attributes

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Keywords: *Evaluation, acid lime, flowers, fruits, yield, cultivars.*

Introduction

Acid lime is more popular for its uses in preparation of refreshing juice and in seasoning foods and making of pickles. Acid lime pickles are very popular not only in India but also in other parts of the world. India exports small quantum of acid lime pickles to other countries. viz., USA, Engaland etc. it is also used in the manufacture of lime squash either alone or in combination with lemons and other citrus fruits. It is a good source of vitamin C and has good anti-oxidant properties. It has many medicinal properties. It is an oppertise, stomachic, antiscorbutic and antihelmintic and it checks biliousness Singh (2000). The acid lime tress under Tamil Nadu conditions flowers normally twice a year during January - February and June – July and yield fruits mainly during July – August and December –January Shrestha (1988).

Methodology

The experimental field is situated at the central block of Horticultural college and Research Institute, Periyakulam, which is located at 10 ^{0} N and 77 ^{0} E with an altitude of 300 m above MSL. The evaluate six acid lime cultivars viz., PKM - 1, Saisarbathi, Pramalini, Vikram, Tenali and Kasipentla. The studied in two seasons (July – August and December – February). The experiment was laid out in a randomized block design and replicated four times. Nine-year-old trees planted at a spacing of 5m x 5m were selected for evaluation and for observations four trees in each replication.

Results and Discussion

The various yield attributing characters have been presented in (Table-1). The highest number of flowers per shoot (10.85), the number of fruit set per shoot (7.67) , number of fruits retained per shoot (4.85), number of fruits per tree (384.85) and yield of fruits per tree (20.50 kg per tree) were recorded in cultivar Vikram during the first season. This was in concurrence with the findings of Manoj Babral and Misra (2007). The cultivar Saisarbathi recorded second best performer for number of flowers per shoot (8.95) in the first season. However, for other characters, *viz.*, number of fruit set per shoot (5.70), number of fruits retained per shoot (3.20), number of fruits per tree (340.34) and yield of fruits per tree (18.26 kg) PKM – 1 was found to be the second-best performer in the first season.

During second season, the highest number of fruit set per shoot was recorded in Vikram (8.25) followed by Saisarbati (6.51). The lowest number of fruit set per shoot was noticed in Kasipentla (5.07). Similarly, the genotype Vikram recorded the highest number of fruits retained per shoot (5.35), fruits per tree (406.35) and yield per tree (22.56kg). It was followed by PKM – 1 which registered (3.85) number of fruits retained per shoot, (366.25) number of fruits per tree and (19.06 kg) of yield per tree. The lowest values for number of fruits retained per shoot (2.80), number of fruits per tree (285.32) and yield per tree (12.70kg) were observed by the genotype Kasipentla.

Table 1. Performance of acid lime cultivars on flowering, fruit set, fruit retention, number of fruits/tree and yield of fruits/tree

S.NO	Cultivars	Season									
		July – August (I)					December – February (II)				
		No. of flowers/ shoot	No. of fruit set/ shoot	No. of fruit retained/shoot	No. of fruits/ tree	Yield of fruits (Kg/tree)	No. of flowers/shoot	No. of fruit set/shoot	No. of fruit retained /shoot	No. of fruits /tree	Yield of fruits (Kg/tree)
1	PKM – 1	8.77	5.70	3.20	340.34	18.26	9.56	6.44	3.85	366.25	19.06
2	Saisarbathi	8.95	5.52	3.06	314.50	15.18	10.38	6.51	3.70	342.15	15.77
3	Pramalini	7.22	4.60	2.45	286.61	12.57	7.73	5.04	2.95	317.12	13.29
4	Vikram	10.85	7.67	4.85	384.85	20.50	12.13	8.25	5.35	406.35	22.56
5	Tenali	8.32	4.65	2.25	302.19	14.12	9.16	5.45	2.92	323.08	14.72
6	Kasipentla	7.37	4.32	2.30	273.87	11.72	8.09	5.07	2.80	285.32	12.70
	SEd	0.31	0.20	0.12	5.43	0.57	0.34	0.23	0.14	5.42	0.62
	CD (0.5%)	0.66	0.44	0.27	11.58	1.22	0.74	0.49	0.30	11.56	1.33

Reference

Anonymous. 2003. Area and production of acid lime in Tamil Nadu. *Hort Stat.*, p.135.

Badiyala, S. D., J. N. Bhargava and S.C.Lakhanpal.1993.Variability studies in kagzi lime (*C. aurantifolia* Swingle) strains of Paonta valley of Himachal Pradesh. *Punjab Hort. J.*, 32 (1 – 4): p.5 – 9

Chakrawar, V. R and S. D. Jature. 1980. Correlation studies on kagzi lime strains. *The Punjab Hort. J.*, 20: p. 39 - 40.

Josan, J . S and Nirmajit Kaur. 2006. Variability and character association analysis in identified mandarin germplasm. *Indian J. Hort.*, 63 (2) : p.152 – 154.

Manoj Dabral and K. K. Misra. 2007. Studies on flowering and fruiting in some Litchi cultivars. *Indian J Hort.*, 64 (2) : p. 207 – 210.

Singh, I.P Shyam Singh and S. K. Verma. 2004. Citrus genetic diversity in Uttaranchal. *Prog. Hort.*, 36 (2) : p. 234-240.

Srinivas, N., Athani, S.I. Sabarad, A.I. Patil, P.B. Kotikal, Y.K. Swamy, G.S.K. and B.R. Patil. 2006. Studies on variability of fruit physical characters, quality and yield in seedling strains kagzi lime (*C. aurantifolia* Swingle). *J. Asian .Hort.*, 2 (3) : p.148 – 150.

Evaluation of Phytochemicals in Chekkurmanis (*Sauropus androgynus* L.) using High Performance Liquid Chromatography (HPLC)

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Keywords: *Phytochemicals, Chekkurmanis, HPLC*

Introduction

Chekkurmanis (***Sauropus androgynus* L**) popularly called "the multi-vitamin green" of the family Phyllanthaceae is a perennial shrub, native to India and Burma region. In view of its rich nutrient composition, this shrub can be explored for the development of health care food products, which can also help in the prevention of malnutrition / micronutrient deficiencies, which is seriously referred as to 'hidden hunger'. Chekkurmanis leaves, however, is reported to contain many alkaloids in considerable amount.

Nutritive evaluation has reported that an analysis of the proximate composition of *S. androgynus* leaves are superior to other commonly consumed leafy vegetables in India. Thus, the aim of the present study is to investigate the presence of phytochemical compounds in Chekkurmanis leaves at different position of the plant.

Methodology

The Leaves of Chekkurmanis collected from Chekkurmanis plants planted in Western Farms, Horticultural College and Research Institute, Periyakulam, Tamilnadu, from two different positions (*i.e.*) terminal and basal. The following study was conducted to detect the presence of phytochemical compounds (Phytol, Squalene, Kaempferol and Papaverine) in collected plant samples.

HPLC Analysis

The High-Performance Liquid Chromatography analysis was performed for the leaf samples using the HPLC (Shimadzu SPD-M10A vp (Kyoto, Japan) equipped with an LC-8A pump) available at Sugarcane Breeding Institute, Department of Entomology, Coimbatore, Tamilnadu. The separation was conducted on a Hypersil BDS C18 column with a C18 guard column.

Results and Discussion

External Standard Quantification

The external standard (ESTD) quantification procedure is the basic quantification procedure in which both calibration and unknown samples are analysed under the same conditions. The results (usually peak height or peak area measured using a data system) from the unknown sample are then related to those of a calibration sample, using a calibration graph to calculate the amount in the samples.

The HPLC analysis was successful in detecting the presence of phytocompounds and quantitatively analysing major components (Phytol, Squalene, Kaempferol and Papaverine) in leaf extracts of *Sauropus androgynus* and the terminal young leaves have been found to contain maximum phytocompounds compared to the basal matured leaves. This signal towards the potential of Chekkurmanis as a great source of nutrition and find place in the category of "Superfood". Further studies are needed to rule out use of phytocompounds present in *Sauropus androgynus* in development of pharmaceuticals, nutraceuticals, herbal and natural preparation that will help the mankind.

Table 1. The amount of analyte or phytocompound (µg) found in each of the sample

Sl.No.	Phytocompound (µg/ml)	Samples			
		HT_1T	HT_1B	ET_1T	ET_1B
1.	Phytol	0.1125202952	0.039360482	0	0.0676165453
2.	Squalene	0.7357031654	0.3334128305	0.0420068451	0.195978124
3.	Papaverine	0.0001572324	0.0003175807	0	0.0064780688
4.	Kaempferol	0.0007258557	0.0013078822	0	0.0157523502

Reference

Petrus A J A. 2013. *Sauropus androgynus* (L.) Merrill- A potentially nutritive functional leafy vegetable. *Asian J. Chem.*, 25 : 9425–9433.

Sankari A, Anand M and Arulmozhiyan R. 2012. Multivitamin greens- Chekkurmanis. *Rashtriya Krishi*, **7**(2):77-77.

Evaluation of Selected Veldt Grape Ecotypes for Anti-Nutritional Factor and Development of Cissus Based Tea

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Keywords: *Cissus quadrangularis, Oxalate, Herbal tea, nutraceuticals, infusions*

Introduction

Cissus quadrangularis is an underutilized vegetable crop known for its high nutritional value. The tender portion of the stem is usually used for culinary purposes and is identified as a potential nutraceutical. It is an excellent medicine to combat osteoporosis and other menstrual problems. It also has been used as an internal medication and external application for fracture in folklore medicines. Tea or herbal infusions have become an irreplaceable part of the daily diet for a population that is concerned about a healthy lifestyle as these are the major contributors for phenols and other antioxidants in today's diet. Thus, this experiment was conducted to evaluate *Cissus* ecotypes to estimate oxalate content and prepare tea from the ecotype with minimum anti-nutritional factor.

Methodology

Ten ecotypes were collected from different places in Tamil Nadu, Kerala and Karnataka.

Estimation of Oxalate content

0.25N HCl was added to one gm well ground sample and was kept in water bath for one hour followed by centrifuging to collect the supernatant. Phosphoric acid was added and supernatant was collected the next day which was then neutralized with ammonia solution (1:1). Acetate buffer was added to the supernatant to precipitate calcium oxalate. The precipitate was then washed in wash liquid (acetic acid in distilled water). The precipitate was then dissolved in hot H_2SO_4 and titrated against $KMnO_4$.

Preparation and evaluation of Cissus tea

Among the ecotypes, the one with least amount of oxalate content was selected for value addition. The tender portion from the vines were procured and was cleaned thoroughly to eliminate any dirt. It was then cut into small pieces of 10mm thickness, shade dried and ground into a coarse powder. This powder was then blended with tea dust in different ratio (10, 20, 30 and 40 per cent) to prepare tea bags of 1gm.

Organoleptic evaluation

The tea bags were brewed in hot water and was evaluated by a panel of twenty-five untrained judges. The consumer preference was evaluated for colour, appearance, odour, flavour and overall acceptability based on a nine-point hedonic scale ranging from like extremely to dislike extremely.

Biochemical estimation

Total phenolic contents in the tea samples were determined by Folin – Ciocalteau method. The total antioxidant activity was estimated using DPPH assay given by Lim *et al.* (2007). The hot water aliquots of each sample were pipetted out and made up to 1 ml using methanol. DPPH solution was added to the samples and incubated at room temperature in dark for 30 mins and the absorbance was measured at 517 nm using spectrophotometer.

Results and Discussion

Among the ecotypes, CBECQ 8 (1.30 mg/g) was found to have least oxalate content **(Figure 1)**. Thus, this sample was further used for the value addition experiment.

The tea infusions were organoleptically tested and the results confirmed that the treatment with 10% Cissus powder and 90% tea dust recorded the highest score for all the sensory attributes *i.e.*, appearance, odour, flavour, taste and overall acceptability (Table 1).

The phytochemical analysis revealed that the same treatment combination 10% Cissus powder and 90% tea recorded highest phenol content (6.57mg/g) and highest antioxidant activity (75.16mg AAE/g) (Figure 2).

Table 1. Score card for sensory evaluation of Cissus tea

Parameters	T1	T2	T3	T4
Appearance	8.80	7.80	7.50	7.30
Odour	8.50	7.80	7.00	6.50
Flavour	8.30	7.30	6.50	5.50
Taste	8.80	8.00	7.00	6.30
Overall acceptability	8.80	7.80	7.30	6.00

Fig 1. Oxalate content in different ecotypes

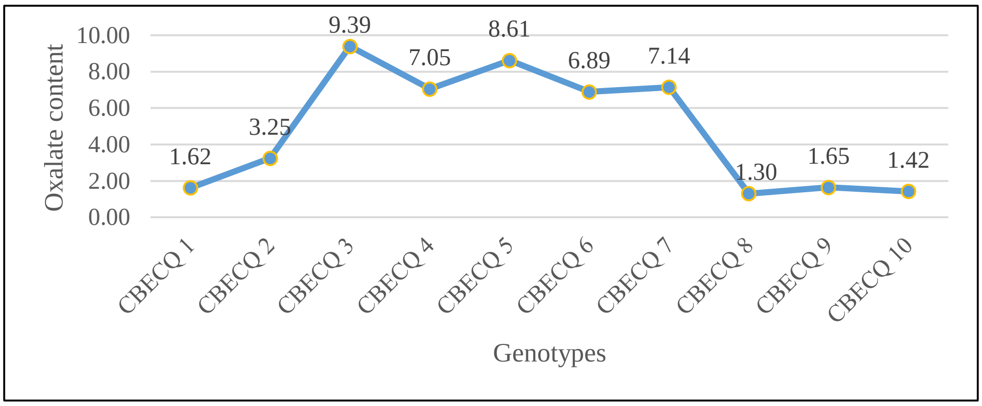
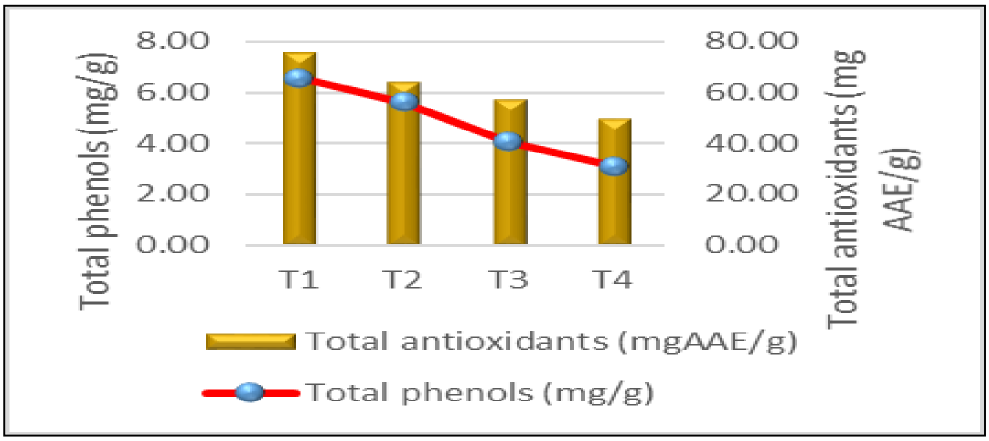


Fig 2. Biochemical content in different treatment combinations of Cissus tea



Reference

Lim, Y.Y., T.T. Lim, and J. J. Tee. 2007. "Antioxidant properties of several tropical fruits: A comparative study." *Food chemistry*, 103 (3):1003-1008.

Extension of Shelf Life of Minimally Processed Jack Fruit (*Artocarpus heterophyllus* Lam.) Bulbs through Postharvest Treatments

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Keywords: *Jackfruit, Minimal processing, Postharvest treatment, Quality, Shelf life*

Introduction

Jackfruit (*Artocarpus heterophyllus* Lam.) is one of the under-utilized tropical fruits, grown in both tropical and sub-tropical climates across the country. Ripened jackfruit has high nutritional properties. It is rich in sugars, pectin, minerals, ascorbic acid and carotenoids. Postharvest life of any fruits can be maximized by giving dipping pre- storage treatment. Postharvest treatment using ascorbic acid, calcium chloride and citric acid alone or in combinations were found to increase the shelf life and also improve the sensory quality of fruits. Use of chemical additives along with modified atmosphere packaging and low temperature storage conditions were found to be effective in maintaining quality, increasing the shelf life and also beneficial in reducing the microbial contamination of minimally processed produce (Cocci *et al*., 2006). In this context, the present study was carried out to study the effect of postharvest treatment on quality and shelf life of fresh cut jackfruit stored under refrigerated condition.

Methodology

The experiment was carried out at Department of Fruit Science, HC&RI, PKM during 2019-2021 with Jackfruit var. Palur 1. Harvested jackfruits were surface sanitized (100ppm chlorinated water) and cut off. Then the bulbs were separated from the rind and phytosanitation was done using 30ppm of chlorinated water. After that the jackfruit bulbs were treated with nine different combinations of ascorbic acid and calcium chloride for five minutes. Treatments were T_1- Ascorbic acid(0.5%), T_2-Ascorbic acid (1.0%), T_3- Calcium Chloride (0.5%), T_4- Calcium Chloride (1.0%), T_5- Ascorbic Acid(0.5%)+ Calcium Chloride (0.5%), T_6- Ascorbic Acid (0.5%)+ Calcium Chloride (1.0%), T_7- Ascorbic Acid (1.0%) + Calcium Chloride (0.5%), T_8- Ascorbic Acid(1.0%) + Calcium Chloride (1.0%), T_9- Control (Water dip) and sodium benzoate (0.045%) which is a common treatment that is used as an preservative. Then the bulbs were packed in polyethylene bag (25 m thickness). Packaged fruits were stored at Refrigerated condition. The experiment was carried out using completely randomized design (CRD) with three replications. Observations such as Physiological loss in weight, firmness(N), total soluble solids (◦B), total sugars (%), microbial count (CFU/g) and shelf life (days) were recorded.

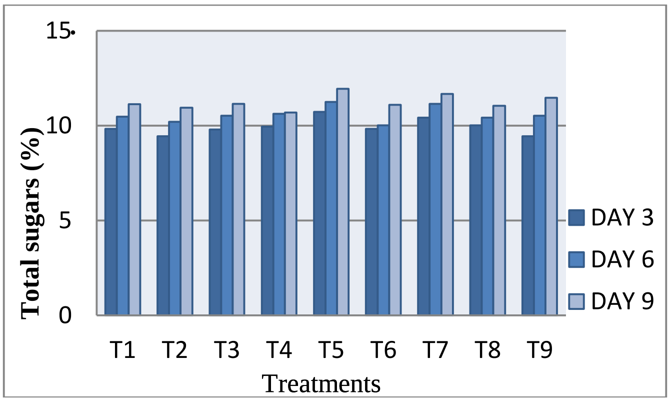
Results and Discussion

Jackfruit bulbs treated with ascorbic acid (0.5%) with calcium chloride (0.5%) showed better performance in terms of minimum PLW (4.38%) (Table 1), maximum retention of firmness (43.69N) , high TSS (24.58◦B) and total sugar content (11.95%) (Figure 1). Microbial analysis showed that the bacterial count was lower in T_5 [ascorbic acid (0.5%) + calcium chloride (0.5%)] treated samples having 1×10^4 CFU/g. Yeast and mould count was lower in bulbs treated with T_7 [ascorbic acid (1.0%) + calcium chloride (0.5%)] having 1×10^2CFU/g. Jackfruit bulbs treated with ascorbic acid (0.5% and 1.0%) along with calcium chloride (0.5% & 1.0%) recorded maximum shelf life of nine days whereas control has minimum shelf life of three days.

Table 1. Effect of Postharvest treatment on physiological loss in weight (%) of minimally processed jackfruit var. Palur 1

Treatments	Storage (days)		
	3*	6*	9*
T_1	2.02	3.85	5.46
T_2	2.67	4.72	6.35
T_3	2.36	4.33	6.30
T_4	2.36	4.49	7.25
T_5	1.25	2.71	4.38
T_6	1.26	2.93	4.60
T_7	1.47	3.14	4.60
T_8	1.60	3.72	5.18
T_9	3.35	6.65	9.57
SEd	0.045	0.102	0.173
CD (0.05)	0.095	0.213	0.367

Fig 1. Effect of Postharvest treatment on Total Sugars (%) of minimally processed jackfruit var. Palur 1



Reference

Cocci, E., P. Rocculi., S. Romani., M. Dalla Rosa. 2006. Changes in nutritional properties of minimally processed apples during storage. *Postharvest Biology and Technology* 39, 265–271.

Prathibha, S. C., K. R. Vasudeva., G. K. Sadananda., G. J. Suresha. 2019. Effect of pre-treatment and packaging on quality of fresh cut jackfruit (*Artocarpus heterophyllus*L.) bulbs. *International Journal of Chemical Studies*., 7(1): 1697-1700.

Chulaki, M. M., C.D. Pawar., S. M. Khan., A. M. Khan. 2017. Effect of ascorbic acid and calcium chloride on chemical properties of firm flesh jackfruit bulbs. *Journal of Pharmacognosy and Phytochemistry*., 6(5): 654-658.

Extraction of Flour and Starch and Recovery percentage of Tuber in Yethapur Tapioca -2

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Keywords: *Cassava starch, Flour, Pomace, Peel, Recovery, Physicochemical*

Introduction

Cassava (*Manihot esculenta Crantz.*) is popularly known as tapioca belonging to the family Euphorbiaceae and which it is originated in North – East Brazil. Tapioca plays a major role in food security in Africa continents. It is the third most important source of calories, after rice and maize. The starchy tuberous roots of cassava provides more than half of the calories consumed by more than 800 million people in Sub-Saharan Africa (SSA), Latin America and Asia. Cassava starch is one of the main ingredient in formulated food system functioning work as a thickening agent, gelling agent, texture modifier and shelf stability in varied applications.

Methodology

The experiment was conducted at the field laboratory of Department of Vegetable Science, Horticultural College and Research Institute, TNAU, Coimbatore. Cassava starch and flour extraction was done in the variety of Yethapur Tapioca -2. The pH was determined with the aid of pH meter. Acidity was determined by the method of AOAC. Moisture content was determined according to (Benesi, 2005) with modifications. 1.50 g of sample was dried in a forced air oven for 3 h at 105°C.

Cassava flour preparation

About 1.5kg of tubers were washed, peeled and cut into small slices and soaked in 0.3% Sodium Metabisulphite solution for 5 minutes Fahir *et al*.(2012). The soaking solution was drained out and the thin slices were dried in hot air oven at 60°C for 10 hours and grounded into flour.

Starch extraction

Cassava starch was extracted following the method of Benesi *et al.* (2004). About 5.0 kg of Cassava roots were peeled, washed and chopped into thin slice and then pulverized in a blender for 2 min. The homogenate paste was mixed with water in the ratio 1:5 (w/v %) and kept it for overnight. The white starch sediments were dried in a hot air oven at 60°C for 2 h, grounded in blender followed by sieving through100 U.S mesh. The extracted waste was dried in an oven and grounded into powder form which it is called pomace.

Results and Discussion

Recovery of flour, starch, pomace and peel

Among the extraction of starch and flour, the flour yield was recorded at 917g out of 1.5kg. From 5.25kg of tuber, the starch recovery recorded was 630.5g, Pomace powder and peel recovery yield of 461.2g, 184.5g were obtained respectively (Table 1).

Physico - chemical parameters of YTP-2 Cassava

Among the samples, the pH value was greater in flour (6.3), pomace (6.1) and peel (6) than in the starch (5.9). The Moisture content of sample varied significantly with greater magnitude in starch (12.6%) than peel (10.2%) followed by pomace (9.33%) and flour (4.66%). The acidity content of the sample was increased in flour (0.89%) followed by pomace (0.61%), peel (0.42%) and starch (0.4%) (Table 1). This similar observation and extraction methods were done in a research study by Tharise *et al*. (2014). The physicochemical characters and recovery per cent of starch is presented in figure 1 and 2.

Table 1. Recovery, pH, Acidity and Moisture content of cassava variety YTP-2

Sample	Recovery (g/kg)	pH	Acidity (%)	Moisture content (%)
Flour	917	6.3	0.89	4.66
Starch	630.5	5.9	0.4	12.65
Pomace	461.2	6.1	0.61	9.33
Peel	184.5	6	0.42	10.2
Mean	548.3	6.075	0.58	9.21
SED	16.121	0.16	0.019	0.225
CD @ 5%	34.17	0.34	0.04	0.541
CV%	4.64	4.18	4.32	4.38

Fig 1. Physicochemical parameters of YTP-2

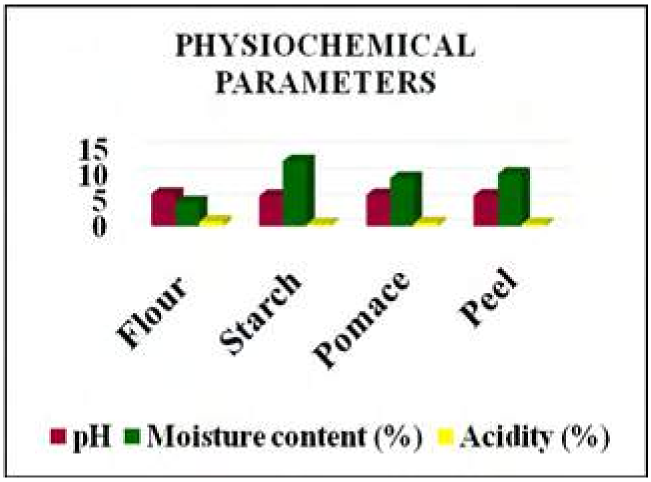
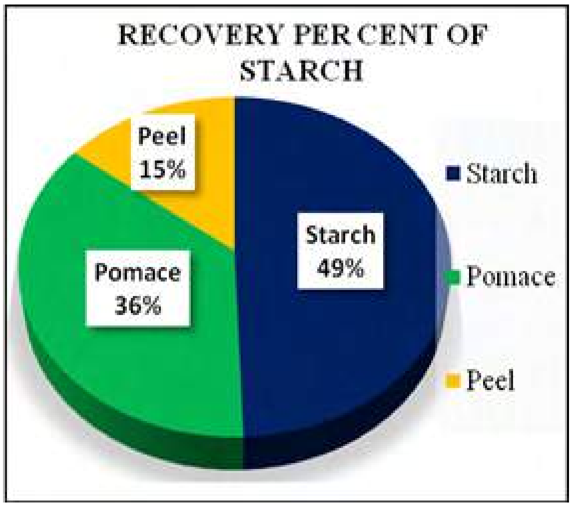


Fig 2. Recovery per cent of YTP-2 Starch



Reference

Benesi, Ibrahim RM, Maryke T. Labuschagne, Alfred GO Dixon, and Nzola M. Mahungu. "Stability of native starch quality parameters, starch extraction and root dry matter of cassava genotypes in different environments." *Journal of the Science of Food and Agriculture* 84, no. 11 (2004): 1381-1388.

Benesi, Ibrahim RobeniMatete. "Characterisation of Malawian cassava germplasm for diversity, starch extraction and its native and modified properties." PhD diss., University of the Free State, 2005.

Fakir, M. S. A., M. Jannat, M. G. Mostafa, and H. Seal. "Starch and flour extraction and nutrient composition of tuber in seven cassava accessions." *Journal of the Bangladesh Agricultural University* 10, no. 2 (2012): 217-222

Tharise, N., E. Julianti, and M. Nurminah. "Evaluation of physico-chemical and functional properties of composite flour from cassava, rice, potato, soybean and xanthan gum as alternative of wheat flour." *International Food Research Journal* 21, no. 4 (2014): 1641.

Flower Induction in Chrysanthemum (*Dendranthema grandiflora* Tzvelev) is Unique Modification of Light Emitting Diodes: White versus Blue, Red and Far-Red Radiation

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Keywords: *Cut Chrysanthemum, light emitting diodes, flower induction, PPF, LI, LTR*

Introduction

Chrysanthemum (*Dendranthema grandiflora* Tzvelev), a critical short-day plant is the third most important cut flower in the international trade that requires a long night for flowering. Under greenhouses, the day length can be altered by the installation of supplemental lighting systems, so that the plants will attain the standard quality and also ensures off-season availability of flowers. Hence, the above study was conducted to understand the effects of modified LEDs on flower induction of chrysanthemum cv Pusa Centenary.

Methodology

A field study was carried out in the aerodynamic polyhouse located at the Department of Floriculture and Landscape Architecture, during the period 2019-20. The experiment was laid in Randomized Block Design with three replications. Different wavelengths composed of white (W), Blue (B), Red (R), and Far-red (FR) light-emitting diodes at 4hr each exposed with white (1900 lumens); R (41 µmol/J); BFr (37 µmol/J); RB (43 µmol/J); RFr (41 µmol/J); RBFr (43 µmol/J) and control with HPS lamp for 4hr (725 µmol/s or J) were irradiated to the plants. The treatments comprised of L_1- 100% White (380 to 740 nm); L_2- 100% Red (625 to 700 nm); L_3- 80% Red+ 20% Blue; L_4 – 80% Red + 20% Far-red (700 to 850 nm); L_5- 75% Blue + 25% Far-red (445 to 850 nm); L_6 – 60% Red + 20% Blue + 20% Far-red (445 to 850 nm); L_7 – Sodium vapour lamp (check). The cultural operations were followed as per the recommendation from the TNAU Horticultural Crop Production Guide (2020). Nine plants in each treatment were selected at random and tagged for observations on different traits. Experimental data is statistically analyzed as suggested by Panse and Sukhatme (2000). The critical differences were worked out for 5 % (0.05) and 1 % (0.01) probability. The treatment differences that were not significant were denoted by "NS".

Results and Discussion

Influence of light emitting diodes on flower induction

Internodal length of the varieties studied was also the highest in mixed lights emitting Blue wavelength in Pusa Centenary under 4-hour extended durations. Acceleration in flowering is observed in many flower crops under low R: Fr ratios. Several traits involved in photosynthesis are regulated by phyB and R and FR lights. The earliness in flower bud emergence (50 days in Pusa Centenary) was observed in 75% Blue + 25% Far-red at 445 nm to 850nm spectral irradiance (L5) followed by L3 (R80B20) (Table 1, Fig. 1 & Fig. 2). The result has implied the negative effects of B and BFr on the growth and photosynthesis of chrysanthemum and this might be due to the inhibitory effect of blue light on stalk growth. The findings are concomitant with Kim *et al.* (2004). Mortensen and Stromme (1987) also observed inhibition of stalk growth under blue irradiance in many greenhouses horticultural crops. Total cut stem yield per square meter (42.65 and 41.99) was the highest in 80%R:20%B than other spectral ranges Pusa Centenary varieties. Pusa Centenary plants which received 80%R: 20% B intensity had intercepted about 17.115 per cent of the light incident on the canopy surface followed by sodium vapour lamp (16.244 % interception).

Table 1. Effect of LEDs on flower induction in chrysanthemum cv Pusa Centenary

Light irradiance (L)	Internodal length (upto 3rd leaf) (cm²)	Specific Leaf area (cm²/g)	Days to first flower bud appearance	Days to first harvest	Number of flower buds	Total cut stem yield/m²
L1	1.00	43.65	70.22	135.01	13.56	41.38
L2	0.95	68.94	67.22	148.93	12.84	34.12
L3	0.87	32.87	64.11	136.32	15.54	41.99
L4	1.39	56.15	68.22	155.68	13.44	36.09
L5	1.11	38.53	50.00	80.56	8.12	40.33
L6	1.08	39.17	75.78	140.99	21.22	40.17
L7	0.83	77.09	72.44	139.87	12.22	40.56
Mean	1.03	50.91	66.86	133.91	13.85	39.23
S.Em	0.2081	4.8879	2.2485	0.3762	0.7775	0.0450
S.ED	0.2943	6.9126	3.1798	0.5320	1.0996	0.0636
CD (p=0.05)	0.6413	15.0612	6.9282	1.1591	2.3958	0.1387
CD (p=0.01)	0.8991	21.1148	9.7128	1.6249	3.3587	0.1944

Fig 1: Effect of LED on PPF ($\mu molm^{-2}s^{-1}$) at above and intercanopy level

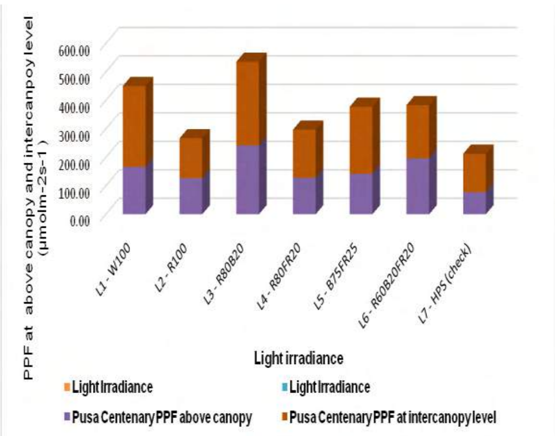
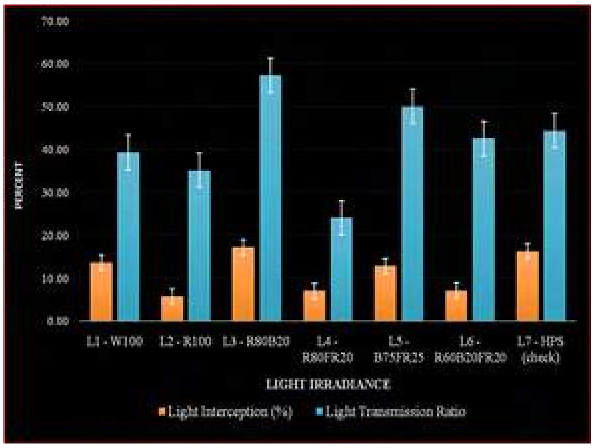


Fig2. Effect of LED on on LI (%) and LTR



Reference

Kim, S.J., E.J. Hahn, J.W. Heo and K.Y. Paek. 2004. Effects of LEDs on net photosynthetic rate, growth and leaf stomata of chrysanthemum plantlets *in vitro*. ***Scientia Horticulturae***, 101(1-2): 143-51.

Mortensen, L. and E. Stromme. 1987. Effects of light quality on some greenhouse crops. ***Scientia Horticulture***, 33: 27–36.

Panse, V. G. and P. V. Sukhatme. 2000. Statistical methods for Agricultural Workers. ICAR. New Delhi.

Intervention of Plant Geometry and Harvesting Heights on Growth and Leaf Yield Parameters in Moringa (*Moringa oleifera* Lam)

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Keywords: *Moringa, plant geometry, harvesting heights, leaf yield*

Introduction

Moringa (*Moringa oleifera*) is a deciduous perennial tree comes under monogeneric family Moringaceae. Moringa is the good source of calcium, phosphorous, iron. Leaves are rich in protein (27%), vitamins, potassium, calcium, iron, phosphorous, beta carotene and natural antioxidants. (El Sohaimy *et al.,* 2015). Moringa control malnutrition in India and other developing nations. Moringa leaves are gaining popularity among growers now a days due to the huge nutritional properties in the leaves. Denser population system increase the productivity of leaves. Harvesting height plays a major role in mechanization of harvest. Therefore, optimum harvesting height should be standardized.

Methodology

Treatment combination consists of four crop geometries *viz.,* 1.50m x 0.25m (S_1), 1.50m x 0.50m (S_2), 1.50m x 0.25m x 0.25m (S_3), 1.50m x 0.50m x 0.50m (S_4) and three harvesting heights of 30 cm (T_1), 45 cm (T_2) and 60 cm (T_3). Study laid out in Split plot design with three replications. Fifteen plants were randomly tagged in each plot and observations such as the plant height, number of primary branches, number of compound leaves, stem girth. Harvesting was carried out in 90 days. Leaves are harvested from each treatment combination and the fresh leaf weight is recorded for all treatment combinations. Fresh leaves were dried using solar drier and dry leaf yield was recorded.

Results and Discussion

Growth Parameters

Among the various spacing; S_3 (1.50 m x 0.25 m x 0.25 m) recorded significantly higher plant height (Table 1). Increased plant height might be due to the competition for light in the closest spacing and etiolation character of plants. This was in concordance with Bagri *et al.,* (2018). The spacing 1.50 m x 0.25 m x 0.25 m exhibits significantly more number of compound leaves due to dense population followed by 1.50 m x 0.50 m x 0.50 m while least number was observed in the spacing 1.5 m x 0.5 m. The spacing S_2 (1.50 m x 0.50 m) shown maximum primary branches (4.09) significantly followed by S_4. Stem girth is significantly higher in the wider spacing 1.5m x 0.50m while the closest spacing has the lower stem girth. There exists no significance in cutting heights.

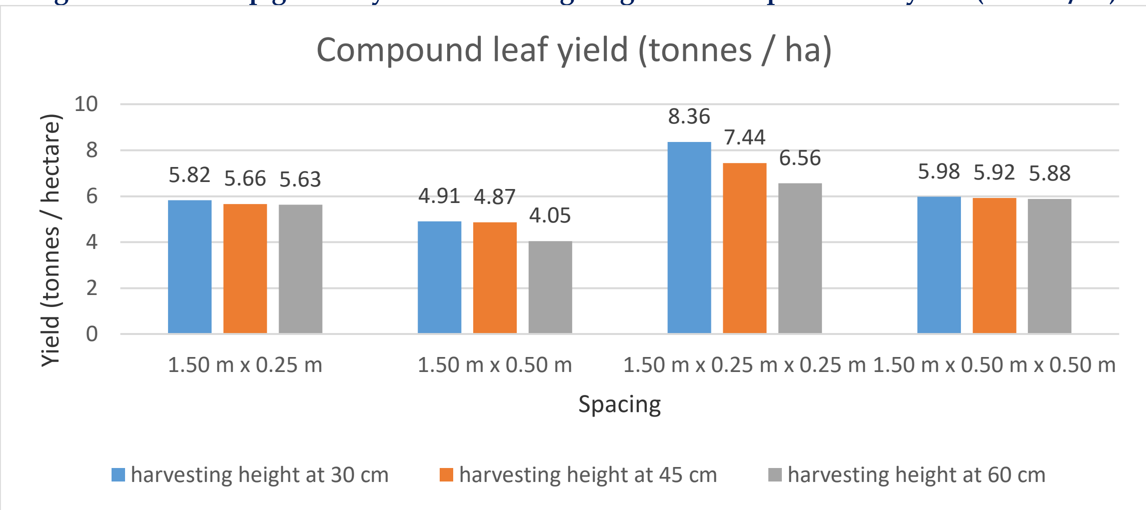
Yield Parameters

The yield of compound leaves per hectare was significantly higher (7.45 tonnes/ha) in the closer spacing (1.50 m x 0.25 m x 0.25 m) followed by spacing 1.5 m x 0.50 m x 0.50 m (S_4). Leaflets weight is significantly greater in S_3 while least in S_4. Adegun and Ayodele (2015) stated that the yield was greater in the closest spacing of 30cm x 40cm than wider spacing 100cm x 100cm. Harvesting at 30cm above the ground level is significantly higher than other heights. Spacing S_3 (0.86 tonnes/ha) has the maximum dry leaf yield followed by S_4 which is on par with S_1. Wider spacing (1.50 m x 0.50 m) accommodates less number of plants and gave low yield which results in minimum dry leaf yield.

Table 1. Effect of harvesting heights and plant densities on Plant height (cm), Number of Compound leaves, Number of Primary branches and Stem Girth

Growth parameters				
Treatment	Plant height (cm)	Compound leaves	Number of primary branches	Stem girth (cm)
Spacing				
S_1	150.02	25.92	2.97	6.55
S_2	143.14	24.41	4.09	7.39
S_3	151.59	29.19	2.63	5.96
S_4	145.05	27.48	3.81	6.85
SEd	**2.12**	**1.06**	**0.32**	**0.29**
CD (P=0.05)	**5.20**	**2.61**	**0.79**	**0.70**
Heights				
T_1	147.95	27.26	3.48	6.59
T_2	146.96	26.69	3.40	6.85
T_3	147.45	26.30	3.25	6.63
SEd	**1.68**	**0.96**	**0.13**	**0.21**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**

Fig 1. Effect of crop geometry and harvesting heights on compound leaf yield (tonnes /ha)



Reference

B Adegun, MK. Ayodele, OJ. 2015. Growth and yield of *Moringa oleifera* as influenced by spacing and organic manures in South-Western Nigeria. Int J Agron Agric Res. 6:30-37.

Bagri, S. Singh, J. Bhatnagar, P. Khatik, G. Meena, SKJKK. 2018. Effect of Date of Transplanting and Crop Geometry on Growth and Physiological Attributes of Cape gooseberry (*Physalis peruviana* L.). Int J Curr Microbiol App Sci. 7(10):3203-3206.

Morphological Characterization of Different Chilli Species for Quantitative and Qualitative Characters

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Keywords: *Chilli species, Morphological, Qualitative, Quantitative character*

Introduction

Chilli (*Capsicum spp.)* is one of the most important vegetable crops belonging to the family Solanaceae and it is domesticated since 7000 BC. The genus *Capsicum* is a diverse plant group which contains approximately 30 species, among them *Capsicum annuum* L., *Capsicum frutescens, Capsicum chinense, Capsicum pubescens* and *Capsicum baccatum* are cultivated in different regions of the world. Morphological characterization of chilli is one of the important tools in breeding programs for identification of *Capsicum* species which can be directly employed to develop newer varieties and hybrids with desirable traits and their specific characters. Hence, this study was undertaken to determine the distinctiveness, uniformity and stability (DUS) of different chilli species.

Methodology

An experiment was conducted in the College Orchard, Department of Vegetable Science, HC & RI, TNAU, Coimbatore during the period 2020-2021 to assess the morphological characters of fourteen chilli genotypes. The genotypes consisted of 14 accessions belonging to different species of *Capsicum* viz., CA-CBE-199, CA-CBE-200, CA-CBE-201, CA-CBE-202, CF-CBE-004, CF-CBE-005, CF-CBE-006, CF-CBE-007, CC-CBE-016, CC-CBE-001, CC-CBE-002, CC-CBE-003, CC-CBE-004, CC-CBE-005. The study was conducted in a randomized block design (RBD) with two replications of twenty plants per replication. The genotypes were evaluated for 18 parameters including fourteen qualitative and four quantitative characters. The qualitative traits were selected from plant descriptors developed by the IPGRI for *Capsicum* spp. The quantitative traits (listed in Table 1(b)) were studied according to the standard procedure of recording data in chilli crop. Mean values were used for comparison.

Results and Discussion

Evaluation of the different genotypes for qualitative and quantitative characters showed that among the different traits studied the following qualitative characters stem shape and plant growth habit were similar in all the species (Table 1) and the remaining 12 traits showed variation (Table 2). The high diversity in the genotypes shows a great potential for improvement of agronomic traits and future breeding in chilli. Thus, biochemical and molecular characterizations plays a significant role in classification of chilli genotypes for any improvement programs.

Fig 1. Leaf length and leaf width of chilli accessions

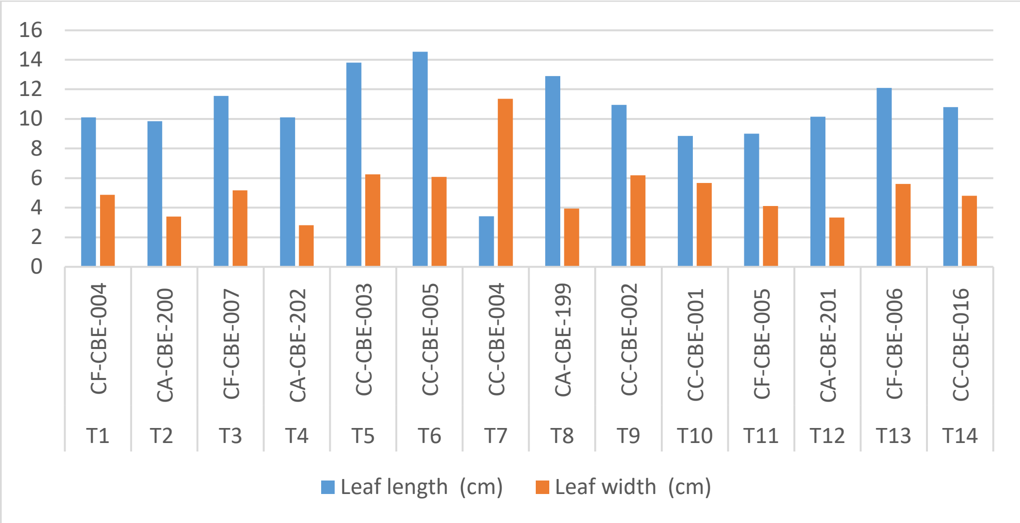
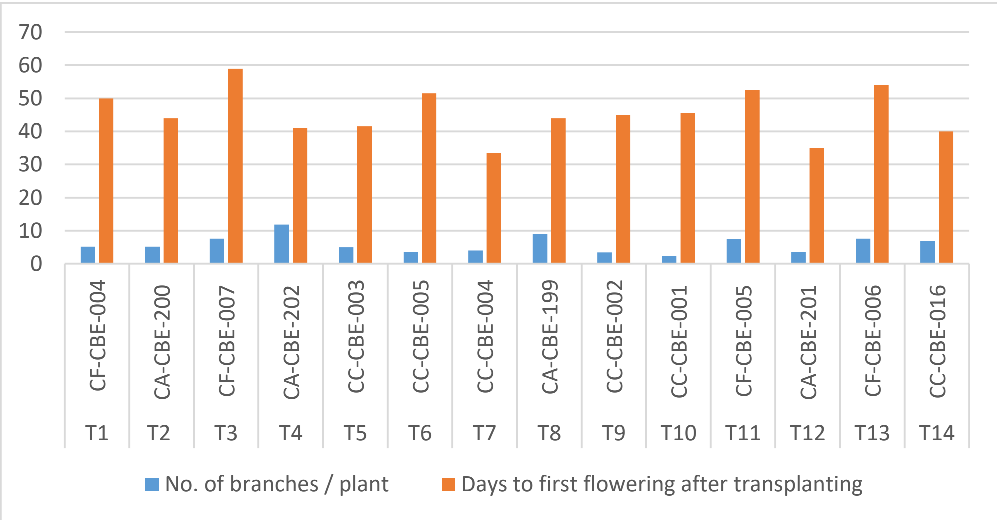


Fig 2. No. of branches/ plant and days to first flowering of chilli accessions



Reference

Orobiyi . L. Y. Loko . F. Sanoussi . A. P. Agre´ .N. Korie . A. Gbaguidi . A. Adjatin . C. Agbangla .A. Dansi (2017) Agro-morphological characterization of chili pepper landraces (Capsicum annuum L.) cultivated in Northern Benin ***Genet Resour Crop Evol***.

Waleed Quresh, Mukhtar Alam, Hidayat Ullah, Shakeel Ahmad Jatoi and Wasif Ullah Khan (2015) Evaluation and characterization of Chilli (*Capsicum annuum* L.) germplasm for some morphological and yield characters ***Pure Appl. Biol.****, 4(4): 628-635*.

Nelly Judith Paredes Andrade , Alvaro Monteros-Altamirano, Cesar Guillermo Tapia Bastidas and Marten Sørensen (2020) Morphological, Sensorial and Chemical Characterization of Chilli Peppers (Capsicum spp.) from the CATIE Genebank ***Agronomy***.

Performance of Okra (*Abelmoschus esculentus* L.) Hybrids for Yield and its Related Traits in Okra

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Keywords: *Okra, Yield, Hybrids*

Introduction

Okra (*Abelmoschus esculentus (L.) Moench*) is an important vegetable crop cultivated throughout India. It belongs to the family Malvaceae and has a chromosome number of 2n=130. Bhendi is allopolyploid in nature (Joshi and Hardas, 1956). In India it is cultivated in an area of 0.51 million ha, with an annual production of 6.17 million tonnes (Anonymous 2019). Keeping this in view the study aims to evaluate the hybrids of okra for enhanced production.

Methodology

Nine hybrids along with one check Bhendi hybrid CO4 were evaluated in randomized block design (RBD) with three replications during summer season under Tamil Nadu Agricultural University, Coimbatore in the year 2021. The hybrids were evaluated and the data were recorded for different traits *viz.*, plant height (cm), fruit length (cm), fruit diameter (cm), yield per plant(g) for five randomly selected plants in each replication.

Results and Discussion

Data recorded were analysed statistically and depicted in Table 1. The result revealed that there is ample variability is present in these hybrids (Rambabu *et al.*, 2019). Data on plant height was recorded highest in the hybrid AE-CBE-92×AE-CBE-921 (166.81cm) while the lowest was noticed in the cross AE-CBE-943×AE-CBE-921 (140.42 cm). With regard to fruit length (19.19 cm), fruit diameter (7.53 cm), fruit weight (39.28 g) and fruit yield per plant (1043.96) maximum value was observed in the hybrid AE-CBE-92×AE-CBE-921, which was followed by the hybrids AE-CBE-943×AE-CBE-93. Considering the above facts, the hybrids i.e., AE-CBE-92×AE-CBE-921, AE-CBE-943×AE-CBE-93 can be exploited commercially for high yield potential.

Reference

Anonymous, (2019). Indian Horticulture Database. *National Horticulture Board, Ministry of Agriculture, Government of India*, Gurgaon.

Joshi, A. B., and M. W. Hardas. "Alloploid Nature of Okra, Abelmoschus esculentus (L.) Monech." *Nature* 178, no. 4543 (1956): 1190-1190.

Rambabu, B., D. P. Waskar, and V. S. Khandare. "Genetic Variability, Heritability and Genetic Advance in Okra." *Int. J Pure App. Biosci* 7, no. 1 (2019): 374-382.

Table 1. Assessment of Quantitative traits in Okra

S.No	Characters	Plant height (cm)	Fruit length (cm)	Fruit diameter (cm)	Yield per plant (g)
1.	AE-CBE-92×AE-CBE-93	146.28	13.92	6.83	837.76
2.	AE-CBE-92×AE-CBE-921	166.81	19.19	7.53	1043.96
3.	AE-CBE-92×AE-CBE-934	151.11	15.07	6.97	894.92
4.	AE-CBE-94×AE-CBE-93	160.40	18.27	7.32	951.08
5.	AE-CBE-94×AE-CBE-921	158.76	18.20	7.29	924.64
6.	AE-CBE-94×AE-CBE-934	163.39	18.45	7.39	962.14
7.	AE-CBE-943×AE-CBE-93	166.05	18.75	6.93	1009.45
8.	AE-CBE-943×AE-CBE-921	140.42	13.41	6.45	810.05
9.	AE-CBE-943×AE-CBE-934	153.44	16.83	6.98	924.48
10.	COBH-4	149.96	16.08	6.73	884.43
	CD 5%	5.9	1.5	0.48	9.71
	SE	2.04	0.52	0.17	5.5
	CV%	2.26	5.41	4.25	1.91

Response of Combined Application of Organic and Inorganic Fertilizers on Growth and Yield of Turmeric (*Curcuma longa* L.)

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Keywords: *Organic, Inorganic and fertilizers*

Introduction

Turmeric (*Curcuma longa* L.) is known as gold of spices. It is used as colouring of food and also known as Indian Saffron. As turmeric is heavy feeder and needs more application of nutrient for growth and development of rhizomes. Use of chemical fertilizers gives higher yield turmeric but which leads to deterioration of soil health. Hence, combined application of organic and inorganic fertilizers is inclination towards traditional farming with minimum usage of fertilizers.

Methodology

The experiment was conducted at Herbal Garden, UAS, Raichur, Karnataka, India, during 2016-2017. The cultivar Salem was used as planting material. The randomized block design was used with eight treatments. The treatment includes 100% RDF + FYM (T_1) as control, 75% RDN + 25% nitrogen through neemcake (T_2), 75% RDN + 25% nitrogen through vermicompost (T_3), 75% RDN + 25% nitrogen through pongamia cake(T_4), 50% RDN + 50% nitrogen through neemcake (T_5), 50% RDN + 50% nitrogen through vermicompost (T_6), 50% RDN + 50% nitrogen through pongamia cake (T_7) and 50% RDN + 2% urea as foliar spay (T_8).

Results and Discussion

The result of the experiment revealed that, combined application of organic and inorganic fertilizers on growth and yield of turmeric which found to be significant variation among the treatments. The growth parameters like plant height (136.90 cm), number of leaves (37.84), number of tillers (6.44), LAI (4.54) was found to be significantly higher with the application of 50% RDN + 50% nitrogen through pongamia cake (T_7). The higher rhizome yield (43.94 t ha^{-1}) was also found in T_7 among all the treatments. On the contrary resulted significantly lower rhizome yield (25.55 t ha^{-1}). However, treatment T_2 also resulted as succeeding treatment to T_7. The increment in the growth as well as yield of turmeric was due to integrated use of organic and inorganic fertilizers. Application of RDN through varied combinations of inorganic and organic sources such as neemcake, pongamia cake and vermicompost resulted higher rhizome yield and also leads to sustained availability of nitrogen throughout the growing phase. (Modupeola, and Olaniyi., 2015 & Singh, 2015).

Reference

Modupeola, T. O. and Olaniyi, J. O., 2015, Effects of nitrogen (N) fertilizer and plant spacing on the growth and rhizome yield of turmeric (*Curcuma Longa* L.) in Ibadan South-West Nigeria. *Int. J. Plant Sci. and Eco*., 1(4): 149-154.

Singh, S. P., 2015, Nutrient supplementation through organic manures for growth and yield of ginger (*Zingiber officinale* Rose.). *Journal of Eco-friendly Agriculture*., 10(1): 28-31.

Table 1. Effect of combined application of organic and inorganic fertilizers on growth and yield of turmeric at harvest.

Treatments	Plant height (cm)	No. of leaves	No. of tillers	LAI	Fresh Rhizome Yield (t ha^{-1})
T_1	118.32	28.93	5.21	4.08	25.55
T_2	129.44	35.28	6.44	3.86	41.41
T_3	121.45	30.80	6.31	3.74	32.87
T_4	127.09	33.88	6.44	3.93	40.76
T_5	119.85	31.68	6.36	3.79	37.44
T_6	120.85	29.12	5.63	3.98	27.73
T_7	136.90	37.84	6.44	4.54	43.94
T_8	121.97	30.69	5.93	3.98	27.8
Mean	125.81	32.27	6.09	3.99	34.7
S.Em ±	3.66	1.85	0.20	0.34	2.47
CD @ 5%	12.02	5.60	0.60	0.79	7.5

Standardization of Suitable Intercrops for Broccoli [*Brassica oleraceae* L. *var. italica*] Based Cropping System

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Keywords: *Broccoli, Intercropping, Garden pea, Multiplier onion, Coriander, Turnip and Fenugreek*

Introduction

Broccoli (*Brassica oleracea* L. var. *italica*) is a member of the Brassicaceae family, which is located near the Mediterranean region (Decoteau, 2000). Broccoli is a rich source of sulforaphane, which has been shown to display potent ant carcinogenic properties. Intercropping is regarded beneficial in terms of saving on tillage, the economy of space, performance of nutrients, and moisture in additional space. Intercropping applies to the growing of two or more different crops, concurrently on the same piece of land. There will be an intercrop competition during all stages of growth. Different intercropping combinations may be found in different agro-climatic zones available in India. The pleasant farmers generally prefer the intercropping system because it produces a higher total crop yield per unit area, provides insurance against total crop failure, and also reduces incidences of pests and diseases.

Methodology

The present Experiment was conducted in Randomized Block Design (RBD) with 11 treatments of Broccoli intercropping with different vegetables, with three replications in the Research field of Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during October, 2019 to March, 2020. Total number of treatments were eleven *viz.* T_1 (Sole Broccoli), T_2 (Sole Garden Pea), T_3 (Sole Multiplier Onion), T_4 (Sole Coriander), T_5 (Sole Turnip), T_6 (Sole Fenugreek), T_7 (Broccoli + Garden Pea), T_8 (Broccoli + Multiplier onion), T_9 (Broccoli + Coriander), T_{10} (Broccoli + Turnip) and T_{11} (Broccoli + Fenugreek), Variety, Broccoli-Saki, Garden pea-Rachna, Multiplier onion-Co 5, Coriander-Kashmeeri, Turnip-Purple top white globe and Fenugreek-Azad - 1were used.

Results and Discussion

The results of the experiment are summarized below.

Broccoli

In terms of plant height and plant spread, treatment Sole Broccoli recorded maximum (17.59, 41.63 and 55.92 cm) Plant Height at 30, 60 and at harvest days respectively and plant spread, maximum (28.39, 43.49 and 64.32 cm) plant spread at 30, 60 and at harvest days respectively. Similar findings previously also reported by Yadav *et. al.*, (2017) and Kaur and Sharma (2018). In terms of curd edible maturity, treatments, Broccoli + Multiplier onion recorded minimum (19.79 days) and Sole Broccoli recorded minimum 57.38 days for curd initiation, 79.70 days for curd harvesting. In terms of curd diameter and curd weight, Sole Broccoli recorded maximum (23.14 cm) and (474.76 g) respectively. In curd yield per plot and per hectare, Sole Broccoli recorded maximum (7.11 kg) yield per plot, and (97.52 q)/ha. Similar findings previously also reported by Demir and Polat (2011) and Kaur and Sharma (2018).

Garden Pea

In terms of Plant height and no. of leaves per plant, Sole Garden pea recorded maximum (17.53, 61.50 and 71.67 cm) plant height. Sole Garden pea also recorded maximum (2.48) branch/plant, (15.32 pods/plant) and (3.92 g) average pod weight. In yield parameter of garden pea, maximum (60.00 g) pod yield/plant, (5.09 kg)/plot and (63.81 q)/hectare was recorded in Sole Garden pea. Similar findings previously also reported by

Ved *et.al.,* (2007) in pea and Kaur and Sharma (2018) in Broccoli.

Multiplier Onion

In terms of plant height, Sole Multiplier onion recorded maximum (10.52, 19.40, 32.94 and 40.27 cm) at 30, 60, and 90 and at harvest days and for the polar diameter and (28.01 g) Bulb yield/plant, maximum Bulb yield per plot (3.23 kg) and per hectare (42.09 q/ha) respectively was recorded in Sole Multiplier onion. Similar findings previously also reported by Kaur and Sharma (2018) and Yildirum E and Cil, B (2020) in onion.

Coriander

Sole Coriander recorded maximum (10.87 and 21.64 cm) Plant height after 30 and at harvest days of planting and (7.60 leaves/plant), (235.85 g) avg. weight of plant/m^2, (1.71 kg) leaf yield/plot and (23.5 q) leaf yield/ha. Similar findings previously also reported by Kaur and Sharma (2018) and Varghese *et.al (*2013).

Turnip

In terms of plant height (33.18cm) and no. of leaves (46.90), Broccoli + Turnip recorded maximum (33.18 and 46.90 cm) and Sole Turnip recorded maximum (26.47 cm) leaf length, (14.60 cm) leaf width and (13.20 cm) Root length (11.48 cm). In terms of yield, Sole Turnip recorded maximum (162.94 g) Avg. weight of fresh root, (16.38 kg) Root yield/plot and (224.65 q) Root yield/ha, and minimum Avg. weight of root (124.90 g), Root yield (6.37 kg)/plot and (87.37 q)/ha was recorded in Broccoli + Turnip. Similar findings previously also reported by Qasim et.al (2013) and Kaur and Sharma (2018).

Fenugreek:

Sole Fenugreek recorded maximum Plant height (11.63 and 15.20 cm) and Number of leaves (12.82 and 24.58 leaves/plant) at 30 and at harvesting days and the maximum leaf yield per plot (2.61 kg) and leaf yield per hectare (35.80 q)/ha. Broccoli + Fenugreek recorded maximum (1.20 and 2.99) branches/plant after 30 and at harvest days. Similar findings previously also reported by Varghese *et.al (*2013).

From the present investigation it is concluded that treatment T_1 (Sole Broccoli) give best results among all intercropped broccoli in terms of Growth and yield character followed by Treatment T_8 (Broccoli + Multiplier onion) and minimum growth and yield was recorded in treatment T_{11} (Broccoli + Fenugreek). Hence suitable intercrops with Broccoli treatment, sole cropping of broccoli produced the maximum growth and yield among the other treatments.

Reference

Kaur, G., and Sharma, M. (2018) Effect of nitrogen doses and inter crops on growth and yield of broccoli (*Brassica oleracea* L. var. *italica), Indian journal of agricultural research,* 52(5): 566-570.

Varghese,L.T. ; Umale,S.B. ; Kawthalkar, M. P(1990) Effect of intercrops on the growth and yield of cabbage , *South Indian Horticulture Vol.38 No.4,196-198*

Yadav, L. P., Singh, A., and Malhotra, S.K., (2016) Growth, yield and quality response of organic broccoli to intercrops and crop geometry, *Indian journal of Horticulture,* 73(3): 376-382.

Yadav L P, Malhotra S K and Singh A (2017) Effect of intercropping crop geometry and organic manures on growth and yield of broccoli (*Brassica oleracea var. italica*), *Indian Journal of Agricultural Sciences,* 87:318-24.

Yildirim E and Guvenc I (2005) Intercropping based on cauliflower: more productive, profitable and highly sustainable. *European Journal of Agronomy,* 22:11-18.

Yildirim E , Cil, B. ; Ekinci, M. ; Turan, M. ; Dursun, A. ; Gunes, A. ; Kul, R. ; Kitir, N (2020) Effects of intercropping system and nitrogen fertilization on land equivalent ratio, yield and mineral content of broccoli.. Acta Scientiarum Polonorum - Hortorum Cultus 2020 Vol.19 No.3 pp.101-109 ref.33.

Studies on Different Months of softwood grafting in Wood Apple (*Feronia limonia* L.) var.PKM 1

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Keywords: *Wood Apple, grafting, months*

Introduction

Wood apple (*Feronia limonia*) synonym (*Limonia acidissima*) belongs to the Rutaceae family. In India, wood apple has many dialectal names like elephant apple, monkey fruit, curd fruit, and Katha bel. Wood apple is a native of India and Srilankan dry plains. It is a very hardy tree grown all over the arid and semi-arid plains of northern, central, eastern and southern regions of India (Angadi *et al*., 2011). The easy and simplest method of wood apple propagation is the raising of seedlings from seeds, the major problem of seeds does not show the true to type character, it will lead to immense variation in fruit character and yield. The common significant effect of asexual propagation is to maintain the genetic uniformity, true to type, and preserve the superior clones or cultivars. Therefore, need to find out a correct month of grafting for the rapid multiplication of wood apple plants.

Methodology

During the year 2020-2021softwood grafting was done from February to July for 6 months to find out the best month of grafting in wood apple var. PKM 1 .Six to eight months old wood apple rootstocks were used for grafting. In softwood grafting, the tip of stock is decapitated with the use of a grafting knife. A longitudinal cut was given to the stock, which looks like a fork or letter V to a length of 4-5cm in a downward direction. The scions had an equal thickness to the stocks, sloppy wedge cut was made in scions. Prepared scions were inserted in "V" sharp rootstocks. 200 gauge thick transparent polythene strips were wrapped in graft union to make a close connection between stocks and scions. After the grafting scions were covered by the poly cap to avoid desiccation. In every treatment, 20 plants were grafted. For each replication five plants were selected for the record the growth parameters *i.e* success percentage, survival percentage, days taken for 1st sprouting, days taken for 50% sprouting, number of sprouts, sprouts length and graft height.

Results and Discussion

The highest success percentage (95.17%) was observed in July (T_6) followed by (89.40%) in June (T_5) and minimum success percentage (71.76%) in March (T_2). Islam *et al*., 2003 revealed that the highest success percentage was noted in June and July months in jack fruit grafting. Grafting season showed a significant effect on survival percentage. The maximum survival percentage (91.33%) was recorded in July (T_6) followed by (83.53%) in June (T_5) and minimum survival percentage (71.78%) was recorded in March (T_2). Gunjate *et al*., 1989 reported the June and July recorded the highest survival percentage in stone grafting in warm humid months.

Days taken for 1st sprouting and 50% sprouting

Days taken for 1st sprouting was lower (6.43days) in July (T_5) followed by (6.66 days) in June. And it was high (9.34days) in April (T_3) (Table 1). The results were supported by Mulla *et al*.,2011 in studies of softwood grafting in Jamun. Days taken for 50% sprouting were lower(10.11days) in June followed by (11.33days) in July(T_6) and March (T_2) recorded the higher (15.76 days) taken for 50% of sprouting. Early sprouting is due to more food material present in scions and high relative humidity in the atmosphere.

Table 1. Effect of season on success percentage, survival percentage, days taken for 1st sprouting, days taken for 50% of sprouting, no of leaves at 30 days interval

Treatments	Success percentage	Survival percentage	Days taken for 1st sprouting(Days)	Daystaken for 50% of Sprouting(Days)
T_1(February)	85.66	80.97	7.66	13.75
T_2 (March)	74.50	71.78	9.11	15.76
T_3 (April)	76.76	74.30	9.34	15.57
T_4 (May)	80.34	76.49	7.45	12.55
T_5 (June)	89.40	83.53	6.66	10.11
T_6 (July)	95.17	91.33	6.43	11.33
Mean	83.63	79.73	7.77	13.17
S.Ed	1.9634	2.0726	0.1273	0.2235
CD at 5%	4.2779	4.5158	0.2773	0.4871

Reference

Angadi S.G, Raghavendra V.N, T.B. Allolli, Venugopal C.K, Mokashi A.N, and Mummigatti U.V, (2011). Propagation Of Wood Apple (*Feronia Limonia* L.) By Budding. *Acta Hortic*. 890, 175-182

Islam M.M, Haque M.A, Haque and Hossain M.M, 2003. Effect of Age of Rootstock and Time of Grafting on the Success of Epicotyl Grafting in Jackfruit (Artocarpus heterophyllus L.*). Asian Journal of Plant Sciences*, 2: 1047-1051.

Gunjate, R.T, 1989. Standardization of stone grafting for the Konan region. *Acta Hortic.*, 231: 164-167

Studies on Growth Parameters of Coriander (*Coriandrum sativum* L.) Genotypes under Drought Condition

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Keywords: *Accessions, Drought, Coriander, Rainfed, Growth parameters*

Introduction

Coriander (*Coriandrum sativum* L.) is an annual herb, which belongs to the family Apiaceae. Rainfed crop production is highly dependent on monsoons and occurrence of moisture stress at varying degrees and at different growth phases is a common problem. The nature and intensity of stress is determined by rainfall distribution, which is generally uncertain. This often results in poor production and productivity. Soil moisture profoundly influences the availability and uptake of mineral nutrients. Water deficit in leaves is associated with reduced rate of organ development. It has many indirect effects on plant growth. A study to understand the physiological responses of the plant to water deficit and to evaluate suitable management practices is therefore essential.

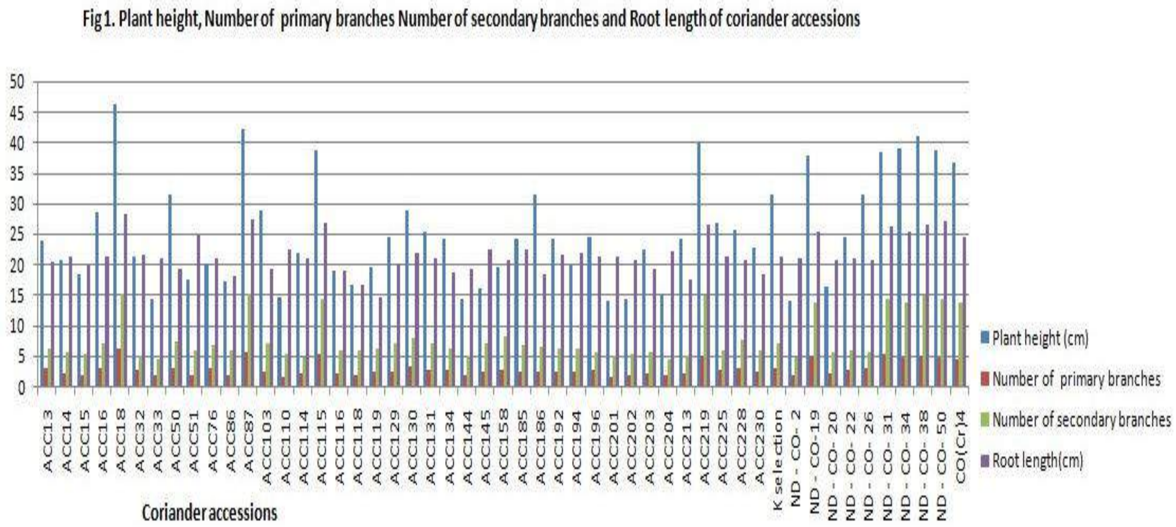
Methodology

In the present study, for preliminary screening 240 accessions were raised in a plot size of 1 m x 1m in a Randomized Block Design. From the 240 accessions, 50 accessions along with check CO (Cr) 4 obtained from Tamil Nadu Agricultural University, Coimbatore-3, and were selected based on yield performance. Selected 50 genotypes were raised in the main field for further screening. The plot size was 3 m x 3 m and 2 rows were maintained for each genotype and replicated thrice under rain fed conditions. The row to row and plant to plant distance was kept 30 cm and 15 cm respectively. The field observations were recorded from randomly selected and tagged five plants from each replication. The data were recorded.

Results and Discussion

The study revealed that the maximum plant height was recorded in ACC 18 46.15 cm when compared to CO(Cr)4 which registered 36.6 cm. Highest number of primary branches were recorded in ACC 18 (6.27), when compared to CO(Cr)4 (4.67). Highest number of secondary branches were recorded in ACC 18 (15.40) when compared to CO(Cr)4 (13.87). ACC 18 recorded the highest root length (28.3 cm) when compared to CO(Cr)4 (24.7 cm), (Fig 1). Vegetative growth phase is the important growth phase of any crop and at this stage, multiplication, elongation and enlargement of cells happen. Kanakadurga *et al*. (2003) observed that growth and yield of mungbean is reduced by moisture stress at any stage of the plant development, but greater injury occurs when the moisture stress coincides with the vegetative stage; thus irreversibly reducing the number of branches. This increased number of branches may be due to the changes in the hormonal level, which induces the growth of the seedlings when they experienced an adverse environmental condition (Premkumar *et al*., 1993). Root length was increased throughout the growth period. Genotypic variation in root penetration and other root traits have been reported in rice (Yu *et al*., 1995). In general, moisture stress increases root length. In the present study, the data recorded on the root length of all accessions has indicated the differential response to moisture stress. Root length ranged from 17.86 to 28.55 cm and CO(Cr)4 had a root length of 25.03 cm. This revealed the fact that the accession ACC 18 which recorded a root length of 28.55cm has a possible tolerance to moisture stress over CO(Cr)4. Similar results of higher rooting depth under moisture stress was recorded in *Vicia faba* (Nadi *et al*., 1969). The imposed water stress killed the root apices and accelerated the death of epidermis. Extensive and deep root systems were found to be the major attributes to drought tolerance (Poehlman, 1991).

Fig 1. Growth parameters of coriander accessions



Reference

Kanakadurga, K., M. Murali Rao, M.V. Reddy and Y. Koteswara Rao. 2003. Effect of early drought stress on morpho-physiological characters and yield of mungbean and urdbean cultivars. Indian J. Pulses Res., 16(2): 133 – 135.

Nadi, E.L., A.H.R. Brouwer and J. Lochen. 1969. Some responses of the root and shoot of *Vicia faba* plants to water stress. Neth. J. Agric. Sci., 17: 133-142.

Poehlman, J.M. 1991. The Mungbean. Oxford and IBH publishing Co.Pvt. Ltd., Bombay

Premkumar, A., K.Eswaran and G. Kulandaivelu 1993. Growth, biochemical and photosynthetic responses of green gram seedlings under water stress to ultra violet– B radiation. Plant physiol, and Biochem., 20 (1): 31-35.

Yu, L.X., J.D.Ray, J.C. O'Toole and H.T.Nguyen. 1995. Use of wax-petrolatum layers for screening rice. Theor. Appl. Genet., 37-44.

Studies on Influence of Effective Micro Organism on Growth and Physiology in Radish (*Raphanus sativus* L.)

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Keywords: *Effective micro-organism (EM), Environment, Radish, growth, physiological characters.*

Introduction

Radish (*Raphanus sativus* L.) is an important root vegetable crop in India. Among the root vegetables, radish is the most popular grown pungent crop known for it fresh edible roots and it is rich in Ca, K, P and vitamin C. Successful commercial cultivation of any crop is possible only if the temperature and other climatic conditions are favourable for its growth and development. In the present scenario of perpetual demand of vegetables and shrinking land holding drastically protected cultivation is the best alternative and drudgery less approach for using land and other resources more efficiently. EM appears to be a good supplement for vegetable crops as it creates favourable condition for the growth of crops, promoting the mobilization of insoluble nutrients and activating the beneficial micro-organisms in soil (Higa 2000, Hussain *et al.*, 2002). Application of EM is found to enhance the growth and yield of many vegetable crops (Fawzy *et al.*, 2012).

Methodology

The field experiment on radish was conducted under shade net, polyhouse and open field conditions at the Department of Horticulture, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal. Radish variety used in this study was Pusa Chetki (Asiatic type). The crop was raised under Randomized Block Design (RBD) with twelve treatment and three replications. The seeds were sown in lines under raised bed (2m X 1m). EM was used at three different concentration as foliar spray *viz.*,0.5 per cent, 1.0 per cent and 2 per cent and control without EM spray was also maintained. The spraying was taken up at weekly interval from 18th day after sowing. The growth and physiological parameter were recorded and subjected for analysis.

Results and Discussion

Among the twelve treatments recorded, the treatment T_4, open condition +2% EM spray recorded the highest value for plant height of 22.54 cm, Leaf length 21.00 cm, leaf breadth 6.54 cm. The positive effect of EM on this important plant growth parameters is mainly due to the presence of beneficial micro organism present in EM which enhances the amino acids, vitamins and micronutrient. The important constituents of protoplasm and chlorophyll leading to the better plant growth as reported by Midan and Sorial (2011) in snap bean. The treatment T_2 Open condition +0.5% EM spray recorded the highest value for number of leaves of 12.00. The increased number of leaves should result to higher rates of photosynthesis hence increased plant growth. The position and distribution of leaves along the shoot influence of the sink strength of the plants. Inoculation of effective micro organism can increase the available nutrition for plant roots and improve photosynthesis (Seren *et al.*, 2013). The treatment T_3 Open condition + 1% EM spray recorded highest value for leaf area of 71.30 cm^2, 1.07. The leaf area was found to increase with increasing concentration of EM during active vegetative growth period and this might be due to the increased acidity of EM spray solution at higher concentration. The increased mineral absorption and enhanced production of auxins and cytokinins due to the beneficial microbes present in the EM culture as reported by Shokouhian *et al.*, (2013) in almond.

Table1. Mean performance of growth and physiological traits influenced by different concentrations of effective micro-organisms and environment

TREATMENT	Plant height (cm)	Leaf Length (cm)	Leaf breadth (cm)	Number of leaves	Leaf area (cm^2)	Leaf area index
T_1 Open condition+ Control	25.56	18.20	6.03	9.46	46.60	0.70
T_2 Open condition +0.5% EM spray	28.80	19.22	6.12	**12.00**	64.00	0.96
T_3 Open condition + 1% EM spray	27.56	19.58	6.50	10.20	**71.30**	**1.07**
T_4 Open condition + 2% EM spray	**29.38**	**21.00**	**6.54**	10.40	66.66	1.00
T_5 Polyhouse condition + Control	24.40	17.26	5.67	9.06	10.80	0.06
T_6 Polyhouse condition + 0.5% EM spray	24.24	18.47	5.72	9.60	11.00	0.07
T_7 Polyhouse condition + 1% EM spray	24.44	18.40	5.95	9.06	22.00	0.24
T_8 Polyhouse condition + 2% EM spray	23.43	18.25	5.93	9.80	18.00	0.33
T_9 Shadenet condition + Control	20.58	16.30	4.67	7.80	26.60	0.4
T_{10} Shadenet condition + 0.5% EM spray	21.45	13.14	4.00	8.00	26.60	0.4
T_{11} Shadenet condition + 1% EM spray	21.81	16.07	5.10	8.60	30.60	0.46
T_{12} Shadenet condition + 2% EM spray	20.87	16.67	5.38	9.06	37.30	0.56
Grand Mean	24.37	17.79	5.64	9.42	35.95	0.52
C. D (0.05%)	5.55	6.33	1.26	2.23	4.26	0.27

Reference

Fawzy, Z.F., A.M.M. El-magd, Y. Li, Z. Ouyang and A.M. Hoda. 2012. Influence of foliar application by EM " Effective Microorganisms" , amino acids and yeast on growth , yield and quality of two cultivars of onion plants under newly reclaimed soil. *J. Agrl. Sci.,* **4**(11): 26-39.

Shokouhian, A.A , GH.Davarynejad , A. Tehranifar , A. Imani and, A. Rasoulzadeh, 2013. Investigation of effective Microorganisms (EM) impact in water stress Condition on growth of almond (*Prunus dulcis* Mill) Seedling. J. Basic. Appl. Sci. Res., 3(2s) 86-92.

Seran,T.H and R.N.M.Shahardeen. 2013. Marketable pod yield of vegetable cowpea (*vigna unguiculata)* as influenced by organic manure fermented with EMsolution. *The open horti.J.*,6:19-23

THEME 06

Trends in Agricultural Engineering for the Changing Landscape

Batch Scale Experiments for Inoculum to Substrate Ratios for Methane Production Using Leather Fleshings

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Keywords: *Fleshings, Anaerobic Digestion, I/S Ratio, biogas, methane*

Introduction

The management of solid waste generated from tannery industries is a dual concern nowadays involving disposal of effluent and storage of solid waste. The tanneries mostly existing in India are small and medium-sized businesses, with daily processing capacity of about 2 to 6 tonnes. Using 2.5 tonnes/day leather processing capacity, the solid waste generated per day is about 1300 kg. Fleshings will account for 375 kg of this total (Sundar *et al*., 2011). Fleshings are rich in lipids and have greater methane potential and hence a they are an appealing substrate for anaerobic digestion.

Methodology

Fleshings are collected from E.K.M Leather Processing Company, Erode, Tamil Nadu subjected to the physico-chemical characterization and the results are summarised in the Table 1. For optimization of I/S ratio, anaerobic digestion experiments were carried out in batch type using 2.5l amber bottles (Kameswari *et al*., 2013). The substrate selected for studies is fleshings and the inoculums are cow dung (CD), elephant dung (ED), and bio-digested slurry (BDS). The different I/S ratios were 75:25, 50:50, and 25:75 for each experiment in which 50% of volume were filled with substrate and the remaining space for gas accumulation. Duplicates were operated and performance is reported for observed values. The biogas generations from the digesters were monitored through water displacement method based on Mariotte principle (Itodo *et al*., 1992).

Results and Discussion

The physico-chemical characterization and results of batch scale experiments are given in Table 1 and Table 2. Daily biogas reading of the bottling experiment for Hydraulic Retention Time (HRT) of 50 days was measured by using the water displacement method and the gas composition of the following treatments were analysed using the saccharometer filled with the 10% KOH solution and the results are shown in the Table 2. Among all the treatments mentioned above, the proportion of LF: BDS : 25:75 yielded the highest biogas production (14840 ml) and methane production (63.77%). This highest CH4 content is caused by lipids existing in the leather fleshings.

Table 1: Physico-chemical characterization of tannery fleshings

Properties	Fleshings
pH	11-12
Moisture content (%)	83±0.35
Total solids (%)	17±0.35
Volatile solids (%)	68±0.84
Chemical Oxygen Demand (g/g)	0.96±0.04
Total organic carbon (g/kg)	360 ±0.92
Total kjeldahl nitrogen (g/kg)	93±0.70
C:N ratio	3.91

Table 2: Methane production from different inoculum to substrate ratio

Treatments	I			II			III		
Parameter	CD_1	CD_2	CD_3	ED_1	ED_2	ED_3	BDS_1	BDS_2	BDS_3
HRT (days)	50	50	50	50	50	50	50	50	50
VS in feed stock	4.73	9.47	14.19	4.73	9.47	14.19	4.73	9.47	14.19
I/S ratio	75:25	50:50	25:75	75:25	50:50	25:75	75:25	50:50	25:75
Total Biogas Generated (ml)	10103	12073	11508	11253	9065	8755	11188	12028	14840
Methane (%)	61.28	61.92	61.03	62.72	62.45	61.95	63.07	63.56	63.77

Reference

Sundar, V.J., Gnanamani, A., Muralidharan, C., Chandrababu, N.K. and Mandal, A.B., 2011. Recovery and utilization of proteinous wastes of leather making: a review. *Reviews in Environmental Science and Bio/Technology,* 10(2), pp.151-163.

Kameswari, K.S.B., Kalyanaraman, C., Porselvam, S. and Thanasekaran, K., 2012. Optimization of inoculum to substrate ratio for bio-energy generation in co-digestion of tannery solid wastes. *Clean Technologies and Environmental Policy*, 14(2), pp.241-250.

Itodo, I.N., Lucas, E.B. and Kucha, E.I., 1992. The effect of media material and its quality on biogas yield. *Nigeria Journal of Renewable Energy,* 3, pp.45-49.

Crop Yield Response Factor an Indicator Tool for Assessing the Efficient Water Utilization

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Keywords: *Deficit irrigation, Yield, Crop response factor*

Introduction

Two levels of deficit irrigation (20% and 40%) were provided for two different growth stages of paddy (Stress at vegetative stage, reproductive stage and both stages). The results revealed that, control and 80% irrigated plot with deficit in vegetative stage gave maximum yield under flooded condition. In drip irrigation, control gave maximum yield, while others showed more reduction in yield in deficit condition. Crop yield response factor can be used as an indicator tool for assessing the yield increase and decrease (Kirda *et al.*, 2000). This crop yield response factor can be used as an indicator for fruit crops, flower crops which has consecutive harvest. Insufficient water supply for irrigation will be the norm rather than the exception and irrigation management will shift from emphasizing production per unit area towards maximizing the production per unit of water consumed. To cope with scarce supplies, deficit irrigation, defined as the application of water below full crop-water requirements (evapotranspiration), is an important tool to achieve the goal of reducing irrigation water use. The main objective of efficient water management is getting high yield of good quality products. The objective of this research is to calculate the crop yield response factor, which serves as an indicator tool for showing how the irrigated water is efficiently used by the plant under deficit irrigation in terms of production.

Methodology

Suitable field requirement was arranged and experiment was carried with the following treatment details. The experimental design carried out was randomized block design with seven treatments and three replications. The treatment details of the experiment are as follows: T_0- absolute control (100% irrigation), T_1- 60% irrigation during Vegetative stage, T_2- 60% irrigation during Reproductive stage, T_3- 60% irrigation during Vegetative stage and Reproductive stage, T_4- 80% irrigation during Vegetative stage, T_5- 80% irrigation during Reproductive stage, T_6- 80% irrigation during Vegetative stage and Reproductive stage.

Methodology to workout Crop yield response factor (Ky)

Crop yield response data from deficit irrigation will be fitted to the following linear equation:

$$\frac{Y}{Y_m} = 1 - k_y\left[1 - \frac{ET_a}{ET_m}\right]$$

where, Y and Y_m are expected and maximum crop yields, corresponding to ET_a and ET_m, actual and maximum evapotranspiration, respectively. k_y is a crop yield response factor that varies depending on species, variety, irrigation method and management, and growth stage when deficit evapotranspiration is imposed. The k_y values are crop specific and vary over the growing season according to growth stages. With k_y>1 = crop response is very sensitive to water deficit with proportional larger yield. Reduction when water use is reduced because of stress (more sensitive crop to water stress). k_y <1 = crop is more to lean to water debit, and often recovers partially from stress, exhibition less than proportional reductions in yield with reduced water use. k_y = 1 = yield reduction is directly proportion to reduced water use (Doorenbos J and Kassam A. 1979).

Calculation procedures

Estimate maximum yield (Y_m) of an adopted crop variety, as determined by its genetic makeup and climate, assuming agronomic factors (Eg. Water, fertilizer, pests and diseases are not limiting.)

- Calculate maximum evapotranspiration (ET_m) according to established methodologies and considering the crop – water requirements are fully met.

- Determine actual evapotranspiration (ET_a) under the specific situation, as determined by the available water supply to the crop.

- Evaluate actual yield (Y_a) through the proper section of the response factor (k_y) for the full growing season over the different growing stages.

Results and Discussion

From the research, it can be concluded that, deficit irrigation when applied at appropriate growth stage can result in good yield when water availability is very low (with minimal usage of water and with lesser yield reduction. Crop yield factor found will give the relation between the water applied and the yield obtained. It gives a relay how the plant has responded to the deficit condition. While adopting deficit irrigation, one should have prior knowledge about the crop yield response factor of the particular crop. Crop yield response factor can be used as an indicator tool for assessing the yield increase and decrease. This crop yield response factor can be used as a indicator for fruit crops, flower crops which has consecutive harvest.

Reference

Doorenbos J and Kassam A. 1979. Yield response to water, FAO irrigation and drainage paper No 33. Rome.

Kirda C, Moutonnent P, Hera C and Nielsen D R. 1999. Crop yield response to deficit irrigation. Dordrecht, the Netherlands, Kluwer Academic Publications.

Kirda C. 2000. Deficit irrigation scheduling based on plant growth stages showing water stress tolerance. Deficit irrigation practices, FAO, Rome.

Design and Development of Portable Fruit Peeler

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Keywords: *Pineapple, Peeler, Fabrication, Performance Evalation*

Introduction

Peeling of pineapple is not an easy process. There are several problems that need to be encountered during the peeling process. The manual peeling of pine apple is difficult and it is very tedious, time-consuming work and requires much strength also. The manual pine apple peeling or scooping is an unhygienic process. Therefore, efforts have been made to develop pineapple peeler for separation of peel and pulp with the following specific objectives of design development and performance evaluation of pine apple peeler.

Methodology

The variety of SIMHACHALAM Pineapple is selected from nearby shop. The length, diameter, weight of pineapple are important for designing of peeler for pineapple. Physiological characteristics of the pineapple like length, mean diameter are measured with the help of cloth tape and vernier calliper up to an accuracy of 0.02 mm. Later different parts like frame, threaded rods, gears, adjusting screw, holding cups and different blades have been designed and fabricated.

Results and Discussion

Performance evaluation of fruit peeler

The performance evaluation of fruit peeler was carried out and the operating parameters such as peeling efficiency, machine production efficiency, peeling losses and unit cost were calculated. The quantity of fruit obtained from the fruit peeler was compared to manual peeling. The result indicates the effect of number of passes of fruit on peeling efficiency with the clearance of 0.2 mm. The value of peeling efficiency was increased with number of passes per fruit and vice-versa. The maximum peeling efficiency of 73% was obtained at 3rd pass. The minimum value of peeling efficiency was obtained at 1st pass and the value of peeling efficiency was 37%. So, by above discussions the maximum peeling efficiency is obtained at three passes of fruit at the clearance of 1mm. From the table the comparison of pineapple peeling efficiency of both manual and mechanical peeling are evaluated and the results shows that the peeling efficiency of fruit peeler is more, values 73% in 5.5 min and the peeling efficiency of the manual peeling is comparatively less, values only 62% in 10min. So, the above results shows that the peeling efficiency maximum by using fruit peeler compared to manual peeling.

Table 1. Percentage of time and labour saving of mechanical peeler over manual peeling

S.NO	Parameters	Peeling Operation		Saving%
		Manual	Mechanical	
1.	Labour Requirement (8h/day)	1	1	-
2.	Output capacity (fruits /hour)	7-8	10-12	46%
3.	Labour cost/ day	100	100	-
4.	Time for peeling	10 min	5.05 min	50%

Table 2. Peeling efficiency of fruit peeler with number of passes

Sample	Initial diameter (mm)	Final diameter (mm)					
		1st pass	PE%	2nd pass	PE%	3rd pass	PE%
Average	88.99	88.62	37	88.42	57	88.26	73%

Table 3. Comparison of peeling efficiency of fruit peeler and manual peeling method

Method	Initial diameter (mm)	Final diameter (mm)	Time for peeling	Peeling efficiency %
Manual Peeling	88.75	88.13	10 min	62%
Mechanical Peeling	88.99	88.26	5.5 min	73%

Reference

Bagher, E., F.M.H. and Yarlagadda, P.K.D.V. 2008.Mechanical peeling of pumpkins. Part 1: Using an abrasive-cutter brush. *Journal of Food Engineering*.89:4489-452.

Chand, K., Pande, R.K., Shahi, N.C. and Lohani, U.C.2013. Pedal opereated integrated potatopeeler and slicer. Agricultural Mechanization in Asia, Africa, and Latin America.44(1):65-68.

Manjunatha, M., Samuel, D.V.K., Rahul, K.A. and Nilesh, G.2012.Development and performance evaluation of a garlic peeler. *Journal of Food Science and Technology*. 51(11):3083-3093.

Development of Tractor Front Mounted Harvester for Finger Millet Crop

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Keywords: *Finger millet, Earheads, Harvesting efficiency, Header loss*

Introduction

Finger millet, also known as ragi, is valued as staple food in south India (Karnataka, Tamil Nadu, and Andhra Pradesh) and in hilly regions of the country. They are not only providing nutritious grain but also provides nutritious fodder within a short span of time. Wekha *et al.*, (2017) reported that finger millet stover contains up to 61 per cent total digestible nutrients and can be used as good fodder. It provides excellent hay and is used as green forage for cattle, sheep and goats (Chaab *et al.*, 2018). The straw resulting from the grain harvest is valuable and can be grazed directly by the animals or used in cut-and-carry feeding systems. Baath *et al.*, (2018) reported that finger millet can generate forage yields ranging from 5.0 to 12.3 Mg ha^{-1}. Hence the grain and straw have to be harvested separately. Manual harvesting of finger millet (whole crop) using sickles involves 25man days per hectare. Scarcity of labor and higher wages during harvesting season is a serious problem, which increases the cost of production. To harvest finger millet, small scale farmers use hand tools, such as scythe or sickle or they use combine harvester which again requires labour for separating the earheads from the stalk. Both the techniques are not suitable for small scale-grain production. Appropriately scaled machinery is needed for harvesting finger millet cultivated by small scale farmers. Hence an attempt was made to develop a suitable tractor front mounted harvester which will combine both the operation (harvesting earheads and cutting stalks) in a single pass.

Methodology

The finger millet harvester developed was provided with two cuts, one at the bottom of earheads and the other at the bottom of the shoot system. Based on the average height of the earhead, the height of the first cut was fixed and the second cut was fixed at 100 mm from the ground level. The concept of a vertical conveyor reaper was adapted for the development of finger millet harvester. The prototype finger millet harvester mainly consisted of harvesting unit and power transmission unit. The power for the front mounted finger millet harvester was taken from the tractor PTO.

Evaluation parameters

The effect of machine and operational parameters were evaluated in terms of harvesting efficiency and header loss at different levels of rotational speed of reel (30, 35 and 40 rpm), mounting height of reel (35, 40 and 45 cm) and forward speed (1.6, 2.68, and 3.48 kmh^{-1}).

Results and Discussion

The test results were statistically analyzed for harvesting efficiency and header loss.

Effect of reel rotational speed and forward speed on harvesting efficiency

The results indicated that the maximum harvesting efficiency of 91.5 per cent was observed for 1.6 kmh^{-1} forward speed at 30 rpm reel rotational speed (Figure 1). The minimum of 73.88 per cent harvesting efficiency was obtained for forward speed of 3.48 kmh^{-1} at reel rotational speed of 40 rpm.

Effect of reel rotational speed and forward speed on header loss

The results indicated that maximum header loss was recorded at 3.48 kmh^{-1} forward speed and 40 rpm reel rotational speed (Figure 2).

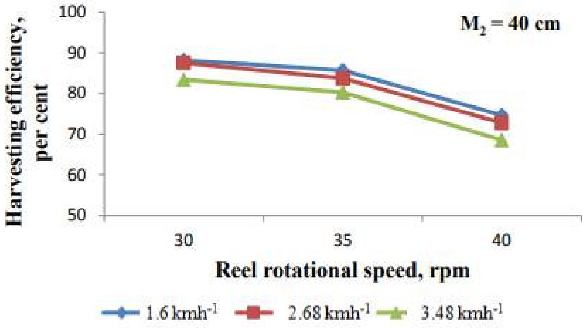

Fig 1: Effect of reel rotational speed and forward speed at selected level of reel mounting height on harvesting efficiency

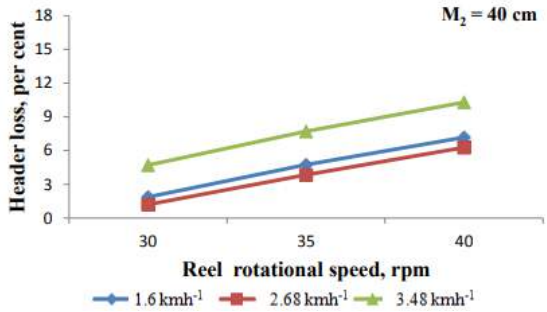

Fig 2: Effect of reel rotational speed and forward speed at selected level of reel mounting height on header loss

The minimum header loss was recorded at 2.68 kmh^{-1} forward speed and 30 rpm reel rotational speed. The increase in forward speed causes slippage of crops from the cutter bar which cause reduction in harvesting efficiency. The reel index has greater impact on header loss. Comparing the best combinations of machine and operational parameters, the maximum harvesting efficiency of 91.5 per cent and minimum header loss of 3.7 per cent was achieved by the developed harvester at the combination of 30 rpm rotational speed of reel, 40 cm mounting height of reel and 2.68 kmh^{-1} forward speed.

Reference

Baath, Gurjinder, Brian Northup, Prasanna Gowda, Alexandre Rocateli, and Kenneth Turner. 2018. "Adaptability and forage characterization of finger millet accessions in US Southern Great Plains." *Agronomy* 8 (9):177.

Chaab, Reza Karmulla, Seyyed Hossein Karparvarfard, Hossein Rahmanian Koushkaki, Alireza Mortezaei, and Mojtaba Mohammadi. 2018. "Predicting header wheat loss in a combine harvester, a new approach." *Journal of the Saudi Society of Agricultural Sciences*. doi: 10.1016/j.jssas.2018.09.002.

Wekha, NW, NK Korir, HF Ojulong, and JP Gweyi-Onyango. 2017. "Phosphorus influence on nitrogen uptake, nutrient and yield attributes of finger millet in semi-arid region of Kenya." Inter Drought-V Conference, Hyderabad.doi: 10.13140/RG.2.2.22612.71041.

Discernment of Fruit Colour from Fruit Images Using Opencv And Raspberry Pi

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Keywords: *Machine Vision, Sorting, Raspberry Pi, Image processing, Programming code*

Introduction

Colour is the first quality attribute of food that consumers examine and it is an important component of food quality that influences market acceptance. Classification of fruits by visual inspection is an arduous, time-consuming process and prone to human error. The machine vision system is a distributed control system that integrates several machine vision modules with image processing algorithm and a user interface unit. This technique would be pertinent for adopting which saves time, cost-effective, consistent and provide accurate sorting than manual methods.

Methodology

This research proposes with a design of colour sorting unit for recognising and sorting tomato fruits into preferred location. The colour sorter was researched, designed and created with Raspberry Pi, USB camera, servo motor and different digital as well as mechanical components. Raspberry Pi is a microcontroller and uses Broadcom SoC, containing a Videocore4 GPU and 64bit Advanced RISC Machine (ARM) CPU core, which runs with 1 GB RAM at 1.2GHz. OpenCV-Python is an OpenCV extension for the Python programming language. A horizontal belt conveyor system was designed to convey the fruits for effective sorting. It consists of pulleys and rollers with an endless loop of carrying medium upon which conveyor belt rotates. Design calculations include length of the belt, angle of contact between belt and pulley, power transmitted by belt and velocity of belt.

Belt length= $\frac{\pi}{2}$ *(d1+d2) +2 + $\frac{(d1-d2)^2}{4x}$

Angle of contact between belt and pulley(α) sinα = ($\frac{r1+r2}{x}$)

Power transmitted by belt (P) =2.3log(T1/T2) = μ θ and T1 = σ*b*t

Velocity of belt (V)= $\frac{\pi dN}{60}$

Image processing Algorithm

Step1: Capture video through webcam
Step 2: Convert (image i.e., BGR) to HSV (hue-saturation-value) and define the range
Step 3: Morphological transformation- dilation and colour tracking
Step4: Raspberry Pi sent PWM (Pulse width modulation) signal to control servo motor
Step5: Actuate servo motor to sort fruits into respective channel.

Results and Discussion

Before designing colour sorter, the engineering properties of tomatoes were studied. The major and minor diameter ranges from 45-60mm and 35-50mm, respectively. The mean geometric diameter, sphericity and surface area were 48.64mm, 0.94 and 7477.14mm^2, respectively. The average length, width, thickness, bulk density and true density were 54.63mm, 48.44mm, 51.42mm, 0.6874g/cm^3, 0.9852g/cm^3, respectively. With dual channel tomato sorting on Raspberry pi ARM platform, the developed algorithm was able to sort the ripen tomatoes from the unripen based on user interfaced colour value. Specific python code is written for colour sorting and run-on native Linux Raspbian OS. Different image processing phases are executed using Pycharm, and Matlab software tools. The developed colour sorter capture image and divert fruits into respective channel at the rate of 1800 fruits/h (i.e.one fruit per 2 seconds).

Table 1. Design calculations for Belt conveyor

S. No	Parameter	Value
1.	Belt length	1660mm
2.	Belt width	280 mm
3.	Belt thickness	3 mm
4.	Angle of contact between belt and pulley(α)	5^0
5.	Belt speed	0.08 m/s
6.	Power at pulley	110 W
7.	Breaking strength	1.47 kN/mm
8.	Torque	330 kN-m
9.	Roller diameter	70 mm
10.	Conveying capacity	1800 fruits/hr


Fig 1: Captured


Fig 2: HSV


Fig 3: Gray scale


Fig 4: Binary


Fig 5: Contrast

Reference

Nuri N Mohsenin Text book of Structure, Physical characteristics and Mechanical properties of plant and animal materials (1978).

Patel, K.K., Kar, A., Jha, S.N. Machine vision system: a tool for quality inspection of food and agricultural products. *J Food Sci Technology* 49, 123–141 (2012).

R.S.Khurmi and J.K.Gupta Textbook of Machine design (2005).

Drought Monitoring using Standardized Precipitation Index (SPI) in Tiruppur

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Keywords: *Drought, DrinC Software, SPI*

Introduction

Meteorological drought is the quickest open event in the process of occurrence and advancement of drought. Rainfall is the primary factor of meteorological drought. There are numerous indicators based on rainfall that are being used for drought monitoring (Smakhtin and Hughes, 2007). Rainfall deviation from normal -a long term mean, is the most commonly used indicator for drought monitoring. The declaration of meteorological drought is done if the total season's rainfall is less than 75% of long-term mean. The main objective of this study is to investigate whether SPI can perform as a better indicator for drought assessment.

Methodology

The study area Tiruppur is located at 11°05'41" N latitude and 77°25'23". McKee et al. (1993) to support the drought monitoring analysis was developed the Standardized Precipitation Index (SPI). The long-term precipitation record was used to calculate the SPI index. This long-term record is fitted to a probability distribution, which is then transformed into a normal distribution so that the mean SPI for the location and desired period is zero. The values of SPI are expressed in standard deviations, positive SPI indicating greater than median precipitation and negative values indicating less than median precipitation (Edwards and McKee, 1997). Classification of drought condition based on the SPI values are given in Table 1. DrinC (Drought Indices Calculator) software package was developed at the Centre for the Assessment of Natural Hazards and Proactive Planning and the Laboratory of Reclamation Works and Water Resources Management of the National Technical University of Athens. It is the user-friendly tool for calculating many drought indices (Tigkas *et al.*, 2015). The daily rainfall data was collected for over a period of 1981 to 2019 (38 years) from State Ground and Surface Water Resources Data Centre, Tharamani, Chennai.

Results and Discussion

Figure 1 shows the SPI for 12-month reference period of Tiruppur using the monthly precipitation record from 1981 to 2019. Based on the 38 years rainfall record in Tiruppur, more 70% (27 years) of the period were under the mild wet and mild dry condition according to the SPI. According to the SPI values, extreme wet, severe wet, severe dry and extreme dry conditions contribute 2.63% each, 5.26% moderate wet, 13.16% moderate dry, 34.21% mild dry and 36.84% mild wet (Table 1). Figure 2 represents the box and whisker plot of 12-month SPI values. From the results of the study, it could be concluded that extreme and severe dry conditions occur at a probability of 2.63%. This shows that the occurrence of drought is of less chance with the existing rainfall pattern observed in the study area. Since drought is a complex phenomenon, it is difficult to analyze and predict accurately. Hence, judicious management of available water resources is vital to mitigate the effect of the drought.

Table 1. Classification of drought condition by SPI values (McKee et al. 1993)

SPI values	Classification	Probability of occurrence (%)
≥ 2.0	Extreme Wet	2.63
1.50 to 1.99	Severe Wet	2.63
1.00 to 1.49	Moderate Wet	5.26
0 to 0.99	Mild Wet	36.84
0 to -0.99	Mild Dry	34.21
-1.00 to -1.49	Moderate Dry	13.16
-1.50 to -1.99	Severe Dry	2.63
≤ -2	Extreme Dry	2.63

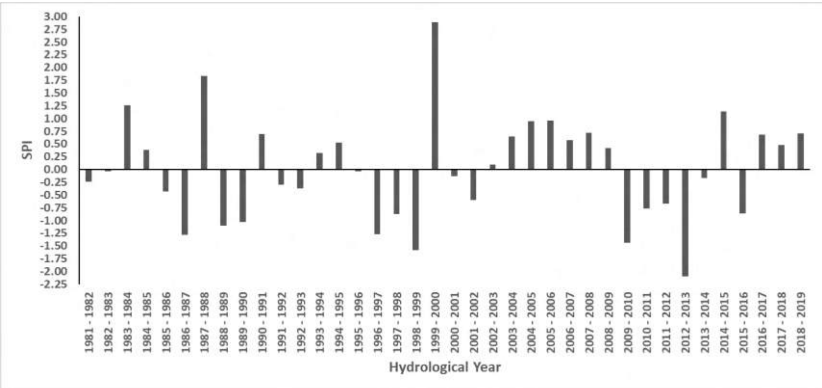

Fig 1: 12-month SPI values

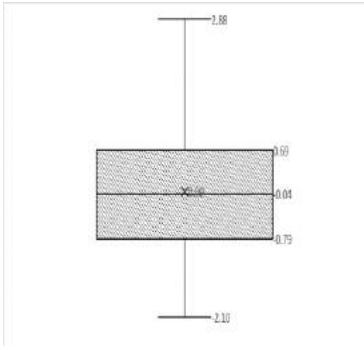

Fig 2: Box whisker of 12-month SPI values

Reference

Edwards, D.C. and T.B. McKee. 1997. Characteristics of 20th century drought in the United States at multiple scales, Atmospheric Science, Paper No. 634: 1-30.

McKee, T.B., N.J. Doeskin and J. Kleist. 1993. The relationship of drought frequency and duration to time scales. In: proceedings of the 8th conference on applied climatology. Anaheim, CA, January 17–23, 1993. American Meteorological Society, Boston, pp 179–184.

Smakthin, V. U., and D.A. Hughes. 2007. Automated estimation and analysis of meteorological drought characteristics from monthly data, Environmental Modeling and Software, 22 (6): 880-890.

Tigkas, D., H. Vangelis and G. Tsakiris. 2015. DrinC: a software for drought analysis based on drought indices. *Earth Science Information,* 8: 697-709

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Energy Densification of Groundnut Shell Through Microwave Assisted Hydrothermal Carbonization

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Keywords: *Groundnut shell, Microwave assisted, Hydro char, Energy quality*

Introduction

Agricultural residues are carbon-neutral, low-cost, lignocellulosic materials and a feasible option for greener energy generation to mitigate CO2 emissions. Higher moisture content, lower density and lower energy content are the major drawbacks of raw agricultural waste materials. Microwave assisted Hydrothermal carbonization (HTC) is an efficient process to handle wet biomass and produces energy intensive hydrochar with improved carbon and energy content in a shorter duration under mild temperature and self-generated pressure. Hydrochar is a hydrophobic, carbon-rich material possessing improved energy properties. It can be produced from any kind of wet waste materials without any pretreatment. With enhanced properties, hydrochar can be used as an alternative solid fuel.

Methodology

Groundnut shells were collected from Department of Oilseeds, TNAU. The collected shells were washed with distilled water to remove the impurities and dried at solar tunnel drier. The dried shells were grinded and sieved using 0.2 mm sieve. Experiments were carried out in a 100 ml Teflon vessel using a modified microwave oven. One gram of groundnut shell was mixed with 20 ml of distilled water and fed into the reaction vessel. The vessel was heated at temperatures of 180, 200 and 220°C at 10°C/ min heating rate. The treated biomass water mixture was held at 200°C for 20 minutes. After the completion of the process, the reactor was cooled to room temperature. The produced hydrochars were washed and filtered using Whatman filter paper number 2 and dried at 105°C for 24 hours. Groundnut shell and produced hydrochars were analyzed for their physico-chemical characteristics and Higher Heating Value (HHV). Mass yield, Energy Densification Ratio (EDR) and carbon recovery were determined. Van-Krevelen diagram was plotted to find the degree of carbonization.

Results and Discussion

Mass yield and HHV of the raw groundnut shell and hydrochars were given in Table 1. As the temperature increased from 180 to 220°C, hydrochar yield was decreased from 61.84 to 45.76%. Decrease in hydrochar yield with respect to temperature was also observed in bamboo sawdust hydrochar produced through microwave-assisted hydrothermal carbonization (Dai *et al.,* 2017). Increase in temperature from 180 to 220°C accelerated the degradation of hemicellulose, partial degradation of cellulose and lignin which in turn decreased the yield of hydrochar. The HHV of the hydrochar was increased (18.66 to 20.15MJ/kg) with the increase in process temperature (180 to 220°C). The increasing trend of HHV with increase in temperature was similar to hydrochars produced from sawdust, coconut shell and wood (Dai *et al.*, 2017; Elaigwu and Greenway, 2019; Shao *et al.*, 2019). This is due to the increased degradation of biomass under sub-critical environment of water through dehydration and decarboxylation reactions. Energy intensified hydrochars were produced through hydrolysis and aromatization of unreacted cellulose and lignin. These reactions effectuate decrease in hydrogen and oxygen content of hydrochar result into higher energy value.

Table 1. Hydrochar yield and HHV

Sample	Mass Yield (%)	HHV (MJ/kg)
GNS	-	17.83
GHC 180	61.84	18.66
GHC 200	54.33	19.24
GHC 220	45.76	20.15

Reference

Dai, L., He, C., Wang, Y., Liu, Y., Yu, Z., Zhou, Y., Fan, L., Duan, D., & Ruan, R. (2017). Comparative study on microwave and conventional hydrothermal pretreatment of bamboo sawdust: Hydrochar properties and its pyrolysis behaviors. *Energy conversion and management,* 146, 1-7.

Elaigwu, S. E., & Greenway, G. M. (2019). Characterization of energy-rich hydrochars from microwave-assisted hydrothermal carbonization of coconut shell. Waste and Biomass Valorization, 10(7), 1979-1987.

Shao, Y., Long, Y., Wang, H., Liu, D., Shen, D., & Chen, T. (2019). Hydrochar derived from green waste by microwave hydrothermal carbonization. *Renewable Energy,* 135, 1327-1334.

Engineering Properties of Pigeon Pea Varieties

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Keywords: *Pigeon pea, varieties, BRG, engineering properties*

Introduction

Pigeon pea (*Cajanus cajan* (L.) is a multipurpose leguminous crop that can provide food fuel wood and fodder for the small-scale farmer in subsistence agriculture. India ranks high in the production of pulses. Pigeon pea, chickpea, black gram, green gram, lentils and peas are major pulses consumed in India. Among legumes, pigeon pea is predominantly grown and consumed in India. It is also known as red gram, arhar and tur dhal. Pulses continued to be an integral component of sustainable crop-production system, as these crops have ability of biological nitrogen fixation, low water requirement and capacity to withstand abnormal weather conditions. The study of engineering properties of food grains is important and essential in the design of processing equipment and storage structures. The shape and size of grains are important in the design and development of sorting and grading machineries for the separation of inert material as well as for the thermal processing calculations. So keeping this in view, present investigation was carried out to study engineering properties of five different pigeon pea varieties in the Department of Processing and Food Engineering, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra (GKVK), Bengaluru during the year 2020-2021.

Methodology

The sun-dried pigeon pea varieties of BRG-1, BRG-2, BRG-3, BRG-4 and BRG-5 used in the present study were procured from NSP (National Seed Project) and AICRP on Pigeon pea, GKVK, Bengaluru (Karnataka.). The grains were cleaned manually to remove foreign materials. For the five pigeon pea varieties engineering properties namely shape, volume, bulk density, true density, moisture content, angle of repose, porosity, sphericity and thousand grains weight were measured. Grain volume was calculated using the formula given by (Jain and Bal, 1997). The bulk density and true density were calculated using the formula used by (Mohesenin, 1986). The moisture content of pigeon pea samples were determined by using an electric hot air oven method (AOAC 1995). One thousand seed weight of samples were observed on a digital weighing balance.

Results and Discussion

The engineering properties of five different varieties of pigeon pea were measured and the results are presented in Table 1.1. It was observed that the grains were medium in size, spherical in shape, white and red in colour. The mean value of bulk density and true density of five different pigeon pea varieties are 806.08kg/m^3 and 1319.8kg/m^3, respectively. The mean value of volume of BRG pigeon pea varieties was 5.29\times10-7. The average value of angle of repose of BRG varieties of pigeon pea grains was 24.28°. The mean value of porosity and sphericity of BRG varieties of pigeon pea were 38.84 and 0.81, respectively. The mean value of 1000 grain weight of BRG varieties of pigeon pea grains was found to be 95.40 g.

Table 1. Engineering properties of five different varieties of Pigeon pea

Properties	Pigeon pea varieties					Mean
	BRG-1	BRG-2	BRG-3	BRG-4	BRG-5	
Shape	Spherical	Spherical	Spherical	Spherical	Spherical	Spherical
Volume (m^3)	6.53×10^{-7}	4.54×10^{-7}	5.52×10^{-7}	5.10×10^{-7}	4.76×10^{-7}	5.29×10^{-7}
Bulk density (kg/m^3)	796.00	812.00	801.00	808.00	813.00	806.00
True density (kg/m^3)	1167.00	1387.00	1250.00	1312.00	1483.00	1319.00
Moisture content (%db)	11.50	12.00	13.30	11.00	9.50	11.46
Angle of repose (°)	24.60	23.70	25.00	23.80	24.30	24.28
Porosity (%)	31.50	41.50	36.00	40.00	45.20	38.84
Sphericity(%)	0.91	0.79	0.77	0.86	0.74	0.81
1000 Grains weight (g)	94.00	95.00	101.00	96.00	91.00	95.40

Reference

Althuntose, E., Ozgoz, E. and Taser, O.F. 2005. Some physical properties of fenugreek seeds (*Trigonella foenum-graceum* L.). **Journal of Food Engineering,**71(1):37-43.

Dutta, S.K., Nema, V.K. and Bhardwaj, R.K. 1998. Physical properties of gram. *Journal of Agricultural Engineering Research,* 39:259-268.

Jain, R.K. and Bal, S., 1997. Properties of pearl millet. ***J****. Agri. Engg Res***.**66:85-91.

Khan, K., Moses, S.C. and Kumar, A. 2017. Physical properties of pigeon pea grains at different moisture content. *Int. J. Pure App*, 5(2): 556-562.

Mohesenin, N. N. 1986. Physical properties of plant and animal materials.***Garden and** Breach Science Publishers*, Inc. New York.

Estimation of Land Surface Temperature for Coimbatore District Using Landsat Imagery

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Keywords: *Land Surface Temperature, climate change, satellite images, RS & GIS*

Introduction

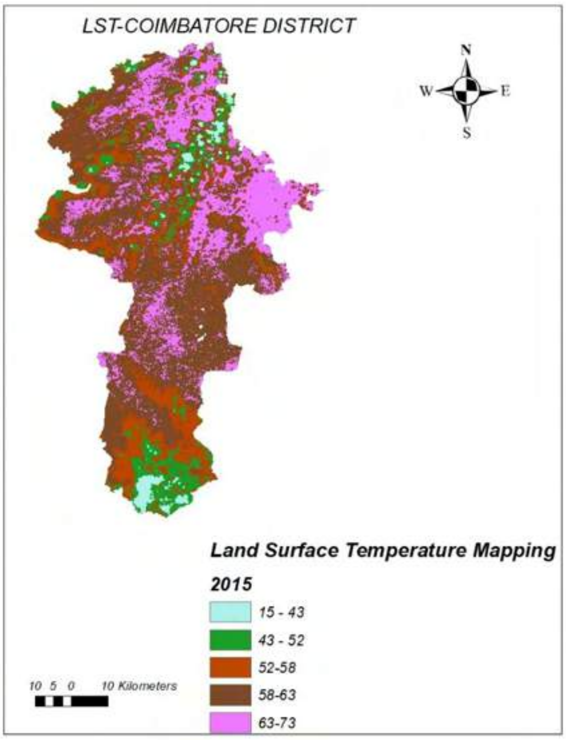
Land Surface Temperature (LST) is the temperature of the earth surface and is one of the key indicators representing the climate change due to urbanization and globalization of the world. It can be also related to the increase in the evapotranspiration of the crop leading to the loss of more water from the plant. LST also plays an important role in increasing the evaporation rate thereby decreasing the surface water availability. It increases the demand for the application of water to crops and lead to occurrences of crop wilting and consequent yield reduction to farmers. LST is a factor that can be predicted with satellite imagery on global level with utmost accuracy. The objective of this study is to find the change in LST between 2015 and 2020 in Coimbatore district.

Methodology

Coimbatore district is one of the urban cities which is sustainably developing but is increasingly subjected to the pressure of climate change and population explosion and therefore severely affected. It can only be observed by comparing the present situation with the past situation (Akhoondzadeh and Saradjian, 2008.). LST measurement is the visual observation of the current climate change around us. LST was calculated by applying a structured mathematical algorithm i.e., Split-Window algorithm (Rajeshwari and Mani, 2014). Band 10 image (Thermal sensor Image) of Landsat 8 imagery of May 2015 and May 2020 were used to obtain the Emissivity, Radiance and Land Surface Temperature maps of the study area. Band 4 and Band 5 data were used to estimate the Normalized Difference Vegetation Index (NDVI) and to observe the vegetative scale pertaining to the LST. LST studies can be done in a large scale to address the impact of global warming and climate change annually and to implement measures to sustain the temperature for agriculture and all other allied works. These can be directly correlated with the green cover and vegetation of that area (Aryalekshmi *et al.*, 2020).

Results and Discussion

The LST were found out spatially over the Coimbatore district and the variation of LST over a period of 5 years gap is depicted in the Figures 1 and 2. From the Figures 1 and 2, it can be understood that the minimum temperature in LST of May 2015 is increased by 4ºC in May 2020 and the maximum temperature is also increased by 1ºC. The areal extent of the LST of high temperature has increased showing the rate of climate change spatially. It could be observed clearly that the area of maximum temperature range has been increased in the North and North Eastern side of the district and the area of minimum temperature range decreased in the southern side of the Coimbatore district. The LST decrease in the central part of the district may be due to the location of hilly terrains. The maximum LST was 73ºC in 2015 and it is increased to 74ºC in the year 2020 and the minimum LST has also increased from 15ºC in May 2015 to 19ºC in May 2020. The observed change in the LST of the Coimbatore district is due to the increase in the built up and urban areas. Most of the lands were converted to barren lands which results in the decrease of vegetation area as well as the change in the LULC of the district (Lim *et al.*, 2012).



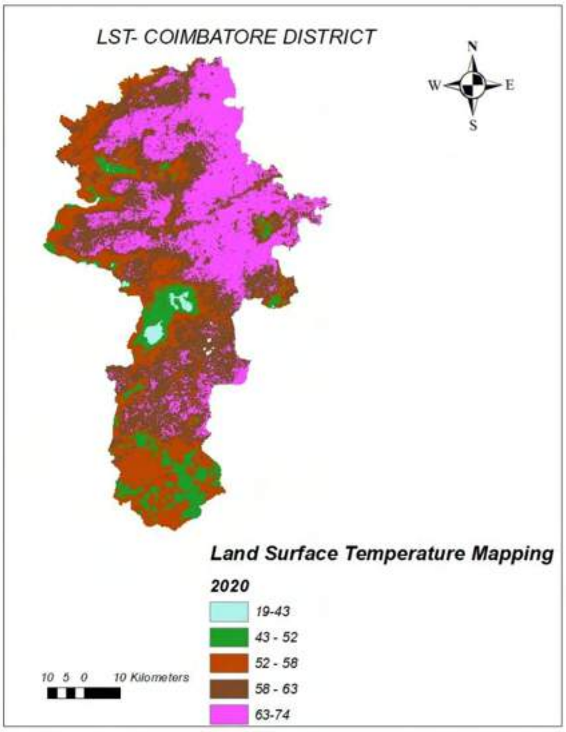


Fig 1: LST of May 2015

Fig 2: LST of May 2020

Reference

Akhoondzadeh, M. and M.R. Saradjian. 2008. Comparison of land surface temperature mapping using MODIS and ASTER images in semi-arid area. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 37 (B8): 873-876.

Aryalekshmi, B. N., R. C. Biradar and K. Chandrasekar. 2020. Land Surface Temperature Estimation of Mandya district using LANDSAT-8 data. *Journal of Applied Science and Engineering,* 23 (4): 583-591.

Lim, H. S., M. Jafri, K. Abdullah and S. Alsultan. 2012. Application of a simple mono window land surface temperature algorithm from Landsat ETM over Al Qassim, Saudi Arabia. *Sains Malaysiana,* 41 (7): 841-846.

Rajeshwari, A. and N. D. Mani. 2014. Estimation of land surface temperature of Dindigul district using Landsat 8 data. *International Journal of Research in Engineering and Technology,* 3 (5): 122-126.

Factors Affecting Performance of Mechanical Linkage Picking Fingers During Automatic Transplanting Of Seedlings

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Keywords: *Mechanical linkage, Picking fingers, Protray, Transplanting frequency and Seedlings.*

Introduction

The nursery seedling removal and plant setting are the important factors to be considered while designing automatic transplanters (Kumar *et al.,* 2012). The automatic transplanter requires either plug or pot seedlings. Removal of the individual seedlings from the trays at the rates of 3 to 5 seedlings s-1 is necessary. The initial investment on production of seedling plug is high and the mechanisms employed for the removal of seedlings from tray are complex (Mao *et al*., 2014). The picking efficiency of a transplanting mechanism is strongly influenced by several factors of probabilistic nature. There are two key factors to be considered in the development of seedling pickup device. One is mechanical characteristics of the gripper and another factor is horticultural characteristics of the protray seedling (Luan *et al*., 2006). In this study, the following probabilistic factors which affected the transplanting operation were studied: grasping the seedling, extraction from the protray cell, transferring and releasing of the seedling.

Methodology

For gripping, removing and dropping, three types of mechanical linkage picking fingers viz., sliding plate cam type, Sliding end cam type finger and four bar type finger were developed (Zhang *et al*., 2010 and Khadatkar, *et al*., 2018) as shown in Fig. 1 and tested with experimental setup. It is necessary to determine the effect of influencing variables on the successfully grasping, removing and releasing the plug seedlings from the protray. For the same the following three variables viz., media moisture content (M), mechanical linkage picking fingers (F) and angle of gripper needle (θ) were selected.

Results and Discussion

At the time of evaluation, totally 196 number of seedlings were used with 98 cell protray. The results showed that the minimum value of missing seedling (6.55 per cent) and maximum success rate of picking (93.45 per cent) are recorded at 18 ±1 per cent of growth media moisture content and at 8° angle of gripper needle with sliding plate cam type picking finger. The transplanting frequency was 840 seedlings ha^{-1}.

Table 1. ANOVA for media moisture content, angle of gripper needle and mechanical picking finger on missing in tomato seedlings

S.No.	Source	df	SS	MS	F	PROB
1.	Total	80	2049.75	25.62	238.47	
2.	Media moisture content (M)	2	989.97	494.98	4607.07	0.000 **
3.	Mechanical linkage finger (F)	2	735.93	367.96	3424.82	0.000 **
4.	Angle of gripper needle (θ)	2	233.48	116.74	1086.56	0.000 **
5.	M x F	4	16.37	4.09	38.10	0.000 **
6.	F x θ	4	56.15	14.03	130.66	0.000 **
7.	M x θ	4	5.81	1.45	13.53	0.000 **
8.	M x F x θ	8	6.20	0.77	7.21	0.000 **
9.	Error	54	5.80	0.10	1.00	

CV = 1.34 %, **Significant at 1% level; * Significant at 5% level

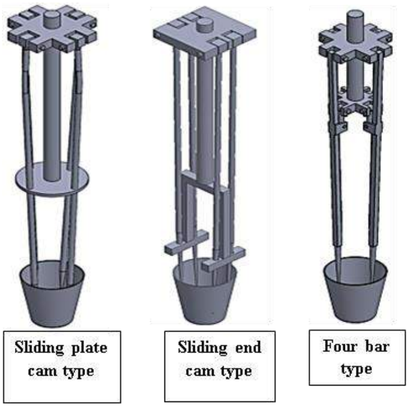

Fig 1: Mechanical linkage fingers

Reference

Luan, J., Chi-Liang, C. and Ju, J. (2006). A feeding mechanism of vegetable seedling transplanter. *Chinese Elect. Period. Ser.* 14(42): 35-42.

Kumar, P. and Raheman, H. (2012). Automatic feeding mechanism of a vegetable transplanter. *International Journal of Agricultural and Biological Engineering.* 5(2): 20-27.

Mao, H., Han, L., Hu, J. and Kumi, F. (2014). Development of a pincette-type pick-up device for automatic transplanting of greenhouse seedlings. *Applied Engineering in Agriculture.* 30(4): 547-556.

Laboratory Study on Effect of Temperature and Particle Size on Pigeon Pea Stalk Bio-Oil Production

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Keywords: *Pigeon pea stalk, Fast pyrolysis, Bio-oil, Biochar, Phenols*

Introduction

Biomass is a promising renewable energy resource used for the substitution of conventional fossil fuels. It can be converted into various biofuels and also used for energy generation through thermochemical routes viz., pyrolysis, gasification and combustion. Fast pyrolysis is the thermal degradation of biomass in an inert environment to produce bio-oil, biochar and non-condensable gases. Bio-oil is a complex mixture of oxygenates derived through the thermal breakdown of biopolymers such as cellulose, hemicellulose and lignin in biomass. The bio-oil obtained can be directly used as a fuel in boilers and industrially important chemicals can be extracted from bio-oil viz., phenols used in resin industry, levoglucosan and hydroxy acetaldehydes in the pharmaceutical industry etc. In this study, pigeon pea stalk biomass was used for the production of bio-oil and biochar at varying temperatures and particle sizes.

Methodology

Pigeon pea stalk was dried, shredded and sieved to obtain the required particle sizes. Different temperatures (450, 500, 500, 600 and 650°C) and particle sizes (<0.2, 0.2-0.5, 0.5-1, 1-1.5 and 1.5-2 mm) were used for the production of bio-oil. The bio-oil production was carried out in a fixed bed laboratory scale pyrolysis system. It consists of fixed bed reactor with external heating arrangement, temperature controller, nitrogen preheating unit and ice cooled condenser. After obtaining the desired process temperature, biomass was fed into the reactor and the volatile vapours are condensed in ice cooled condenser to obtain bio-oil. The quantity of char collected was also measured. GC-MS analysis was carried out to identify the various chemical compounds present in bio-oil. FTIR analysis was performed to identify the functional groups present in bio-oil.

Results and Discussion

The results obtained from the laboratory study of bio-oil production from pigeon pea stalk and its analysis by GC-MS and FTIR are discussed in this section Bio-oil production at different temperatures and particle sizes is given in Table 1. It can be observed that the bio-oil production was maximum at the temperature of 500°C for the particle size of 0.2 mm. Higher volatile and cellulose content favoured the maximum production of biocrude. Higher temperature above 550°C led to the reduction in bio-oil which may be due to the secondary reactions of heavy molecular weight compounds in the pyrolysis vapours which became active at temperatures over 500°C. The increase in particle size leads to higher amount of char production. This may be due to the fact that larger the size of the particle, temperature gradient between the core and the particle is more which results in higher amount of biochar (Guizani *et al.*, 2017). From the GC-MS analysis, it is found that the major compounds present were amines, acids, phenols, furfural and aldehydes. The compounds such as propanamide, cyclobutanol, phenylephrine, propanoic acid, pentanal, p-cresol and pyridine were present in the range between 5 and 7 per cent. Dimethyl sulfoxide, furfural and hydroxylamine were found to be higher at 450°C and 500°C. The FTIR results indicate the presence of alkenes and aromatic structures between 1000-1500 cm^{-1} wavelengths (Doshi *et al.*, 2014). Broad O-H stretching vibrations between 3000 and 3500 cm^{-1} indicates the presence of amines and amides in the obtained bio-oil. It can be concluded from this study that the pigeon pea stalk can be used for the production of various biofuels and biochemicals through anaerobic thermal degradation process.

Table 1. Bio-oil and biochar production at varying temperatures and particle sizes

Temp.(°C) & Yield (%) / Particle Size (mm)	450		500		550		600		650	
	Bio-oil	Bio char	Bio-oil	Bio char	Bio-oil	Bio char	Bio-oil	Bio char	Bio-oil	Bio char
0.2	38.5	25.1	40.8	24.4	38.2	24.1	35.4	22.9	32.6	21.6
0.5	38.2	26.9	40.3	26.5	38.0	23.5	35.1	22.1	32.2	21.8
1	37.1	28.4	39.2	27.3	37.4	25.7	34.6	23.6	32.0	23.0
1.5	35.2	28.9	39.0	28.3	36.8	27.5	34.1	25.1	31.7	24.8
2	34.5	30.2	37.5	28.2	36.5	27.8	33.2	26.5	30.6	26.3

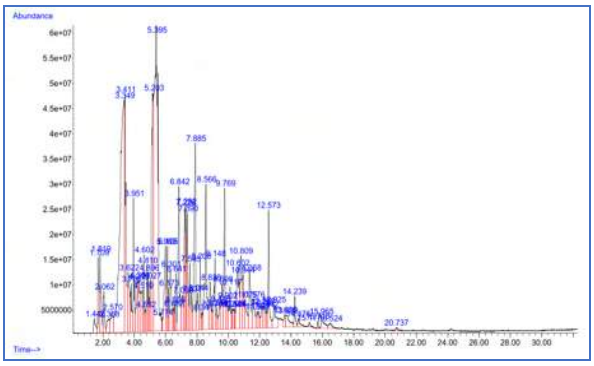

Fig 1: GC-MS characterization of bio-oil

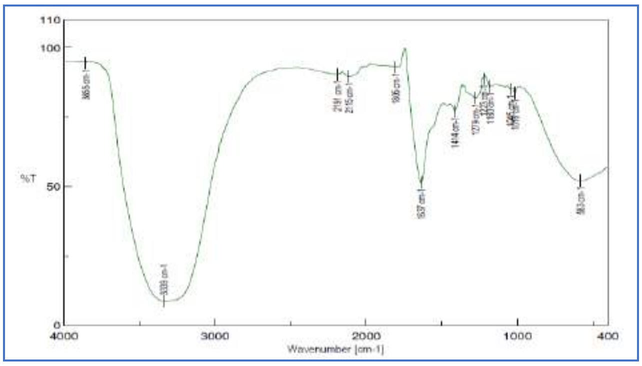

Fig 2: FTIR analysis of bio-oil

Reference

Guizani, C., S. Valin, J. Billaud, M. Peyrot and S.Salvador. 2017. Biomass fast pyrolysis in a drop tube reactor for bio oil production: Experiments and modeling. *Fuel.*, 207: 71-84.

Doshi, P., G. Srivastava, G. Pathak, and M. Dikshit. 2014. Physicochemical and thermal characterization of nonedible oilseed residual waste as sustainable solid biofuel. *Waste Management*, 34(10): 1836–1846.

Land Surface Temperature Assessment in Lalgudi Block of Trichy District Using Remote Sensing Algorithm

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Keywords: *Land surface temperature, Landsat 8, Remote Sensing*

Introduction

Land Surface Temperature describes the exchange of energy and water between the land surface and atmosphere, and influences the rate and timing of plant growth. The variations in land surface heat fluxes affect the ecological environment and hydrological processes (Hu *et al.*, 2019). Soil moisture estimation (Veettil *et al.*, 2016) and evapotranspiration modelling (Silva *et al.*, 2018) can be done based on LST for estimating the crop water requirement and planning efficient water management strategies in a regional scale. In this paper, land surface temperature was estimated from Landsat 8 satellite data for Lalgudi block of Trichy District located in Tamil Nadu.

Methodology

The Landsat 8 satellite images were downloaded from the USGS Earth Explorer website. LST was calculated from the thermal band (band 10) radiance values of Landsat 8 image by using the following equation:

$$T_s = \frac{K_2}{\ln\left(\frac{\varepsilon_s * K_1}{\rho_b}\right)} \quad (1)$$

The constants K_1 and K_2 for band 10 are 774.8853 and 1321.0789 which is taken from the metadata file. The surface emissivity (ε_s) is the ratio of the thermal energy radiated by the surface to the thermal energy radiated by a blackbody at the same temperature and calculated from equation 3. The radiance (ρ_b) is calculated from the pixel values of different bands (DN_b) using the following equation:

$$\rho_b = Add_{rad,b} + Mult_{rad,b} * DN_b \quad (2)$$

where $Add_{rad,b}$ is additive (0.10000) and $Mult_{rad,b}$ is multiplicative (3.3420E-04) terms related to different band radiance.

$$\varepsilon_s = \begin{cases} 1.009 + 0.047 \ln NDVI & NDVI > 0 \\ 1 & NDVI \le 0 \end{cases} \quad (3)$$

Thus the surface emissivity is empirically derived from NDVI. NDVI is the ratio of difference in reflectivity of near-infrared (NIR) band and red band to their sum.

$$NDVI = \frac{NIR - RED}{NIR + RED} \quad (4)$$

In Landsat 8 image, the near infrared is band 5 and the red is band 4. The study was conducted for two growing seasons (2017-19) from eleven Landsat 8 images.

Results and Discussion

The spatial and temporal variation of LST in Lalgudi block is shown in Figure 1. The LST variation in River Colleroon was higher in the sand bed and comparatively lesser in standing water. This is indicated in the images by dark brown color on the south eastern part i.e sand bed and sandal color on the south western part (water) (Fig. 1 c,d,e,h). The LST was higher in the northern part having barren land and dry vegetation exists. The dry vegetation includes cactus, prosopis etc. Likewise fallow land exhibited a maximum LST (29.2^{o}C) in the study conducted at Malda (Pal *et al.*, 2017). The LST value of a lake located in the eastern part of Lalgudi was around 20oC when water is available (Fig. 1i). The LST increased in December 2017 (Fig. 1c) and January 2018 (Fig. 1d) images because of the presence of water weeds on the surface of water. It was reported that the LST of water bodies was higher compared to LST of water hyacinth (Pal *et al.*, 2017). The scenes used in this study falls in the active tillering (December 2017) and panicle initiation (January 2018) stage of samba season paddy crop. In both the stages of paddy, the LST was in the range of 23 to 25 ^oC. Similarly, LST of sugarcane was also in the range of 23 – 25^{o}C. In December 2017 and January 2018 scenes, the LST of Banana was comparatively higher because there existed newly planted banana plants. The combined effect of soil and young banana plants was the reason behind the increase in LST. The coconut plantations, forest area and *Prosopisjuliflora* exhibited similar trend of LST ranging from 24 – 29 ^oC. This was greater when compared to LST of the paddy. This kind of monitoring studies helps in adopting suitable policies to overcome or minimize the problems triggered by increase in land surface temperature and helps to evaluate land surface–atmosphere exchange processes in models.

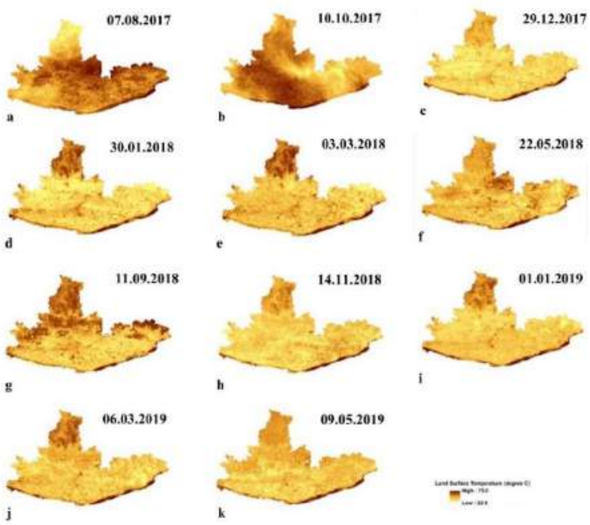

Fig 1: Variation of LST of Lalgudi Block

Reference

Hu, G., Zhao, L., Wu, R. L. X., Wu, T., Zhu, X., Pang, Q., Liu, G.Y. and Du, E. 2019. Simulation of land surface heat fluxes in permafrost regions on the Qinghai-Tibetan Plateau using CMIP5 models. *Atmospheric Research.*

Pal, S., and Ziaul, S. 2017. Detection of land use and land cover change and land surface temperature in English Bazar urban centre. The Egyptian Journal of Remote Sensing and Space Science, 20(1), 125–145.

Silva, B.B., Mercante, E., Boas, M.A.V., Wrublack, S.C. and Oldoni, L.V. 2018. Satellite-based ET estimation using Landsat 8 images and SEBAL model. *RevistaCiênciaAgronômica.* 49 (2): 221-227

Veettil, Anoop Valiya, and Ashok K. Mishra. 2016. "Water security assessment using blue and green water footprint concepts." *Journal of Hydrology* 542:589-602.

Land Use and Land Cover Change Detection Using Geospatial Techniques in Lower Bhavani Basin, Tamil Nadu

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Keywords: *Land-use/land-cover, Remote sensing, Landsat, Google Earth Engine, GIS*

Introduction

Land cover-land use analysis provides knowledge about landscape patterns and their changes which over time gives very important insights into the ongoing natural and human processes in the ecosystem. Remotely sensed data are extensively and efficiently used in land-use/land-cover (LULC) classification (Sinha *et al*., 2013). In the last decade, RS data processing has moved from traditional workstations equipped with state-of-the-art hardware, and RS software, to cloud-based platforms that allow users to instantly access and analyze huge pre-processed geospatial data through user-friendly, web-based interfaces, and effective scripting languages. Among these platforms, Google Earth Engine (GEE) is achieving considerable success because it is a cloud-based geospatial analysis platform that allows users to solve, in a very efficient way, the primary problems related to the management of large amounts of data, their storage, integration, processing, and analysis (Gorelick *et al*., 2017). The aim of this paper is to evaluate the LULC change in the lower bhavani basin from 2014 to 2019, integrating Google Earth Engine (GEE) as a web-based remote sensing platform and GIS.

Methodology

The LULC classification is based on a supervised approach which, as usual, needs to collect from the training points the necessary information utilized to train the classifiers. The CART and RF classifiers were used in GEE. To perform the LULC classification using the in-detail code. Landsat 8 data Collection 1 Tier 1 calibrated top-of-atmosphere (TOA) reflectance dataset containing 11 bands including two thermal bands directly available in GEE is considered for this study.

The general workflow for supervised classification followed is:

- Collect training data. Assemble features which have a property that stores the known class label and properties storing numeric values for the predictors.
- Instantiate a classifier. Set its parameters if necessary.
- Train the classifier using the training data.
- Classify an image or feature collection.
- Estimate classification error with independent validation data.

In this study, the accuracy of LULC classifications is evaluated using a confusion matrix implemented in GEE in which the LULC linked to the validation points is statistically compared with the output classifications. The confusion matrix allows calculating the overall accuracy.

Results and Discussion

Land-cover classification

LULC map for the lower bhavani basin from satellite imageries considering five majors viz; Agriculture; Built-up; Current Fallow; Forest and Waterbody. LULC classes for the entire area was generated and area statistics was computed (Fig.1 and Fig.2). The result of this study reveals that the major land use in the study area is agriculture and current fallow, next dominant land use is forest which was recorded as 26.54% in 2019 due to agroforestry practices. During the study period (2014–2019), there has been no change in waterbody. The change in built up area, 7.37% in 2019 as against 5.45% in 2014 were noted due to urban sprawl. Accuracy assessment was done using 30% of training data in each class and confusion matrix was generated. Overall classification accuracy for the classified image of 2019 was found to be 85%

LULC change from 2014 to 2019

From the LULC change matrix it was inferred that from 2014 to 2019 the changes were observed from fallow land to agricultural land. About 4% (10243.87 ha) of agricultural land has converted to current fallow while 7% (16014.84 ha) area changed from current fallow to agricultural land in 2019. The area under current fallow in 2014 has been converted to built-up (8460.70 ha) in 2019 due to urban sprawl. It can be observed that there is no change from other classes to Waterbody. Results obtained from LULC change matrix shows that there is no major land cover change in the lower bhavani basin for the study period. GEE showed, considerable versatility and adaptability due to its cloud architecture, its user-friendly interface, and its efficient scripting language. Among the many images classification techniques present, in recent year machine learning classifiers have been reported to produce highly accurate classification results.

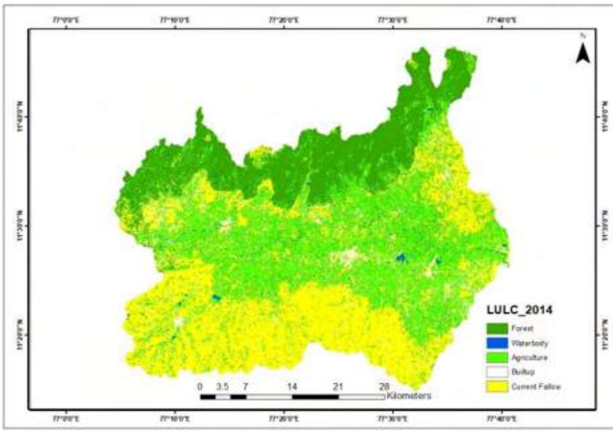

Fig 1: Land use land cover of Lower bhavani basin during 2014

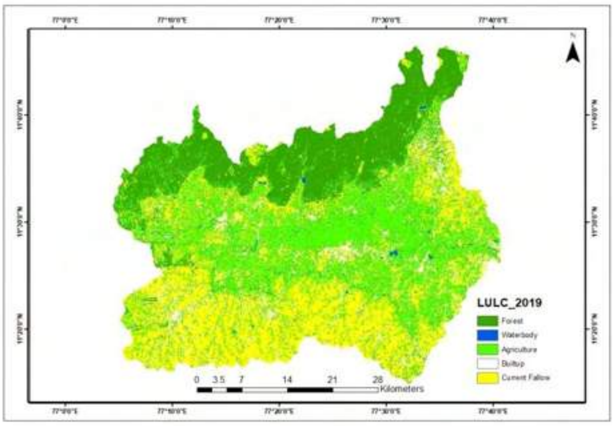

Fig 2: Land use land cover of Lower bhavanibasin during 2019

Reference

Sinha, S., Sharma L.K., Nathawat, M.S., 2013. Integrated Geospatial Techniques for Land-use/Land-cover and Forest Mapping of Deciduous Munger Forests (India). Universal Journal of *Environmental Research and Technology*. 3 (2), 190-198

Gorelick, N.; Hancher, M.; Dixon, M.; Ilyushchenko, S.; Thau, D.; Moore, R., 2017. Remote Sensing of Environment Google Earth Engine: Planetary-scale geospatial analysis for everyone. *Remote Sens. Environ*, 202.

Markov Chain Model of Weekly Rainfall Probability Analysis for Agricultural Planning in Dharmapuri District of Tamil Nadu

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Keywords: *Markov chain model, wet spell, dry spell, conditional probability*

Introduction

Dharmapuri district was created in 1965 when the former Salem district was divided into Salem and Dharmapuri. The district is located between 11" 47' and 12" 33' north latitude, and 77" 45' and 76" 45' east longitude. The average annual rainfall is 850mm, with temperatures ranging from 17^0C to 37^0C. The main crops grown in this region are paddy, ragi, legumes, groundnut, sugarcane, cotton, coconut, and sammai. There are a variety of soil types in the district, including red loamy soil, lateritic costal alluvium soil, black soil, red, and sandy soils. The soil is generally deficient in nitrogen and phosphate, which has a negative impact on crop output. Consequently, using the Markov chain model, an attempt was made to assess the initial and conditional chance of dry and wet periods, as well as the probability of two and three consecutive dry and wet spell weeks

Methodology

Daily rainfall data for 40 years (1980 – 2019) were collected from Regional meteorological centre, Chennai, Tamil Nadu. The dry and wet period study was conducted using weekly rainfall based on the Markov Chain Model.

The different notations followed in the Markov chain Analysis are given below:

Initial Probability: Pd = Fd/n; Pw= Fw/n

Conditional Probability: Pdd = Fdd/Fd; Pww = Fww/Fw; Pwd = 1-Pdd; Pdw = 1-Pww

Consecutive Dry and Wet Week Probability: P2d = Pd_1 x Pdd_2; P2w = Pw_1 x Pww_2; P3d = Pd_1 x Pdd_2 x Pdd_3; P3w = Pw_1 x Pww_2 x Pww_3. Where Pd denotes the chance of the period being dry, and Pw is the probability of the period being wet. The number of dry weeks observed is Fd, the number of wet weeks observed is Fw, the number of years of data utilised is n, and the probability of a dry week being followed by another dry week is Pdd (conditional). Fdd is the number of dry weeks followed by another dry week, Pwd is the probability of wet week preceded by another dry week, Pdw is the probability of dry week preceded by another wet week, P2d is the probability of two consecutive dry weeks, P3d is the probability of three consecutive dry week, P2w is the probability of consecutive two wet weeks, P3w is the probability of three wet weeks. Pd_1 is the probability of the period being dry (1st week), Pdd_2 is the probability of the second consecutive dry week, given that preceding week being dry, Pdd_3 is the probability of the third consecutive dry week, given that the preceding week being dry, Pw_1 is probability of the period being wet (1st week), Pww_2 is the probability of the second consecutive wet week, given that the preceding week being wet and Pww_3 is the probability of the third consecutive wet week, given that the preceding week being wet.

Results and Discussion

The results pertaining to initial and conditional probabilities of dry and wet weeks and consecutive dry and wet weeks for all the 52 standard meteorological weeks. From the 1st through the 32nd Standard Meteorological Week (SMW), the chance of a dry week was 75-100%. The probability of a dry week followed by another dry week was high up to the 32nd standard week, while the probability of a dry week followed by a wet week was high up to the 31st standard week, ranging from 75 to 100%. During the 37th to 45th weeks, the conditional probability of a rainy week followed by another wet week ranged from 43.8 to 68% (Fig.1). Two consecutive dry weeks have a 55 to 97.5% chance of occurring within the first 32 weeks of the year, according to an analysis of consecutive dry and wet spells. In the first 32nd week of the year, the probability of three consecutive dry weeks ranged from 32.6 to 92.6%. The equivalent values for two and three consecutive wet weeks from the first to the 35th weeks were low, ranging from 0% to 40% and 0% to 12%, respectively. From the 39th to the 45th week, the chances of having two or three consecutive dry weeks were just 10% to 30% and 0-12.5%, respectively. The study revealed that the last 2-3 weeks of the year may remain under stress as there is more than 50% probability for 2 and 3 consecutive dry weeks.

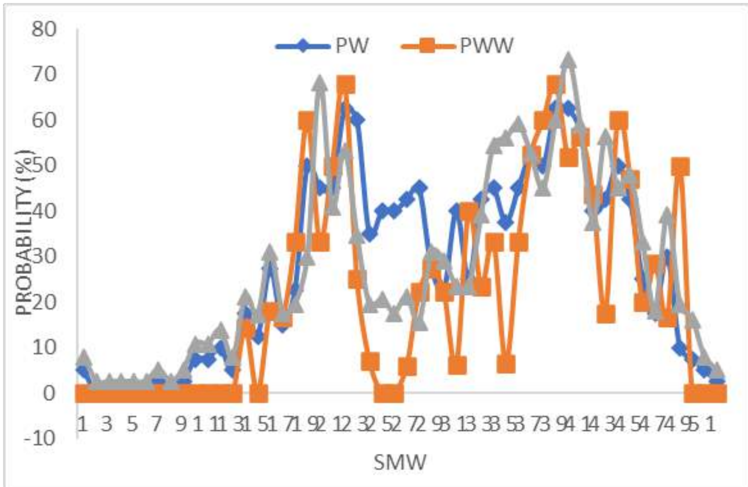

Fig 1: Initial and conditional probability of rainfall in Dharmapuri by Markov chain model

Reference

Adane, G. B., Hirpa, B. A., Lim, C. H., & Lee, W. K. (2020). Spatial and temporal analysis of dry and wet spells in upper awash river basin, ethiopia. *Water* (Switzerland), 12(11), 1–18. https://doi.org/10.3390/w12113051

Manikandan, M., Thiyagarajan, G., Bhuvaneswari, J., & Prabhakaran, N. K. (2017). Wet and Dry Spell Analysis for Agricultural Crop Planning. 7(1), 11–22.

Tyubee, B. T., & Iwan, M. T. (2019). A Markov Chain Analysis of Wet and Dry Spell for Agricultural Crop Planning in the Middle Belt Region of Nigeria. *Journal of Agriculture and Environmental* Sciences, 8(2), 132–147. https://doi.org/10.15640/jaes.v8n2a16.

Production of Activated Carbon from Maize Cob Using Zinc Chloride as Dehydrating Agent: Effect of Activation Sequence

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Keywords: *Maize cob, Chemical activation, Zinc Chloride, Activated carbon, Surface area*

Introduction

Activated carbon is a porous carbonaceous material produced from any organic precursor using chemical/physical activation process. It is one of the most promising adsorbents used in the industries for gas separation and purification process due to its higher porosity, adsorptive capacity and surface area properties. It can be produced by any naturally occurring or synthetic carbonaceous solid precursor. Activated carbon derived from agricultural residues can be relatively inexpensive and renewable. Among the activation methods, chemical activation offers advantages such as higher surface area and lower activation temperature. During chemical activation process, the precursor will be impregnated with chemical dehydrating agents and activated under inert environment. The present study was carried out to know the effect of activation sequence using zinc chloride as dehydrating agent on pore characteristics of activated carbon produced from maize cob.

Methodology

The maize cob was collected from the Department of Millets, Tamil Nadu Agricultural University and used for this study. The maize cob biomass was washed with distilled water to remove any dirt and sun dried in open atmosphere. The activated carbon was produced through different activation sequence, i.e., one step and two step chemical activation processes. The zinc chloride ($ZnCl_2$) was used as dehydrating agent in the activation process and steps involved in the processes are briefly discussed.

One step chemical activation process

The maize cob sample was impregnated with $ZnCl_2$ in the ratio of 1:1. To enhance the chemical reaction, the mixture was diluted with distilled water, mixed for 2 h using magnetic stirrer at ambient temperature and reactants were kept for overnight. The impregnated mixture was dried at 105 ± 5^{0}C for 24 h and further activated at 600^{0}C for 1 h at a heating rate of 10^{0}C min-1 under N_2 environment (300 ml min^{-1}). Further, the activated carbon was washed with 0.1 M HCl solution and rinsed using hot distilled water followed by cold distilled water until pH value reaches neutral. This step helps in removing residual $ZnCl_2$ chemicals from the activation process. Finally, the product was dried at 105 ± 5^{0}C for 24 h (Ravichandran *et al.*, 2018).

Two step chemical activation process

Activated carbon was synthesized using a two-step process viz., carbonization and chemical activation. Initially, the maize cob was carbonized at 600^{0}C with a heating rate of 10^{0}C min^{-1} in the N_2 environment (300 ml min^{-1}) and held for 1 h. The char was subsequently activated with $ZnCl_2$, by following one step activation process.

Characterization of produced activated carbon

The activated carbon produced from both one and two step activation process was characterized using surface area analyser (N_2 adsorption at −196 ^{0}C). The surface area and total pore volume was calculated from the isotherms through Brunauer-Emmett-Teller (BET) equation and Barrett-Joyner-Halenda (BJH) analysis.

Results and Discussion

The nitrogen adsorption–desorption isotherms of the activated carbon produced through two different activation sequence is shown in Fig.1. The isotherms belong to a mixed type of isotherms I (microporous structure) and IV (mixture of microporous and mesoporous structure) of IUPAC classification. From Table 1. the surface area of activated carbon produced from maize cob using one step activation process (912 m^2 g^{-1}) was found to be higher as compared with two step activation process (627 m^2 g^{-1}). This might be due to the presence of $ZnCl_2$ which promoted water molecule extraction from the biomass structure during one step activation process. In addition to that, breakdown of cellulose molecules resulted in rise in intra and inter-coated cavities due to dehydration reaction, which may ensure larger surface area of the activated carbon. During the thermal treatment of $ZnCl_2$ impregnated biomass, carbon, hydrogen and oxygen atoms in the biomass were liberated as carbon monoxide, carbon di oxide, methane and other distillates resulted in the development of more pores on the surface of the activated carbon. Whereas in two step activation process, $ZnCl_2$ reacted with interior and exterior of char surface and aided in removal of disorganized carbon resulting in pore formation (Saka 2012). In conclusion, activating agent $ZnCl_2$ had impact on enhanced quality of the activation carbon in terms of increased surface area and average pore diameter produced by one step activation than two step chemical process.

Table 1. Pore structure characteristics of activated carbon produced from maize cob

Activated carbon production sequence	Surface area (BET) m^{2}g^{-1}	Total pore volume (cm^{3}g^{-1})	Average pore diameter (nm)
One step activation	912	0.93	14.45
Two step activation	627	1.12	13.90

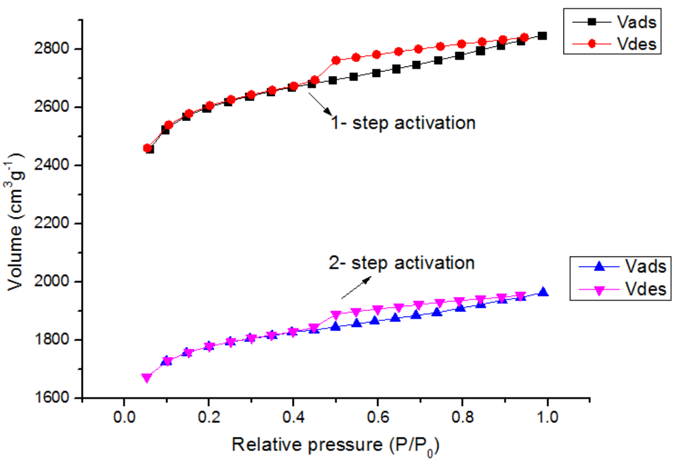

Fig 1: Nitrogen adsorption and desorption isotherm of activated carbon

Reference

Ravichandran, P., P. Sugumaran, S. Seshadri, and Altaf H. Basta. 2018. Optimizing the route for production of activated carbon from Casuarina equisetifolia fruit waste. Royal Society open science 5., 7: 171578.

Saka, Cafer. 2012. BET, TG–DTG, FT-IR, SEM, iodine number analysis and preparation of activated carbon from acorn shell by chemical activation with ZnCl2. *Journal of Analytical and Applied Pyrolysis.*, 95: 21-24.

Rooftop Garden- as Revenue Generating Component- A Case Study

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Keywords: *Rooftop garden, Revenue generation, Urban agriculture*

Introduction

Rooftop garden farming gives a way to produce food crops like a kitchen garden. Urban rooftop farming is developing because of increasing awareness in urban agriculture. The concept of rooftop greenery with vegetables, greens and flowers would help to meet the daily requirement of a small family besides paving way for generating additional income by the way of selling the extra produce (Green, 2004). The garden also provided nearly 400 g of fresh monthly vegetable harvest per m^2 of garden (Chitra *et al*., 2020). The current study with type design helps us to understand the suitability and optimality of the growing food crops in rooftops.

Methodology

Suspicion about the quality of vegetables available in urban markets and recycling of household waste is the main motivation for these farming (Vazhacharickal and Buerkert, 2011). The rooftop terrace area available in an urban environmental has been found in the range of 10x10m a maximum of 50x50 m. However, for practical purposes of type designs the basic unit terrace area can be considered as 30x30m for a rational allotment of vegetable and ornamental plants. The following type design with 30x30m rooftop terrace area with apparitional plot areas for vegetables in the middle and aesthetic ornamental plants is outlined as follows (Figure 1).

1.Peripheral buffer of width 2m is used for ornamental plants for aesthetic value of building environmental.
2.The middle core partition of terrace has been sub divided into 16 troughs of width 45cm and length 26 m with an effective canopy spread and walking space for a with 1.6 m (0.8 m on both sides).
3.Each trough is cultivated with a different crop such as tomatoes, brinjal, bhendi, chillies, onions, greens, medicinal plants, climbers like gourds, pineapples, water melon, papaya etc.
4.For each trough allotted for its plants the possible yields, the household requirement and the yield excess for sale have been worked.

Results and Discussion

The saving on expenditure towards vegetables from outside market and the appropriate revenue potential of yield excess by way of sales to the market have been worked out (Table 1). It has been established from this type design that rooftop terrace garden would excellently scope for self-sufficiency in day-to-day kitchen requirement besides a significant revenue generation potential for operation and maintenance of terrace garden. The quality of water used to get quality produce can be accomplished by using rooftop rain water harvesting systems which help to irrigate terrace plants in combination with the municipal water supply or bore well water supply in individual household. From the above analysis as the B/C ratio are 3.28 it can be noticed that it can be easily adoptable and easily affordable by anyone.

Table 1. Daily requirements of vegetable for average family and price

S.No	Vegetable	Requirement (g)	Price/kg	Total amount (Rs)
Daily Requirement of Vegetables				
1	Tomato	500	50	25
2	Brinjal	500	35	17.5
3	Bhendi	500	30	15
4	Onion(big)	250	26	6.5
5	Onion (Small)	250	74	18.25
6	Coriander leaf	1 bunch	56	14
7	Chilli	250	45	11.25
8	Gourd	500	30	30
9	Amaranthus (Greens)	1 bunch	17	17
10	Curry leaf	1 bunch	26	13
		Total 167.5		
Weekly Requirement				
1	Beet root	500	38	19
2	Cabbage	500	32	16
3	Mint	2 bunch	25	25
		Total 60		
Cost of vegetables for Total weekly requirement = Rs 1230				

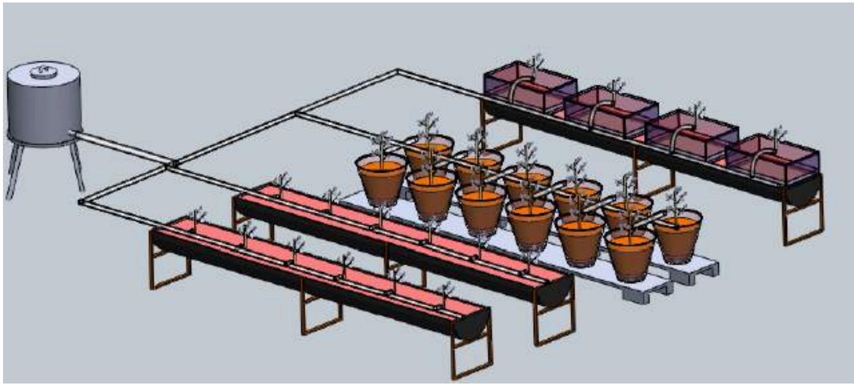

Fig 1: A type design of rooftop farming

Reference

Chitra,C., S.S. Nath, P. Varshney, S. Kumar.2020. Assessment of terrace gardens as modifiers of building microclimate, Energy and Built Environment,

Green, B. 2004. A guide to using plants on roofs, walls and pavements (Greater London Authority, London).

Vazhacharickal ,P.J. and A. Buerkert. 2011. Sustainable cities: an overview of the urban and peri-urban agricultural production in Mumbai Metropolitan Region (MMR). *Leituras de Economia Política* 19: 69- 87.

Studies on Drying of Tamarind Fruit

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Keywords: *Dehulled, hulled, drying rate, moisture content*

Introduction

Tamarindus indica L., commonly known as tamarind belongs to Fabaceae family, which means that they comprised of fruits with seeds enclosed with in an encapsulated pod. Tamarind fruits begin to ripen during the months of February-March. The pods are allowed to ripen on the tree until the outer shell is dry and could be easily separated from the pulp without adherence. Tamarind is highly hygroscopic and sticky in nature. It is recommended that fruit should be harvested when the moisture content is less than 20% to facilitate the separation of the shell from the pulp.

Methodology

Tamarind fruits (dehulled and hulled) were dried in a convective tray dryer at three temperatures namely 40, 50 and 60^{0}C and the drying data was recorded at every one-hour interval. Dehulled and hulled tamarind fruit at a moisture content of 35.35±1 %(d.b.) and 41.64±1 %(d.b.), respectively spread in a thin layer and dried at 40, 50 and 60^{0}C, till the sample attained safer moisture content 15±1 % (d.b.). From the data, the drying characteristic curves were plotted between moisture removal rate and drying time. A plot between moisture content on dry basis and drying time was also made to interpret the data easily.

Results and Discussion

Drying characteristics of dehulled and hulled tamarind fruit

Drying characteristic curves of dehulled and hulled tamarind fruit dried at 40, 50 and 60^{0}C in a convective tray dryer are shown in Figure 1 and 2. The moisture content during drying decreases continuously with the increasing time at the drying temperature of 60^{0}C. The drying time required to dry the dehulled tamarind fruit at 60oC from an initial moisture content of 35.35 %(d.b.) to 15.46 %(d.b.) was found to be 4h. Whereas, the drying time required for drying the dehulled tamarind fruit at 40 and 50^{0}C was found to be 30 and 8 hours, respectively. The drying time required to dry the hulled tamarind fruit at 40, 50 and 60^{0}C from an initial moisture content of 41 %(d.b.) to 15±1 %(d.b.) was found to be 30, 16 and 5, respectively.

Effect of drying air temperature on drying rate of tamarind

There is a continuous decrease in drying rate from the beginning to the end of the drying operation irrespective of the temperature of drying air used. When 60^{o}C hot air was used for drying, the dehulled tamarind recorded the highest drying rate of 0.004 kg of moisture removal per hour per kg of dry matter during the first one hour of drying and the lowest drying rate of 0.00062 kg of moisture removal per hour per kg of dry matter during the last one hour of drying. Whereas in case of 40 and 50^{0}C drying air temperatures, the maximum drying rate recorded was 0.00267 and 0.0333 kg of moisture removal per hour per kg of dry matter during the first one hour of drying and the minimum value recorded was 0.00002 and 0.00052 kg of moisture removal per hour per kg of dry matter during the last one hour of drying, respectively. It is also observed that at any point of drying time, an increase in drying air temperature recorded increased drying rates within the range of drying air temperatures studied. Similar trend of drying rate was observed for the dehulled tamarind fruit when dried at 40 and 50^{0}C drying air temperatures. It is concluded that the mechanical drying of dehulled and hulled tamarind at 60^{0}C had higher moisture removal rate followed by mechanical drying at 50^{0}C and 40^{0}C. It was observed that drying of tamarind occurred in the falling rate period

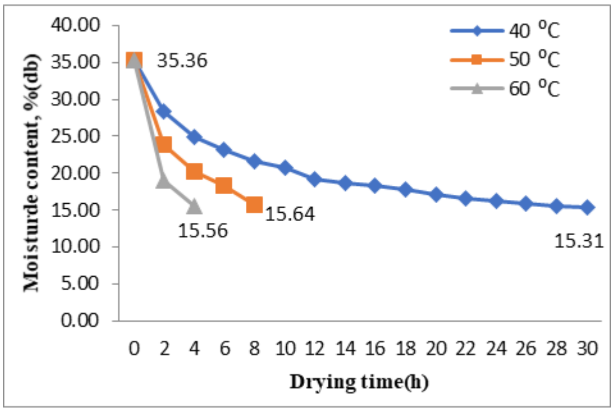

Fig 1: MC of dehulled tamarind fruit dried at 40, 50 and 60⁰C in convective tray dryer

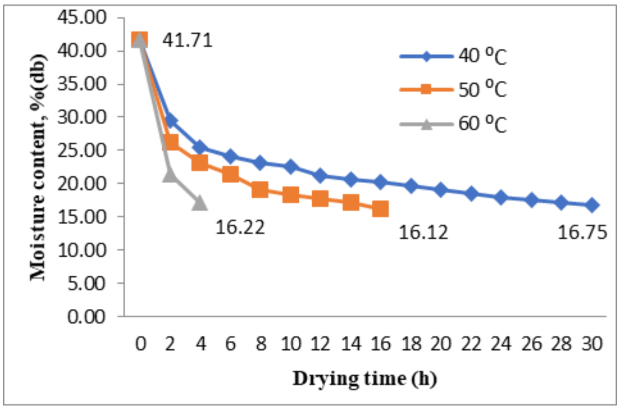

Fig 2: MC of hulled tamarind fruit dried at 40, 50 and 60⁰C in convective tray dryer

Reference

Idhayavarman, S. 2019. Development of a belt conveyor type dryer for drying dehulled tamarind fruit. M.Tech Thesis submitted to TNAU, Coimbatore.

Muzaffar, K., S. A. Sofi, and P. Kumar. 2018. Comparative study of ripe tamarind pulp andspray dried tamarind pulp powder for compositional analysis. *International Journal of Advanced Science and Technology*, 7(4): 756-761.

Pandian, N.K.S., P. Dhananchezhiyan, and S. Parveen. 2013. Physical and engineering properties of tamarind fruit. International journal of Scientific *Engineering and Technology*, 2(11): 1083-1087.

Sinha, Amit Kumar, S. Patel, and P. L. Choudhary. 2012. Some studies on physical and chemical properties of tamarind at different moisture content. *Journal of Plant Development Sciences*, 4(1): 81-84.

Study of Feasibility of Solar Tunnel Dryer for Preparing Onion Powder

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Keywords: *Drying, solar tunnel dryer, onion powder, small –scale industry.*

Introduction

Drying is one of the traditional methods used for the preservation of agricultural produce. Onion has a large market in India and the cost varies throughout the year. Drying provides value addition to the produce. The study was conducted by using a solar tunnel dryer for drying onion. Drying characteristics and cost economics were determined for onion. This study was conducted to determine the feasibility of solar dryers for Indian farmers, small-scale industry or start-ups.

Methodology

A small unit of solar dryer installed at PDKV; Akola was used for the study. Digital thermometer was fixed inside the drier to measure the temperature, weighing of material was done by using an electronic balance, a low-capacity vegetable slicer, a low-capacity grinder is used to prepare the powder and hot air oven. Raw material, onion was collected from the local market. Primary unit operations such as peeling, cutting, or slicing were done. The material was weighed on an electronic balance and then kept in a solar tunnel dryer for drying. Then 10 g sample was kept separately in the solar tunnel dryer to take weight readings. Readings were taken in 1 hr intervals until equilibrium moisture content was reached. Dried onion was then ground by using a grinder to prepare the onion powder. To determine the initial moisture content, the oven-dry method is used. About 10 g of samples were taken in an oven and the moisture content on a wet basis (wb) was calculated using the Eq. (1)

$M\ (\%\ wb) = (m_i - m_f)/\ m_i$ -------- (1)

where, M is moisture content, m_i and m_f are initial and final moisture content. The Moisture ratio of the produce was computed by the following formula (Chakraverty, 1988). $MR = (M-M_e)/(Mo-Me)$ where, M is moisture content %(db), Me is EMC, %(db), Mo is IMC %(db)

Drying rate- The drying rate of the sample during the drying period was determined as follows (Chakraverty, 1988). $DR=DW/Dt$ where, DR is drying rate, g/min, DW is weight loss in 1 h interval, Dt is the difference in time reading, min.

Results and Discussion

Initial Moisture Content (Oven drying method) present in the onion sample was 90% (wb).

Drying of onion (Solar tunnel dryer)

The total drying time for solar drying of onion was 7 h. Table 1 represents the values of moisture content, drying rate, and moisture ratio with respect to time. The initial and final weight of the solar tunnel dried onion sample was 10 g and 1.6 g respectively. The final moisture present in the dried sample was 0.42 g. Total moisture removed from the sample was 8.4 g. Initial Moisture content was 747.45% (db) reduced up to 35.59 % (db). The drying rate after the first hour was 0.0461 (g/min) and at the end of drying it was 0.0200 (g/min). Figure 1 shows the relation between drying rate, time, and moisture ratio. Figure 2 shows the relation between moisture content and time.

Feasibility of Solar tunnel dryer for farmers and startup

From the data above, the solar dryer is efficient for drying sliced onion. The quality of dried onion powder was good, both in taste and appearance. Thus, solar dryers would reduce storage losses of onion and could provide a good income source for farmers. The cost of onion powder available in the market ranges between Rs. 300 to Rs.700 per kg. The estimated cost of onion powder prepared by using a solar dryer was Rs.571 per kg.

Table 1. Values of Moisture content, drying rate and Moisture ratio with respect to time

Sr. No.	Time(min)	Weight of sample, (g)	Moisture removed, (g)	Moisture present, (g)	Moisture content (db)	Drying rate(g/min)	Moisture ratio
1	0	10	0	8.82	747.45	0	1
2	60	7.23	2.77	6.05	512.71	0.0461	0.67
3	120	5.14	4.86	3.96	335.59	0.0405	0.42
4	180	3.8	6.2	2.62	222.03	0.0344	0.26
5	240	2.9	7.1	1.72	145.76	0.0295	0.15
6	300	2	8	0.82	69.49	0.0266	0.047
7	360	1.8	8.2	0.62	52.54	0.0227	0.023
8	420	1.6	8.4	0.42	35.59	0.0200	0

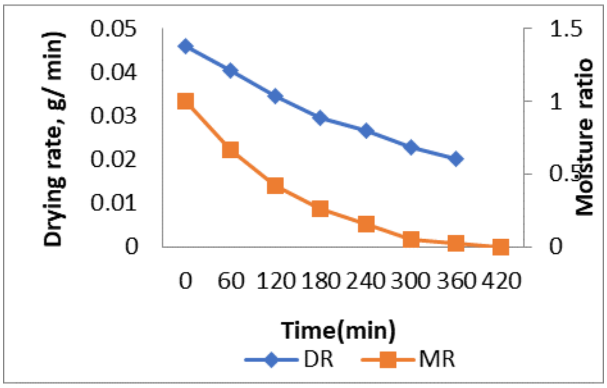

Fig 1: Drying rate v/s time v/s Moisture content

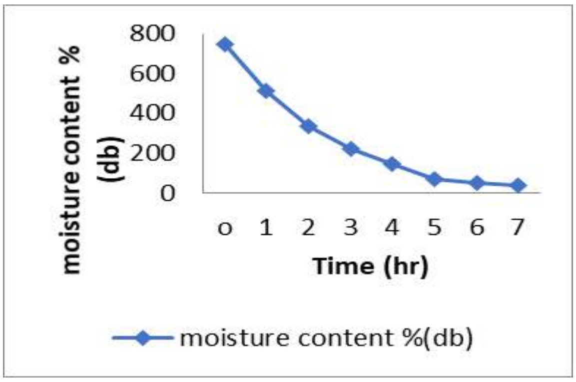

Fig 2: Moisture content v/s Time

Reference

P.N. Sarsavadia (2007) Development of a solar-assisted dryer and evaluation of energy requirement for the drying of onion Elsevier, *Renewable Energy* 32: 2529–2547

Rai, G. D. (1994), Solar Energy Utilization Khanna publications, New Delhi: 1-3

Rathore NS, Panwar NL. (2010) Design and development of energy efficient solar tunnel dryer for industrial drying. Clean Tech Environ Policy

Sharma, G, P.; Verma, R. C. and Pathare, P. B. (2005). Thin-layer infraredradiation drying of onion slices. J. *of Food Engineering*, 67(3): 361-366S.

Vijaya Venkata Raman, S. Iniyan, Ranko Goic S. (2012) A review of solar drying technologies Elsevier, *Renewable and Sustainable Energy Reviews* 16: 2652–2670

Sub - Atmospheric Pressure Superheated Steam Drying of Carrot Slices

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Keywords: *Superheated steam drying ,Volume, Apparent density,Rehydration, Case-hardening.*

Introduction

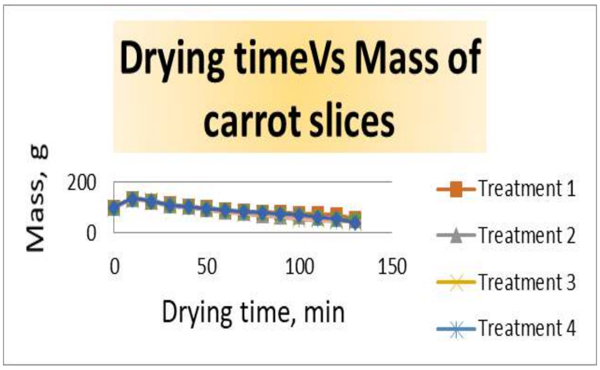
Superheated steam drying (SHSD) is a novel, hybrid, air-less drying technology, by utilizing steam beyond its boiling point as a drying medium in order to remove moisture from the food material. This technology is useful for high-value food stuffs, besides environment and energy saving benefits and overcome many constraints of the conventional drying techniques (Tang *et al.*, 2000). Carrot (*Daucus carota*), a major root vegetable is rich in bioactive compounds like carotenoids and dietary fibers along with significant health-promoting functional components. The present study is taken up to dehydrate the carrots using superheated steam under sub-atmospheric pressure conditions and extend its shelf-life with superior quality characteristics. Hence, the dehydrated carrot will constitute as an attractive snack in the form of crisps.

Methodology

Fresh carrots were purchased from a local farmer and stored at 4 ± 2^{0}C. Prior to the start of experiments, the carrots were washed, peeled and sliced into 2 mm thickness. The drying studies were carried out under sub-atmospheric pressure levels (0.8, 0.5 bar), superheated steam temperatures (70, 90^{0}C) and volumetric steam flow rate (0.1, 0.5 m^3/h). The moisture content of carrot slices was determined by vacuum oven method (AOAC, 1975). The effect of operating parameters on the drying characteristics as well as changes in volume, apparent density, rehydration ability and case hardening effect in terms of shrinkage, of the dried product were evaluated. A higher steam circulating velocity of more than 13 m/s was considered for the study. The flow rate of steam into the drying chamber was maintained at about 25 kg/h. The volume and apparent density was measured by water displacement method (Mohsenin,1986). A model was developed using Minitab 19.2 statistical software.

Results and Discussion

The carrot slices at initial moisture content of 425% (d.b.) was dried to 52.80% (d.b.) in the low-pressure superheated steam dryer. An increase in drying temperature from 70 to 90^{0}C lead to a reduction in the drying time of about 59 and 42%. The moisture content decreased faster with a decrease in operating pressure from 0.8 to 0.5 bar. The higher drying rate was observed when the dryer was operated at 90^{0}C and 0.5 bar. The volume and apparent density of the dried carrot slices had an insignificance of operating conditions. The carrot slices showed a uniform shrinkage pattern and a better rehydration capability. The model developed by considering quality attributes of dried carrot slices as a function of time with R2 of 98.74% was y = 554 – 133 density + 79 porosity + 37.6 RR + 48.8 shrinkage. The carrot slices dried in the low-pressure superheated steam dryer was shelf-stable, nutrient-rich, fresh-like and utilized as convenient Ready-to-Eat (RTE) snack food product.



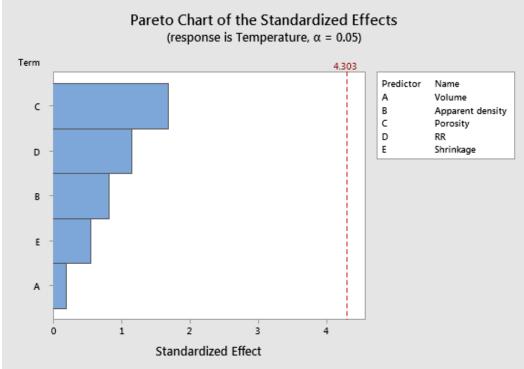


Fig 1: Drying curve of carrot slices subjected to combination of treatments

Fig 2: Standardized effect of superheated steam temperature on quality attributes of the dehydrated carrot slices

Reference

AOAC. 1995. Official methods of analysis of AOAC International. Arlington, Va.: AOAC International Private Limited, USA.

Mohsenin, N.N. (1986). Physical Properties of Plants and Animal Materials. Gordan Breach Sci. Press, New York, USA, pp.881.

Tang, Z., S. Cenkowski and W. E. Muir. 2000. Dehydration of sugar-beet pulp in superheated steam and hot air. Transactions of the ASAE, 43 (3): 685-689.

Vegetation and Water Indices for Mettupalayam Taluk of Coimbatore District of Tamil Nadu: A RS and GIS Approach

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Keywords: *NDVI, NDWI, NDMI, Mettupalayam, Vegetation Indices.*

Introduction

Vegetation is one of the vital parts of the terrestrial Ecosystem. It regulates the flow of many biogeochemical cycles and also serves as wildlife habitat and the energy source. Vegetation cover reduces the soil erosion. So, the vegetation analysis become important. Vegetation Indices help to analyse the vegetation in the particular area. Remote sensing and GIS provide the facility to analyse vegetation spatially with more resolution. With this concept the study on Vegetation Indices for Mettupalayam Taluk was carried out in this paper.

Methodology

Mettupalayam Taluk of Coimbatore District of Tamil Nadu was taken as a study area for this study. Mettupalayam in located in the foot hills of Nilgiris on the bank of Bhvani River. For this study the Landsat 8 image was downloaded from https://earthexplorer.usgs.gov/. Landsat 8 data was used as an input for ArcGIS 10.3 software to calculate the indices.

Results and Discussion

The vegetation indices such as NDVI, GNDVI, NDWI, MNDWI, NDMI and WRI were calculated using the following formula by Landsat 8 images. Normalized Difference Vegetation Index (NDVI) quantifies vegetation by measuring the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs). Based on the values obtained from the output, it classified as different vegetation cover such as water body, land, shrubs and healthy vegetation. Green Normalized Difference Vegetation Index (GNDVI) for Mettupalayam ranges between -0.157051 to 0.49213. NDWI values are ranging from -0.49213 to 0.157051. Normalize Difference Water Index (NDWI) value lies between -1 to 1. Generally, water bodies NDWI value is greater than 0.5. Vegetation has much smaller values which distinguishing vegetation from water bodies easily. MNDWI ranging between -0.733634 to 0.251996. Normalized Difference Moisture Index (NDMI) values lies between -0.395872 to 0.389368. Water Ratio Index (WRI) values ranges from 0.25803 to 1.40562. These Vegetation and Water Indices was used in the natural resources management.

Table 1. Formula for Vegetation and Water Indices Calculation

S.No	Index	Formula
1	Normalized Difference Vegetation Index (NDVI)	$NDVI = \frac{NIR - RED}{NIR + RED}$
2	Green Normalized Difference Vegetation Index (GNDVI)	$GNDVI = \frac{NIR - Green}{NIR + Green}$
3	Normalized Difference Water Index (NDWI)	$NDWI = \frac{Green - NIR}{Green + NIR}$
4	Modified Normalized Difference Water Index (MNDWI)	$MNDWI = \frac{Green - SWIR2}{Green + SWIR2}$
5	Normalized Difference Moisture Index (NDMI)	$NDMI = \frac{NIR - SWIR1}{NIR + SWIR1}$
6	Simple Ratio (SR)	$SR = \frac{NIR}{RED}$
7	Water Ratio Index (WRI)	$WRI = \frac{Green + RED}{NIR + SWIR2}$

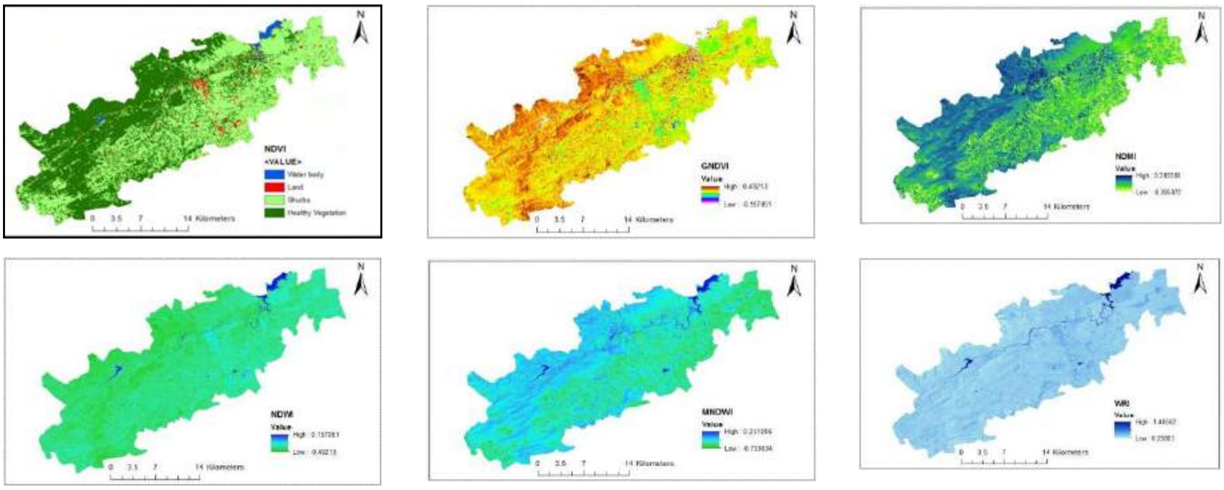

Fig 1: Vegetation and Water Indices for Mettupalayam Taluk

Reference

Feyisa G.L, Meilby H, Fensholt R and Proud S.R. 2014. Automated water extraction index: a new technique for surface water mapping using landsat imagery. *Remote sensing of environment,* 140:23-35.

https://earthobservatory.nasa.gov

Mcfeeters S.K. 1996. The use of normalized difference water index (ndwi) in the delineation of open water features. *International journal of remote sensing.,* 17: 1425–1432.

Mukherjee N.R and Samuel C. 2016.Assessment of the temporal variations of surface water bodies in and around chennai using landsat Imagery. *Indian journal of science and technology,* 9(18).

THEME 07

Perspectives in Nutrition and Dietetics

Bioactive Compounds and Nutritional Composition of Chocolate Prepared from Selected Spices

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Keywords: *Chocolate, spices, dietary fibre, polyphenols, flavonoids*

Introduction

India encloses a variety of spices, which are known to exhibit antidiabetic properties due to the presence of polyphenols and flavonoids, which acts as the major bioactive components and helps in the management of diabetes and cardiovascular diseases due to their antioxidant activity.The total polyphenol content of the cocoa beans is about 6–8% by dry weight and dark chocolate is considered one of the major contributors of antioxidants to the American diet after fruits and vegetables (Andres-Lacueva *et al.,* 2008; Manach *et al.,* 2004). Foods developed by incorporating spices have the potential to contribute to a healthier society. There has been mounting evidence in recent years that food choices are an important factor in reducing the risk of developing heart disease, metabolic diseases, cancer, and obesity. Hence, the present study was carried out to determine the nutritional composition and bioactive compounds of chocolate prepared from selected spices viz., fenugreek, black cumin, coriander and cinnamon powders at different equal level of substitution (1% [SPIC1]), 1.5% [SPIC2] and 2% [SPIC3]).

Methodology

The cocoa mass and cocoa butter were purchased from Morde Foods Private Ltd., Pune. Spices viz., coriander, fenugreek, black cumin, cinnamon and sugar were purchased from Sri MRV supermarket, Redhills, Chennai.The moisture, protein, fat, crude fiber, total ash content were analyzed according to the method described in AOAC (2006), carbohydrate content was calculated by difference method as described by Muller and Tobin, (1980), and total dietary fiber content was determined by the enzyme-gravimetric method as described in AOAC (2016).The total phenolic content was determined according to the method given by Chun *et al.,* (2003).The total flavonoid content was determined according to the method described by Lin and Tang, (2007).The condensed tannin content was determined according to the method described by Schanderl, (1970).

Results and Discussion

Nutritional composition of spices incorporated chocolate

The nutritional components viz., moisture, protein, fat, crude fibre, total ash, carbohydrate and total dietary fibre content of the control and spice powders incorporated chocolate (SPIC) were presented in **Table 1**.Amongthe chocolates developed, 2% incorporation level recorded maximum dietary fibre content of 5.82g/100g.

Bioactive compounds of spices incorporated chocolate

Bioactive compounds viz., total phenols, total flavonoids and condensed tannin content of the control and spice powders incorporated chocolate (SPIC) were presented in **Table 2**. Among the chocolates developed, 2% incorporation level recorded maximum total phenols, total flavonoids and condensed tannin content of 25.91mg/g, 96.07mg/g and 13.31mg/g respectively.

Table 1. Proximate composition of spice powders incorporated chocolate

Parameters	Moisture (%)	Protein (%)	Fat (%)	Crude fibre (%)	Total ash (%)	Carbohydrate (%)	Total dietary fibre (%)
Control	1.18±0.008a	5.44±0.017a	27.98±0.009c	0.26±0.039a	1.81±0.011b	63.34±0.026d	3.34±0.010a
SPIC1	1.27±0.010b	5.94±0.016b	27.38±0.014a	0.61±0.012b	1.69±0.014a	63.11±0.022c	4.12±0.014b
SPIC2	1.50±0.013c	6.03±0.015c	27.51±0.012b	1.03±0.014c	1.75±0.022a	62.17±0.051b	4.92±0.109c
SPIC3	1.53±0.009c	6.17±0.014d	28.25±0.016d	1.33±0.012d	2.06±0.008c	60.67±0.028a	5.82±0.012d
F-value	290.634**	407.246**	910.198**	451.926**	123.287**	1290.925**	369.684**

Table 2. Bioactive composition of spice powders incorporated chocolate

Bioactive compounds	Total phenolics (mg/g of GAE)	Total flavonoids (mg/g of Quercetin)	Condensed tannins (mg/g of Tannic acid)
Control	**13.17±0.150^{a}**	**78.81±0.165^{a}**	**5.33±0.048^{a}**
SPIC1	**17.46±0.120^{b}**	**80.38±0.144^{b}**	**6.61±0.107^{b}**
SPIC2	**22.30±0.185^{c}**	**82.42±0.158^{c}**	**10.76±0.128^{c}**
SPIC3	**25.91±0.345^{d}**	**96.07±0.366^{d}**	**13.31±0.203^{d}**
F-value	**652.166****	**1206.089****	**764.374****

Reference

Andres-Lacueva, C., M. Monagas., N. Khan., M. Izquierdo-Pulido., M. Urpi-Sarda., J. Permanyer., and R.M. Lamuela-Raventos. 2008. Flavanol and flavonol contents of cocoa powder products: influence of the manufacturing process. *Journal of Agricultural and Food Chemistry*, 56(9): 3111-3117.

AOAC. 2006. Official Methods of Analysis, 18th edition. Association of Official Analytical Chemists, Gaithersburg, MD.

AOAC. 2016. Official Methods of Analysis of AOAC International, 20th edition. AOAC International, Rockville, Maryland, USA.

Chun, O.K., D.O. Kim., and C.Y. Lee. 2003. Superoxide radical scavenging activity of the major polyphenols in fresh plums. *Journal of Agricultural and Food Chemistry*, 51: 8067-8072.

Lin, J.Y., and C.Y. Tang. 2007. Determination of total phenolic and flavonoid contents in selected fruits and vegetables, as well as their stimulatory effects on mouse splenocyte proliferation. *Food Chemistry*, 101(1): 140-147.

Manach, C., A. Scalbert., C. Morand., C. Remesy., and L. Jimenez. 2004. Polyphenols: food sources and bioavailability. *The American Journal of Clinical Nutrition*, 79(5): 727-747.

Muller, H.G., and G. Tobin. 1980. Nutrition and Food Processing, Croom Helm, London.

Schanderl, S. H. 1970. In: Method in Food Analysis, Academic Press, New York, p. 709.

Comparison of Phytochemical Profile of Raw and Cooked Horse Gram (*Macrotyloma uniflorum*) Seeds by GC-MS/MS

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Keywords: *Horse gram, cooking, boiling, roasting, GC-MS/MS*

Introduction

Horse gram (*Macrotyloma uniflorum*) is an underutilized and unexplored food legume. They are low in fat and excellent sources of protein, dietary fiber, a variety of micronutrients and macronutrient. The most important pharmacological activities of the horse gram are astringent, anthelmintic, antipyretic, anti-oxidant activity, urinary discharges, and cardiovascular disease. The seeds of *Macrotyloma uniflorum* contain much more bioactive substances such as alkaloid, phenolic acid, tannin, flavonoids, fiber, essential fatty acid etc., which have significant metabolic and physiological effects. Even though, the horse gram is a richest source of phytochemical, the bioactive compounds are lost significantly during cooking process. Hence, the study was carried to evaluate the effect of different methods of cooking on phytochemical profile of horse gram.

Methodology

The horse gram seeds were cooked (pan boiling, pressure cooking, roasting) and the phytochemicals present the samples were extracted with methanol. The methanolic extract of raw and cooked seeds were analysed by GC-MS/MS. GC-MS/MS was carried out using a TSQ 8000 Evo system (ThermoFisher Scientific, Palo Alto, CA, USA). Separation was done on a nonpolar TG-5MS fused silica capillary column (30 m × 0.25 mm i.d., 0.25 µm film thickness; Code 26098-1640, Thermo Fisher Scientific, USA) with helium carrier gas at 1.2 mL/min constant flow.

Results and Discussion

The phyto chemicals present in the horse gram seeds such as :

N-Trifluoroacetyl methoxytyramine,

2-Trimethylsilylthiobenzoic acid trimethylsilyl ester,

2-Methyl-2(p methoxy)mandelate,

bis(trimethylsilyl)-, 2-Butyl-10H-acridin-9-one,

2,4 Dihydroxyacetophenone,

p-Trimethylsilyloxyphenyl bis(trimethylsilyloxy)ethane,

4-tert-Butyl 2-(trimethylsilyl)phenol,

3-(10-Methyl-10H-acridin-9-ylideneamino)-benzoic acid,

Protocatechuic acid

All the above phytochemicals were totally reduced to not detectable level during cooking process because of the high heat sensitivity and leaching of the active compounds.

The raw seeds of horse gram contain highest amount of phytochemical such as aldehyde, ketone, organic acid, amino acids, sugars, phenolic compounds than the cooked seeds. The retention of phytochemicals was highest in the pressure-cooked samples. The pan boiling and roasting leads to the significant loss of phytochemical which are sensitive to heat.

Table 1. Identified phytochemicals and their average percentage area (*n*=3) of raw and cooked horse gram

S. No	Phytochemicals	Raw	Pan boiling	Pressure cooking	Roasting
1.	4-Hydroxybenzaldoxime	0.36	0.45	0.30	0.20
2.	Phloroglucinaldehyde, tris(trimethylsilyl) ether	0.43	0.20	0.22	0.25
3.	N-(Trifluoracetyl)-O,O',O''-tris(trimethylsilyl)epinephrine	0.40	n.d.	n.d.	0.33
4.	3-Isopropoxy-1,1,1,7,7,7-hexamethyl-3,5,5-tris(trimethylsiloxy)tetrasiloxane	0.47	0.25	0.13	0.31
5.	o-Methoxymandelic acid	0.46	0.35	n.d.	n.d.
6.	3,4-Dihydroxybenzaldehyde, bis(trimethylsilyl) ether	0.36	0.25	0.04	n.d.
7.	Trimethylsilyl-di(timethylsiloxy)-silane	0.38	0.47	0.14	0.66
8.	5-Methylsalicylic acid	1.06	0.06	0.14	n.d.
9.	2,6-Dihydroxybenzoic acid	0.41	0.48	0.40	0.41
10.	Benzoic acid, 4-methyl-2-trimethylsilyloxy-, trimethylsilyl ester	0.71	0.16	n.d.	n.d.
11.	3-Butoxy-1,1,1,5,5,5-hexamethyl-3-(trimethylsiloxy)trisiloxane	0.74	0.33	0.43	n.d.
12.	Tris(tert-butyldimethylsilyloxy)arsane	0.79	n.d.	n.d.	0.22
13.	2-Butyl-10H-acridin-9-one	0.36	n.d.	n.d.	n.d.
14.	p-Trimethylsilyloxyphenyl-bis(trimethylsilyloxy)ethane	0.42	n.d.	n.d.	n.d.
15.	Protocatechoic acid	0.36	0.25	n.d.	n.d.
16.	1,4-Cyclohexadiene, 1,3,6-tris(trimethylsilyl)-	0.31	0.09	0.30	0.08
17.	Carbamazepine-10,11-dihydro-10-ol	0.63	n.d.	n.d.	n.d.
18.	3-Methyl-2-(trimethylsilyl)oxybenzoicacidtrimethylsilyl ester	0.38	0.33	0.34	0.48

Reference

Vashishth, R., Semwal, A.D., Pal Murugan, M. *et al.* Post-harvest processing, cooking and textural properties of horse gram (*Mycrotyloma uniflorum*) varieties. *Food Measure* **12,** 257–268 (2018). https://doi.org/10.1007/s11694-017-9636-9

Effect of Simple Processing on Selected Organophosphate's Pesticide Residues in Cotton seed

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Keywords: *Cottonseed, Processing, Pesticide residues, Organophosphates*

Introduction

Cotton is at the fourth-largest place in agricultural chemical consumption among countries, namely India, China, Brazil, USA and Pakistan who face the problems are boll weevil, cotton bollworm, pink bollworm, whitefly and leaf curl virus worsening. These pests were controlled by the application of different dosage of organophosphates (OP's), organochlorines (OCP's) and pyrethroids (PP's) though disturbing the acetyl-cholinesterase enzyme activities in the nervous system, resulting in impaired nerve coordination. The physicochemical properties of the pesticides can be changed by the different food processing techniques.

Methodology

The selected nine OP's compounds (Phorate, Dimethoate, Methyl parathion, Malathion, Chlorpyrifos, Quinalphos, Profenofos, Ethion and Triazophos) were prepared in the concentration of 1.0 g/ml from the stock standard. The untreated and pesticide free cottonseed sample (T_1) was treated with 1 g/ml/g (1ppm) of pesticide solutions to 5g of sample (T_2). They were kept for 1 hour at ambient temperature in closed condition and further analysed for residues concentration. Again, T_2 samples were adapted to the different methods of processing such as (i) roasting at 80°C for 5 min (R_1) and 10 min (R_2), (ii) soaking for 6 hours (S_1) and 12 hours (S_2) and (iii) autoclave for 5 min (AC_1) and 10 min (AC_2). All the samples residues were analysed as per QuEChERS extraction method and validated by GC-MS/MS.

Results and Discussion

OP's residue of unfortified and pesticide fortified samples

The OP's residues concentration as influenced by different processing conditions in the pesticide fortified cottonseed samples and MRL (Maximum Residue Level) for cottonseed were presented in Table 1. The T_1 sample showed a non-detectable concentration level for all OP's residues. The T2 treated samples had an all OP's residues with concentration ranging from 856 to 1138ng/g of sample. Also, this residues resulted accumulated more than MRL and was thus not suitable for consumption and may cause illness to human and environment.

Effects of processing on OP's pesticide residues

The OP's concentration as per the effect of processing in pesticide fortified cottonseed samples were shown in Table 1. The selected OP's compounds residue was presented in T_2 and its concentration accounted for a maximum in methyl parathion (1138ng/g) followed by dimethoate (992ng/g), ethion (991ng/g) and least in profenofos (856ng/g). The selected OP's compound such as phorate was detected in the treatment R_1 and R_2 as 56.45 and 88.93ng/g respectively, methyl phorate residue in S_1 (115.77ng/g), chlorpyrifos residue in R_1 (18.64ng/g) and R_2 (25.49ng/g) process and ethion residue was presented in the roasting process as 8.42 and 9.68 in R_1 and R_2 respectively and autoclaving process as 0.89 and 0.67ng/g in AC_1 and AC_2 respectively by subjecting to the pesticide treated cottonseed samples. The OP's compound residues *viz.*, phorate, chlorpyrifos and ethion residue concentration were detected high in R_2 process compared with R_1

(p<0.05). In soaking treatment as S_1 and S_2 showed a not detectable limit of OP's residues exception of methyl parathion in S_1 (115ng/g). Autoclaving processes inhibited the selected OP's residue accumulation except for ethion in pesticide treated cottonseed samples. By considering the MRL of OP's compounds set by the Japan Food chemical Research Foundation, the processed sample from R_1 and R_2 treatments showed as excess than MRL (0.05mg/kg) for phorate residue and the other OP's compounds residue were presented from all processed samples that had a non-detectable or low concentration level than MRL.

Table 1. Pesticide residues in pesticide free, pesticide fortified, and pesticide fortified cum processed cottonseed samples (ng/g) and MRL (mg/kg)

S.No	Pesticide name	T_1 (ng/g)	T_2 (ng/g)	R_1 (ng/g)	R_2 (ng/g)	S_1 (ng/g)	S_2 (ng/g)	AC_1 (ng/g)	AC_2 (ng/g)	MRL* (mg/kg)
Organophosphates										
1	**Phorate**	nd	925.0± 13.21	56.45± 0.84	88.93± 2.60	nd	nd	nd	nd	0.05
2	**Dimethoate**	nd	992.0± 5.37	nd	nd	nd	nd	nd	nd	1.0
3	**Methyl parathion**	nd	1138.0± 8.80	nd	nd	115.77± 2.91	nd	nd	nd	1.0
4	**Malathion**	nd	892.0± 7.89	nd	nd	nd	nd	nd	nd	20
5	**Chlorpyrifos**	nd	938.0± 8.29	18.64± 0.12	25.49± 0.65	nd	nd	nd	nd	0.05
6	**Quinalphos**	nd	961.0± 3.07	nd	nd	nd	nd	nd	nd	0.02
7	**Profenofos**	nd	856.0± 8.15	nd	nd	nd	nd	nd	nd	3.0
8	**Ethion**	nd	991.0± 8.09	8.42± 0.21	9.68± 0.21	nd	nd	0.89± 0.01	0.67± 0.02	0.3
9	**Triazophos**	nd	948.0± 9.67	nd	nd	nd	nd	nd	nd	0.2

***Pesticide MRL for cottonseed set by FFCR; T_1- Untreated pesticide free; T_2-Pesticide treated sample; R_1- Roasting 5 min; R_2-Roasting 10 min; S_1-Soaking 6 hours; S_2-Soaking 12 hours; AC_1-Autoclaving 5 min; PC_2-Autoclaving 10 min**

Reference

Gurbuz, Y., Demir, O. L., Yİgİt, M. F. and Karatas, E. (2014). Effects of heat processing on nutritive value of whole cottonseed. In *XVI International Symposium," Feed Technology", 28-30 October 2014, Novi Sad, Serbia. Proceedings* (pp. 245-252). University of Novi Sad, Institute of Food Technology.

Mahugija, J. A. M., Kayombo, A. and Peter, R. (2017). Pesticide residues in raw and processed maize grains and flour from selected areas in Dares Salaam and Ruvuma, Tanzania. *Chemosphere*, *185*: 137-144.

Lehotay, S. J. and Cook, J. M. (2015). Sampling and sample processing in pesticide residue analysis. *Journal of Agricultural and Food Chemistry*, 63(18): 4395-4404.

Enhancing Functional and Nutritional Characteristics of Multigrain Mix by Incorporating Jamun Seed Powder

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Keywords: *Jamun seed powder, Multigrain health mix, Glycemic index, Bioactive compounds*

Introduction

The diabetes is one of the major metabolic disorder and a leading health problem in the world which is characterized by glucose intolerance and hyperglycemia. There are about 425 million people who have been suffering from diabetes in 2017 and this will be expected to rise up to 552 million by 2030 around the world. There is a need of therapeutic measures for the management of diabetes because the side effects and cost of commercial medications and drugs the people are interested in need of traditional and complimentary medicines. Jamun seed is widely used in the treatment of different diseases in particular diabetes. When there is an optimum amount of sugar already present in the blood, the jamboline, is a glycoside compound present in the jamun seed which helps in controlling the blood sugar level by switching off the mechanism of conversion of starch into sugar. The jamun seed powder can be blended with multigrain mix contain foxtail millet flour, defatted soya bean flour, whole wheat flour which are low in bioactive compounds to increase the functional and nutritional characteristics of multigrain mix.

Methodology

The jamun fruits were cleaned thoroughly in running tap water to remove dust and dirt particles. The jamun seeds and edible pulp were separated using hand pulper. Then, jamun seeds were dried in hot air oven at 60°C for 8 hours. The dried seeds were ground into fine powder using electric churner and sieved using BS 60 mesh sieve. The jamun seed powder was incorporated into prepared multigrain mix contain whole wheat flour, foxtail millet flour, defatted soya bean flour. To standardize multigrain mix, preliminary trials were conducted and prepared by incorporating 2, 4, 6, 8, 10 % jamun seed powder to multigrain mix presented in Table 1. Based on organoleptic evaluation after preparing products 4 % incorporation of jamun seed powder was found to be highly acceptable for health mix. The prepared jamun seed powder incorporated multigrain mix was sieved to remove any inedible matter and stored in an airtight containers for further analysis. The jamun seed powder was analyzed for its nutritional content. The jamun seed powder incorporated multigrain mix was analyzed for sensory, nutritional evaluation and Glycemic index also analyzed.

Results and Discussion

Chemical characteristics

The jamun seed powder incorporated multigrain mix contain 11.21 percent moisture, 3.23 percent ash, 59.79 percent carbohydrate, 19.45 percent protein, 1.65 percent fat, 3.25 percent fiber, 6.32 mg/100g iron, 105.62 mg/100g calcium. The glycemic index of jamun seed powder incorporated multigrain mix was estimated and compared with that of the control sample. The results are revealed in table 2. The developed multigrain mix will be highly suitable for commercialization.

Table 1. Composition of jamun seed powder incorporated health mix

SI. No	Composition (g)	Treatments					
		T_0	T_1	T_2	T_3	T_4	T_5
1.	**Whole wheat flour**	100	58	56	54	52	50
2.	**Foxtail millet flour**	-	10	15	20	25	30
3.	**Soya flour**	-	30	25	20	15	10
4.	**Jamunseed powder**	-	2	4	6	8	10

Table 2. Chemical characteristics of jamun seed powder incorporated multigrain health mix

Parameters	Result of Sample
Moisture (%)	11.21
Ash (%)	3.23
Carbohydrate (%)	59.79
Protein (%)	19.45
Fat (%)	1.65
Fiber (%)	3.25
Iron (mg/100g)	6.32
Calcium (mg/100g)	105.62

Table 3. Glycemic index of jamun seed powder incorporated multigrain mix

SI. No	Product	Glycemic index
1.	Control sample (T0)	62.42 (Moderate GI)
2.	Multigrain mix (T2)	51 (Low GI)

Reference

Raza, Ahmad, Muhammad Usman Ali, Tanzeela Nisar, Saeed Ahmad Qasrani, Riaz Hussain, and Muhammad Nawaz Sharif. (2015). "Proximate composition of Jamun (Syzygium cumini) fruit and seed." *digestion* 2 (4).

Marufa, Mushtari Akter, Pabitra Chandra Das, and Abdullah Iqbal. (2019). "Utilization of Jamun seed powder in composite cake formulation." *Journal of the Bangladesh Agricultural University* 17 (4):599-605.

Evaluation of Glycemic Index of Quality Protein Maize

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Keywords: *Quality protein maize, Glycemic index, diabetics, High fibre foods*

Introduction

Maize (*Zea mays* L.) is also known as corn, is one of the world's leading cereal grains along with rice and wheat. Considering area sown and annual production, it occupies an important position in world economy and trade as food, feed and industrial grain crop. Maize is commonly consumed as a source of cereals with functional properties and health benefits. The carbohydrates present in the maize that exhibit low glucose response after ingestion have been shown to be beneficial in the management of diabetes and hypelipidemia. Maize are part of all meals in India and the common maize naturally deficit of two amino acids. To overcome the deficit, new variety of maize "Quality protein Maize (QPM) has developed that contains the amino acids, lysine and tryptophan, changes this "inadequacy" of maize. Glycemic index (GI) is a useful concept for the management of blood glucose in those affected by diabetes.

Methodology

Glycemic Index (GI) of Quality Protein Maize (QPM) was determined by computed incremental area under the glucose response curve (IAUC) method in ten female (aged 19-22 years) subjects. The test samples were given as maize grits (T_1), milled rice (T_2) and mixture of equal portion of maize grits and milled rice (T_3) and white bread (T_0) which was used as the control food. Each subject was instructed to fast for 10–12 hours and refrain from any strenuous physical activity a day prior to the in vivo testing. During the test, the subjects the fasting blood samples (FBG) were obtained. The food sample assigned for the given day was taken within a 15-minute period. Each meal occasion was accompanied by 220–250mL water which is made constant for each subject. Blood samples were obtained at time intervals of 0 (FBG), 15, 30, 45, 60, 90, and 120 minutes and analyzed the area under the glucose response curve for each food. The GI of each food was expressed as % mean glucose response to the test food divided by the standard food taken by the same subject and was determined using standard formula.

Results and Discussion

The proximate composition of test foods showed that higher amount of starch, protein and dietary fibre content. Among the foods, T_1 contains high amount of protein and dietary fibre and T_2 has higher in starch content compared to other samples (*Table 1*). The test foods of the QPM maize grits, milled rice and QPM grits - milled rice mixture GI were assessed based on the IAUC method. Mean blood glucose concentration peaked at 30 minutes postprandial after the ingestion of the QPM grits, and milled rice-QPM grits mixture. The computed incremental area under the glucose response curve (IAUC) level varied significantly across test foods. Resulting GI values ***(Fig. 1***) of the test foods were 82.16 11.04, 118.42 12.75, and 95.24 16.32 for QPM grits, milled rice, and QPM grits–rice mixture, respectively. This study showed that ingestion of QPM grits resulted in lower blood glucose response in healthy subjects compared to milled rice and the rice-QPM grits mixture. Differences in the chemical composition and physicochemical properties of the test foods may have contributed to the differences in the glucose response observed. QPM grits have the highest dietary fiber content (5.30 grams/100 grams of QPM grits) among the test foods, this contributed to the lower glycemic response in the pure QPM grits.

Table 1. ***Proximate composition of control and test foods (per 100g)***

Parameters	T_0	T_1	T_2	T_3
Moisture (g)	9.30 0.58	8.70 0.95	8.84 1.03	8.41 1.62
Protein (g)	12.63 1.20	12.27 1.21	5.62 0.89	9.14 0.28
Fat (g)	4.60 0.20	5.40 0.31	1.54 0.74	2.49 0.26
Starch (g)	68.66 1.16	70.24 1.56	77.38 1.84	74.08 1.47
Fiber (g)	1.60 0.14	5.30 0.11	2.03 0.51	3.80 0.21
Ash (g)	1.50 0.04	1.20 0.09	1.92 0.32	1.80 0.02

T_0 – Control (bread); **T_1** – QPM grits; **T_2** – Milled rice; **T_3** – QPM grit-milled rice mixture; *Mean SD

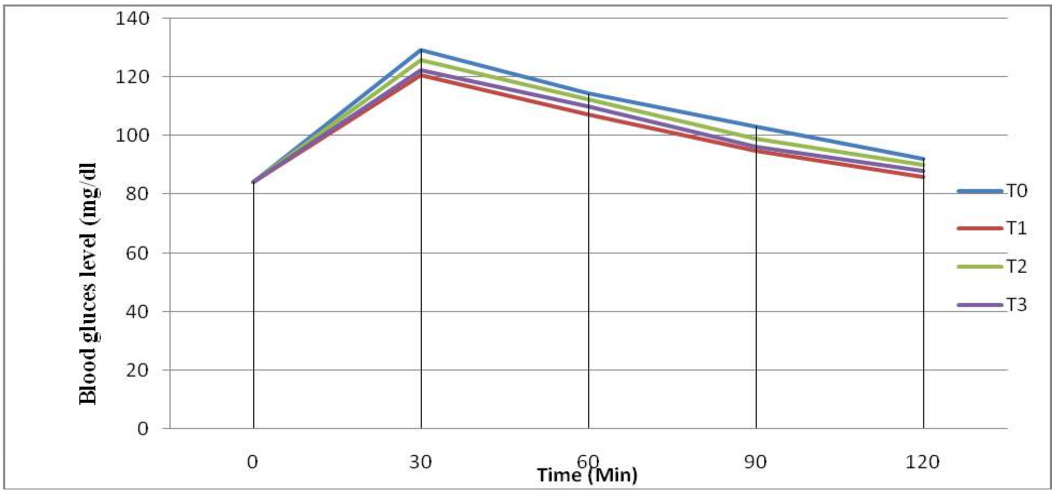

Figure 1. Mean blood glucose (mg/dl) response to control and test foods

Reference

Vasal, S. K. 2002. Quality Protein Maize: Overcoming the Hurdles. *Journal of Crop Production*. 6(2): 193-227.

Panlasigui L. N. and Thompson L. U. 2006. Blood glucose lowering effects of brown rice in normal and diabetic subjects. *International Journal of Food Sciences and Nutrition*. 57 (3-4): 151–158

Panlasigui, L.N., Bayaga, L. T., Barrios, E.B. and Cochon, K.L. 2010. Glycaemic Response to Quality Protein Maize Grits. *Journal of Nutrition and Metabolism*. doi:10.1155/2010/697842.

Exploring the Functionality of Ethnic Fermented Sour Beverages and its Standardization with Improved Shelf Stability for Industrial Use

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Keywords: *Traditional rice, Fermentation, Nutritional characteristics, Shelf stability*

Introduction

Rice is the staple food for two third of the Indian population. Many types of ethnic fermented cereal foods are widely consumed across the world. In fermented food preparation, the microorganisms play a crucial role in improving the sensory characteristics, bioenrichment of nutrients, health promoting attributes and preservation of foods. Fermented rice is one of the traditional staple foods in Tamil Nadu. Traditionally the leftover cooked rice is allowed for fermenting overnight and consuming in the following day to preserve the food resources. The one-day-old, cooked, water-soaked and fermented rice known as '*pazhaya sadham*' or '*palam soru*', fermented rice water as *pazhaya sadham kanchi* or *Neeragaram* used as healthy water in natural medicine. Extracts obtained from rice, is an alternative beverage for consuming healthy products with desirable nutritional characteristics.

Methodology

The neeragaram was prepared using traditional rice mappillai samba. The mappillai samba was used as raw rice (unpolished, polished) and parboiled rice (unpolished, polished) for processing of neeragaram. It was prepared by pressure cooking (20 mins), the cooked rice along with varied species such as small onions, green chillies and required amount of water was added in a mudpot, allowed for overnight fermentation in an incubator at 30°C. The fermented rice water has nutritional characteristics such as carbohydrates, fat, fibre, enzymatic activity, B vitamins and minerals like iron, potassium, sodium and zinc. The preparation of neeragaram was depicted in Figure 1 and 2.

Table 1 Different treatments of neeragaram (Mappillai Samba)

S.No	Treatments	Rice Variations
1.	T_1	Raw rice (Unpolished)
2.	T_2	Raw rice (Polished)
3.	T_3	Parboiled rice (Unpolished)
4.	T_4	Parboiled rice (Polished)

Results and Discussion

The nutrient content of the neeragaram prepared from unpolished and polished, raw and parboiled mappillai samba were analysed and the results are given in Table 2.

The study concluded that among four different treatments of neeragaram the T_1 (Raw rice - Unpolished) are highly acceptable based on consumer acceptability. The unpolished raw rice provided higher amounts of nutrients such as energy (68 kcal), carbohydrates (11.15 %), protein (4.21 %), fibre (2.59 %), fat (0.93 %) and minerals like iron (4.21 mg/100g), potassium (181.7 mg/100g), sodium (61.23 mg/100g) and zinc (2.32 mg/100g) high in the neeragaram. The developed product will be highly suitable for commercialization with improved shelf stability.

Table 2 Nutritional characteristics of neeragaram

S.No	Nutrients	T_1	T_2	T_3	T_4
1.	**Energy (Kcal)**	68.29	59.02	57.15	51.29
2.	**Carbohydrates (%)**	11.15	9.03	10.59	8.16
3.	**Protein (%)**	4.21	3.80	4.09	3.72
4.	**Fibre (%)**	2.59	1.25	2.28	1.26
5.	**Fat (%)**	0.93	0.71	0.82	0.66
6.	**Iron (mg)**	4.21	3.80	3.98	3.62
7.	**Potassium (mg)**	181.7	172.0	152.6	143.2
8.	**Sodium (mg)**	61.23	62.78	56.45	58.89
9.	**Zinc (mg)**	2.32	1.89	2.10	1.76

Figure 1. Preparation of fermented sour beverage (neeragaram)

Rice grains (100g)

↓

Soaking the grains in water

↓

Cooking the soaked rice grains by adding 300 ml water, 2.5 g salt (Pressure Cooker 20 mins)

↓

Adding 300 ml water and species to the cooked rice in a mud pot

↓

Overnight fermentation (Incubator at 30°C)

↓

Fermented sour beverage (neeragaram)

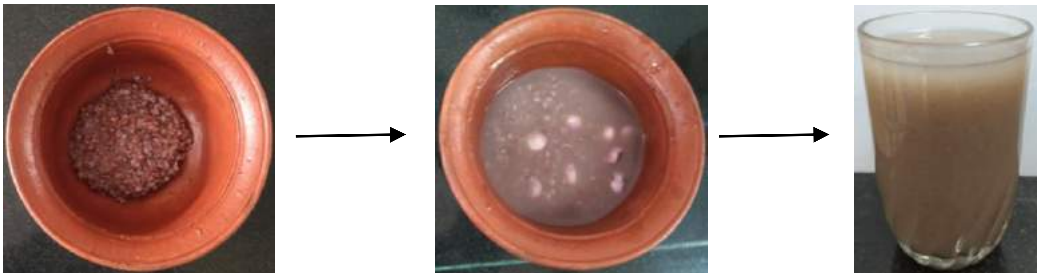
↓

Packaging

↓

Storage

Figure 2. Preparation of fermented sour beverage (neeragaram)



Cooked Rice — Fermentation — Fermented Sour Beverage

Reference

Blandino, A., Al-Asceri, M.E., Pandiella, S.S., Cantero, D. and Webb, C. (2019). Cereal based fermented foods and beverages. *Food Res. Int*, 3(5), 27-43.

Vaidya, R.H and Sheth, M.K. (2019). Processing and storage of Indian cereal and cereal products alters its resistant starch content. *J Food Sci Technol*, 48(8), 622-627

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Extraction of Citrus Peel Essential Oil and Evaluation of its Physico Chemical Properties

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Keywords: *Citrus fruits, essential oil, extraction, physico chemical properties*

Introduction

Citrus fruits are highly consumed as fresh produce or as juice. Peel which is the primary waste product obtained from the fruit is naturally discarded. This peel contains a wide variety of secondary components with substantial antioxidant and antimicrobial activity. Essential oil which is present in the peel can be extracted by solvent distillation, steam or hydro distillation and super critical fluid extraction methods. Citrus peel essential oil is antiseptic in nature and contain medicinal and fragrance compounds. They are rich sources of flavonoids, alkaloids, coumarins, limonoids, carotenoids, phenolic acid and many polymethoxylated flavones. This essential oil can be used in the food system as edible coating or flavouring agent. For this study, three different citrus fruits ((Lemon (*Citrus limon*), Mosambi (*Citrus limetta*) and Mandarin orange (*Citrus reticulata*)) were selected and the essential oil from these citrus fruit peels were studied for physico chemical and antioxidant property.

Methodology

Citrus fruit peel was procured from local market of Madurai and processed for the study. The segments from the peel were separated and cut into pieces, dried and powdered for oil extraction. The essential oil was extracted from the powdered sample by hydro distillation method and the optimum condition was standardized using time, temperature and solid- solvent ratio. Physical (Color, viscosity, specific gravity, density and solubility), chemical (free fatty acid value, iodine value, peroxide value, saponification value and thiobarbituric acid value) and antioxidant property was estimated in the citrus peel essential oil. Volatile compound profile was analysed using GC-MS.

Results and Discussion

The results of the physical and chemical parameters of citrus peel essential oil were given in Table 1 and 2. From the result it was noted that the viscosity and density of all three essential oil was lower than that of water. Lemon peel oil has significantly lower peroxide value, saponification value and higher iodine value which denotes that the quality of lemon peel oil was better than other two essential oils. The total antioxidant capacity of orange peel oil was 73.70 % RSA, mosambi peel oil was 77.12 % RSA and lemon peel oil was 89.20 %RSA.

The study concluded that citrus peel can be used for oil extraction by hydro distillation method. Lemon oil contains lower peroxide value and saponification value. Peroxide value indicates the primary oxidation in oil. Lower number of peroxide value indicates a good quality of oil. Likewise, lemon peel oil possesses good antioxidant property. The major volatile compound present in all three citrus fruit peel essential oil was D-Limonene which is responsible for the antimicrobial property of the essential oil. Therefore, citrus peel essential oil can be used in food system as flavouring agent and edible coating material.

Table 1: Physical parameters of citrus peel essential oil

S.No	Sample	Color value			Viscosity (mPa.s)	Specific gravity	Density (g/ml)	Solubility in water
		L*	a*	b*				
1.	**Reference (water)**	54.56	-2.90	-10.00	1.0	1.0	0.99	-
2.	**Orange peel oil**	99.8	-6.47	-9.61	0.99	0.84	0.83	Insoluble
3.	**Mosambi peel oil**	102.43	-1.09	-22.04	0.95	0.86	0.85	Insoluble
4.	**Lemon peel oil**	111.38	-0.64	-26.77	0.88	0.85	0.85	Insoluble

Table 2: Chemical parameters of citrus peel essential oil

S.No	Sample	FFA (oleic acid equivalent in %)	Iodine value (gI_2/100g oil)	Peroxide value (meq/kg of sample)	Saponification value (mg KOH/g oil)	TBA value (mg melanaldehyde)	TAA (%RSA)
1.	Orange peel oil	31.4±0.70[c]	107±0.63[b]	2.2±0.05[c]	140.3[c]±0.31[c]	0.47[c]±0.03[c]	73.70±0.65[c]
2.	Mosambi peel oil	29.9±0.67[b]	103±0.82[c]	2.6±0.08[b]	121.6±0.90[b]	0.17±0.09[b]	77.12±0.41[b]
3.	Lemon peel oil	23.5±0.63[a]	116±0.02[a]	1.6±0.04[a]	112.2±0.13[a]	0.03±0.05[a]	89.20±0.09[a]

(FFA- Free Fatty Acid, TBA- Thiobarbituric Acid Value, TAA- Total Antioxidant Activity)

Reference

Atti-Santos, A. C., Rossato, M., Serafini, L. A., Cassel, E., and Moyna, P. (2005). Extraction of essential oils from lime (Citrus latifolia Tanaka) by hydrodistillation and supercritical carbon dioxide. *Brazilian Archives of Biology and Technology,48*(1): 155-160.

Giwa, S. O., Muhammad, M., and Giwa, A. (2018). Utilizing orange peels for essential oil production. *Journal of Engineering and Applied Sciences, 13*(1): 17-2

Extraction, Quantification and Assessing the Anti-Microbial and Stability Properties of Betalain Pigment in *Bougainvillea glabra* and *Celosia argentiana*

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Keywords: *Quantification, Antimicrobial and Stability properties, Betalain, Bougainvillea, Gompherna*

Introduction

Plant pigments include Chlorophyll, Anthocyanins, Carotenoids and Betalains. Betalains are highly water soluble pigments which is found in 13 family of the order Caryophyllales (Cai*et al*., 2005). Betalain pigment can be used as a colourant in food, textile and Pharmaceutical industries due to their medicinal and colour retention properties. Though the extraction procedure and their properties has been limited to some crops like Beet root, this work has been aimed to study their properties in flower crops like Bougainvillea and Celosia.

Methodology

The ideal solvent and the extraction procedure of betalain pigment from flowers was already standardized with water and shade dried method (Lavanya*et al*., 2019). The Lyophilized aqueous extract was quantified by HPLC method using two solvent system (Solvent A- 1% acetic acid inn water and Solvent B- 1% acetic acid in acetonitrile) with the flow rate of 1 ml/min against a particular betalain pigment called Betanin (Fernández-López*et al*., 2002).Anti-bacterial and anti-fungal properties were analyzed by agar well diffusion method against the various bacteria (*Escherichia coli, Pseudomonas aeruginosa, and Bacillus substilis*) and fungi species (*Rhizopus spp*. and *Aspergilles niger*) with different concentrations of the betalain extract (100 mg/ml, 200 mg/ml, 300 mg/ml, 400 mg/ml and 500 mg/ml) respectively. The Relative Inhibition zone diameter was measured and calculated (Yıldız*et al*., 2008). The Stability studies were carried out by storing the pigment extract from the flower samples at different temperature (-80°C, -20°C, 0°C, 4°C and at 30°C)and light intensity (Dark, 565 Lux and 1140 lux). The change in the betalain content with respect to storage was measured for up to 28 days.

Results and Discussion

HPLC quantification of betanin

Based on the Rt and elution of standard and peak, the betanin content was quantified in the flower samples. The results confirmed that Celosia flower extract recorded higher betanin content of 133.5 ppm followed by Bougainvillea (81ppm).

Antimicrobial activity of Bougainvillea spectabilisand Celosia cristata

In Bougainvillea highest antibacterial activity of 2.57 cm (RIZD) at 500 mg/ml concentration was obtained against *Bacillus subtilis* cultures. Amongthefungal cultures, higher inhibition was against *Aspergilles niger*(2.931 cm of RIZD) followed by *Rhizopus spp*(1.26 cm RIZD). Among the different microorganisms tested against Celosia, it was observed that higher antimicrobial activity was exhibited against *Pseudomonas aeruginosa* withan RIZD of 3.47 cm at 500mg/ml.

Stability of Bougainvillea spectabilisand Celosia cristatabetalain extract at different temperature

In Bougainvillea and Celosia highest stability was observed when the pigments were stored at -80°C (22.67 mg/l and 21.32 mg/l of betalain content) followed by storage at -20°C (21.71mg/l of betalain content) on 28th day of storage. However, there was no significant effect on betalains stored at 4°C for one month and the values were on par with each other. Pigments stored up to 8°C had no significance effect on degradation their values were found to be on par with each other even up to 28 days of storage.

Stability of Bougainvillea spectabilisbetalain and Celosia cristata extract at different light intensities

In Bougainvillea and celosia, the results revealed that on 7th day of storage at 1140 lux (T_1), betalain content exhibited a significant reduction of 24.07mg/ml and 26.15mg/l from the initial content of 28.35mg/l. Complete degradation of betalain pigments was recorded when stored at 1140 and 565 lux after a week. Complete degradation of betalains occurred in case of pigments stored at 565lux (T_2) and 1140lux (T_1) after a week.

Reference

Cai, Y.Z. 2005. Characterization and application of betalain pigments from plants of the Amaranthaceae. Trends in Food Science & Technology., 43:155-162

Fernández-López, J. R. Castellar.J. Obón. & L. Almela. 2002. Screening and mass-spectral confirmation of betalains in cactus pears. Chromatographia., *56*(9-10):591-595

Lavanya,V. S. P. Thamaraiselvi. D. Uma. 2019. Studies on Extraction of Betalain Pigments by Different Solvents and Assessing Antioxidant Activity of *Bougainvillea spectabilis* and *Celosia argentea* Flowers. Madras Agric. J., 106:1-3.

Yıldız, L.K.S Başkan. E. Tütem. &R. Apak. 2008. Combined HPLC-CUPRAC (cupric ion reducing antioxidant capacity) assay of parsley, celery leaves, and nettle. Talanta*,* *77*(1): 304-313.

GC-MS Analysis of Bioactive Compounds in Methanolic Extract of Tamarind Seed Flour

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Keywords: *Bioactive compounds, GC-MS, Tamarindus indica, Phytochemicals*

Introduction

Tamarindus indica L, an evergreen tree belongs to the sub-family of Caesalpinioideae and family of Fabaceae. The most undervalued by-product of the tamarind pulp industry is tamarind seed. The seeds possess good nutritional profile, particularly rich in essential amino acids and fibre. Apart from being a nutritionally rich compound, the seeds are rich in bioactive compounds (Kalra *et al.*, 2011) which possess various biological activities such as antioxidant, anti-inflammatory, anti-obesity and anti-diabetic properties. The phytochemical screening of the tamarind seeds would highlight the presence of secondary metabolites in a quantitative manner.

Methodology

Sample preparation

The dehulled tamarind seed flour was used for GC-MS analysis. A known quantity of sample (10 g) was taken and HPLC grade methanol (100 ml) was used to saturate the sample. The saturation was carried out for the duration of 24 hours with occasional shaking. The sample was filtered with muslin cloth after 24 hours and whatman No.1 filter paper was subsequently used for second filtration. The concentration of extract was done in flash evaporator and the extract was filtered with anhydrous sodium sulphate to get moisture free extract.

Procedure for GC-MS

GC-MS analysis was carried out on Shimadzu GC-MS QP 2020 system consisting of auto sampler and gas chromatograph interfaced to a Mass Spectrometer (GC-MS) instrument.

Results and Discussion

The quantitative analysis of Tamarind seed flour (methanol extract) by GC-MS showed the presence of 25 major peaks (Fig.1). Phytochemical compounds identified with their name, retention time and % of peak area with biological activity are presented in Table 1.

The results validated the presence of bioactive compounds which possess various biological activities ensuring the nutraceutical rich nature of tamarind seeds.

Fig.1 Bioactive compounds screening of Tamarind seed flour by GC-MS

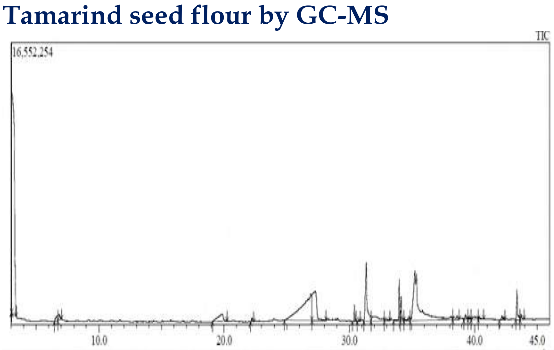

Table 1: Phytochemical profile of Tamarind seed flour

Peak#	R.Time	Area%	Name	Biological activity
1	3.027	4.36	Pentane, 2,4-dimethyl-	Pentane from breath-Indicator of lipid peroxidation
2	3.076	32.54	Pentane, 2,4-dimethyl-	
3	6.670	0.63	Diglycerol	Derivative- Diglycerol monolaureate has anti-listerial activity
4	6.836	0.66	Glycerin	Bactericidal activity
6	22.199	0.19	Dodecanoic acid	Anti-microbial activity
7	26.935	16.02	Tetradecanoic acid	Repellant activity, larvicidal activity
8	27.304	7.40	4-O-Methylmannose	No activity reported
9	30.424	0.57	Hexadecanoic acid, methyl ester	Anti-fungal, Anti-bacterial activity

Reference

Kalra, P., S. Sharma, and S.K. Suman. 2011. "Antiulcer effect of the methanolic extract of Tamarindus indica seeds in different experimental models." *Journal of pharmacy and bioallied sciences* 3 (2):236.

Moisture Sorption Isotherm of Freeze-Dried Palmyra Palm Tender Fruit Endosperm (Nungu)

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Keywords: *Borassus flabellifer, adsorption isotherms, freeze-drying, Water activity, mathematical models*

Introduction

Palmyra palm Tender Fruit Endosperm (PTFE) is a seasonal delicacy called as Nungu was freeze dried to increase its shelf life. The objective of this experiment is to determine the moisture sorption characteristics of freeze dried PTFE in the temperature range of 25° C to 45°C and to examine the applicability of sorption models to estimate the property of sorbed water and to calculate the safe moisture for storage.

Methodology

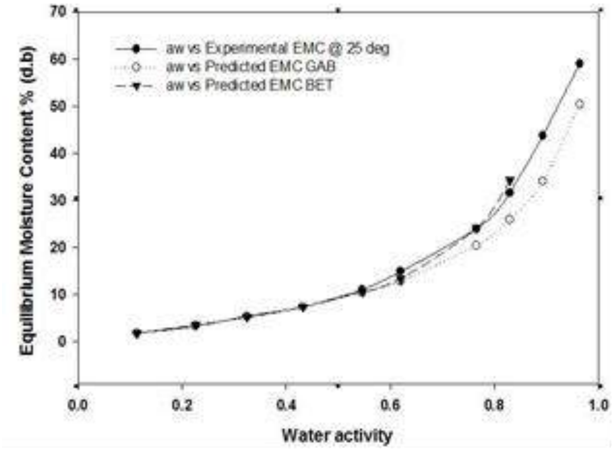
Procured PTFEs were minimally processed and stored at 0°C. Then blast freezed prior to freeze drying. Freeze drying condition applied were 375 mTorr of operating pressure and 55 °C as shelf temperature and dried for 13 hours, then packed in metalized pouches with zero permeability. The isopiestic method (Rahman et al. 2019), was used to develop the moisture sorption isotherm, where 1 g of freeze dried PTFE samples were placed in an open petridish in air sealed glass jar consisting of saturated salt solutions (recommended by Greenspan, 1977); for temperature control sorption containers were placed in regulated chambers maintained at 25°C, 35°C and 45°C. Reagent grade salt solutions in the water activity range of 0.11 to 0.97 were used to equilibrate the product sample with water activity. Weights of sample were recorded every 24 hours and apparent equilibrium was judged to have been attained when difference between the 3 consecutive weights did not exceed 1 mg the equilibrium period ranged from 11 days to 21 days. Sorption isotherm was modeled using GAB (Guggenheim, Anderson and de Boer) and BET (Brunauer, Emmett and Teller) models. These models were applied using non-linear regression method.

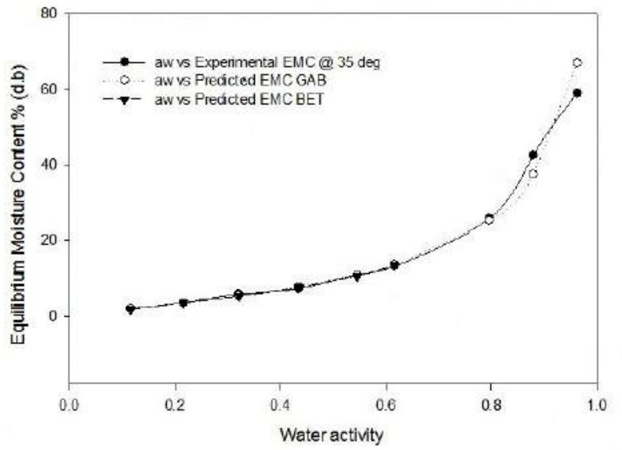
GAB model	BET model
$m = \dfrac{CKa_w m_0}{(1-ka_w)(1-ka_w+Cka_w)}$	$m = \dfrac{Ca_w m_0}{(1-a_w)[1+(C-1)]a_w}$

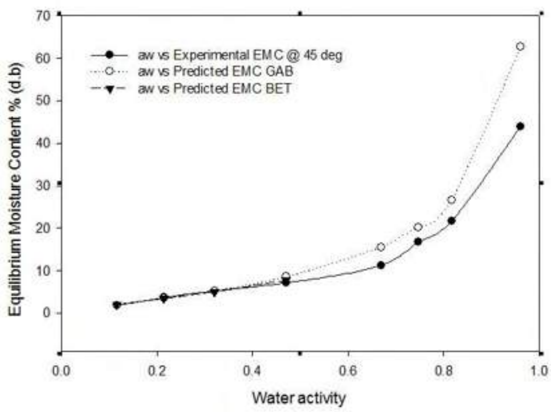
where, a_w is the water activity, m_o is the monolayer moisture content, and C and K represent constants.

Results and Discussion

The extrapolation of m_0 is critical for storage condition of the processed products. This m_0 does not impart any metabolic reactions and storage less than or equal to this value increase the shelf life. Comparison between, experimental data, GAB and BET isotherms at 25°C, 35°C and 45°C were depicted in the figures. Goodness of fit was determined using RMSE against the experimental isotherm data. GAB model suited the best in all simulated temperatures and RH conditions; and RMSE is well reflected in the table. The sharp upward deflection after 0.7 a_w was observed in all three temperature conditions. Adsorption isotherm of PTFE exhibited type –II sigmoidal shape curve that is a characteristic of high sugar foods (Tejada-Ortigoza et al. 2017) . EMC decreased with increase in temperatures (table m_0 values). PTFEs were freeze-dried to a range of 4.81to 5.78 % moisture content by dry basis which provided the water activity of 0.508 ± 0.05. GAB equation also suggested a water activity below 0.55 for better storage.







GAB & BET parameters for moisture sorption isotherm for freeze-dried PTFE (m_0 g/100 g by dry basis)

Temperature	m_0	C	K	GAB RMSE	BET RMSE
25 °C	8.0973	2.041	0.8837	4.665	36.153
35°C	7.638	2.266	0.9267	8.003	40.606
45°C	7.444	2.394	0.9223	4.256	30.097

Reference

Rahman, Mohammad Shafiur, Mohammed Khalfan Al-Khusaibi, Kutaila Abbas AL-Farsi, Ismail Mohamed Al-Bulushi, Aisha Abushelaibi, and Nasser Al-Habsi. 2019. "Moisture Sorption Isotherm and Thermal Characteristics of Freeze-Dried Tuna." *International Journal of Food Studies* 8(1). doi: 10.7455/ijfs/8.1.2019.a8.

Tejada-Ortigoza, Viridiana, Luis Eduardo Garcia-Amezquita, Vinicio Serment-Moreno, J. Antonio Torres, and Jorge Welti-Chanes. 2017. "Moisture Sorption Isotherms of High Pressure Treated Fruit Peels Used as Dietary Fiber Sources." *Innovative Food Science & Emerging Technologies* 43:45–53. doi: 10.1016/j.ifset.2017.07.023

Nutritional and nutraceutical properties of Grape Seed Powder

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Keywords: *Grape seed, nutraceuticals, phenolics, flavonoids and antioxidants*

Introduction

Grape (*Vitis* spp.) is one of the most economically important plant species due to its diverse uses in production of wine, juice, resins and other food products. It is cultivated in all regions where temperate condition prevails (Georgia *et al*, 2014). Grapes are one of the most widely grown fruit and the total production of grapes is approximately 60 million tons worldwide. The major producers of grapes are the USA, China, Italy, and France. Grapes can be categorized into seedless, wine grapes, table grapes, and raisin grapes (Ma and Zhang et al, 2017). Grape marc consists of grape skins (50%), seeds (25%), and stalks (25%). Grape seeds are the industrial byproduct of the wine process. Grape seeds are treated as waste if extracts are not made and it is estimated that about 10–12 kg of grape seeds in 100 kg of wet residues are produced by the industry (Matthaus, 2008).

Methodology

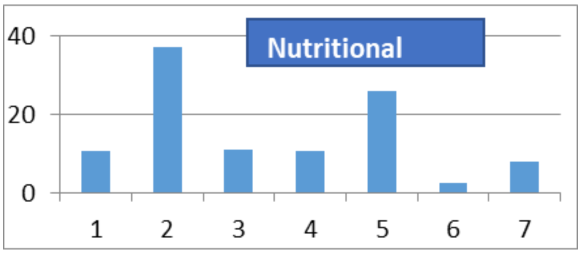
Nutritional and nutraceutical analysis of grape seed

The grape seed powder was analyzed for the nutritional and nutraceuticals parameters viz, moisture, fiber, fat, protein, carbohydrates, ash, total polyphenols, total flavonoids, total antioxidant activity and minerals like calcium, selenium, mg, cobalt sodium, potassium, zinc, Mn, Iron, phosphorous, chlorine, copper.

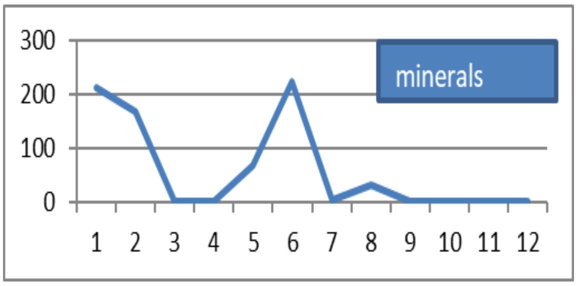
Results and Discussion

Nutritional and nutraceutical analysis of grape seed

The study revealed that the moisture content was 10.5%, fiber 37%, fat 11%, protein 10.7%, carbohydrates 26%, ash 2.58%, phenols 8mg GAE/100g and minerals are calcium 212.77mg/100g, Mg 169.43mg/100g, chlorine 0.61%, copper 1.60%, sodium 68.93%, potassium 224.00, Mn 4.57%, Zinc 32.83%, phosphorous 1.7%, iron 0.83%, selenium 0.41%, cobalt 0.73%.



1-moisture, 2- fibre, 3-fat, 4-protein, 5-cho, 6-ash,7- phenol



1-calcium, 2-Mg, 3-clorine, 4- cu, 5-Na, 6-k,7-Mn,8-Zn,9-phos,10-Fe,11-se,12-Co

With regard to the antioxidant, total phenol and flavonoid content extracted by different solvents, the acetone extract of grape seed has been found to possess good antioxidant activity, total phenolic compounds and flavonoids content. The extract is also rich in various photochemical components. So that the grape seed may constitute a good source of healthy compounds, could be useful in the prevention of diseases.

Table 1. Analysis of total phenolic, flavonoids and antioxidants.

Sample	Total Phenolic	total flavonoids	%inhibition IC50(µg/ml)	IC50(µg/ml)
Acetone (Acetone 70%)	463.256±14.77	138.421±0. 617	89.191	36.64
Ethanol(Methanol)	581.658***±12.12	141.545±0.855	90.25	39.57
Methanol (Ethanol70%)	683.432***±4.00	167.256±0.40	96.35	39.55
Water(water)	241.589±6.478	137.456±0.50	83.48	39.65

Reference

AGARWAL, C, SINGH, R.P. AND AGARWAL, R., 2012, GSE induces apoptotic death of human prostate carcinoma cells via Caspase activation and Cytochrome 'C' release. *Carcinogenesis*. 23(11):1869-1876.

ELA, E. I. AND OMARA, E.A., 2014, Genotoxic and histopathological aspects of treatment with Grape Seed Extract on CPA induced mice.*CellBiology*. 2(3):18-27.

Nutritional and Sensory Properties of Groundnut Germ Substituted Chapatis

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Keywords: *Food processing, Groundnut germ, Vitamins, Chapattis, Sensory Profile*

Introduction

Food processing industry by-products are considered as a potential source of functional compounds. They are utilized for their good nutritional and therapeutic properties. Groundnut processing generates mainly groundnut seed coat and groundnut germ as major by-products. Groundnut germ contributes 5 - 6 percent of the total weight of the processed groundnut. It is rich in many therapeutic and nutraceutical components such as essential fatty acids, vitamin E, B vitamins etc. But till date, the groundnut germ is utilized only for cattle feed. It has the potential to yield many commercially valuable compounds such as groundnut germ oil and functional food ingredients such as protein isolate, B vitamins *etc*.

Methodology

Groundnut germ was collected from the groundnut chikkis industries in two different locations such as Madurai and Kovilpatti comprising of ten processing units. Five units from each location were randomly selected for sample collection. After pretreatment the samples were converted into flour by grinding in a pulverizer and sieved through BS 80 mesh sieve to get fine particles. chapati is made of whole wheat flour, salt and water. The chapatis were prepared as per the method described by (Navnidhi *et al.*, 2007) with some modification. The groundnut germ flours were substituted with whole wheat flour in different ratios to get the high quality chapatis with good sensory and nutritional quality characteristics and they were studied for their nutritional and sensory properties.

Results and Discussion

Groundnut germ flour have higher level of fat and protein content of 44.55±1.36 g/100g and 25.38±0.67 g/100g respectively. The groundnut germ flour contained the thiamine, riboflavin, niacin and vitamin - E content of 2.58±0.32, 0.39±0.10, 26.13 ± 0.79 and 77.65 ± 2.50 mg/100 g respectively. The magnesium and phosphorous content was high in groundnut germ 234±6.50 mg/100g and 270±5.00 mg/100g respectively. Highest sodium (21±0.75 mg/100g) and potassium content 723±9.75 mg, zinc content 5.5±0.40 mg/100g was found in groundnut germ flour. The chapatis substituted with groundnut germ flour at the level of 30 per cent is found to have higher level of fat (7.94 g/100g) and protein content of 11.93 g/100g. The carbohydrate content was found to be 46.81 g/100g in groundnut germ flour substituted chapatis (T_{C1}) and 50.00 g/100g in Control (T_{C0}). In case of sensory scores the (Tc_0) control had the sensory scores of 8.8, 8.3, 8.9, 8.6, 8.9, and 8.9 for appearance, color, flavor, texture, taste and overall acceptability respectively. T_{C1} had sensory scores for appearance 8.4, color 8.2, flavor 8.1, texture 8.7 taste 8.2 and overall acceptability score of 8.2. The groundnut germ flour at the level of 30 per cent found to be a potential source to substitute in chapatis to improve their nutritional profile without significant effect on sensory characteristics. Similar to that it can be substituted with other food products to improve their nutritional composition.

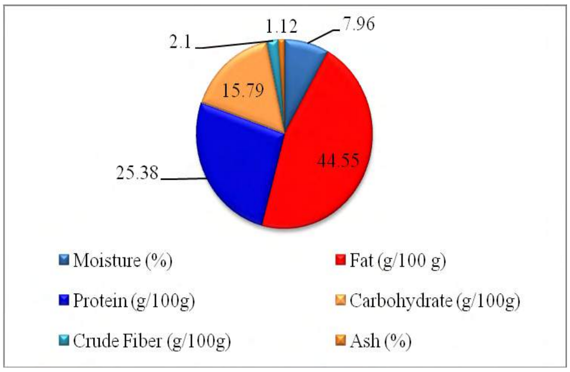

Figure 1. Proximate composition of groundnut germ flour

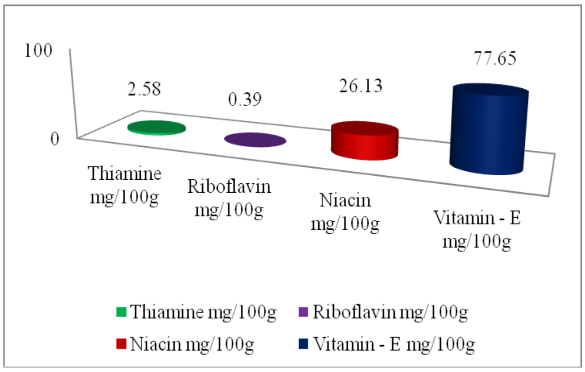

Figure 2. Vitamin composition of groundnut germ flour

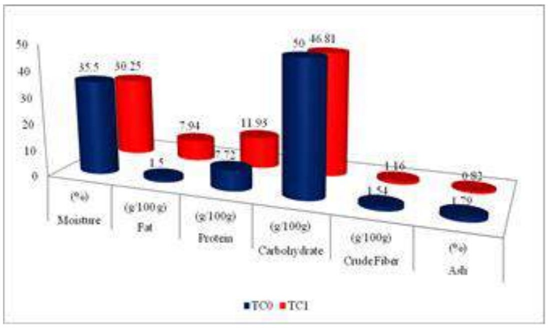

Figure 3. Mineral Composition of groundnut germ flour

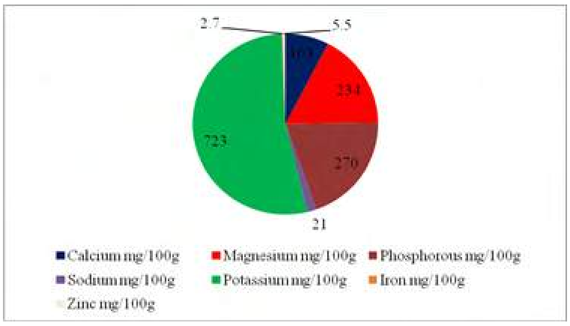

Figure 4. Proximate Chemical composition chapatis substituted

Reference

Yadav, D.N., Singh, K.K. and Rehal, J. 2012. Studies on fortification of wheat flour with defatted rice bran for chapati making. *Journal of Food Science and Technology*. 49(1): 96 - 102.

Navnidhi., Panghal, A. and Khatkar, B.S. 2007. Process optimization for test baking of chapatti. *Indian Food Packers*. 5, 98 - 102.

Optimization of Drying Process for the Development of Pumpkin Flesh and Seed Kernel Flour

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Keywords: *Blanching, acid treatment, cabinet drying, freeze drying*

Introduction

Pumpkin belonging to the Cucurbitaceae family, is a rich source of β-carotene and the seeds are rich in unsaturated fatty acids. Pumpkin made into flour helps to increase the shelf life as well as ensuring year around availability of this great source of β-carotene. pumpkin can ensure a good uptake of provitamin A and lutein, the carotenoids with special physiological functions. (Murkovic *et al.*, 2002). Pumpkins also have pharmacological effects such as anti-diabetic, anti-inflammation, anti-hypertension, anti-tumor, anti-hypercholesterolemia. (Aamir *et al.*, 2017).. Pumpkin fruit flour is suitable for development of food products with high dietary fibre content (Cerniauskiene *et al.*, 2014). This study was aimed at finding an optimum technique for drying, to maximize the retention of nutrients, for the production of pumpkin flesh and seed kernel flours.

Methodology

Pumpkin fleshweighing 6 kg was cut into approximately 5mm thick slices. 2kg of the slices was soaked in 0.1% citric acid and 2kg of slices were blanched at 90˚C for 5minutes. 2kg was kept as control i.e, without any pre-treatment. The pre-treated pumpkin flesh was divided into two groups out of which one group was subjected to cabinet drying at 65˚C for 18 hours and the other group was subjected to freeze drying below 100Pa and -40˚C for 9 hours. The dried pumpkin slices were subjected to size reduction using pulverizer for flour preparation. The seeds were subjected to solar drying and cabinet drying. The physical properties such as flour recovery, moisture content, water solubility index, water absorption index, bulk density and chemical properties such as total sugars, protein, fat of the resultant flesh and kernel flours were analysed.

Results and Discussion

Effect of pre-treatments on the flour

A significant difference in the effect of two treatments (acid and blanching) on the chemical properties of the pumpkin flour was obtained while there is a little or no effect posed by the pre-treatments on the physical properties of the flour.

Effect of drying methods on the flour

The chemical properties were not significantly affected by the change in drying methods but there was a significant difference in the physical properties. Flour recovery was higher in cabinet drying method and the maximum yield was obtained by blanched cabinet dried pumpkin.

Table 1. Physical analysis of pumpkin flesh and kernel flour

Sample		Flour recovery (%)	Final moisture	Bulk density (kg/m³)	WAI (ml/g)	WSI (%)
Cabinet dried pumpkin flesh flour	Untreated	12.5	9.01	674	8.3	25
	Acid treated	10.7	7.14	717.6	8.5	20
	Blanched	14.2	4.90	656	8.2	25
Freeze dried pumpkin flesh flour	Untreated	10.7	9.28	320.4	10.6	15
	Acid treated	10.3	7.29	362.4	10.8	10
	Blanched	11.2	7.73	356	9.2	10
Seed kernel flour	Cabinet dried				3.2	5
	Solar dried				2.3	5

Table 2: proximate constituents of pumpkin flesh and kernel flour

Sample		Total Sugars	Protein	Fat
Cabinet dried pumpkin flesh flour	Untreated	8.0	22.25	0.75
	Acid treated	15.3	17.75	0.35
	Blanched	12.06	9.25	0.2
Freeze dried Pumpkin flesh flour	Untreated	13.6	20.75	0.5
	Acid treated	15.89	20.5	0.36
	Blanched	11.7	12.13	0.1
Seed kernel flour	Cabinet dried	0.9	49.5	44.0
	Solar dried	0.82	39.5	36.1

Reference

Balassa, B (1965). Trade Liberalization and Aamir Hussain Dar, SA Sofi, Shafiya rafiq. (2017). Pumpkin the functional and therapeutic ingredient: A review. International *Journal of Food Science and Nutrition*, 2(6): 165-170.

Cerniauskiene. J, Kulaitiene. J, Danilcenko. H, Jariene. E and Juknevciene. E. (2014). Pumpkin Fruit Flour as a Source for Food Enrichment in Dietary Fiber. *Not Bot Horti Agrobo*, 42(1): 19-23

M. Murkovic, A. Hillebrand, J. Winkler, E. Leitner and W. Pfannhauser. (1996). Variability of fatty acid content in pumpkin seeds (*Cucurbita pepo L.*). *Europpean Food Research & Technology*, 203(3): 216-219

Quantification of Bioactive Compounds in *Piper Betle* Leaves Extract by Gas Chromatography Mass Spectrometry (GC-MS) Technique

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Keywords: *Piper betle leaves, Gas Chromatography Mass Spectroscopy, Retention Time and Area*

Introduction

Piper betle is an aromatic perennial creeper in the Piperaceae family. The leaves are an important source of phenol, which has anti-tumor, anti-mutagenic, and immunomodulatory properties. The aim of this study is to use Gas Chromatography Mass Spectrometry (GC-MS) to determine the bioactive compound in Piper betle leaves extract. The GC-MS results revealed the presence of over 100 compounds, with 20 of them having a probability of greater than 30. The compound phentermine shows highest peak at retention time of 9.346 mins followed by Hexadecanoic acid, Tetradecanoic acid, Eugenol, Dodecanoic acid.

Methodology

For the study, fresh *Piper betle* leaves were used. Dirt and other foreign particles are washed out of the leaves. For the study, a sample of about 4 kg was taken and dried in a cabinet dryer. The leaves are dried at 60°C until they are completely dry (Pin *et al*., 2014). The dried sample was powdered and weighed. The final powder weighed around 420 g. Bioactive compounds in Piper betle leaves are extracted using a water solvent extraction method. The 200 g sample was mixed with 6 litres of distilled water in a 30 ml: 1g ratio (Pin *et al*., 2011). The water and sample are mixed thoroughly before being kept in a water bath at 60°C for 1 hour. To collect fresh leaf extract, the obtained sample is filtered using filter paper. The compound present in the extract was identified using Gas Chromatography Mass Spectrometry (GC-MS).

Results and Discussion

GC-MS was used to examine the Piper betle leaf extract at brix of 0.30. Figure 1 illustrates results of GC-MS analysis.

The result shows that the highest peak was obtained at retention time of 9.35 mins whereas the highest peak indicate the higher concentration of bioactive compound. Phentermine is a methyl group on the alpha carbon of amphetamine that is used to treat obesity and accelerate weight loss. Eugenol, Dodeconic acid, Tetradecanoic acid, and phyton are identified at retention times of 7.78 mins, 10.676 mins, 13.763 mins, and 21.276 mins, respectively.

The *Piper betle* leaves extract mostly consists of fatty acid derivatives like like dodecanoic acid, tridecanoic acid, tetradecanoic acid, pentadecanoic acid and octadecanoic acid where these compound are useful for treatment of viral infection. Eugenol and phytol are the derivatives of alcohol which used as an antiseptic, anti-inflammatory and antiallergic effects. Thus the *Piper betle* leaves extract used for further processing like encapsulation.

Table 1. Retention time Vs Area

Compound	Retention Time(mins)	Area%
Phentemine	9.35	1.764
Hexadecanoic acid	18.96	26.665
Tetradecanoic acid	13.763	0.248
Eugenol	7.78	1.764

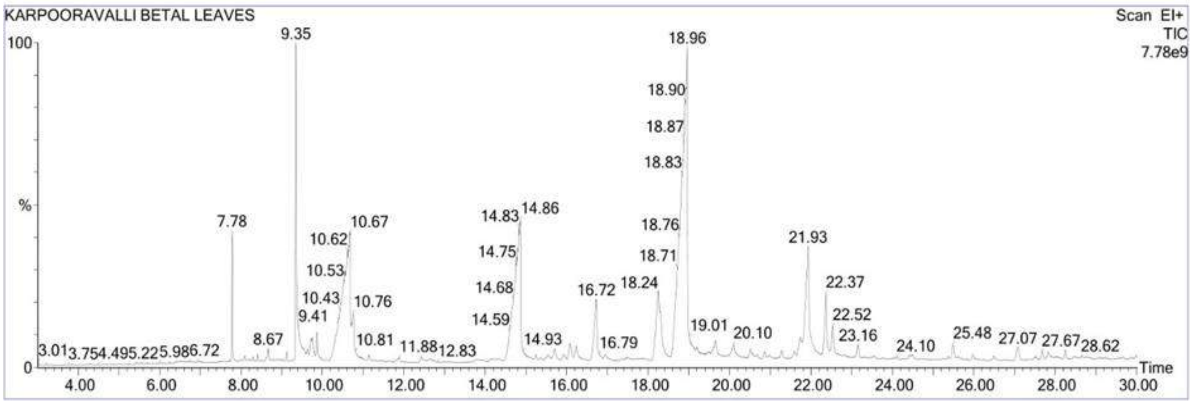

Fig 1. GC-MS analysis result-Retention time vs Intensity

Reference

Pin, Kar Yong, T. G. Chuah, A. Abdull Rashih, C. L. Law, M. A. Rasadah, and T. S. Y. Choong.2009. "Drying of betel leaves (Piper betle L.): Quality and drying kinetics." *Drying Technology* 27, no. 1: 149-155.

Pin, K. Y., A. Luqman Chuah, A. Abdull Rashih, M. A. Rasadah, C. L. Law, and T. S. Y. Choong.2011. "Solid-liquid extraction of betel leaves (Piper betle L.)." *Journal of Food Process Engineering* 34, no. 3: 549-565.

Screening the Antioxidant Activity of Recombinant Inbred Rice Lines and their Parent (Kavuni*CO 50)

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Keywords: *Kavuni, RILs, CO 50, anti-oxidant activity and lutein*

Introduction

Black kavuni is a traditional blackish pigmented rice variety in Tamil Nadu. The black colour pigment contain higher level of phytochemical (flavanoids, anthocyanin and lutein) and minerals (iron, zinc, calcium, copper, sodium, potassium and magnesium). Among farmers, the cultivation of kavuni rice is not successful, because of low yielding character. In order to increase the production, reduce micro nutrient deficiency among population and reduce the gradual erosion of traditional therapeutic kavuni rice, there is a need to improve the agronomic features of kavuni rice by changing the undesirable properties without modifying the nutritional and therapeutic properties through the conventional plant breeding and biotechnology methods.

Methodology

Paddy varieties such as black kavuni (traditional variety), CO 50 (high yielding variety) and Recombined inbred lines (RILs) viz., 13-2, 13-3, 13-5, 31-3, 31-6, 32-2, 35-2, 35-3, 39, 40, 131-4, 143-1, 144, 144-1, 144-2, 144-3, 144-5,145-2,145-3,145-6,148-2, 163-5 and 271-2 were received from the Department of Plant Biotechnology, CPMB, TNAU, Coimbatore. The extraction of lutein was carried out based on the procedure suggested by Weber (1987). The DPPH assay was carried out based on the method suggested by Lim *et al.*, (2007). The hydroxyl radical scavenging activity was measured by the procedure given by Halliwell *et al.*, (1987). The superoxide anion scavenging activity was assessed by the method of Nishikimi *et al.*, (1972). Nitric oxide scavenging activity was calculated as described by Marocci *et al.* (1994). The total antioxidant activity was measured using ABTS assay (Gulcin *et al.*, 2007).

Results and Discussion

Lutein content and total antioxidant activity (DPPH) of RILs and parent rice varieties (Table 1.)

Figure 1. Anti-oxidant activity of RIL and parent varities

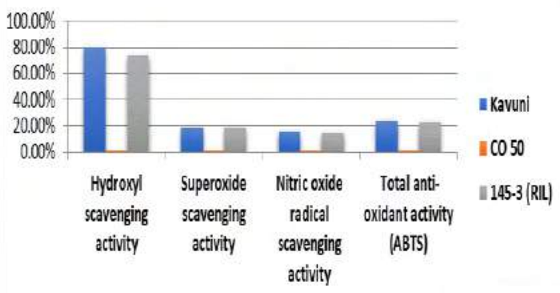

Table 1. Lutein content and total antioxidant activity (DPPH) of RILs and parent rice varieties

S. No	Name	Lutein (µg/100g)	DPPH (% inhibition at 1000µg/ml)
	Parent		
1.	CO 50	68.48 ±1.07[o]	0.180
2.	Kavuni	294.60±1.00[a]	83.04
	White colour RILs		
3.	13-2	74.13±1.16[n]	0.17
4.	13-3	73.2±0.04[noe]	0.17
4.	13-5	73.64±2.24[no]	0.16
6.	31-3	68.46±1.91[o]	0.18
7.	131-4	77.42±0.68[mne]	0.16
	Light black colour RILs		
8.	31-6	88.78±0.36[ke]	52.01
9.	35-2	88.92±2.96[k]	61.01
10.	144	101.8±0.14[je]	62.01
12.	144-1	74.74±1.49[n]	50.02
12.	144-3	97.96±0.43[je]	61.02
13.	144-5	84.13±0.12[kl]	55.03
14.	144-2	82.41±1.34[lme]	58.02
15.	163-4	83.7±0.47[kle]	51.01
	Dark black colour RILs		
16.	32-2	149.2±2.13[de]	79.02
17.	35-3	142.12±2.32[fe]	82.01
18.	39	127.17±0.69[ghe]	73.04
19.	40	122.09±3.04[ie]	81.99
20.	143-1	141.91±3.47[f]	81.05
21.	144-2	171.34±4.48[de]	80.01
22.	145-3	274.53±6.47[b]	82.03
23.	145-6	201.46±0.27[ce]	82.02
24.	148-2	124.06±0.84[h]	79.02
24.	271-2	132.18±2.16[g]	80.03

Reference

Ponnappan S, Thangavel A, and Sahu O. Milling and physical characteristics of pigmented rice varieties. *Journal of Food and Nutrition Sciences*. 2017;5(6):236-241.

Devraj, Lavanya, et al. Study on physicochemical, phytochemical, and antioxidant properties of selected traditional and white rice varieties. *Journal of Food Process Engineering*. 2020;43(3):e13330.

Chay C, Hurtada W, Dizon E, Elegado F, Norng C, Raymundo L. Total phenolic, antioxidant activity and physic-chemical properties of waxy pigmented and non-pigmented rice in Cambodia. *Food Research*. 2017;1(1):9-14.

Standardization of Betel Leaf Incorporated Acid Lime Squash

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Keywords: *Betel leaf, acid lime, squash, value addition*

Introduction

Piper betel colloquially known as betel vine is one of the most important plants in Southeast Asia. The leaves, which are the most commonly used plant part, are pungent and possess aromatic flavor. The medicinal value of these leaves was recognized during 600 AD when ayurvedic system of medicine came into practice. Betel leaves are beneficial to the throat and remove viscidity in human beings. Leaves help in digestion and tend to remove the bad smell of the mouth. The juice of betel leaves is used as an adjunct to pills administered in the ayurvedic medicines. The fresh crushed leaves are used as antiseptic for cuts and wounds. It is also good for the respiratory system and is used in treatment of bronchitis, cough and cold. The leaves of the plant have been traditionally used for chewing. Pan chewing is considered as a good and cheap source of dietary calcium. It increases digestive capacity when used with lime. Betel leaf incorporated food products are limited, it would have potential to enlarge its use in various foods due to its health benefits their will be tremendous scope for new food products containing ingredients that would reduce risk of diseases or improvement in health (Aishwarya *et al*., 2016; Vaibhav *et al*., 2019).

Methodology

Karpoori variety of betel leaves and acid lime of local variety were purchased from the local market, Madurai. They were washed thoroughly with water. The betel leaves were cut in to small pieces and juice was extracted using juicer and strained by using muslin cloth to get a clear juice. Acid lime was squeezed to extract juice. Five different combinations of betel and acid lime juice were chosen for the preparation of squash in ratio of (10:90, 20:80, 30:70, 40:60, 0:100). The mixed fruit squash was prepared by using betel leaf and acid lime with FSSAI specification viz., fruit pulp –25%, TSS 45ºbrix, acidity – 1.0% and Sodium benzoate 600 ppm. Sugar syrup was prepared using required amount of sugar and citric acid. The prepared syrup was filtered and allowed to cool. The fruit juice was added to the syrup and mixed thoroughly. The calculated amount of sodium benozoate was mixed in a small quantity of fruit juice and added to the prepared squash and mixed well. The prepared squash was filled into pre sterilized glass and pet bottles of 750 ml (capacity) with head space, sealed air tight and stored at room and refrigeration for further studies. The squashes were organoleptically evaluated using 9-point hedonic scale. Chemical constituents such as total phenols, total flavonoids, anti-oxidants and vitamin C, total sugars and reducing sugars were analyzed in the samples at 0 and 30 days.

Results and Discussion

Based on the sensory evaluation, the squash prepared with 30:70 (betel with 30% and acide lime with 70%) combination, was found to be highly acceptable in sensory attributes among all the treatments.betel with 30% and acide lime with 70% The chemical changes were noted for the initial and final days of the storage. The pH and TSS was significantly increased and the acidity of the sample was gradually decreased during storage period. The total sugar content was increased normally and the reducing sugar was drastically increased respectively. The anti-oxidant activity was 73.52 (%). The blended squash will increase the consumption of betel leaf in the amidst of community for its health benefits.

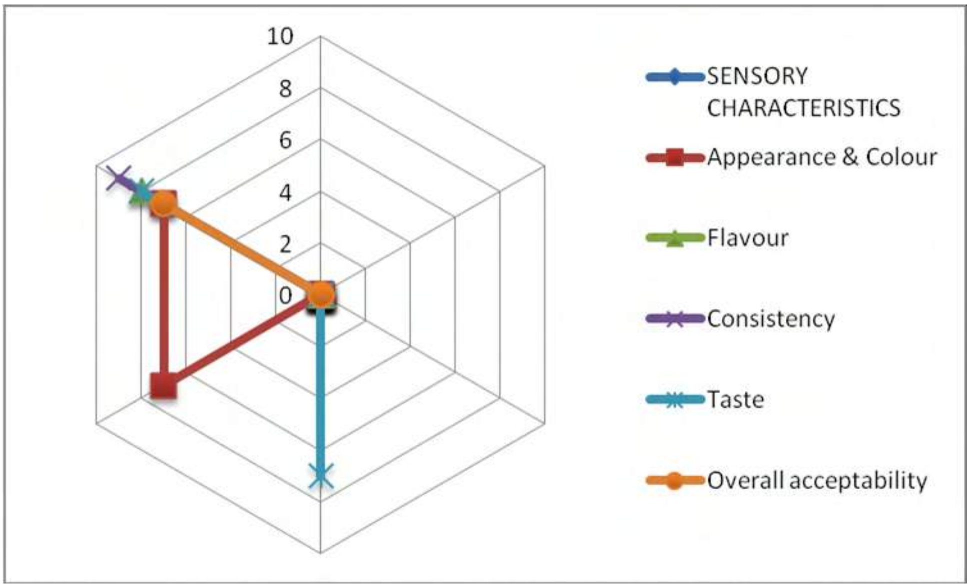

Figure 1. Sensory score analysis for lemon based betel squash

Reference

Aishwarya, J., Chauhan, E. S., Singh, A. and Tiwari, A. (2016). A Review: Nutraceutical properties of Piper betel (paan). *Am. J. of Phytomed. Clini. Ther*, 4(2): 028-041.

Vaibhav S. Kamble, Dhyaneshwar D. Patange, Dinakar K. Kamble, Karishma S. Kamble and Sharad J. Patil. (2019). Process Optimization for Flavoured Milk Added with Piper betel Leaves. *Int.J.Curr.Microbiol.App.Sci*. 8(01): 713-724

Study on Phytochemical Compounds Retention in HPD Dried Drumstick Powder by GC – MS and PCA Analysis

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Keywords: *Drumstick, HPD dryer, phytochemicals, GC - MS, nutraceutical*

Introduction

Drumstick (*Moringa oleifera* Lam.) is an incredible plant to mankind, because of its pharmacognostical and nutraceutical properties. *M. oleifera* are rich in vitamins, minerals and phytochemicals such as tannins and flavonoids are helpful in reducing non communicable and micro nutrient deficiency diseases. About one fourth of moringa produce is spoiled due to improper post-harvest handling. There is a need for processing in moringa will meet the demand of market thought the year. Dehydration is a method of preservation, in which conventional drying takes more time, energy and microbial contamination will affects the organoleptic property and product quality. Alternatives to conventional drying, advanced dryer *viz*., freeze- or vacuum-drying and heat pump-assisted dehumidified air dryer (HPD) used for drying heat-sensitive materials. HPD dried products are having higher retention of sensory and nutritional properties.

Methodology

Physico -chemical characteristics were analyzed in the fresh drumstick and HPD dried drumstick powder. To determine the presence of alkaloids, tannins, flavonoids, steroids, terpenoids and saponins in drumstick phytochemical screening was carried by using different solvents (Methanol, ethanol, chloroform, hexane, acetone and ethyl acetate). Identification of bioactive components were analysed in fresh drumstick and HPD dried HPD drying for drumstick powder (Fig 2).

The moringa fruit HPD dried at 55 C had 97.22 % powder recovery and water solubility index of the powder increased (67.18 to 71.18 %) with increasing drying temperature. The water absorption was more in 65 C and oil absorption was more in 55 C. The hauser's ratio and carr index measures the flow properties were the drumstick powder dried between 55 C to 65 C have excellent flowability. HPD dried drumstick powder at 55ºC was found maximum physicochemical properties, drying characteristics and higher retention of bioactive compounds with special reference to high powder recovery, excellent flowability and also better retention of nutrients like β – carotene, total antioxidant, flavonoids, phenol drumstick powder by using GC - MS analysis. Dried drumstick powder was prepared by using fresh drumstick pieces, were steam blanched for 2-5 min then sulphating 0.1% for 10 min. After that dehydration process done with different temperature (45, 55 and 65°C) in HPD drier. Then dehydration characteristics of drumstick powder were analyzed.

Results and Discussion

The selected moringa pod contain much valued for nutraceutical properties where the total antioxidant, flavonoids and phenols activity were 188.60mg $100g^{-1}$, 6.15mg REg^{-1} extract and 26.87mg $GAEg^{-1}$ extract respectively and with a mineral content of calcium - 37, iron - 1.18 and phosphorous - 108.5 mg $100g^{-1}$.

Identification of bioactive components in drumstick by GC-MS (Fig 1)

From the qualitative screening, phytochemical were highly present in methanol and ethanol extracts. Among the phytochemicals tannins and flavonoids were highly detected in different solvent extract. The extract of both fresh and dried powder contain 50 bioactive compounds of which the maximum quantum was found in 15 compounds such as 2,6-Dihydroxybenzoic acid 3TMS derivative (29.90

%), Butanal 2-ethyl-3-methyl- (23.56 %), these bioactive compound are act as a various nutraceuticals and therapeutic values

Optimization of HPD drying for drumstick powder (Fig 2)

The moringa fruit HPD dried at 55 C had 97.22 % powder recovery and water solubility index of the powder increased (67.18 to 71.18 %) with increasing drying temperature. The water absorption was more in 65 C and oil absorption was more in 55 C. The hauser's ratio and carr index measures the flow properties were the drumstick powder dried between 55 C to 65 C have excellent flowability. HPD dried drumstick powder at 55°C was found maximum physicochemical properties, drying characteristics and higher retention of bioactive compounds with special reference to high powder recovery, excellent flowability and also better retention of nutrients like β – carotene, total antioxidant, flavonoids, phenol and vitamin C.

Fig 1. Chromatogram obtained from the GC-MS with the extract of drumstick

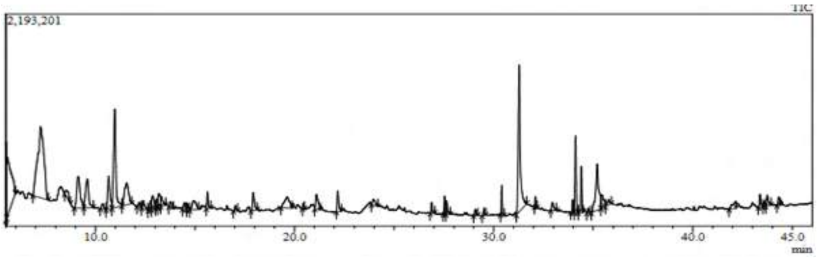
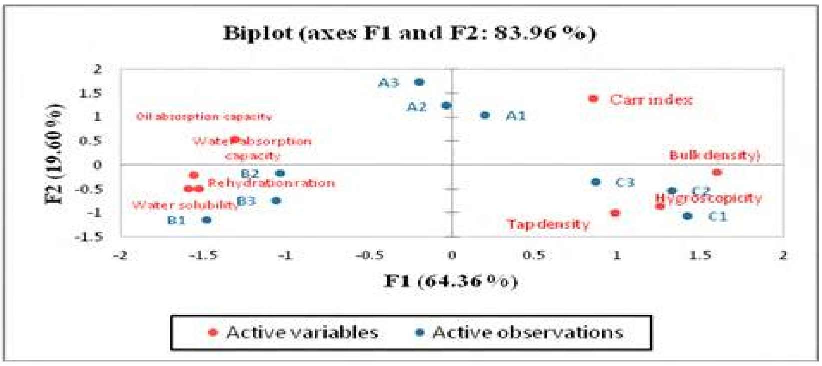


Fig 2. Principal component analysis of dehydration characteristics variables



Reference

Abbas, R. K., Elsharbasy, F. S., & Fadlelmula, A. A. (2018). Nutritional Values of Moringa oleifera, Total Protein. Amino Acid, Vitamins, Minerals, Carbohydrates, Total Fat and Crude Fiber, under the Semi-Arid Conditions of Sudan. *J Microb Biochem Technol*, 10, 56-58.

Aliyu, A., Chukwuna, U. D., Omoregie, E. H., & Folashade, K. O. (2016). Qualitative phytochemical analysis of the leaf of Moringa oleifera lam. from three climatic zones of Nigeria. *Journal of Chemical and Pharmaceutical Research*, 8(8), 93-101

Butz, D., & Schwarz, M. (2004). Heat Pump Drying (HPD)-How refrigeration technology provides an alternative for common drying challenges. *Ki Luft und Kaltetechnik*, (4), 140-144

Nutritional and Rheological properties of Pumpkin Seed Based Fruits Spread

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Keywords: *Nutritional values, Pumpkin seeds, Spreads, Textural properties*

Introduction

Fruits spreads are made by using processed fruit juice, concentrated form of fruit juice or whole fruit along with sugar. The pumpkin seeds usually considered as industrial waste products and thrown out. In some areas seeds are utilized as uncooked, cooked or roasted for the domestic purpose. They are rich in protein, fibers, minerals like iron, zinc, calcium, magnesium, manganese, copper and sodium, polyunsaturated fatty acids (PUFA), phytosterol and vitamins, they might be considered important for the food industries. Mango is one of the most important tropical fruits and it gives pleasant taste, aroma and high nutritional value. It is a rich source of water, sugars, fiber, minerals, vitamins and antioxidants. Papaya belongs to the family of *Caricaceae*. It has a high nutritive value and it is rich source of Iron, calcium, vitamin A, B and C. Muskmelon is the family of Cucurbitaceae. It contains rich source of phenolic phytochemicals and other essential nutrients.

Methodology

Pumpkin seed has been roasted and make into powder form. The pulps were extracting from β-carotene rich fruits such as mango, papaya and muskmelon. The fruit pulps (25%) were mixed with roasted seed powder (70%) and to get a desirable consistency of fruits spreads. The fruits spreads were pasteurized at 60°C for 30 mins to increase the shelf life and quality of a spreads. The spreads were packaged in two different types of packaging material such as food grade glass container and polypropylene container. They were kept in refrigerated conditions at 4°C for further analysis. The pumpkin seeds based fruits spreads were analyzed the nutritional content such as protein, fat,carbohydrate and fiber after organoleptic evaluation. The fruits spreads were analyzed the textural properties like hardness, adhesiveness, springiness, cohesiveness, gumminess, chewiness, resilience and viscosity. The spreads were analyzed the microbial content includes total plate count, yeast and mold. The pumpkin seed based fruits spreads were analyzed the Phytochemicals and antioxidant activity also analyzed.

Results and Discussion

Proximate composition of pumpkin seed based fruits spreads

Pumpkin seed based fruits spreads has 15.23 to 15.64 percent of moisture, 6.7 to 7.18 percent of protein, 4.53 to 4.89 percent of fat, 5.29 to 5.69 percent of fiber and 15.36 to 28.67 percent of carbohydrates. The pumpkin seed based fruits spreads had 15.41 to 23.04°Brix of total soluble solids(Table 2).

Texture properties of pumpkin seed based fruits spread

The fruits spreads had 85.82 to 764.54 g hardness, -88.54 to-205.45 g adhesiveness, 0.87 to 0.95 springiness,0.48 to 0.74 cohesiveness, 64.78 to 344.06 gumminess, 61.53 to 311.64 chewiness. The pumpkin seeds based fruits spread had 2.21 to 3.58 centipoises of viscosity. The fruits spreads had 20.63 to 36.24 %RSA of antioxidant properties. Among the fruits spreads, the mango based fruits spreads had secured the highest score values(Table 3).
The pumpkin seeds are considered as an underutilized seeds but it has enormous nutritional values and also nutraceutical properties. It was used in the spread to increase the nutritional value of the spread.

Table 1. Combination of pumpkin seed based fruits spread

Treatment	Fruits (70%) + seed powder (25%)
T_1	Mango + pumpkin seed powder
T_2	Papaya + pumpkin seed powder
T_3	Muskmelon + pumpkin seed powder

Table 2. Proximate composition of pumpkin seed based fruits spread (100g)

Parameters	T_1	T_2	T_3
Moisture (%)	15.23	15.36	15.64
Protein (%)	7.18	7.01	6.7
Fat (%)	4.89	4.53	4.65
Fiber (%)	5.59	5.69	5.29
Carbohydrate (%)	28.67	19.55	15.36

Table 3. Texture properties of pumpkin seed based fruits spread

Parameters	T_1	T_2	T_3
Hardness (g)	85.99	709.05	155.47
Adhesiveness (g.sec)	-88.65	-154.45	-205.76
Springiness	0.95	0.87	0.91
Cohesiveness	0.73	0.48	0.68
Gumminess	64.81	344.27	106.27
Chewiness	61.69	311.84	97.05
Resilience	0.06	0.07	0.06
Viscosity (centipoises)	2.34	3.21	3.61

Reference

Devi, NM, RV Prasad, and N Sagarika. (2018). "A review on health benefits and nutritional composition of pumpkin seeds." *International journal of chemical studies* 6 (3):1154-1157.

Malkanthi, HHA, SH Umadevi, and KV Jamuna. (2018). "Glycemic response and antioxidant activity of pumpkin seed powder (Cucurbita maxima) blended biscuits." *Journal of Pharmacognosy and Phytochemistry* 7 (4):1877-1882.

Ultrasound Assisted Extraction of Bioactive Compounds from Three Types of Germinated Millets

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Keywords: *Germination, Millets, Extraction, Bioactive compounds, Ultrasound*

Introduction

Minor millets such as foxtail millet (*Setaria italica*), barnyard millet (*Echinochloa crusgalli*), and little millet (*Panicum sumatrense*) are known for their role in disease prevention due to their bioactive compounds such as polyphenols and amino acid contents. Germination was found to increase the bioactive compounds present in food grains. Ultrasound extraction has been applied to extract the bioactive compounds from foods. Therefore, the germinated seed flours from foxtail, barnyard and little millet were subjected to ultrasound extraction to extract poyphenols and free amino acids.

Methodology

About 5 g of flours from germinated foxtail (GFM), barnyard (GBM) and little millet (GLM) were taken in an Erlenmeyer flask, water (RO) and ethanol (50%) were added at 1:10 of solid to liquid ratio. The flasks were kept on cold condition. Total time of extraction was 10 min, pulse on and off was set for 50 and 10 seconds, respectively with 35 % amplification. The samples were then filtered using four layers of cheese cloth. Evaporated in a rotary flash evaporator at 50 C, 80 rpm for 15 min. The samples were centrifuged and stored at 4 C until analysis. Total polyphenols and total free amino acids were analyzed in the extracted samples.

Results and Discussion

Effect of solvent on extraction of total polyphenol and free amino acid contents in three types of germinated millet flour

As a source of phenols and amino acids to incorporate in development of functional beverages, millets were subjected to extraction. Total polyphenol content was observed high in little millet extracted with ethanol compared to foxtail and barnyard millet extract (Fig 1). Whereas high total free amino acid content was observed in foxtail millet extracted with water followed by ethanol extracted little millet flour (Fig 2). High amount of polyphenol content in germinated little millet flour extract is due to presence of high content in the flour. Similarly, high content of amino acid in foxtail millet flour is due to the presence of high amino acids compared to other two millets.

High content of phenols and amino acids can be obtained from the ethanol extraction of germinated little millet flour by applying ultrasound extraction technique. The results of this study showed that ultrasound assisted extraction using ethanol as a solvent can provide bioactive compounds which can be incorporated in the development functional fruit and vegetable beverages.

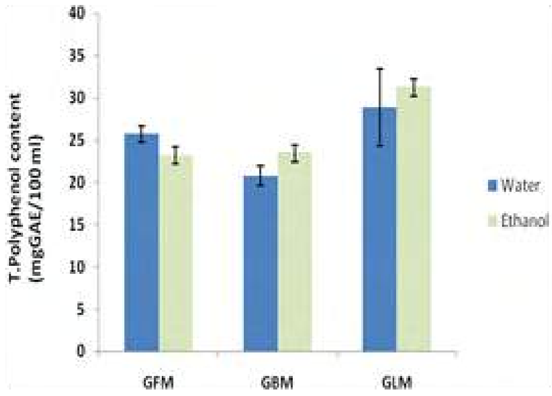

Fig 1: Total polyphenol content in water and ethanol extracted germinated millet flours. Bars represent standard error (n=3)

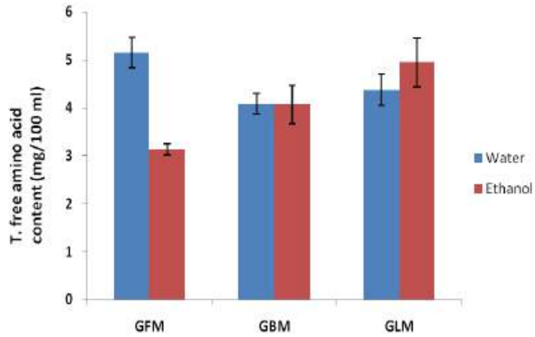

Fig 2: Total free amino acid content in water and ethanol extracted germinated millet flours. Bars represent standard error (n=3)

Reference

Alvarez-Jubele, L., Wijngaard, H., Arendt, E.K and Gallagher. 2010. Polyphenol composition and in vitro antioxidant activity of amaranth, quinoa, buckwheat and wheat as affected by sprouting and baking. *Food Chem*. 119, 770-778.

Hubner, F. and Arendt, E.K. 2013. Germination of Cereal Grains as a Way to Improve the Nutritional Value: A Review. *Critical Reviews in Food Science and Nutrition*. 53:853–86

Nazni, P. and Devi, S.R. 2016. Effect of Processing on the Characteristics Changes in Barnyard and Foxtail Millet. *J. of Food Process and Technol*. 7: 566. doi:10.4172/2157-7110.1000566

Rodrigues, S., Fernandes, F.A.N., Brito, E.S., Soura, A.D., & Narain, N. (2015). Ultrasound extraction of phenolics and anthocyanins from jabuticaba peel. *Industrial Crops and Products*, 69, 400-407.

Underutilized Pulse Extrudates and their Nutritional Specifications

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Keywords: *Extrudates, Horse gram, Moth bean, Twin Screw Extruder*

Introduction

At present, the perspective towards consumption of underutilized pulses is increasing due to the thrust of new alternative protein sources to meet the demand for vegetable proteins.Legumes are the good source of protein packed with number of health benefits. Horse gram and Moth bean are the underutilized crops had many health benefits. Due to its flavor, cooking time the pulses are neglected for human consumption. It is rich in protein, iron, calcium and B-complex vitamins. Highly recommended for diabetes and obese patient to reduce the weight of the body. Also rich in polyphenols, flavonoids and major anti-oxidants.

Methodology

Horse gram and Moth bean were purchased from the local market Madurai, Tamil Nadu. The seeds are thoroughly cleaned and washed to remove broken grain, dust, stones and other foreign materials. Then the seeds were soaked for 6-8 hours and dried it in a cabinet drier for 7-8 hours. The dried pulses were milled to flour using pulverizer and it is sieved through BS100 sieve.

Results and Discussion

During storage, the moisture content was increased for horse gram from 9.07-11.98 and for moth bean it is in the range of 8.40-10.97. The carbohydrate was increased from 70.98-74.65 for horse gram and for moth bean it exists in the range of 60.20-65.28g. The fat content was decreased. The protein were lies in the range of 21.00-19.92g/kg for horse gram and for moth bean it is 22.50-20.97g/kg.The significant changes were observed in the dietary fibre and mineralcontent during the storage of product. The extrudates were similar in appearance and texture compared with commercially available product. In this conclusion, the underutilized pulses will assuredly replace the animal protein.

Table 1. Changes in nutritional specifications

Nutritional Parameter	Horse gram		Moth bean	
	0 days	90 days	0 days	90 days
Moisture (%)	9.07	11.98	8.40	10.97
Carbohydrate (g/100g)	70.98	74.65	60.20	65.28
Protein (g)	21.00	19.92	22.50	20.97
Fat (g)	2.35	1.90	4.65	3.98
Fibre (g)	16.17	16.03	4.20	3.92
Calcium (mg/kg)	126	125	310	308
Iron (mg/kg)	13.00	12.86	11.00	10.47
Starch (g/100g)	34.55	34.08	35.28	35.01
Phytate (mg/kg)	15.08	10.26	8.00	7.45
Anti-oxidant (%)	10.00	11.28	10.20	11.88

Reference

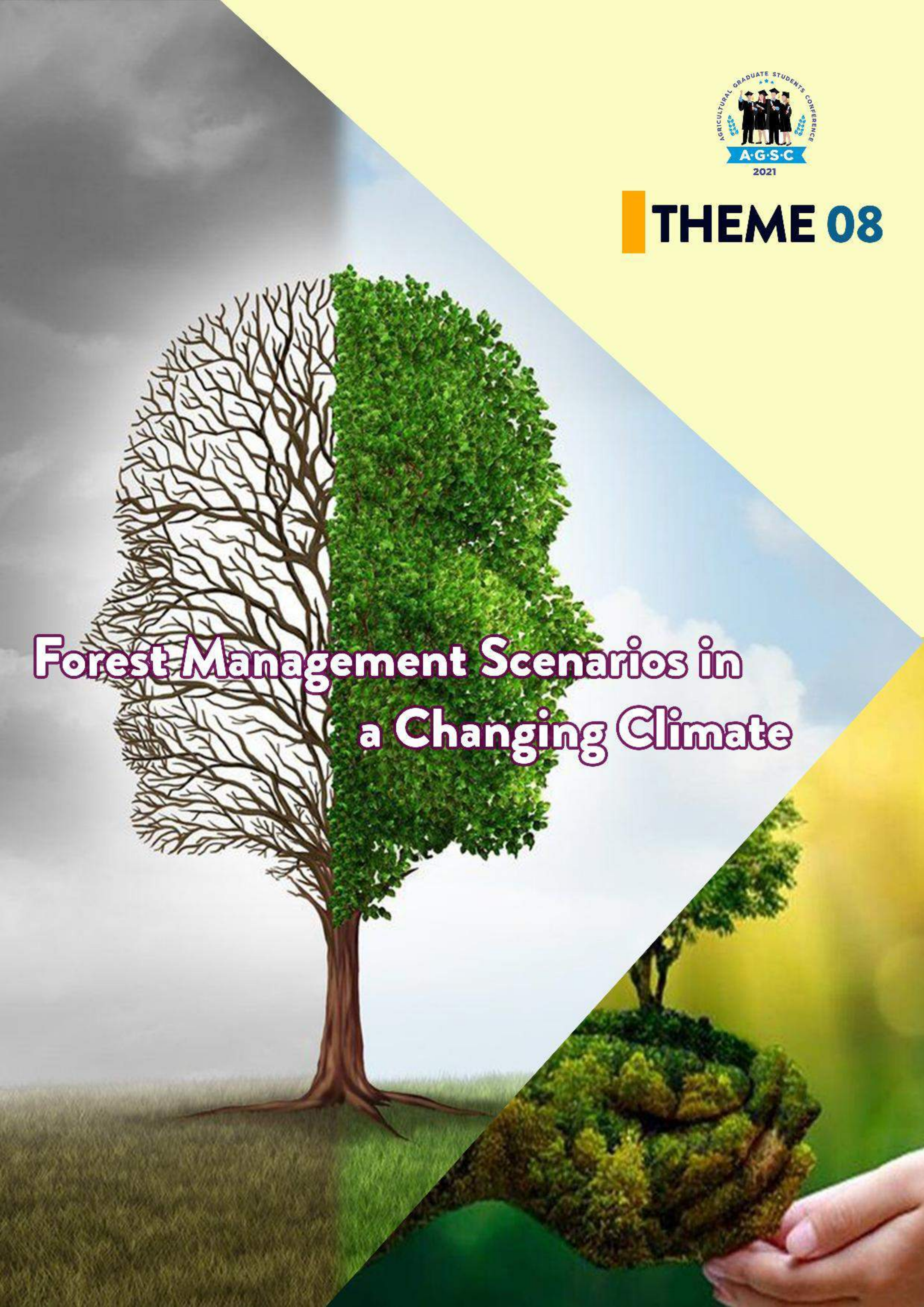
AOAC (Association of Official Analytical Chemists). Official methods of analysis of the association of officialanalytical chemistry. 16th (Eds.), Washington. 1997; 2:235-236.

Cohen EH. *Journal of Assoc. Anal*. Chem. (1917); 54:212.

Coulibaly, A., Kouakou, B., and Chen, J. (2012). Extruded adult breakfast based on millet and soybean: Nutritional and functional qualities, source of low glycemic food. *Nutrition and Food Sciences*.

THEME 08

Forest Management Scenarios in a Changing Climate



Ailanthus excelsa: An alternate tree species for plywood utility

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Keywords: *Ailanthus, plywood utility, mechanical*

Introduction

The wood is an important material that can be used in different forms and situations. Its characteristics are comparable to those of other structural materials, but increased demand for wood has caused a decrease in forest resources. One way to increase forest resources, thereby protecting the natural forest wherein composite products especially plywood has been developed as an alternative to solid products. The plywood has increased dimensional stability, uniformity and higher mechanical strength, improved stress distributing properties, reduced processing cost and better appearance. Considering the properties of Ailanthus wood and specifically the properties of plywood in various literature, this study was conducted with the objective of assessing the plywood properties of *Ailanthus excelsa* of different girth classes

Methodology

Ailanthus excelsa of 10-year-old trees were selected and the logs were categorized into three different girth classes *viz.*, 30-45 cm, 45-90 cm and 90-120 cm with four replications. The physical properties *viz.*, volume, green wood density, dry wood density and moisture content and the mechanical properties viz., static bending strength, tensile parallel to grain, tensile perpendicular to grain, compression parallel to grain and compression perpendicular to grain were determined. The wood mechanical properties determine the quality of veneer and plywood. Hence, the mechanical properties of Ailanthus wood was assessed on Universal Timber Testing Machine in accordance with IS 1708. The maximum static bending strength was calculated by dividing the load to failure by the cross sectional area of the specimen. The specimen size for measuring the tension parallel to grain was 32.5 x 5 x 1.5 cm. The specimen size for measuring tension perpendicular to grain was 32.5 x 5 x 2 cm. The compression strength parallel to grain was carried out using the specimen size of 2 x 2 x 30 cm. The following plywood properties *viz.*, veneer recovery, veneer shrinkage, thickness swelling, water absorption, density, modulus of elasticity across the grain, modulus of rupture across the grain, modulus of elasticity along the grain, modulus of rupture along the grain and glue shear strength were assessed as per the standard procedure.

Results and Discussion

The increase in MOE with girth size may be attributed to increments of growth rings, addition of more mature wood and the increasing age of cambium as the tree grows in girth. Wood that has a high modulus of elasticity indicates that it is difficult to bend. Similar trend of increase in MOE has been reported in *Melia dubia* (Saravanan *et al.*, 2014), Teak (Izekor *et al.*, 2010), *Acacia auriculiformis* (Shukla *et al.*, 2007), *Nauclea diderichii* (Fuwape and Fabiyi, 2003) and Slash pine (Macpeak *et al.*, 1990). The mean values of compression strength parallel to grain in Ailanthus wood were 298.70 Kg cm^{-2}, 314.91 Kg cm^{-2} and 325.36 Kg cm^{-2}) for different girth classes. This study showed that significantly higher value was recorded in T_3 and lower value in T_1.The similar trend was noticed in compression perpendicular to grain with the mean values ranged from 102.47 to 114.69 Kg cm^{-2} (Table 1).

Table 1 FAO. 2020. World Food and Agriculture: Statistical Yearbook 2020. Rome.

Treatments (Girth classes)	Static Bending strength (*Kg cm-2*)	Tension parallel to grain (*Kg cm-2*)	Tension perpendicular to grain (*Kg cm-2*)	Compression parallel to grain (*Kg cm-2*)	Compression perpendicular to grain (*Kg cm-2*)
T_1 (30-45cm)	319.39	376.86	109.24	298.70	102.47
T_2 (45cm-90 cm)	326.76	384.75	112.39	314.91	108.66
T_3 (90 cm- 120 cm)	347.86	396.04	124.87	325.36	114.69
S Ed	0.544	0.177	0.239	0.192	0.235
CD (0.05)	1.144	0.373	0.503	0.403	0.449

Reference

FUWAPE, J.A. AND J.S. FABIYI. 2003. Study on wood density of plantation grown *Nauclea diderichii* wood. *J. Trop. For. Prod.*, 9(1&2): 45-53.

IZEKOR, D.N., J.A. FUWAPE & A.O. OLUYEGE. 2010. Effects of density on variations in the mechanical properties of plantation grown *Tectona grandis* wood. Scholars Research Library. *Arch. App. Sci. Res.*, 2(6): 113-120.

MACPEAK, M.D., L.F. BURKER & D. WELDON. 1990. Comparative study of WoodPhysical and Mechanical properties of *Melia dubia*. *Forest Product Journal*, 40(1): 11-14.

SARAVANAN, V., K.T.PARTHIBAN, S. THIRUNERAISELVAN, P. KUMAR AND S. VENNILA & U.S. KANNA, 2014. Comparative study of wood physical and mechanical properties of *Melia dubia* with *Tectona grandis* at different age gradation. *Research Journal of Recent Sciences,* 3:256-263.

SHUKLA, S.R., R.V. RAO, S.K. SHARMA, P. KUMAR, R. SUDHEENDRA AND S. SHASHIKALA. 2007. Physical and mechanical properties of plantation-grown *Acacia auriculiformis* of three different ages. *Australian Forestry*, 70(2): 86-92.

Assessing the Biomass Productivity of Eucalyptus Plantations at Different Age Gradations

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Keywords: *Biomass, Eucalyptus, Age gradations*

Introduction

Eucalyptus originates from Myrtaceae family and it is native to Australia, Tasmania and near islands. Economically, eucalyptus trees constitute one of the most valuable groups in the order Myrtales. This species has high economic value, as it is major source of paper and plywood industries. It is one the most adapted species under agroforestry plantations in India due to the assured market price and high returns. Biomass of eucalyptus plantation which includes both the above- and belowground of trees for example, leaves, twigs, branches, boles, as well as roots of trees. Biomass is often reported as a mass per unit area ($g\ m^{-2}$ or $Mg\ ha^{-1}$) and usually as dry weight (water removed by drying). In worldwide, the biomass has become important and presently, is an important tool in implementation of emerging carbon credit mechanism (Mugasha *et al.* 2013). The estimation of biomass and the biomass studies are time consuming, expensive and applicable to localized conditions. Typically, biomass comprises measureable tree variables such as DBH, height, canopy spread, etc. that are closely correlated to biomass (Chave *et al.* 2014) and DBH is the most important variable used for predicting biomass (Verma *et al.* 2014).

Methodology

The Eucalyptus clonal plantation established at the fields of Tamilnadu Newsprint and Papers Limited, Kakithapuram (11° 3′ N latitude and 77° 59′ E longitude) were formed base material for the current study. The laboratory studies were conducted at Silviculture and Agroforestry laboratories of Forest College and Research Institute, Mettupalayam, Tamil Nadu.The present study was undertaken in 1- to 5-year-old Eucalyptus plantation. The field experiment was conducted in factorial randomized block design . The Eucalyptus plantations of 1, 2-, 3-, 4- and 5-year-old were selected for the present study. The total height of trees was measured by using Haga altimeter in all ages of plantations randomly and expressed in metre (m). All the experimental trees were marked at 1.37 m from ground level with a band of 1 cm around the stem using orange paint. The dbh of trees was arrived at by using the formula *viz.*, G/3.14 and expressed in centimetre.The volume of standing trees was estimated using the formula $V = r^2 h$ and expressed in m^3. The volume of felled trees was calculated using the quarter girth formula i.e., $V = (g/4)^2 x\ l$ and expressed in m^3.

Results and Discussion

Tree growth

In the present study, the growth of Eucalyptus *viz.*, height, gbh, dbh and volume increased with an increase in age. The results revealed that there was a gradual increase in height, gbh, dbh and volume when the age of trees increases. The mean tree height in different ages of Eucalyptus was ranged from 6.00 m to 15.50 m. The gbh and dbh of trees were ranged from 16.00 cm to 25.50 cm and 5.10 cm to 8.12 cm respectively at first year and fifth year.

The results depicted a significant difference in total biomass due to ages. In the present study there was increase in biomass over the age which was clearly supported by Ravi (2012) who reported that there was increase in biomass with increase in age of *Casuarina equisetifolia*. The total biomass dry weight differed from 30.31 t ha^{-1} to 149.51 t ha^{-1} in 1st and 5th year old trees respectively. The similar biomass increment was observed by Kraenzel *et al.* (2003) in teak plantations and estimated that the total tree dry biomass varied from 122 to 1365 kg. (Table. 1)

From this study there was a significant increase in growth and biomass of trees as the age increases. This exponential increase in incremental growth and biomass due to age would occur upto certain age and slow growth in current annual increment.

Table 1. Total biomass of Eucalyptus plantations at different ages (t ha^{-1})

Age of plantations (yrs)	AGB fresh weight (t ha^{-1})	AGB dry weight (t ha^{-1})	BGB fresh weight (t ha^{-1})	BGB dry weight (t ha^{-1})	Total biomass fresh weight (t ha^{-1})	Total biomass dry weight (t ha^{-1})
1	35.98	22.32	12.89	7.99	48.87	30.31
2	51.10	33.54	16.88	10.78	67.98	44.32
3	75.11	47.11	29.97	19.99	105.08	67.1
4	99.70	71.98	36.66	25.00	136.36	96.98
5	151.05	111.76	50.86	37.77	201.93	149.51
SEd	0 .294	0.379	0.004	0.074	0.654	0.371
CD (0.05)	0.623	0.804	0.009	0.157	1.387	0.787

Reference

Chave, J., Réjou-Méchain, M., Búrquez, A., Chidumayo, E., Colgan, M. S., Delitti, W. B. and Vieilledent, G. (2014). Improved allometric models to estimate the aboveground biomass of tropical trees. *Global change biology*, *20*(10), 3177-3190.

Kraenzel, M., Castillo, A., Moore, T., & Potvin, C. (2003). Carbon storage of harvest-age teak (Tectona grandis) plantations, Panama. *Forest Ecology and Management*, *173*(1-3), 213-225.

Mugasha, W. A., Eid, T., Bollandsås, O. M., Malimbwi, R. E., Chamshama, S. A. O., Zahabu, E., and Katani, J. Z. (2013). Allometric models for prediction of above-and belowground biomass of trees in the miombo woodlands of Tanzania. *Forest Ecology and Management*, *310*, 87-101.

Ravi, (2012). Carbon sequestration potential of Casuarina equisetifolia in coastal tracts of Tamil Nadu. Ph.D. thesis, FRI University, Dehradun.

Verma, A., Kaushal, R., Alam, N. M., Mehta, H., Chaturvedi, O. P., Mandal, D., and Singh, C. (2014). Predictive models for biomass and carbon stocks estimation in Grewia optiva on degraded lands in western Himalaya. *Agroforestry systems*, *88*(5), 895-905.

Assessing the Carbon Sequestration Potential of Eucalyptus Plantations of Different Ages

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Keywords: *Carbon Sequestration, Eucalyptus*

Introduction

The investment in forestry sector to store carbon in the trees and forests is one of the viable options for offsetting the gases released by fossil fuel burning and mitigating the potential effect of global warming. Perennial vegetation, notably forests have an important role to play in regional, national and international greenhouse gas balances. Afforestation and Reforestation (A/R) as an effective way to reduce atmospheric carbon by building up terrestrial carbon stocks and to produce Certified Emission Reductions (CERs) in the second commitment period of the Kyoto Protocol (2013–2020). The carbon sequestration by tree plantations and the existing forest area is estimated to sequester 15-20 % GHG emissions in India. No attempt has been made so far to assess the biomass and soil carbon sequestration at micro level. Therefore, the current study is designed to estimate the carbon stock available in Eucalyptus plantations of different ages.

Methodology

Eucalyptus hybrid clonal plantations established by Tamil Nadu Newsprint and Papers Limited, Kakithapuram (11° 3′ N latitude and 77° 59′ E longitude) was taken for this study. The laboratory studies were conducted at Forest Soils and Forest Microbiology laboratories of Forest College and Research Institute, Mettupalayam. The present study was undertaken in 1 to 5 year old Eucalyptus plantations. Two different soil depths *viz*., 0-15 cm and 15-30 cm and two distances from the tree *viz*., 0.5 m and 1.0 m were choosen. The tree samples of various components *viz*., stem, branches, leaves and roots were collected from selected Eucalyptus plantations of different ages, then samples were air dried and oven dried. Oven dried biomass samples were powdered in Willey Mill and carbon content in above ground components of plantations was determined by using Ash content method.

The total biomass carbon was calculated by using the following formulae.

i) AGB carbon (t C ha^{-1}) = Components of above ground biomass (t ha^{-1}) Carbon content (%)

ii) BGB carbon (t C ha^{-1}) = Components of below ground biomass (t ha^{-1}) Carbon content (%)

iii) Total biomass carbon stock (t C ha^{-1}) = AGB carbon + BGB carbon

Results and Discussion

Carbon Content in Above Ground Biomass

The results reported that there was a significant difference in the carbon content (C) in above ground biomass between the ages of plantations. The per cent carbon content in stem wood diverged from 40.20 per cent in 1 yr old to 48.97 per cent in 5 yr old plantations and the total stem wood carbon ranged from 4.24 t C ha^{-1} in 1 yr old plantation to 37.97 t C ha^{-1} in 5 yr old plantation. The data depicted that the carbon content of stem wood increased with an increase of age (Table 1). The estimated total biomass carbon varied from 15.17 t C ha^{-1} to 74.77 t C ha^{-1} in first year to fifth year of eucalyptus plantations. The estimated total carbon (i.e., soil organic carbon and estimated total biomass carbon) diverged from 34.99 t C ha^{-1} in one year old plantations to 98.32 t C ha^{-1} in 5 yr old plantations (Figure 2). Soil and vegetation therefore represent potential sinks for carbon sequestration. Several authors have suggested afforestation as a possible means of mitigating global climate change (Shivanna et al., 2006; Arya et al., 2018; Jithila and Prasadan, 2018; Mishra and Prasad, 2018; Jogattappa et al., 2020).

Table 1. Total carbon content in above and below ground biomass of Eucalyptus plantations at different ages (%)

Age of plantations (yrs)	Carbon content (%)			
	Stem wood	Branch wood	Leaf	Root
1	40.20	33.48	37.65	28.77
2	42.65	34.83	38.01	38.37
3	45.89	40.23	40.29	39.39
4	46.63	45.45	41.52	42.93
5	48.97	47.48	43.44	45.96

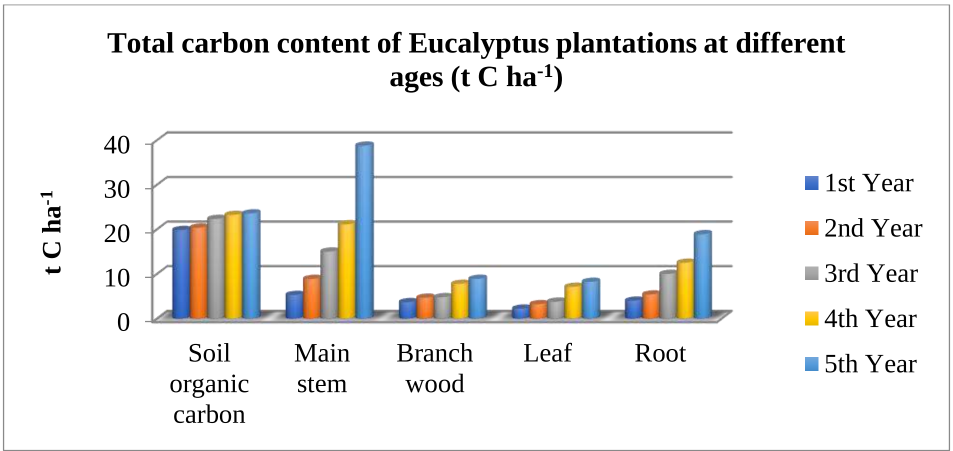

Figure 1.Total carbon content of Eucalyptus plantations at different ages (t C ha^{-1})

Reference

Arya A, Shalini Negi S, Kathota JC, Patel AN, Kalubarme MH (2018). Carbon Sequestration Analysis of dominant tree species using Geo-informatics technology in Gujarat State (India). International Journal of Environmental Geoinformatics. 4(2):79–93.

Jithila P.J, Prasadan P.K (2018). Carbon sequestration by trees-a study in the Western Ghats, Wayanad Region. Indian Journal of Ecology. 45(3): 1–14.

Jogattappa N, Shashidhar, Appaji N, Malve S (2020). Carbon Sequestration Potential of Trees in Kuvempu University Campus Forest Area, Western Ghats, Karnataka. Socio-economic and Eco-biological Dimensions in Resource use and Conservation pp 303-312

Mishra P.C, Prasad S.M (2018). Carbon sequestration in plantation of forest trees in Garhwa social forestry division. Jharkhand. IOSR Journal of Agriculture and Veterinary Science 11(5):1–6.

Shivanna H, Janagiri P. Balachandra H.C, Kyatappanvar S (2006). Potential of *Pongamia pinnata* in carbon sequestration - An important bio-diesel plant. My Forest, 42(1): 5-11.

Assessing the Productivity and Carbon Sequestration Potential of Different Aged *Melia Dubia* Plantations

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Keywords: *Productivity, Carbon sequestration, Melia dubia*

Introduction

A fast-growing species is one that is capable of putting on a girth at breast height of 1 cm month^{-1}. *Melia dubia* has an ability to increase its girth at a faster rate at about 25.0 cm year^{-1}. *Melia dubia* has been identified as a high carbon assimilating potential species and one of the best species for plywood. Assuring a buy back for the species, the plywood industry has fixed a ceiling of 90 cm girth for the harvestable wood. With its rapid growth potential, the species could definitely fetch good returns at the end of 5-6 years (Rekha *et al*., 2010). Recently there is a growing awareness on the promotion and utilization of *Melia dubia*. Its multi-various uses like pulpwood, timber, fuelwood and plywood can fit as a suitable species for plantation programme. It has been screened as an alternate species for pulpwood (Parthiban *et al*., 2009).

Methodology

Melia dubia plantations established in the farmer's field at Chennampatti, Bhavani Taluk situated at Erode district (11° 70′ N latitude and 77° 68′ E longitude) were taken for the current study. The laboratory studies were conducted at forest soils laboratories at Forest College and Research Institute, Mettupalayam. The following growth attributes and volume of trees (both in standing and felled trees) were recorded. The tree samples of various components *viz*., stem, branches, leaves and roots were collected, air dried and oven dried. Oven dried biomass samples were ground in Willey Mill and carbon content in above ground components of plantations was determined by Modified Walkley and Black's wet oxidation method as in Jackson, 1958 (Jha, 2005).

Results and Discussion

Growth and biomass of trees at different ages

The tree height, girth and diameter at breast height of *Melia dubia* trees of 1 to 5 years old was recorded. The data depicted that the magnitude of growth parameters increased with an increase in age of trees. The volume of standing and felled trees differed significantly due to age. The results of volume indicated that the trees expressed an exponential relation in volume over the ages.

Tree biomass

The above ground biomass of trees *viz*., stem, branch and leaf of 1 to 5-year-old plantations was recorded. The results showed that fresh weight and dry weight of above ground biomass components increased with a concomitant increase in age of trees. There was a significant difference in the above ground biomass components between the ages. Similarly, the below ground biomass was assessed and it revealed that the root fresh and dry weight also increased with an increase of age of trees. The results revealed that the total biomass fresh weight and dry weight increased gradually with an increase of age.

Carbon sequestration potential of trees at different ages

The carbon content in different above ground biomass components *viz*., stem, branch and leaf and below ground biomass carbon *viz*., root of Melia *dubia* trees of 1to 5 year old was estimated. The data revealed that the per cent carbon content of stem, branch, leaf and root wood increased with an increase of age (Table 1). Analogous to this, the total biomass carbon content also increased due to the age of the trees.

In the present study, the estimated and the assumed total carbon content of *Melia dubia* plantations of five different ages were recorded and it was found to be in increasing trend over ages. It was observed from the present study, that *Melia dubia* plantations have higher growth, and it sequested significant amount of carbon with age and it also had a positive effect on soil ecology. Hence, this species can be chosen as a carbon sink to mitigate the consequences of global warming.

Table 1. Growth and volume of *Melia dubia* plantations at different ages

Age of plantations (yrs)	Mean height (m)	Mean girth at breast height (cm)	Mean diameter at breast height (cm)	Mean volume of standing trees (m^3 $tree^{-1}$)	Mean volume of standing trees (m^3 ha^{-1})*	Mean volume of felled trees ($m^3 tree^{-1}$)	Mean volume of felled trees ($m^3 ha^{-1}$)
1	6.50	23.93	7.62	0.017	18.89	0.023	25.07
2	8.30	27.74	8.83	0.030	33.33	0.039	42.32
3	10.40	31.10	9.90	0.040	44.44	0.063	68.36
4	10.90	38.52	12.27	0.070	77.77	0.100	108.00
5	11.30	45.82	14.38	0.110	122.21	0.150	151.50

Reference

Divya, M.P., R. Jayaramasoundari, M. Paramathma, N. Chandrasekaran, M. Govindarao and S.K. Dhjani. 2010. A compendium on 25 years of agroforestry research under AICRP on Agroforestry 1983-2008. pp. 13-14.

Parthiban, K.T., A.K. Bharathi., R. Seenivasan., K. Kamala and M.G. Rao.2009. Integrating *Melia dubia* in Agroforestry farms as an alternate pulpwood species, APA News 34:3-4.

Biochemical and Early Growth Response of Different Teak (*Tectona Grandis* Linn.F) Genotypes Under Irrigated Conditions

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Keywords: Teak, Genotypes, Growth attributes, Chlorophyll and Carotenoids

Introduction

Teak (*Tectona grandis* Linn. f) is considered as "the paragon of timbers" belongs to the family Lamiaceae, has highest timber value and it is the World's premier hardwood timber. Up-to date there was no such innovating programme for utilizing the existing genetic variation among the broader genetic base population. Hence, by systematic tree improvement programme of Teak (*Tectona grandis* Linn.f) will addresses the shortage of raw material source to the wood based industry. Initially, the study was proposed to determine the growth and biochemical attributes of different teak genotypes under irrigated condition.

Methodology

The study was carried out in the teak germplasm established at the Forest College and Research Institute, Mettupalayam, Coimbatore. There are six different genotypes *viz*., Lanka (Assam), Baroda (Gujarat), Visakapattinam (Andhra Pradesh), Shivamoga (Karnataka), Nilambur (Kerala) and Topslip (Tamilnadu) were collected and established in the experimental trial. The experiment was laid out in a randomized block design replicated three times in 3 X 3 m spacing plot. Irrigation as per the daily pan evaporimeter value and fertigation as per the calculated fertilizer schedule were imposing with the drip irrigation system.

(i) Biometric observation

Biometric observations *viz*., tree height (m), Collar girth (cm) was recorded during 6 and 12 months after planting. The height of trees was using the instrument tree telescope. The collar girth of trees was measured using the tailor's tape.

(ii) Estimation of biochemical attributes

The chlorophyll (a, b and total) as well as carotenoid content in leaves were estimated by the method of (Yoshida *et al*.,1971), chlorophyll is extracted in 80 % acetone and absorbance are read in a spectrophotometer. Using the absorption coefficients the amount of chlorophyll is calculated. The data was quantitatively expressed in mg/gm.

Results and Discussion

From the computed data it is observed significant differences found between the genotypes in each of the parameters observed. The genotypes which showed maximum height and collar girth of 4.01 m and 25.12 cm were recorded in Baroda. In our present study irrigation is carried out based on daily pan evaporimeter value, so trees attain 3 to 4 m of height and 22 to 26 cm of collar girth within one year of planting i.e., early growth phase.

Chlorophyll content maintains the photosynthesis process and it is directly proportional with plant growth and development. High chlorophyll content will enhance the photosynthetic rate and finally it will improvise the quality and quantity of yield and nutrient content (Larekeng *et al*., 2019). From our investigation also it is proven that the Baroda (Gujarat) genotypes which possess higher chlorophyll and carotenoids content have also showed maximum height and collar girth

Table1: Growth and Biochemical attributes of different teak genotypes

GENOTYPES	Collar girth			Height			Chl. a	Chl. b	Total Chl.	a/b ratio	Carotenoids
	6 MAP	9 MAP	12 MAP	6 MAP	9 MAP	12 MAP					
Assam	11.56	14.65	23.78	1.09	1.87	3.56	1.08	0.51	1.65	2.13	0.57
Gujarat	13.36	17.98	25.12	1.60	2.55	4.01	1.13	0.55	1.47	2.07	0.59
Andhra Pradesh	12.00	16.65	24.97	1.45	2.25	3.69	1.13	0.46	1.59	2.47	0.51
Karnataka	11.97	15.87	23.64	1.37	2.15	3.71	1.12	0.45	1.56	2.43	0.54
Nilambur	10.33	13.95	22.33	0.86	1.75	3.53	1.16	0.53	1.43	2.17	0.52
Topslip	11.19	14.55	22.44	1.29	2.01	3.50	0.89	0.39	1.28	2.25	0.5
Mean	11.73	15.60	23.71	1.27	2.09	3.668	1.084	0.480	1.497	2.253	0.537
SE(d)	0.38	0.32	0.97	0.05	0.10	0.125	0.056	0.021	0.067	0.082	0.015
CD	0.86	0.73	2.18	0.11	0.22	0.279	0.125	0.046	0.150	0.183	0.033
CV %	4.04	2.58	5.06	5.09	5.87	4.180	6.330	5.290	5.520	4.450	3.390

Reference

Dotaniya, M.L, Meena, V.D, Lata, M & Meena, H P. (2013).Teak plantation – a potential source of income generation, *Popular Kheti*, 1(3), 61-63.

Katwal, RPS. 2003. "Teak in India: status, prospects and perspectives." Proceedings of the international conference on quality timber products of teak from sustainable forest management. Peechi, India.

Anjum, F., Yaseen, M., Rasul, E., Wahid, A., & Anjum, S. (2003). Water stress in barley (*Hordeum vulgare* L.). II. Effect on chemical composition and chlorophyll contents. *Pak. J. Agric. Sci*, *40*, 45-49.

Comparative Growth Performance and Eco-Physiological Response of Tree Species Grown Under Intensive Silvicultural Management Practices

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Keywords: *Biometric attributes, Eco-physiology, Silviculture, Precision Silviculture, Tree Species*

Introduction

Wood from forest is the world's major renewable commodity. Demand for wood and other forest products are increasing, which resulted in serious depletion of forest cover. In natural vegetation and rainfed plantations, there have been low annual growth increments in wood, so this cannot meet the increasing needs of the industries and local communities. The gap between demand and supply of forest produce is so wide. In order to bridge the widening gap, forest productivity has to be maximized by adopting new ways (Different forest management techniques) and technologies through farm forestry. Therefore, hand in hand silvicultural technologies, viz., Pruning, water management, fertilizer management, thinning were applied to increase the annual increment of the tree species. To adopt these intensive silvicultural farming technologies, the study was carried out for attributing the growth performance and eco-physiological response of tree species that are commonly grown in farm forestry.

Methodology

The tree plantation was established during 2017 and maintained at Department of Silviculture and NRM, Forest College and Research Institute, Mettupalayam, Coimbatore, India (11° 19′ N and 77°56′ E) with an altitude of 300 m above MSL and mean annual rainfall of 920.5 mm. The soil was Illupanatham soil series, slightly alkaline (pH-7.87) in nature; soil was loamy sand, well drained and non saline (EC-0.20 dSm^{-1}). The study was carried out in 7 different tree species namely *Neolamarckia cadamba, Acrocarpus fraxinifolius, Grewia tiliaefolia, Melia dubia, Tectona grandis, Swietenia macrophylla* and *Dalbergia sissoo.* The plantation was established with 3m x 2m spacing and regularly managed with water management (Drip irrigation based on the soil surface), drip fertigation (Fertilizer was applied through drip), pruning (Side branches was removed periodically), and thinning operations for improving the diameter of trees. Biometric attributes viz., height and diameter at breast height (DBH) was measured during 12 months after planting (MAP), 24 MAP and 36 MAP. Using a Portable Photosynthesis System (PPS, model LCpro+ Photosynthesis System CO gas analyzer, UK), the net rate of photosynthesis rate and transpiration rate were estimated between 09.00 am to 11.00 am for three sunny days for effective results.

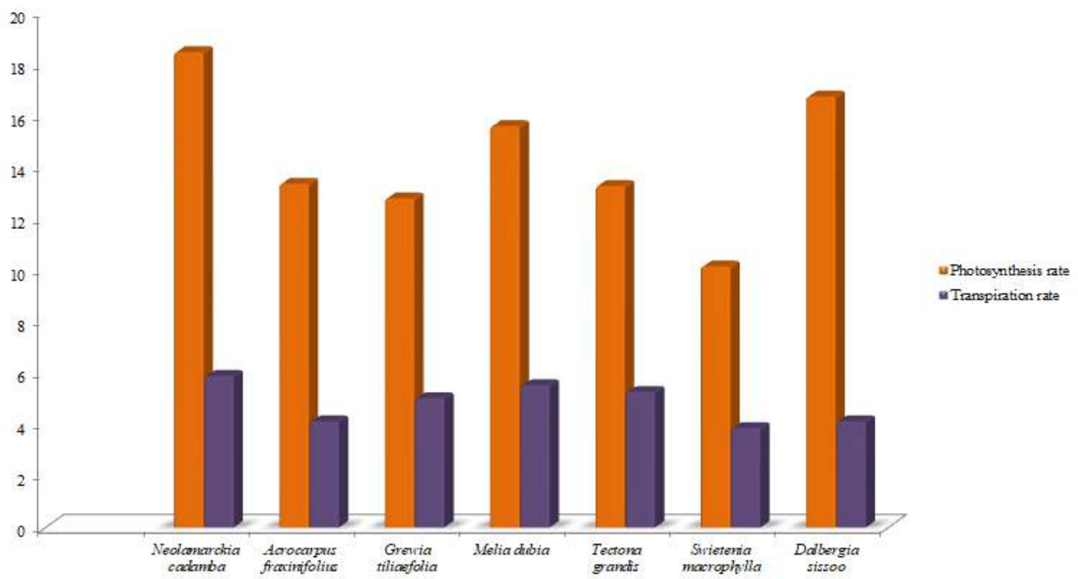
Results and Discussion

The silvicultural management practices (Pruning, water management, fertilizer management, thinning) in farm plantation is nowadays mandatory for improving the growth of the tree species (Hari Prasath *et al.*, 2016) in farmlands. It is also important to note that, the drip irrigation system used in arid region helps directly in irrigating trees at rhizosphere soil and it also helped in reducing the cultivation cost to farmers. Among the seven tree species in present study, *Neolamarckia cadamba* was exhibited maximum height of 11.55 m and diameter of 0.813 m during 36 MAP followed by *Melia dubia* (Height of 11.36 m and diameter of 0.0.640 m), *Grewia tiliaefolia* and minimum in *Swietenia macrophylla* (Height of 7.21 m and diameter of 0.412 m). The similar trend of experimental result was observed during 12 MAP and 24 MAP. On studying the eco-physiological performance, *Neolamarckia cadamba* exhibited maximum photosynthesis rate of 18.42 µ mol. m^{-2} s^{-1} followed by *Dalbergia sissoo* and minimum of 10.11 µ mol. m^{-2} s^{-1} was recorded in *Swietenia macrophylla*. On supporting the present result, Balasubramanian *et al.*, (2005) reported that maximum photosynthesis and transpiration rate was observed in *Dalbergia sissoo* even under wasteland condition at Sivagangai, Tamil Nadu.

Table 1. Effect of silvicultural practices in biometric attributes of tree species

Tree species	12 MAP		24 MAP		36 MAP	
	Height (m)	Diameter (m)	Height (m)	Diameter (m)	Height (m)	Diameter (m)
Neolamarckia cadamba	5.87	0.214	8.25	0.547	11.55	0.813
Acrocarpus fraxinifolius	4.11	0.098	6.66	0.241	9.24	0.457
Grewia tiliaefolia	5.01	0.155	7.54	0.351	10.51	0.574
Melia dubia	5.51	0.215	8.04	0.403	11.36	0.640
Tectona grandis	5.25	0.073	7.77	0.311	9.25	0.590
Swietenia macrophylla	3.85	0.054	5.17	0.217	7.21	0.412
Dalbergia sissoo	4.11	0.074	5.88	0.398	7.54	0.601

Figure 1: Effect of silvicultural practices on eco-physiological response of tree species



Reference

Hari Prasath, C.N., A.Balasubramanian, S.Radhakrishnan and M.Prasanthrajan. 2016. Growth and carbon stock assessment in three year old fast growing trees grown under wasteland condition at Sivagangai district of Southern Tamil Nadu. ***International Journal of Forestry and Crop Management***, 7(1): 29-34.

Balasubramanian, A., C.N. Hari Prasath, S.Radhakrishnan and S.Manivasakan. 2017. Comparision of Growth Performance in Timber Tree Species Cultivated under Drip Irrigation on Farm Lands. ***International Journal of Plant & Soil Science***, 16(4): 1-4.

Effect of Different Seed Extraction Methods on Physical and Physiological Quality of Teak (*Tectona Grandis* L.F) Drupes

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Keywords: *Cost and Returns, Hybrid Maize, Profitability.*

Introduction

Teak has one of the most valuable timber in the world. It is native to India and the Southeast Asian region (Myanmar, Thailand, and Laos), where it is a major supply of wood. It is widely spread in tropical and subtropical regions of the world (Tiwari *et al*., 2004). It is mostly propagated through seeds. One of the main limitations of teak is delayed and sporadic germination due to dormancy. It exhibits physical dormancy due to presence of hard or stony mesocarp in the drupe. To overcome the problem, true seeds that are available in the drupe need to be extracted and used for seedling production without any problem of dormancy. But extraction of true seed from the fresh teak drupe is not an easy process and it demands more mechanical power. In order to address this issue, an experiment was conducted in view of developing a device to extract true seed from drupes without causing any mechanical damage to the true seed. Extracted true seeds were subjected to Scanning Electron Microscope (SEM) analysis to observe the mechanical damage.

Methodology

The study has been carried out in Agricultural Engineering College and Research Institute, TNAU, Trichy, Tamil Nadu. In this experiment, true seeds extraction methods such as hammer mill mechanism, three roller mechanism, press plate using auger mechanism and manual method were followed to extract one kg of teak drupes. The extracted true seeds were determine the damage during extraction using physical, physiological, chemical, radiographical and Scanning Electron Microscope (SEM) methods.

Results and Discussion

Among the four methods followed for true seed extraction, manual way of extraction recorded the highest number of total true seeds (1071), normal true seed (636) and very less number of damaged true seed. The time taken for extraction of true seed from one kg of drupe by following hammer mill power operated method was only 4 min. This method is less time consuming but it needs further refinement to minimize the true seed damage **(Table 1)**. SEM image of teak true seeds extracted by hand operated press plate showed only partial removal of seed coat and minor cross-sectional crack in the ventral side of the seed. Visibly deep longitudinal crack in top ventral side of the seed was noticed in manually extracted seeds. Manual hammering of seeds also resulted in the complete removal of seed coat from seeds. The results clearly indicated that seeds extracted through manual hammering caused more damage to the seeds compared to the seeds extracted through press plate extraction. Bapat and Phulari (1995) developed a teak fruit treatment machine did not study the germination potential of the mechanically extracted seeds. It is concluded that among the four methods tested, true seeds extracted by hand operated press plate recorded higher germination of 40.0 and 48.0 % on 14 and 28 DAS and lesser mechanical damage **(Figs. 1&2)**.

Reference

Tiwari, C.K., Sharma, S and R.K. Verma. 2004. Effect of fungicide and plant growth hormones on germination of Teak (*Tectona grandis* L.). ***J. Trop. For. Sci.***, 16: 25-34.

Bapat, A.RandM.M. Phulari. 1995. Teak Fruit Treatment Macidne-a Prototype-II. *Indian Forester.*, 121(6): 545-549.

Table 1: Effect of different methods of true seed extraction on teak seed physical quality parameters*

Parameters	Hammer mill power operated Extraction	Three roller power operatedExtraction	Hand operated press plate Extraction	Manual Extraction
Drupe taken for extraction (g)	1000	1000	1000	1000
Broken drupe weight (g)	876.0	296.0	905.00	879.75
Unbroken drupes (g)	-	668.0	-	-
Total true seed weight (g)	8.76	1.872	18.93	19.24
Invisible loss (g)	115.24	36.0	76.07	101.25
Normal true seed weight(g)	4.10	1.048	10.71	12.34
Damaged true seed weight (g)	4.60	0.820	8.19	6.93
Total number of true seed	512	68	1065	1071
Number of normal true seed	240	8	618	636
Number of damaged true seed	272	60	454	429
Time taken for extraction (min)	4.0	5.5	75.6	150.0

***Pooled mean of four replications**

Fig 1. Electron microscopy view of whole teak seed, hand operated press plate extracted seed

Fig 2. Electron microscopy image of manually extracted teak seed

Effect of Eucalyptus Plantations on Soil Ecology

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Keywords: *Eucalyptus, Soil Ecology*

Introduction

Eucalyptus is an evergreen tree species and it is indigenous to Australia, New Guinea, Indonesia, Philippines and is grown to mainly for pulp and paper, fuel wood, plywood, gum and oil used in medicines. Eucalyptus has 700 species sub species and more than 100 species are economically important (Amenu, 2017). Growing eucalyptus in low precipitation or dry areas may cause adverse environmental problems because of increasing the competition between other species *viz.*, water, nutrient, sunlight and space and may occurrence of allelopathy. The allelochemicals effects of eucalyptus reducing the crop yields due to nutrient depletion and exudation of toxic chemicals. And also, the eucalyptus trees need more amount of water and compete with associate species for the available water in the soil (Anib *et al.*, 2001).

Methodology

The soil samples were collected from 1, 2, 3, 4 and 5 years old Eucalyptus plantations in the identified area at two different depths *viz.*, 0-15 cm and 15-30 cm at 0.5 m and 1m distance away from all the directions of the tree base. The collected samples were pooled, air dried, ground, sieved in 2 mm sieve and stored in polythene bag for analysis.

The bulk density was determined by core sample method and infiltration rate was calculated by double ring infiltrometer method. The pH and electrical conductivity were estimated by soil water suspension 1:2 ratio method (Jackson, 2005). The organic carbon by wet chromic aid digestion (Walkley and Black, 1934), Available nitrogen by alkaline permanganate method, Available phosphorous by Olsen's method and Available potassium by Neutral Normal NH_4 OAc flame photometry method were estimated.

Results and Discussion

The present study indicated there was a slight decrease in the bulk density of soil when age of the plantation increased from 1.28 Mg m^{-3} in one year old to 1.24 Mg m^{-3} in five year old plantation. Pleiothora of evidences are available that organic matter increases the availability of nitrogen (Table 1). The similar results were observed in the present study. The increased nitrogen content might be due to the transformation of organic nitrogen from the inorganic nitrogen. In the current study, the soil available nitrogen decreased with the increase in soil depth in all the age groups (270 Kg ha^{-1} in 0.5 m depth and 249 Kg ha^{-1} in 1.0 m depth of one year old plantation. This was in accordance with the Raj *et al.*, (2016) who reported that a negative relationship was observed between soil depth and available nitrogen content under the *Eucalyptus tereticornis.*

Among the soil depths, maximum soil available N was recorded in surface layer and minimum in subsurface layer. Similar trend was observed in phosphorus and potassium. Alike soil physiochemical properties, the soil biological properties *viz.*, bacteria, fungi and actinomycetes population was found to be increased over the ages of plantation. Finally, we concluded from this study, it is found that the Eucalyptus plantations have positive effect on soil ecology.

Table 1. Soil available nitrogen in Eucalyptus plantations at different ages (Kg ha^{-1})

Age of plantations (yrs)	Lateral distance from the tree base (m)	Soil available nitrogen (Kg ha^{-1})		
		Soil depth (cm)		Mean
		0-15 (P1)	15-30 (P2)	
1	0.5	274	265	270
	1.0	253	244	249
	Mean	**263**	**255**	**259**
2	0.5	274	272	273
	1.0	260	249	255
	Mean	**267**	**260**	**264**
3	0.5	294	286	290
	1.0	281	280	280
	Mean	**283**	**287**	**285**
4	0.5	303	284	294
	1.0	286	284	285
	Mean	**294**	**284**	**289**
5	0.5	316	308	312
	1.0	295	285	290
	Mean	**306**	**297**	**301**
Control (Open Field)		**270**	**269**	**270**

	SED	CD (0.05)		SED	CD (0.05)
T	0.163	0.325	TD	0.231	0.460
D	0.103	0.206	DP	0.146	0.291
P	0.103	0.206	TP	0.231	0.460
TDP	0.327	0.651			

Reference

Amenu, B. T. (2017). Review on Impact of Eucalyptus Plantation on the Soil. International Journal of Scientific Research in Civil Engineering. Vol.2 (2).

Anib E.L., Diab, I. E., and Ibrahim, S. I. (2001). Influence of *Eucalyptus* on some physical and chemical properties of a soil in Sudan. *Communications in Soil Science and Plant Analysis*, 32(2267), 2278.

Jackson, M. L. (2005). *Soil chemical analysis: advanced course*. UW-Madison Libraries Parallel Press.

Raj, A., Jhariya, M. K., and Bargali, S. S. (2016). Bund based agroforestry using eucalyptus species: a review. *Current Agriculture Research Journal*, 4(2), 148.

Walkley, A., and Black, I. A. (1934). An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. Soil science, 37(1), 29-38.

Evaluation of Growth Performance of *Bixa Orellana* L. Progenies Under Nursery Conditions

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Keywords: *Natural dyes, Annatto, growth, variation, progenies*

Introduction

Bixa orellana L. commercially known as Annatto. It is one of the important dye yielding species. *Bixa orellana* could be the domesticated species from Bixa urucura Wild. (Moreira *et al*., 2015). The Seed arils are the plant part containing dye pigments. Bixin is the most highly utilizing natural colorant in food industries, textiles as well as cosmetic industries (Teixeira *et al* ., 2019). The demand for natural dyes are keep on increasing because of awareness on the ill effects synthetic dyes. The present study will help to identify the best genetic resource for further exploitation and improvement of the species.

Methodology

The statistical design used was Completely Randomized Block Design (CRBD) with 20 progenies as treatments and 3 replications for each treatment. Each replication carries 25 seedlings. The data were taken for every 45 Days After Sowing (DAS) for 3 growth periods such as 45 DAS, 90 DAS, 135 DAS. The growth performance was measured using the traits such as shoot length, collar diameter, root length and number of leaves. From the data taken sturdiness quotient and volume index were derived. Data were analysed separately using TNAUSTAT software. Estimates of mean, variance and standard error were done as per procedures described by (Panse & Sukhatme, 1978).

Results and Discussion

In all the 3 growth periods, TNBI003, TNBI004, TNBI008 and TNBI0012 have shown significant superiority consistently for shoot length. Likewise, TNBI003, TNBI008, TNBI0014 and TNBI0021 have shown significant superior values continuously for collar diameter. Progenies such as TNBI005, TNBI008, TNBI0012, TNBI0017 and TNBI0021 have shown significant superior values consistently in the case of root length. Similarly, progenies such as TNBI008, TNBI009 and TNBI0013 have shown significant superior values continuously in the case of number of leaves. Only one progeny TNBI006 has shown significant superiority consistently in the case of sturdiness quotient. For volume index, TNBI003, TNBI008, TNBI0014 and TNBI0015 have shown significant superior values in all three growth periods. Similar studies were done and resulted the importance of seed sources for variation in Bixa orellana L. (Kala *et al* ., 2017) and genetic resources as well in *Ailanthus excelsa* (Kanna *et al* ., 2019).

The progenies evaluated under nursery conditions for 3 growth periods revealed that TNBI008 expressed superiority in almost all the five traits viz., shoot length, collar diameter, root length, number of leaves and volume index. TNBI003 showed superiority in three traits viz., shoot length, collar diameter and volume index. Growth performance of these progenies under different growth periods are tabulated (Table 1). These 2 progenies could be utilized for further tree improvement programmes.

Table 1. Growth performance of superior progenies for different traits

Progeny code	Growth periods	Shoot length (cm)	Collar Diameter (cm)	Root Length (cm)	Number of Leaves	Sturdiness Quotient	Volume Index (cm^3)
TNBI 003	45 DAS	19.33	0.41	8.43	11.45	45.66	3.32
	90 DAS	10.46	0.23	17.08	22.22	46.99	0.55
	135 DAS	42.26	0.58	37.04	33.67	72.75	14.44
TNBI 008	45 DAS	11.18	0.24	13.03	13.67	0.65	11.18
	90 DAS	18.43	0.41	20.34	28	3.15	18.43
	135 DAS	37.57	0.56	39.87	39.67	67.65	12.09

Reference

Kala, S., Kumaran, K., Srimathi, P., Reeja, S., & Singh, R. (2017). Studies on Variability, Correlation and Path Analysis Using Important Seed Traits in Bixa orellana (L). Journal of Tree Sciences, 36(1), 93-102.

Kanna, S. U., Krishnakumar, N., Kather, M. M. A., & Jailani, K. (2019). Growth performance of Ailanthus excelsa through progeny test.

Moreira, P. A., Lins, J., Dequigiovanni, G., Veasey, E. A., & Clement, C. R. (2015). The domestication of annatto (Bixa orellana) from Bixa urucurana in Amazonia. Economic botany, 69(2), 127-135.

Panse, V., & Sukhatme, P. (1978). Statistical methods for agricultural workers New Delhi. ICAR Publication, 41-50.

Teixeira da Silva, J. A., Zeng, S., Godoy-Hernández, G., Rivera-Madrid, R., & Dobránszki, J. (2019). Bixa orellana L.(achiote) tissue culture: a review. In Vitro Cellular & Developmental Biology Plant, 55(3).

Extraction of Dye from the flowers Of *Delonix* Regia (Boj. Ex Hook) Raf. and Dyeing Of Cotton Fabrics

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Keywords: *Extraction, Flowers, Dye, Delonix regia, Dyeing of Cotton Fabrics*

Introduction

Although dyes abound in the natural environment, dyes can also be formed in different ways and used in different applications depending on their manufacturing process. Narayana swamy *et al.*, (2016). These include various parts of plants such as flowers which can be processed to obtain many colors. (Harris, 1995) asserted that plants in the environment can be exploited to achieve natural colors of various shades to color natural fibres. Delonix regia orginates from Legminosae family commonly called as gulmohor, and it is widely introduced to tropical countries around the world. Flower reported to contain rich content of β-sitoserol, tannins, saponins, flavonoids, steroids, alkaloids and carotene hydrocarbons. Veigas, J. M *et al.*, (2012). Leaves and flowers of D. regia showed strong phytotoxicity against Mikania. Keka Sinha *et al.*, (2012). The study indicates that the flowers of Delonix regia to be contain rich source of potentially useful natural antioxidants like poly phenol and flavonoids.

Methodology

The Flowers collected from the tree *Delonix regia* has been washed with the running tap water. After the water in the flowers has been drained out, the petals/the material size is reduced to smaller in size. Aqueous extraction method was used for dye extraction. The flowers are weighed for 200 gm and is soaked in 1 litre of water and then allowed for boiling for about 45 minutes at a temperature of 60^{0}C. After the color change, the extract is then filtered. During dyeing, the metal then binds the molecules of the mildly acidic dyestuff, thereby creating the so-called lake which is insoluble. Hence, the dyed material is color fast when washed (Bohmer, 2002).

Results and Discussion

Phytochemical characterization

The results pertaining to GC-MS analysis led to the identification of number of compounds from the methanolic extract of Delonix regia flower. These compounds were identified through mass spectrometry attached with GC. The identification of the compounds was confirmed based on the concentration (peak area %), retention time (RT), molecular formula and molecular weight.

Color fastness to Rubbing – EN ISO 105 X12 : 2002

As far as color fastness to rubbing is concerned, the cotton fabric dyed with Delonix regia flower extract without using mordant (T1) exhibited a grey scale rating of 4-5 at dry condition and 3-4 at wet condition. Likewise, the cotton fabric treated with CuSo4 (T2) showed the grey scale rating of 4 at dry condition and 3-4 at wet condition. Finally the cotton fabric also treated with CuSo4 + Vinegar (T3) exhibited the grey scale rating of 4-5 at dry condition and 3-4 at wet condition. Similarly the cotton fabric treated with Alum (T4) showed the grey scale rating of 4-5 at dry condition and 3-4 at wet condition. For colour fastness to persipiration, the cotton fabric is dyed with methanolic extract of Delonix regia flower testing with five treatments, among the five treatments T3 (CuSo4 + Vinegar) showed better result when compare with other treatments in color fastness to perspiration.

Table 1. Color fastness to rubbing for Cotton (*Grey Scale Rating)

Treatments	Staining on Adjacent Cotton*	
	Dry	Wet
T1	4-5	3-4
T2	4	3-4
T3	4-5	3-4
T4	4-5	3-4
T5	4 - 5	3

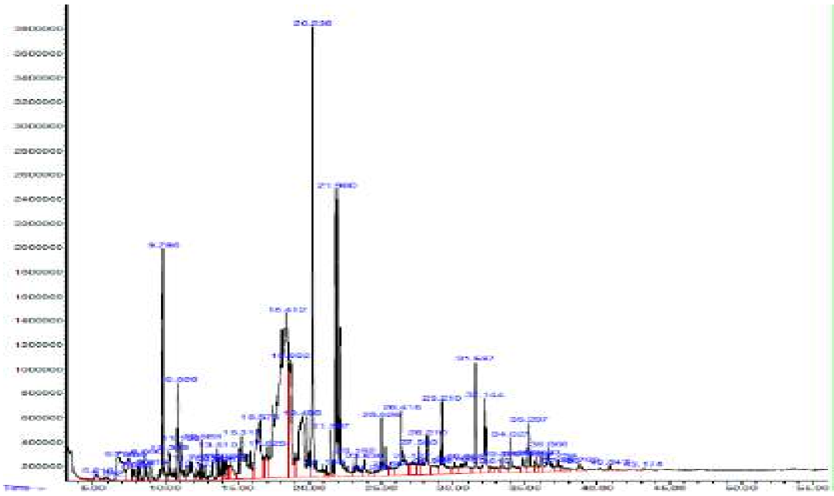

Fig 1. GC-MS Chromatogram for methanolic extract of Delonix regia

Reference

Bohmer Harald. 2002. Natural dyes and textiles. International Economic Botany, 57(4):454-460.

Veigas, J. M., Divya, P., and Neelwarne, B. (2012). Identification of previously unreported pigments among carotenoids and anthocyanins in floral petals of Delonix regia (Hook.) Raf. Food research international, 47(1), 116-123.

Narayana swamy, V., K.N. Ninge Gowda and R.Sudhakar. 2016. Extraction and dyeing conditions of natural dye from flowers of Plumeriarubra on textiles and fastness properties. Indian Journal of Traditional Knowledge, 15(2): 278-284.

Keka Sinha, Papita Das Saha, Siddhartha Datta. 2012. Extraction of natural dye from petals of Flame of forest (Butea monosperma) flower: Process optimization using response surface methodology (RSM). Dyes and Pigments, 94; 212 – 216.

Flowering response of Tamarind clones to pruning under High Density Plantation

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Keywords: *Tamarind, High Density Planting, Pruning, Fruit yield*

Introduction

Tamarind is long lived, large, evergreen or semi evergreen tree, 20-30 m tall with a thick trunk up to 1.5-2 meter across and upto 8 m in circumference. The trunk forks at about 1m above ground and is often multi-stemmed with branches widely spreading, drooping at the ends and often crooked but forming a spreading, rounded crown (Prasath *et al*., 2017). The concept of high density planting of horticultural crops has gained traction as the amount of cultivable land continues to dwindle, as well as rising energy, taxes, production costs, and land costs, all of which are contributing to the rising demand for horticulture produce. Furthermore, because huge trees take several years to bear fruit, the overall cost of production per unit area rises and extension of roads also leads the cutting of road side tamarind tree which causes less productivity. Pruning is a popular and beneficial technique for a range of ornamental plants grown in natural sunlight or in a greenhouse (Sarkka and Erikson, 2003). Pruning allows more light into the canopy, which is necessary for flower bud development, fruit set and growth, and the development of red colour. With the foregoing in mind, the current research aims to increase tamarind productivity via pruning techniques in high density plantation in shorter term of time with high yielding clones.

Methodology

The tamarind grafts of Hasanur 06, Hasanur 09, Mullampadi, PKM 1 and Urigam were assembled and raised under the high density planting techniques with spacing of 3 x 3 m in 2018 at Precision Silviculture Field, Forest College and Research Institute, Mettupalayam and would be utilized for intensive silvicultural management studies of Tamarindus indica. The experimental data were subjected to statistical analysis by ANOVA for analysis of randomized block design as described by Panse and Sukhatme (1978).

Results and Discussion

Among five different clones, significant difference were observed for average sprout per branch after pruning, Hasanur 06 recorded maximum sprout (59.56), followed by PKM 01 (47.50), Mullampadi (33.17), Hasanur 09 (34.57) and minimum in Urigam (26.70).Clones varied considerably in number of fruits and fruit yield per tree in which Hasanur 06 recorded maximum yield (9.05 kg/tree) followed by PKM 01 (5.20 kg/tree), Hasanur 09 (2.00 kg/tree), Mullampadi (1.30 kg/tree) and minimum fruit yield in Urigam (0.10 kg/tree). The results are in with findings of Nagarajan et al., (1996) revealed that production of flowers significantly varied between clones in Tamarind and also clones with longer vegetative terminal shoots were found to produce more flowers.

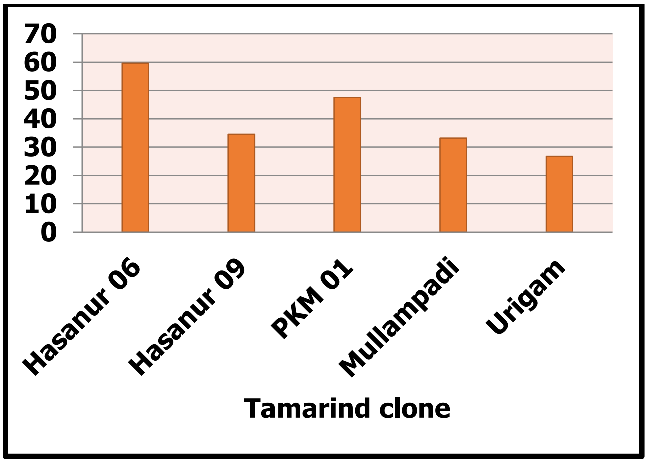

Fig 1. Average sprout per branch after pruning

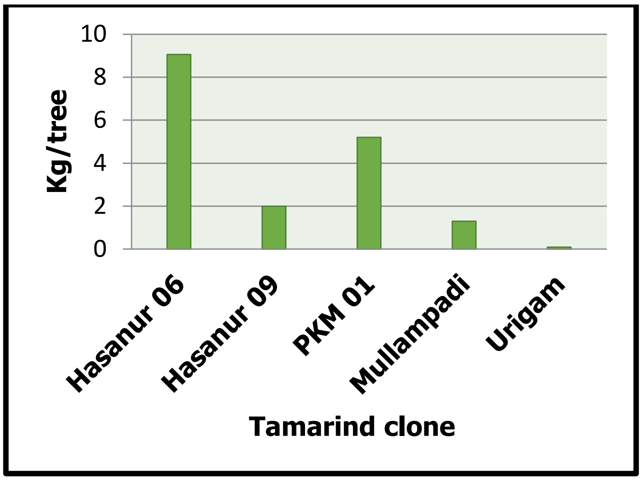

Fig 2. Fruit yield per tree

Reference

Nagarajan, B., Nicodemus, A., Mandal, A. K., Verma, R. K., Gireesan, K., & Mahadevan, N. P. (1998). Phenology and controlled pollination studies in Tamarind. Silvae Genetica, 47(5), 237-240.

Panse, V. C., & Sukhatme, P. V. (1978). Statistical methods for Agricultural workers. III Rev. Ed. ICAR, New Delhi.

Prasath, C. N., Balasubramanian, A., Radhakrishnan, S., Mayavel, A., & Manivasakan, S. (2017). Effect of chemicals and growth regulators on fruit yield in tamarind plantation in Paiyur village of Krishnagiri District, Tamil Nadu. Advances in Applied Research, 9(2), 97-98.

Sarkka, L. E., & Eriksson, C. (2003). Effects of bending and harvesting height combinations on cut rose yield in a dense plantation with high intensity lighting. Scientia horticulturae, 98(4), 433-447.

Genetic diversity studies in *Toona ciliata* M Roem Progenies using D^2 analysis

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Keywords: *Toona ciliata - Growth attributes - Genetic diversity - D^2*

Introduction

Toona ciliata is the species comes under the family is called Meliaceae, its native to India, Australia, Indochina peninsula, Pacific Islands and southern china. In Brazil *Toona ciliata* M Roem generally known as Australian red cedar and in china it's commonly known as Chinese mahogany. It is having more economic value because of its colour, growth, good timber quality and red heart wood (Zhan *et al*., 2019). The genetic diversity presented in the population will assist to produce a rich base population for initiating suitable selection (Zobel, 1981). After clustering, the superior group or individual may honestly be utilized for raising profitable plantation for meet out industrial wood demand. Purpose of genetic diversity through Mahalanobis D^2 estimation in Toona ciliata has not been attempted so far and thus underscores investigation.

Methodology

Toona ciliata was selected as the experimental material for the current study which consists of 16 progenies established as a progeny evaluation assessment. Progenies evaluation trail was established at Forest College and Research Institute, Mettupalayam. *Toona ciliata* progenies were planted in a Randomized Block Design with three replications at an espacement of 4m x 4m.

Estimation of biometric attributes

Sources of progenies

The predominant 16 *Toona ciliata* progenies were collected in the districts of Tamil Nadu via, Nilgiri and Dindigul and in Karnataka in the district of Kodagu and in Punjab in the district of Ludhiana were surveyed and a total number of 16 candidate plus trees were elected.

Determination of genetic diversity

The data were recorded 2 months interval after planting in *Toona ciliata* progenies for evaluation of genetic diversity.

Determination of genetic divergence

D^2 statistics were used for determination of genetic divergence. With D2 statistical results, the clustering of progenies was prepared (Rao, 1952).

Results and Discussion

The D^2 analysis grouped 16 progeny of *Toona ciliata* genetic resources into five clusters. Among the five clusters, the cluster II has nine progenies. The maximum intra cluster distance was resolved by the cluster II. The highest inter cluster distance was in cluster IV which indicated the presence of wider genetic distance between *Toona ciliata* progenies. Among the growth characters, volume index contributed maximum percentage towards genetic divergence followed by basal diameter, while the basal plant height recorded minimal role to the divergence. Past study also given similar results in *Ailanthus excels* (kanna *et al*., 2019). Table 1 Inter and intra cluster values of *Toona ciliata* progenies based on biometric attributes.

Table 1. Inter and intra cluster distances of Toona ciliata progenies

Cluster	1	2	3	4	5
I	1.693	2.092	2.005	2.563	1.278
II		1.546	1.704	2.941	1.777
III			0.679	2.546	1.050
IV				0.000	2.271
V					0.000

Reference

Brune, A., & Zobel, B. (1981). Genetic base populations, gene pools and breeding populations for Eucalyptus in Brazil. Silvae genetica, 30(4-5), 146-149

Kanna, S. U., Krishnakumar, N., & Jailani, K. M. M. A. K. (2019). Genetic Divergence Studies in Ailanthus excelsa Using D2 Analysis. International Journal of Environment and Climate Change, 416-424

Rao, C. R. (1952). Advanced statistical methods in biometric research.

Zhan, X., Li, P., Hui, W., Deng, Y., Gan, S., Sun, Y. ... & Deng, X. (2019). Genetic diversity and population structure of Toona ciliata revealed by simple sequence repeat markers. Biotechnology & Biotechnological Equipment, 33(1), 214-222.

Physical and mechanical properties of *Dalbergia sissoo* Roxb. and *Eucalyptus tereticornis* Sm.

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Keywords: *Physical properties, mechanical properties, Dalbergia sissoo and Eucalyptus tereticornis*

Introduction

Dalbergia sissoo orginates from Fabaceae family and it is native to Indian subcontinent and southern Iran. It is also known as Indian rosewood. This is one of the fast growing tree species and the wood from tree is used as various utility. *Eucalyptus tereticornis* orginates from Myrtaceae family and it is native to eastern Australia and southern New Guinea. It is also known as Forest red gum. This is good fast growing tree species and wood from tree is used in pulp and paper, hardboard, fibre board and particle board. The tree grows to a height of 20 to 50 m with a girth of up to 2 m. Mechanical properties of wood are its fitness and ability to resist applied for external forces. Wood density and moisture determines to a greater extent, the mechanical properties of wood including elastic properties, which characterize resistance to deformation and strength properties and resistance to applied loads. Mechanical properties of wood are its fitness and ability to resist applied for external forces.

Methodology

The sample trees of *Dalbergia sissoo* and *Eucalyptus tereticornis* were felled at stump height of 15-20 cm using power chain saw. About one meter length billets from the felled sample trees were collected for analysis. The billet was debarked, cleaned and labelled for analyses, which are used for preparation of samples for physical and mechanical properties. The basal billets of one meter length were converted into scantlings of 40 × 5 x 5 cm cross section to prepare test samples from pith to periphery in one radial direction selected randomly just below breast height for the study of mechanical properties after air drying of the wood. Mechanical tests were conducted as per the Indian Standard Specification IS 1708 (Part 5): BIS (1986) by Universal Testing Machine.

Results and Discussion

Mechanical Properties of wood

In the current study, Both Modulus of Elasticity and Modulus of Rupture vary within the species with variation in moisture content and specific gravity. The MOR values recorded high in Dalbergia sissoo 114.72 (N/mm2) &117.14 (N/mm2) (perpendicular and parallel to grain). The MOE value recorded high in Dalbergia sissoo (5309.87 & 7462.93) respectively.

Physical Properties of wood

The moisture content plays an important role in deciding the utilization of wood. Sosa. A *et al.*(2015). The moisture content recorded for both the species are 9.620% for *Dalbergia sissoo* and 9.578% for *Eucalyptus tereticornis* indicated that both the species can be used for furniture and in construction Industries. The acceptable moisture level in wood depends on final use of the wood, Simpson and TenWolde (1999). Basic density indicates the relationship of dry mass to solid volume measures, or how much dry wood weights per a solid measure of wood. Variation in the basic density accounted for 70% to 80% of the variation in tear, compression and bending strength. The general acceptance that increased basic density was key requirement for determining strength of the wood. From current study wood density recorded high in *Dalbergia sissoo* (0.607& 0.59). In the current study, the compression strength (parallel and perpendicular to Grain) was found to be higher in *Dalbergia sissoo* (33.13 & 46.64). MOE (Modulus of Elasticity) implies that deformation produced by low stress is completely recoverable after loads are removed. When loaded to higher stress levels, plastic deformation or failure occurs, Daffner *et al.* (1992). The MOE value recorded high in *Dalbergia sissoo* (5309.87 & 7462.93) respectively. The MOR also called as shear modulus indicates the resistance to deflection of a member caused by shear stresses, Zhou. Q *et al.* (2014). The species with high MOE values is not suitable for timber purposes. Jayawickrama. K *et al.* (2009).

Table 1. Mechanical Properties of Dalbergia sissoo and Eucalyptus tereticornis

S. No	Species	MOE Parallel to grain (N/mm²)	MOE Perpendicular to grain(N/mm²)	MOR Parallel to grain(N/mm²)	MOR Perpendicular to grain(N/mm²)
1	**Dalbergia sissoo**	5309.87	7462.93	99.56	279.86
2	**Eucalyptus tereticornis**	4036.27	4659.73	75.68	174.74
	Mean	4673.07	6061.33	87.62	227.3

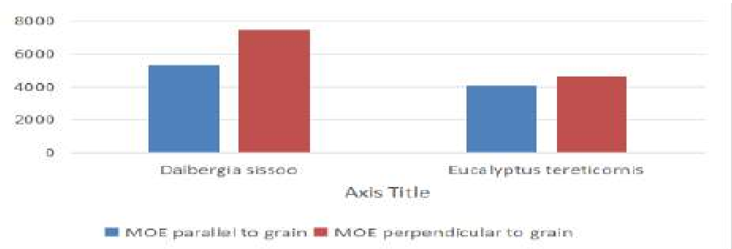

Fig 1. MOE (Modulus of Elasticity) (N/mm²) for Dalbergia sissoo and Eucalyptus tereticornis

Reference

Daffner, R. H., and Pavlov, H. (1992). Stress fractures: current concepts. AJR.American journal of roentgenology, 159(2), 245-252.

Jayawickrama, K. J. S., Ye, T. Z., Gupta, R., and Cherry, M. L. (2009).Including wood stiffness in tree improvement of coastal Douglas-fir in the US Pacific Northwest: A literature review and synthesis.

Simpson, W., and TenWolde, A. (1999). Physical properties and moisture relations of wood. Chapter, 3, 2-1.

Zhou, Q., Gong, M., Chui, Y. H., and Mohammad, M. (2014). Measurement of rolling shear modulus and strength of cross laminated timber fabricated with black spruce. Construction and Building Materials, 64, 379-386.

Sosa, A., Acuna, M., McDonnell, K., and Devlin, G. (2015). Managing the moisture content of wood biomass for the optimisation of Ireland's transport supply strategy to bioenergy markets and competing industries. Energy, 86, 354-368

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Screening of Shade Tolerant Medicinal Plants for Teak *(Tectona Grandis Linn.)* Based Agroforestry System

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Keywords: *Agroforestry System, Medicinal Plants*

Introduction

Agroforestry is a low-input system which combines trees with crops in various combinations or sequences. It is an alternative to intensive cropping systems (Upadhaya *et al.*, 2021). Medicinal plants have a promising future because there are about half million plants around the world, and most of them their medical activities have not investigate yet, and their medical activities could be decisive in the treatment of present or future studies (Hassan *et al.,* 2012). Heavy pressure on natural forests not only leads to deforestation but also lead to large-scale destruction of medicinal plants either knowingly or unknowingly by the local people. These apart many plants of medicinal value are also being lost gradually without knowing their medicinal value. Teak is grown in combination with many agricultural crops at least in the initial few years of establishment. It is very popular in Tamil Nadu (Saravanan and Berry, 2021). Keeping these in view, the present study was designed to findout shade tolerant medicinal plants under teak based agroforestry system.

Methodology

A field trial to screen the shade tolerant medicinal plants under teak based Agro forestry system was laid out at Forest College & Research Institute, Mettupalayam. Which is situated on the foothills of the Kothagiri hills of the Western ghats sprawling in an area of 200 ha. The geographical position of the institute is 11.19°N and 76.56′E at 300 m above MSL.

An existing plantation of 0.6 acre was chosen and subsequently thinning was carried out, cleaned and then plots of 4 x 2 m were designed with irrigation channels. The field has eight-year-old trees on red gravelly soil at 4x2m spacing. In this experiment, there are seven medicinal plants were taken as intercrops under the shade of teak trees as well in open as pure crops. The crops *viz*., Adathoda (*Adathoda vasica* (Tourn.) Mill.) 1m x 1m, Withania (*Withania somnifera* Dunal.) 50 cm x 50 cm, Chottukathalai (*Aloe vera* (Tourn. ex Linn.) 60 cm x 45 cm, Thulasi *(Ocimum sanctum* Linn.) 50 cm x 50 cm, Gymnema (*Gymnema sylvestre* R.Br.) 1m x 1m, Tuduvalai (*Solanum trilobatum* Linn.) 50 cm x 50 cm and Thiruneertrupachalai (*Ocimium basilicum* Linn.) 50 cm x 50 cm were grown in the open field without shade as a control. In this experiment both treatment and control was replicated thrice and Factorial RBD was taken for analysis part to compare shade and unshaded conditions. The results were subjected to an analysis of variance and tested for significant difference according to Panse and Sukhatme (1967).

Results and Discussion

The per cent decreases over unshaded for T_1 (*Adathoda)* and T_2 (*Withania)* was recorded 29.65 and 26.25 respectively. The lowest plant height of 11.30 cm was registered by (T_7) *O. basilicum* in 180 DAS. This shows that Plant height is reduced considerably under shade of Teak. The same trend was observed by (kumar *et al.,* 2016) in palmarosa (160.5 cm) fallowed by patchouli (66.0 cm) and lemongrass (60.0 cm) teak-based agroforestry model. The RCY performance of *Gymnema* was best under teak. Among the treatments, the highest RCY was registered by (T_5) *Gymnema* (174.72 per cent). The next best treatments were *O. sanctum* (T_4-86.95 per cent) and *Withania* (T_2-81.66 per cent) (Table 1). The low values were registered by *Adathoda* (T_3- 72.73 per cent). Among the stages, the highest value of RCY was observed at 180 DAP (96.11) and low values recorded at 90 DAP (88.89) under both shade and open conditions. Shade influences the leaf and root production of medicinal plants under Teak. From the study it was found that *Gymnema* is a shade-loving crop. All other crops are shade tolerant, but its yield was reduced considerably under shade than open. Aloe vera, Tulasi, and Adathoda can also give good yield under optimally pruned conditions.

Table 1. Effect of shade on relative crop yield (%) of seven medicinal plants under teak based agroforestry system

Treatments	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS	Mean
T_1	79.46	74.36	70.16	78.34	81.52	82.27	77.68
T_2	87.38	74.32	77.19	80.52	87.29	83.26	81.66
T_3	56.39	60.36	62.36	82.44	86.48	88.34	72.73
T_4	86.18	84.38	86.23	86.24	88.50	90.16	86.95
T_5	183.35	180.22	176.49	169.41	169.30	169.55	174.72
T_6	73.19	79.24	75.29	75.39	78.62	77.70	76.57
T_7	72.63	73.42	74.52	77.49	79.35	81.49	76.48
Mean	91.22	89.47	88.89	92.83	95.86	96.11	92.40

	SEd	CD (P= 0.05)
C	0.073	0.145
S	0.067	0.134
C x S	0.178	0.355

Reference

Hassan, B. A. (2012). Medicinal plants (importance and uses). Pharmaceut Anal Acta, 3(10), 2153-2435.

Kumar, D., Bijalwan, A., Kalra, A., & Dobriyal, M. J. (2016). Effect of shade and organic manure on growth and yield of patchouli [Pogostemon cablin (blanco) benth.] under teak (Tectona grandis lf) based agroforestry system. Indian For, 142(11), 1121-1129.

Panse, V.C. and Sukhatme, P.V. 1967. Statistical methods for agricultural workers. 2nd edition, ICAR, New Delhi. 328 p.

Saravanan, S., & Berry, N. (2021). Agroforestry practices in Tamil Nadu, India–a boon for farmers for livelihood security. Current Science, 120(4), 644-653.

Upadhyaya, K., Ram, A., Dev, I., Kumar, N., Upadhyaya, S., Gautam, K., & Arunachalam, A. (2021). Above-and below-ground interactions in teak-barley agroforestry system in the Bundelkhand region of Central India. Indian Journal of Agroforestry, 23(1).

Spatial and Temporal Patterns of Microclimate in Miyawaki Plantation

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Keywords: *Carbon dioxide, sequestration, Miyawaki, afforestation*

Introduction

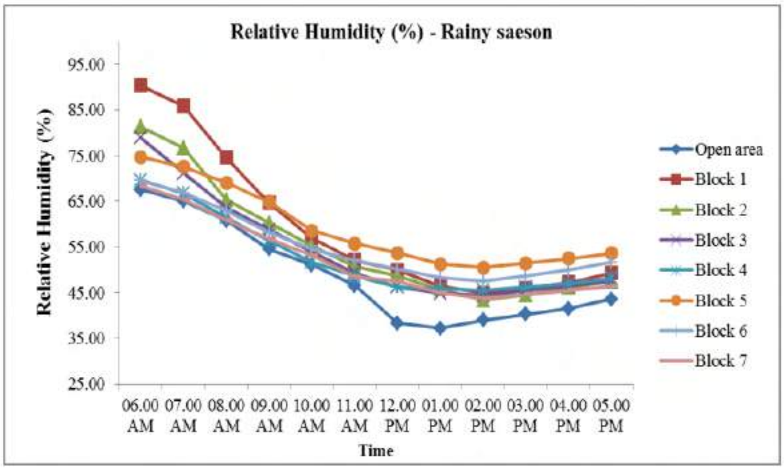
Carbon dioxide is one of the major greenhouse gases present in atmosphere. Some anthropogenic activities like burning of fossil fuels are the main cause of increase in CO_2 concentration. The level of CO_2 in atmosphere increased globally from 325 ppm to 414.18 ppm after 1970. In global CO_2 emission atlas, China ranks first followed by USA and India (Atlas, 2018). The increased levels of CO_2 trap the heat in the atmosphere which causes increases in the Global Mean Temperature. IPCC predicted that global mean temperature will be increased by minimum of 1.4^{0}C and maximum of 5.8^{0}C. Increased greenhouse effect affects climate, agricultural productivity, coral reefs and even enhanced the occurrence of diseases too. To overcome and mitigate the impacts, carbon sequestration should be boosted by increasing the forest area for storage of CO_2. Among many ways to capture CO_2 in the atmosphere, Miyawaki afforestation is one of the most favoured strategies now-a-days. It is an afforestation method that utilizes local tree species to make thick, multi-layered timberlands. In this study, the impact of Miyawaki afforestation was observed at Coimbatore and it has been documented.

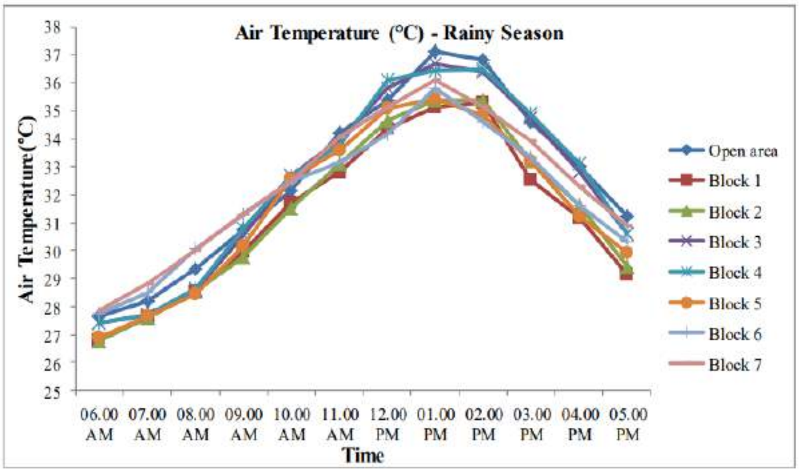
Methodology

Miyawaki afforestation has been taken up in Anna University campus, Coimbatore. Eight plots were chosen for the study, seven plots with the Miyawaki method of plantation (1m x 1m spacing) with various native tree species and one as open natural tree stand (3m x 3m spacing). In each block, three quadrats of size 10 x 10 m were fixed and observations for this study was regularly recorded only from these plots. Six individuals for each species were taken for observation for micro climatic parameters (Temperature, Relative humidity) has been taken from initial to final stage of the study. The seasonal observation was made for one week per season and observations were recorded every hour from 6.00 AM to 6.00 PM.

Results and Discussion

During rainy season the relative humidity was highest in Miyawaki plantation (59.13 %) and the lowest in open natural tree stand (48.79 %). During winter season and summer season, the relative humidity was higher in Miyawaki plantation than in open natural tree stand. During rainy season, soil temperature was highest in open natural tree stand (27.20°C) and the lowest in Miyawaki plantation (26.48°C). During the winter and summer season, the soil temperature in Miyawaki plantation was on a par with that of open natural tree stand. During the rainy season, highest air temperature was recorded in open area (32.54°C) and the lowest in Miyawaki plantation (31.25°C). During winter, the similar trend was followed in the open natural tree stand and Miyawaki plantation. Chen *et al.* (1995) and Davies-Colley *et al.* (2000) found the greatest contrast in microclimate between forest interior and cleared land during the early afternoon (12.00–15.00 hours), particularly on sunny and windy days, suggesting that edge effects, and contrasts between embedded and abrupt edges, would also be at their maximum at that time of the day. The edge effects apparently break down as the forest interior and exterior temperature and humidity approach were at similar levels Chen *et al.* (1995), Davies-Colley *et al.* (2000) and Norton (2002).





Reference

Chen, J., J.F. Franklin, and T.A. Spies. 1995. "Growing-season microclimatic gradients from clearcut edges into old-growth Douglas-fir forests." Ecological Applications 5 (1):74- 86.

Davies-Colley, R.J., G. Payne, and M. Van Elswijk. 2000. "Microclimate gradients across a forest edge." New Zealand Journal of Ecology 24 (2):111-121.

Norton, D.A. 2002. Edge effects in a lowland temperate New Zealand rainforest: Department of Conservation Wellington

Standardization of Cutting Size for Mini- Clonal Propagation of *Tectona grandis Linn.*

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Keywords: *Mini clonal technology-cutting size- Teak*

Introduction

Teak is a slow growing tree, conventionally reproduced through seeds, but germination is often difficult, usually less than 50%, because the hard seed coat limits the production of a large number of seedlings in a defined time (Baghel *et al.*, 2005). A promising alternative for clone's production refers to the mini cutting technique, which favours considerably adventitious rooting compared to traditional cutting (Hartmann *et al.* 2011). The main feature of the technique is the use of juvenile plants as source of vegetative propagules. The study will be performed to explore mini clonal propagation techniques by using moderately hard stem cuttings.

Methodology

Different length of mini cuttings *viz.*, (up to 2 cm, 2- 4 cm, 4- 6 cm,6- 8 cm, 8- 10 cm) were excised from the mother plants. Thereafter, the cuttings were treated with IBA at 6000 ppm concentration. The treated cuttings were planted in coir pith rooting medium. Subsequently the cuttings were placed inside polytunnel and mist chamber. In the mist chamber, the cuttings were subject to intermittent misting (misting for 60 seconds duration at 30 minutes interval) for maintaining relative humidity of 60-80% and temperature of 25 - 30°C / 15 - 20°C during day/night. (Gehlot *et al.*, 2014). The average temperature and relative humidity of poly tunnel was maintained at 25 - 35˚C and 70 to 80 per cent respectively by intermittent spraying of water using rose cans. After 60 days, the cuttings were carefully removed from the rooting medium and observations were recorded on rooting percent, root length, shoot length, and survival percent, following which rooted cuttings were transferred to polythene bags.

Results and Discussion

Effect of cutting size on survival percent

Among all the treatments, T3 registered significantly higher survival percent (91.67%) followed by T2 (87.80%) while the lowest survival percent was observed in T5 (77.78%) (Table.1). The plethora of work done by Husen and Pal, (2006) in *Tectona grandis* towards to increase the survival percent.

Effect of cutting size on vigour index

Vigour index varied significantly due to length of the cutting. Compare to all other treatments, T3 registered maximum vigour index (1996.75) followed by T2 (1664.76) while the lowest vigour index was registered in T5 (878.22) (Fig.1). Similar studies have been conducted by Wendling and Xavier, (2005) in *Eucalyptus grandis.* Among the various sized cuttings planted, 4-6 cm long cuttings registered significant values for number of roots per cutting, survival per cent and vigour index. Survival rate and growth of the mini-cuttings were maximum in 4-6 cm long cuttings when treated with IBA @ 6000 ppm raised in coir pith rooting medium. The results indicated that, apical shoot cuttings of teak could be made use of to produce ramets of promising teak genotypes through mini clonal technology en *masse*.

Table 1. Color fastness to rubbing for Cotton (*Grey Scale Rating)

Cutting size	Rooting per cent	Root length(cm)	No. of. roots per cuttings	Survival per cent	Vigour index
Upto 2cm	78.22	9.00	5.25	86.36	1617.41*
2-4cm	96.16*	17.00*	7.96*	87.80	1664.76*
4-6cm	88.74	12.00*	9.21*	91.67*	1996.75*
6-8cm	82.34	5.00	5.42	87.17	795.50
8-10cm	72.46	7.00	5.16	77.78	878.22
Mean	83.58	10.00	6.60	86.16	1390.53
SE(d)	4.52	0.29	0.34	3.04	59.74
CD(0.05)	10.07	0.65	0.76	6.77	133.10

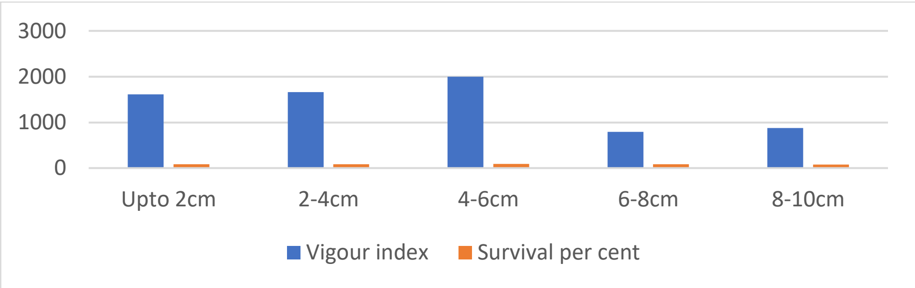

Fig 1. cutting size on growth performance of teak

Reference

Baghel, Ravi singh. 2005. "Genetic transformation studies in teak (Tectona grandis linn. F) using mature cotyledon cultures." jnkvv, jabalpur.

Hartmann, Hudson Thomas, and Dale E Kester. 2011. Plant propagation: principles and practices: Prentice-Hall.

Gehlot, Ashok, Sarita Arya, and Inder Dev Arya. 2014. "Vegetative propagation of Azadirachta indica A JUSS (NEEM) troughh cuttings: a review." Natva. Sinop 2 (4):239-246.

Wendling, Ivar, Gilvano Ebling Brondani, Leonardo Ferreira Dutra, and Fabrício Augusto Hansel. 2010. "Mini-cuttings technique: a new ex vitro method for clonal propagation of sweetgum." New Forests 39 (3):343-353.

Husen, Azamal, and Mohinder Pal. 2006. "Variation in shoot anatomy and rooting behaviour of stem cuttings in relation to age of donor plants in teak (Tectona grandis Linn. f.)." New Forests 31 (1):57-73.

Studies on Seasonal Variation in Water quality of Vellode Bird Sanctuary, Erode, Tamil Nadu

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Keywords: *Vellode, water quality, physicochemical properties, seasonal variations*

Introduction

Wetlands constitute a wealth of our biodiversity (Bhat *et al*., 2009). The health of the wetland is directly related to the water qualities of water bodies. Therefore, the water quality analysis is very important to determine the health of the wetland and determining the physicochemical and biological factors is important, as they might affect directly or indirectly the distribution and production of fish, aquatic birds and animals (Sikoki and Veen, 2004; Shib, 2014). The purpose of the study was measuring the physicochemical parameters of Vellode bird sanctuary and to determine the seasonal changes of physicochemical parameters and to quantify the correlation relationship between different physicochemical parameters.

Methodology

The pH was estimated by Digital pH meter (Systronics type-361), Electrical conductivity was analyzed by Digital conductivity meter 304 Systronics, total dissolved solids was recorded by digital conductivity meter and physicochemical parameters was done as per the guidelines of American Public Health Association, (2013). The Nitrate, Phosphate, Sulphate, Calcium, Magnesium and Sodium in the lake water were estimated by Atomic Absorption Spectrophotometer- Perkin Elmer method (Simpi *et al*., 2011).

Results and Discussion

The values of pH, electrical conductivity, total dissolved solids, total hardness, biological oxygen demand, chloride and sulphate were maximum in summer season [(7.14 ± 0.18), (0.372 ± 0.02 dS/m), (189.6 ± 7.97 mg/l), (179.7 ± 7.87 mg/l), (0.385 ± 0.05 mg/l), [(224.0 ± 6.33 mg/l) and (20.9 ± 1.59 mg/l)] respectively. The values of dissolved oxygen, chemical oxygen demand, nitrate, phosphate, calcium, sodium and magnesium were observed higher in monsoon season [(3.553 ± 0.37 mg/l), (164.6 ± 4.56 mg/l), (14.00 ± 3.51 mg/l), (0.262 ± 0.04 mg/l), (88.22 ± 7.20 mg/l), (34.30 ± 4.78 mg/l) and (52.08 ± 9.18 mg/l)] in the following order respectively.

Table 1. Water quality parameters of Vellode Bird Sanctuary (July-2019 to May-2020)

S. No	Parameters	Values		
		Monsoon	Winter	Summer
1.	pH	6.681 ± 0.41	6.491 ± 0.23	7.143 ± 0.18
2.	Electrical Conductivity (dS/m)	0.211 ± 0.01	0.319 ± 0.02	0.372 ± 0.02
3.	Total Dissolved Solids (mg/l)	141.6 ± 2.41	165.7 ± 7.40	189.6 ± 7.97
4.	Dissolved Oxygen (mg/l)	3.553 ± 0.37	3.080 ± 0.11	2.920 ± 0.16
5.	Biological Oxygen Demand (mg/l)	0.242 ± 0.03	0.380 ± 0.05	0.385 ± 0.05
6.	Chemical Oxygen Demand (mg/l)	164.6 ± 4.56	160.0 ± 3.74	30.27 ± 1.26
7.	Total Hardness (mg/l)	160.6 ± 15.97	156.0 ± 13.79	179.7 ± 7.87
8.	Nitrates (mg/l)	14.00 ± 3.51	9.951 ± 2.99	5.630 ± 1.55
9.	Phosphates (mg/l)	0.262 ± 0.04	0.107 ± 0.01	0.097 ± 0.01
10.	Chlorides (mg/l)	195.7 ± 18.0	205.1 ± 9.89	224.9 ± 6.33
11.	Sulphate (mg/l)	12.02 ± 5.50	14.00 ± 3.55	20.91 ± 1.59
12.	Calcium (mg/l)	88.22 ± 7.20	80.15 ± 7.94	75.64 ± 4.74
13.	Magnesium (mg/l)	52.08 ± 9.18	24.30 ± 6.06	31.11 ± 7.58
14.	Sodium (mg/l)	34.30 ± 4.78	30.92 ± 3.41	29.76 ± 1.10

*mean of 55 samples

Reference

American Public Health Association. (2013). "APHA. 2005". Standard Methods for the Examination of Water and Wastewater. 21st ed. American Public Health Association, Washington DC, 1220p.

Bhat, I. P., Cristopher, S. S., and Hosetti, B. B. (2009). Avifaunal diversity of Anekere wetland, Karkala, Udupi district, Karnataka, India. Journal of Environmental Biology, 30(6), 1059-1062.

Shib, A. (2014). Seasonal variations in physico-chemical characteristics of rudrasagar wetland-a Ramsar site, Tripura, North East, India. Research Journal of chemical sciences, 4(1), 31-40.

Sikoki, F. D., and Veen, J. V. (2004). Aspects of water quality and the potential for fish production of shiroro reservoir Nigeria. Liv. Sys. Sus. Dev, 2, 7pp.

Simpi, B., Hiremath, S. M., Murthy, K. N. S., Chandrashekarappa, K. N., Patel, A. N., and Puttiah, E. T. (2011). Analysis of water quality using physico-chemical parameters Hosahalli Tank in Shimoga District, Karnataka, India. Global Journal of Science Frontier Research, 11(3), 31-34.

SWAT MODEL CALIBRATION AND UNCERTAINTY ANALYSIS FOR STREAMFLOW PREDICTION IN THE ALIYAR SUB-BASIN OF TAMILNADU

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Keywords: *Sensitivity, SUFI-2 algorithm, SWAT-CUP, Streamflow, Uncertainty*

Introduction

In this study, the Soil and Water Assessment Tool (SWAT) model was used in this research to understand the hydrological process of the Aliyar sub-basin, owing to its uniqueness of the research aspects. This research aims to test and evaluate the usefulness and performance of SWAT, to model hydrological parameters with reasonable accuracy as indicated in the global researches of this successful hydrological model. Hydrological understanding could open the gates of agricultural productivity estimates using Crop Simulation Models as key components. This helps in the optimal scheduling of deficit irrigation to save the crop (Farahani *et al.*, 2009). With this background, the main objective of this study was to simulate the streamflow of the Aliyar sub-basin using the SWAT model integrated with model calibration and uncertainty analysis using the SUFI-2 algorithm and to evaluate its applicability for the Aliyar sub-basin. This modelling study also provides support to water resource managers in effectively planning and managing agricultural water resources, soil erosion, as well as natural disasters.

Methodology

Parambikulam Aliyar (PAP) basin is an inter-state water distribution project located in the southwestern part of peninsular India as a collaboration between Kerala and the Tamil Nadu States. Aliyar sub-basin which is considered to be the important sub-basin in PAP was undertaken for this study. European Centre for Medium-Range Weather Forecast (ECMWF) reanalysis Interim (ERA-I) data available at a 0.75° horizontal resolution (Dee *et al.*, 2011) was used as initial and boundary conditions in Weather Research and Forecasting model(WRF). The source of the Digital elevation model (DEM) used in the study was 1 Arc Second (30m) Shuttle Radar Topographic Mission (SRTM) (https://earthexplorer.usgs.gov/). A digital soil map of Tamil Nadu at a scale of 1:50,000 obtained from the Department of Remote Sensing and Geographical Information System, Tamil Nadu Agricultural University (TNAU) were used to define the soils of the sub-basin. The land use/land cover data were obtained from the National Remote sensing Centre (NRSC) for the year 2011. This was developed by NRSC using multi-temporal Resource SAT-1 AWiFS (Advanced Wide Field Sensor) data. In this study, the Aliyar sub-basin which was considered to be the major sub-basin of the PAP basin was taken for SWAT simulations.

Results and Discussion

The objective function used for parameterisation was the Nash Sutcliffe coefficient (NS). The further predictive capability of the model was quantified by PBIAS, RSR and R^2. The R^2 value was more than 0.8 for calibration (0.84) and validation (0.86) indicated the existence of a good agreement between the observed and simulated streamflow. The NS value above 0.7 during calibration (0.79) and validation (0.83) also demonstrated the good performance of the model. PBIAS demonstrated a smaller deviation of simulated values from the observed values by 10.7 and 8.7 % for the calibration and validation phase respectively. Low RSR showed better modelling efficacy during both calibration (0.52) and validation (0.31) periods (Table 1.). In the present investigation streamflow discharge of the SWAT model was compared with the collected stream discharge of the Aliyar dam in the Aliyar sub-basin (Fig 1 and 2). The calibration and validation were done for the daily streamflow. The best fit of a set of sensitive parameters responsible for simulating streamflow was evaluated using the predominant indices such as P-factor and R-factor.

Table 1. SWAT model statistics for calibration and validation of stream flow in Aliyar sub-basin

Parameters	P-factor	r-factor	R^2	NS	PBIAS	RSR
Calibration	0.82	0. 23	0.84	0.79	10.7	0.52
Validation	0.88	0. 18	0.86	0.83	8.7	0.31

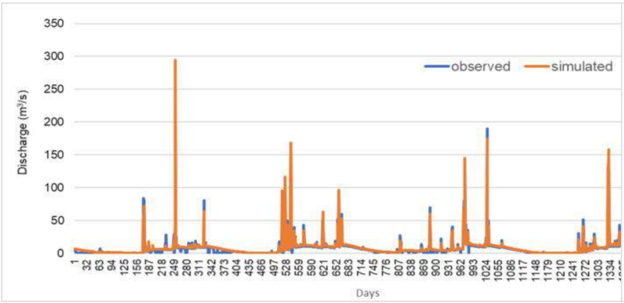

Figure 1. Calibration of simulated stream flow with the observed stream flow (2006-2009) in Aliyar reservoir in the Aliyar sub-basin

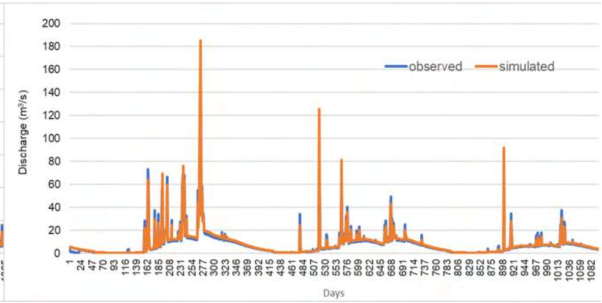

Figure 2. Validation of simulated stream flow with the observed stream flow (2010-2012) in Aliyar reservoir in the Aliyar sub-basin

Reference

Dee, Dick P, SM Uppala, AJ Simmons, Paul Berrisford, P Poli, S Kobayashi, U Andrae, MA Balmaseda, G Balsamo, and d P Bauer. 2011. The ERA-Interim reanalysis: Configuration and performance of the data assimilation system. ***Quarterly J. Royal Meteorol. Soc.,*** 137 (656): 553-597.

Farahani, Hamid J, Gabriella Izzi, and Theib Y Oweis. 2009. Parameterization and evaluation of the AquaCrop model for full and deficit irrigated cotton. ***Agron. J.,*** 101 (3):469-476.

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THEME 09

Approaches in Bio Nanotechnology for Enhancing Agricultural Productivity

Comparison of Curcumin and Nanocurcumin for Parameters Deciding Bioavailability

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Keywords: *Nanocurcumin, Mean droplet size, Polydispersity index, Zeta potential, Crystallinity*

Introduction

Turmeric of commerce is the dried rhizome of the plant *Curcuma longa* L. The chief active chemical constituents of turmeric roots are curcuminoids containing curcumin (77%), demethoxycurcumin (DMC; 17%), and bisdemethoxycurcumin (BDMC; 3%). Limitations of curcumin include: (i)low hydrophilicity and intrinsic dissolution rates, (ii)low physico-chemical instability, (iii)rapid metabolization, (iv)low bioactive absorption, (v)poor pharmacokinetics and bioavailability, and (vi)low penetration and targeting efficacy. Nanoencapsulation techniques can improve the anti-microbial and antioxidant capacity of curcuminoids, because they provide sustained release, good stability, enhanced solubility in aqueous mediums for the bioactives, resulting in higher functionality and bioactivity without any considerable change in quality and sensory properties.

Methodology

Curcumin formulation was prepared by dissolving 25mg of curcumin in 5 ml of solvent (ethanol) along with lipophilic surfactant (Span20) as organic phase and the aqueous phase consists of water, carrier (Beta cyclodextrin) and hydrophilic surfactant (Tween 80). The curcumin formulation was ultrasonicated at 20 kHz, amplitude of 40% and pulse on/off of 10s/10s for 20 minutes. Curcumin and encapsulated nanocurcumin formulations were characterized for mean droplet size, polydispersity index and stability using particle size analyser (PSA) and nature of the sample were analyzed through x- ray diffraction (XRD).

Results and Discussion

Mean droplet size, polydispersity index, zeta potential and degree of crystallinity for curcumin and nanocurcumin were compared.

Mean droplet size and polydispersity index:

The mean droplet size of curcumin is 3410.7nm (Figure 1) whereas the mean droplet size of nanocurcumin is 45.7 nm (Figure 2). Polydispersity index of curcumin is 3.005 which denotes the heterogeneity of molecules and larger size whereas the polydispersity index of nanocurcumin is 0.387 which denotes the homogeneity of molecules and smaller size.

Zeta potential

Zeta potential of curcumin formulation is -0.8 mV which denotes that the curcumin formulation is not stable (Figure 3) whereas the zeta potential of nanocurcumin formulation is -29.8 mV confirming the formulation stability Figure 4). The X- ray diffraction of curcumin indicates crystalline nature whereas the degree of crystallinity is reduced in nanocurcumin. Particle size, Polydispersity index and crystallinity are important parameters that decide the stability and bioavailability of curcumin formulation. The results confirm that the nano formulation of curcumin has desirable size, PI and surface properties.

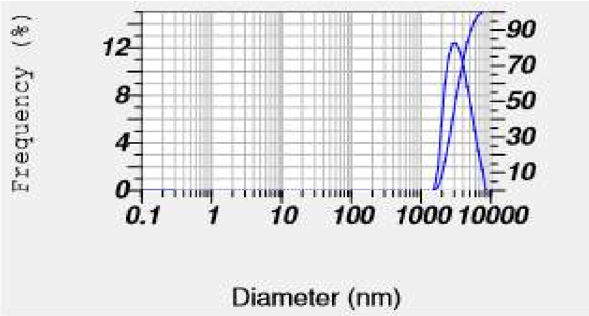

Fig 1. Mean droplet size of curcumin

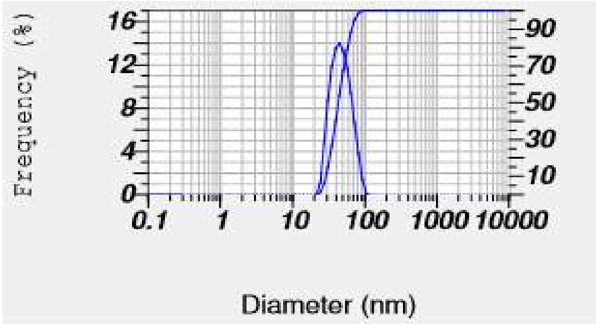

Fig 2. Mean droplet size of nanocurcumin

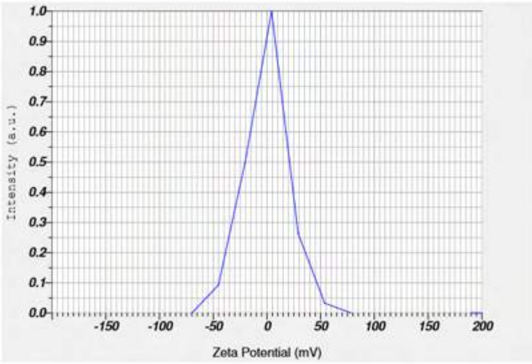

Fig 3. Zeta potential of curcumin

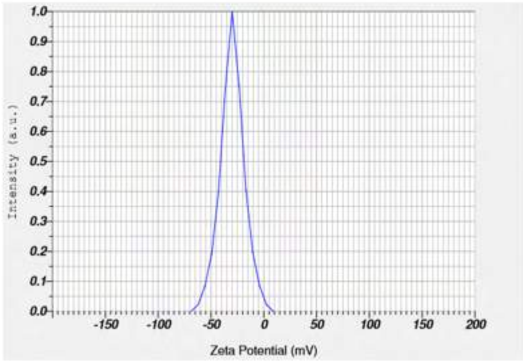

Fig 4. Zeta potential of nanocurcumin

Reference

Lee, S. B., Garcia, C. V., Hong, S. J., Shin, G. H., & Kim, J. T. (2019). Production of turmericextract-loaded nanoemulsions at the laboratory-scale and pilot-scale: Comparison of processing conditions and properties. Journal of Food Engineering, 261, 125-132.

Ipar, V. S., Dsouza, A., & Devarajan, P. V. (2019). Enhancing curcumin oral bioavailability throughnanoformulations. European journal of drug metabolism and pharmacokinetics, 44(4), 459-480.

Esatbeyoglu, T., Huebbe, P., Ernst, I. M., Chin, D., Wagner, A. E., &Rimbach, G. (2012).Curcumin- from molecule to biological function. Angewandte Chemie International Edition, 51(22), 5308-5332.

Effect of Multinutrients Loaded Electrospun PVA Nanofibre on Green Gram (*Vigna Radiata (L.) Wilczek)*

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Keywords: *MNC, Nanofibre, PVA, green gram*

Introduction

The present experiments were carried out in the field No.NA1 at ARS, Bhavanisagar TNAU, during 2021 to evaluate the efficacy of MNC encapsulated electrospun nanofibre coated green gram seeds (CO 8). In the experiment higher usage of fertilizers causes less nutrient response and imbalanced fertilization. The electrospun nanofibre developed from polyvinyl alcohol (10%) and it was suffuse with macro; micro multi nutrients. The novel technology had record higher plant height (47.78 cm) at maturity stage, crop growth rate (1.5-9.45 gm^{-2}day^{-1}), Net assimilation rate (0.51-1.82 mg cm^{-2} day^{-1}) at flowering stage and seed yield recorded highest in (854.42 kg ha^{-1}) compared to conventional fertilization. This nanofibre technology fork out unique idea for the fertilizer industry owing to minimize the fertilizer usage and improve the nutrient use efficiency.

Methodology

The electrospun fibre were developed from basic raw material by using polyvinyl alcohol (PVA) at 10% with molecular weight of 115,000 g mole^{-1} purchased from Astron Chemicals (India), Ahmedabad and green gram seed Co-8 were procured from department of pulses, TNAU, coimbatore, Tamil Nadu, India, Field experiments were handling at field no NA-1, Agricultural research station, Bhavanisagar. During summer season 2020-2021. multinutrient mixture 100% concentrated formulation specifically prepared for electrospun nanofibre loading. The field experiment splitted into 3 treatments *i.e.* absolute control, conventional fertilizers and 100% concentrated of MNC loaded nanofiber.

Results and Discussion

Effect of MNC Loaded electrospun nanofibre on growth parameters

Crop Growth rate

In nanofibre coated green gram seed influence the crop growth rate recorded between vegetative to flowering, flowering to pod filling and pod filling to harvest stage represented in Fig.1 (A). Crop growth rate varied from one crop stage to other stage. Highest crop growth rate was observed in CGR (1.57 - 9.45 g.m^{-2}day^{-1}) in 100% concentrated MNC loaded electrospun nanofibre.

Net assimilation rate (NAR) (mg cm^{-2}day^{-1})

The influence of electrospun nanofibre NAR declined from vegetative stage to harvest stage. Declining rate of NAR due to the controlled release of multinutrients from electrospun nanofibres to surface of rhizospheric zone Fig.1 (B). The NAR observed at different stages of crop period 30-45 DAS, 45-60 DAS and 60~75 DAS. Whereas nanofibre coated crop exhibit the inclination of NAR observed high level in 0.51 to 1.82 mg cm^{-2}day^{-1} throughout the crop period after that 0.48 to 1.93 mg cm^{-2}day^{-1} were observed in RDF applied field. Finally lowest peak of NAR was noticed in 0.39 to 1.29 mg cm^{-2}day^{-1}.

Grain yield

Nanofibre coated electrospun nanofibre great influence to increase the grain yield Fig.1 (C) were as 100% concentrated MNC loaded electrospun nanofibre coated green gram seeds yield increases (854.42 Kg ha^{-1}). This productivity level closely associated on par with conventional fertilizer applied field (785.07 Kg ha^{-1}) and low productivity were record in T_0 (402.18 Kg ha^{-1}).

Haulm yield

Electrospun nanofibre seed coating technology also increases the haulm yield by 41% compared to absolute control Fig.1(D). The haulm yield increase due to the high concentration of MNC (include all macro, micro nutrients) loaded nanofibre cause improve the haulm yield 1820.10 to 2370.64 kg ha^{-1}. This might be due to regulated supply of nutrients at rhizospheric zone which is controlled by hydrophilicity of polymer. Similar observation of nanofibre coated seed increase haulm yield observed previously by (Dhoke *et al*., 2013).

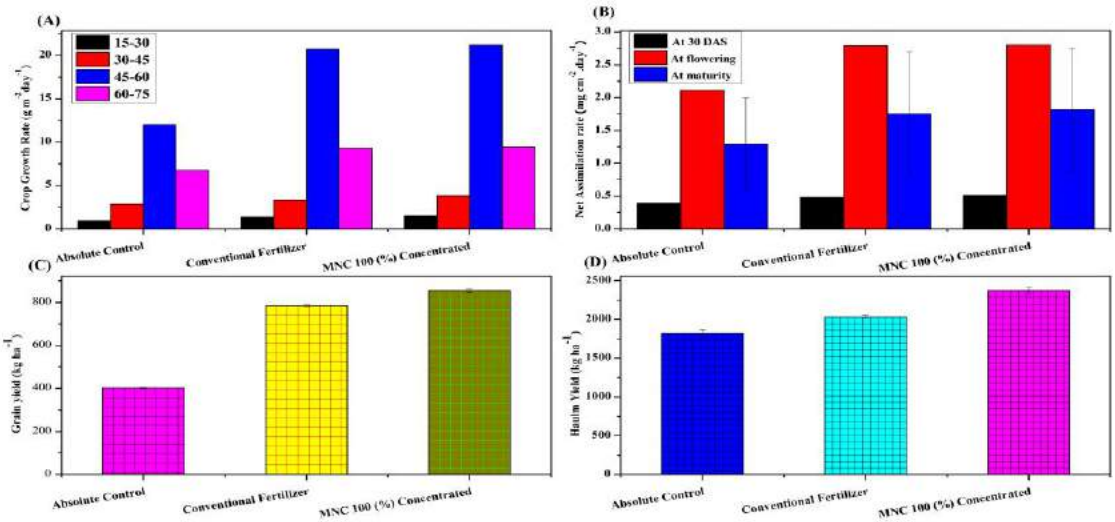

Fig 1: Effect of Multinutrients loaded electrospun nanofibre on Crop growth rate, Net assimilation rate, Grain yield and Haulm yield

Reference

Dhoke, S. K., Mahajan, P., Kamble, R., & Khanna, A. (2013). Effect of nanoparticles suspension on the growth of mung (Vigna radiata) seedlings by foliar spray method. Nanotechnology development, 3(1), e1-e1.

Electrospun Nanofibers for Controlled Release of Hexanal to Extend the Shelf Life in Mango Fruits (*var.* Neelum)

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Keywords: *Nanofibers, Hexanal, Shelf life, Mangoes, Encapsulation*

Introduction

Mangoes are highly appreciated by the consumers all over the world because of its delicacy and nutritional value. Hence, high demand is being placed in the market for its storage and export to different parts of the world. Mangoes are highly perishable; export to far countries are difficult. Technology for extending the shelf life of mango during transport is need of the hour. Hexanal, a volatile plant produced aldehyde has the property to extend the shelf life of fruits by inhibiting the action of the enzyme Phospholipase D – the key enzyme involved in fruit ripening process (Paliyath and Subramanian, 2008). Hence application of hexanal exogenously to the fruits may enhance its post-harvest shelf life (Anusuya *et al*., 2016). In the present study, multilayer electrospun nanofiber matrices were developed to encapsulate hexanal and controlled release for extending the shelf life of fruits.

Methodology

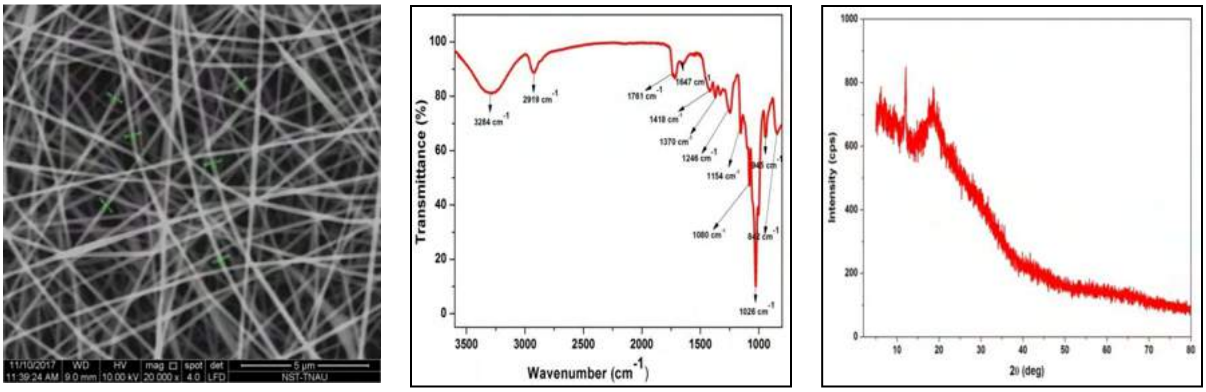
Electrospinning is a versatile technology used to produce nanofibers. Nanofibers are one dimensional nanomaterials used to effectively encapsulate volatile molecules. Multilayer nanofibers matrices were developed by using PVA and β-Cyclodextrin as sheath (wall) and hexanal as core solution followed by an additional layer of Poly (lactic-co-glycolic acid) by overlay method of electrospinning. Single layer nanofiber matrices are prepared using PVA and β-Cyclodextrin as sheath solution and hexanal as core solution. The prepared nanofiber matrices are characterised in SEM, XRD and FTIR and exposed to Mango fruits (var. Neelum) in carton boxes with different treatments viz., T1 (Control), T2 (Single layer nanofibers matrices) and T3 (Multilayer nanofibers matrices) to observe the shelf of mango fruits. Biochemical analysis like Physiological los in weight (PLW), Firmness, Total soluble solids (TSS) and pH were studied at different day intervals.

Results and Discussion

The results of the study revealed that uniform beadless nanofiber was formed through electrospinning process and confirmed through SEM with an average diameter of about 247 nm and 171 nm for monolayer and multilayer nanofiber matrices respectively. The FTIR spectra confirmed the loading of hexanal in to the matrices by exhibiting the aldehyde functional peak around 1716 cm^{-1}. The diffraction angles and peak intensity of XRD patterns can be used to verify the crystallinity of the samples. The 2θ value for multilayer nanofiber matrices occurred at 18.69^0; 12.04^0 (Fig. 1). The results of biochemical analysis like PLW, Firmness, TSS and pH were given in the Table 1. From the study concluded that untreated fruits had shelf life of 5 days and the fruits exposed to hexanal loaded single layer nanofiber matrices remained good for 7 days. A significant increase in shelf-life of fruits about 9 days was observed in mango fruits exposed to hexanal loaded multilayer nanofiber matrices. The results are in agreement with the findings of Jincy *et al.*, (2017) as they have reported that the shelf-life of mango fruits were extended for a period of 2 days by post-harvest dip of fruits in hexanal.

Table 1. Biochemical Analysis of Mango fruits exposed to hexanal loaded Nano fiber

Analysis	Treatment/ Days	0	2	4	6	8
PLW (%)	**T1**	-	4.97±0.03^{c}	11.51±0.13^{c}	13.03±0.08^{c}	19.11±0.16^{c}
	T2	-	4.31±0.04^{b}	7.51±0.07^{b}	11.57±0.08^{b}	17.29±0.02^{b}
	T3	-	1.36±0.01^{a}	5.77±0.06^{a}	9.80±0.05^{a}	14.31±0.03^{a}
CD(0.05)			0.0946	0.2728	0.2147	0.2881
Firmness (N/m)	**T1**	38.78±0.80^{NS}	28.13±1.57^{NS}	18.34±0.60^{b}	10.62±0.30^{b}	5.29±0.40^{c}
	T2	38.61±0.97^{NS}	30.23±0.54^{NS}	22.70±0.89^{a}	14.76±0.99^{a}	9.55±0.58^{b}
	T3	38.15±0.74^{NS}	31.21±0.61^{NS}	24.27±0.58^{a}	15.73±0.34^{a}	10.84±0.27^{a}
CD(0.05)		2.5453	3.0767	2.1264	1.8951	1.3057
TSS (°Brix)	**T1**	15.85±0.07^{NS}	17.27±0.27^{b}	22.30±0.57^{b}	23.80±0.31^{c}	26.54±0.49^{c}
	T2	16.03±0.21^{NS}	16.85±0.22^{ab}	19.81±0.21^{a}	22.60±0.33^{b}	24.74±0.49^{b}
	T3	15.89±0.16^{NS}	16.37±0.21^{a}	19.31±0.19^{a}	20.68±0.24^{a}	23.15±0.35^{a}
CD(0.05)		0.4813	0.7053	1.1019	0.9005	1.3508
pH	**T1**	3.49±0.03^{NS}	4.08±0.03^{b}	4.40±0.04^{b}	4.97±0.03^{b}	5.30±0.05^{c}
	T2	3.48±0.02^{NS}	3.73±0.04^{a}	3.81±0.02^{a}	4.20±0.02^{a}	4.73±0.04^{b}
	T3	3.49±0.04^{NS}	3.71±0.05^{a}	3.82±0.02^{a}	4.28±0.03^{a}	4.47±0.05^{a}
CD(0.05)		0.0990	0.1281	0.0872	0.0809	0.1379



SEM **FTIR** **XRD**

Fig 1: Physico-chemical characterization of electrospun nanofiber

Reference

Anusuya, P., R. Nagaraj, G.J. Janavi, K.S. Subramanian, G. Paliyath and J. Subramanian. 2016. Pre harvest sprays of hexanal formulation for extending retention and shelf life of mango (Mangifera indica L.) fruits. *Sci. Hortic.*, 211: 231–240.

Jincy, M., M. Djanaguiraman, P. Jeyakumar, K.S. Subramanian, S. Jayasankar and G. Paliyath.2017. Inhibition of phospholipase D enzyme activity through hexanal leads to delayed mango (Mangifera indica L.) fruit ripening through changes in oxidants and antioxidant enzymes activity. *Sci. Hortic.*, 218: 316-325.

Paliyath, G. and J. Subramanian. 2008. Phospholipase D inhibition technology for enhancing shelf life and quality. In: G. Paliyath, D.P. Murr, A.K. Handa, S. Lurie (Eds.), Postharvest Biol. Technol. Fruit. Vegetable Flowers., Isted. Wiley-Blackwell, USA, 195-239.

Field Evaluation of TNAU Nano Bio-Pesticide Formulation against Tea Mosquito Bug, *Helopeltis Theivora* Waterhouse in Tea

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Keywords: *Tea mosquito bug, Tea, Nano biopesticide, Evaluation*

Introduction

Tea, *Camellia sinensis* (L.) O. Kuntze, is an intensively cultivated as large- and small-scale plantations. Worldwide, several species of mirids that are associated with tea and among them, *Helopeltis theivora* Waterhouse (Heteroptera: Miridae) is the predominant insect pest, causes severe economic damage with yield loss. Considering the importance of TMB, a novel nano-biopesticide formulation has been developed by Department of Nano Science Technology, TNAU, Coimbatore. This unique formulation contains multifunctional botanical and mineral molecules, embedded in nano polymer. The nano polymer matrix aids in the controlled delivery of functional molecules, protecting and enhancing their stability under field conditions besides promoting the growth through amine moiety.

Methodology

Field experiment was carried out at Parry Agro Industries Limited tea plantations in Valparai hills of Tamil Nadu during the cropping period of September, 2020. Eight treatments were laid out with four replications (25 bushes /replication) in a Randomized Complete Block design (RBD). The treatments were T1 – TNAU Nano Bio-pesticide formulation @ 5ml/ lit, T2 - Thiacloprid 21.7 SC @ 1ml/lit., T3 - Thiamethoxam 25 WG @ 0.5gm/lit., T4 - *Beauveria bassiana* @ 3g/lit., T5- *M. anisopliae* WP 12 @ 10g/lit., T6 - *Metarrhizium anisopliae* WP 10 @ 10g/lit., T7 - *M. anisopliae* 11@ 10g/lit., and T8 – Control. Observations on the total no. of shoots/bush, infested shoots/bush, % shoot damage and no of TMB population/ bush were recorded as pre- treatment (before spray) and 7th day after spraying and the collected data were subjected to statistical analysis using the STAR (Version: 2.0.1, IRRI, Philippines, 2013–2020).

Results and Discussion

The results showed that among the treatments, less % damage, less no of TMB population/bush and higher % reduction over control were observed in TNAU Nano bio-pesticide formulation followed by Thiacloprid 21.7 SC, Thiamethoxam 25WG, *Metarrhizium anisopliae* WP 11, *M. anisopliae* WP 10, *Beauveria bassiana*, *M. anisopliae* WP 12 (24.22; 9.03 and control on 7 DAS, respectively (Table 1and Fig.1). The results are in agreement with the earlier findings of Ghatak *et al.*, (2008) and Roy *et al.*, (2010), who have validated the field efficacy of botanical and biological insecticides against TMB. The results revealed that TNAU Nano bio-pesticide formulation recorded less % damage, less no of TMB population / bush and higher % reduction over control compared to other treatments.

Table 1. Field evaluation of TNAU Nano Bio-pesticide against TMB, H. theivora in Tea

Treatments	% Shoot infestation by TMB /Bush			Number of TMB/ bush	
	Pre treatment Count (PTC)	7th Day	%Reduction over control	Pre treatment count (PTC)	7th Day
T1	24.74±0.1	16.34ᵃ±0.1	32.38	0.40±0.0	0.20ᵃ±0.0
T2	24.63±0.1	18.31ᵇ±0.2	29.31	0.40±0.0	0.20ᵃ±0.0
T3	25.86±0.2	22.46ᶜ±0.1	21.97	0.40±0.0	0.40ᵇ±0.0
T4	24.42±0.0	27.91ᶠ±0.1	11.47	0.40±0.0	0.40ᵇ±0.0
T5	24.22±0.1	28.08ᵍ±0.1	9.03	0.30±0.0	0.50ᶜ±0.0
T6	24.77± 0.0	25.74ᵉ±0.1	16.38	0.40±0.0	0.50ᶜ±0.0
T7	24.24± 0.0	25.54ᵈ±0.0	19.46	0.30±0.0	0.40ᵇ±0.0
T8	24.68±0.2	32.34ʰ±0.0	0.00	0.40±0.0	0.90ᵈ±0.0
SEd	**NS**	**0.560**	-	**NS**	**0.004**
CD @0.5 %	**NS**	**0.268**	**-**	**NS**	**0.002**

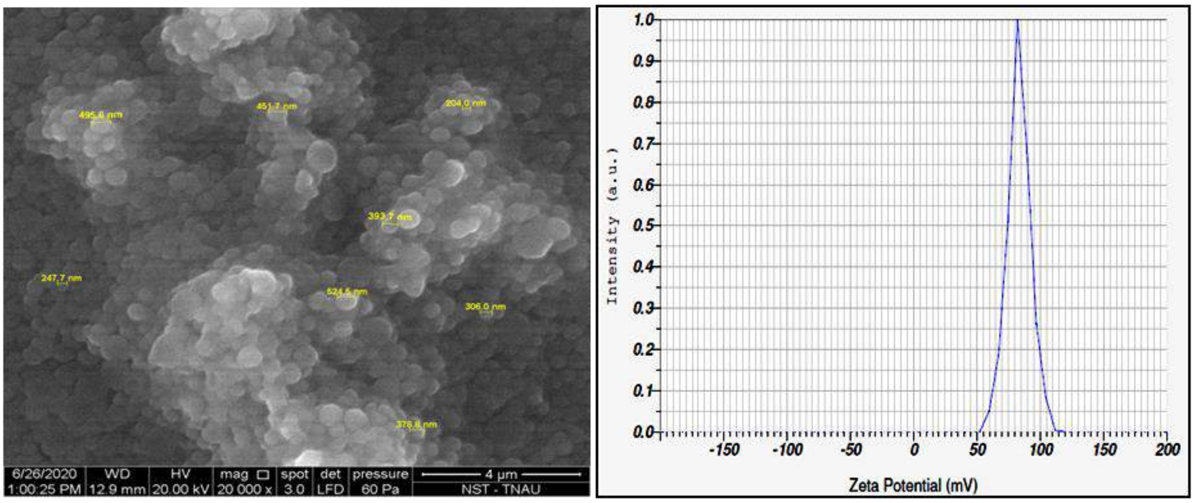

Fig 1: Nano Bio-pesticide Formulation under Electron microscope and their zeta potential

Reference

Ghatak, S.S., Reza, M.W and Poi, S.C. 2008. Bio-efficacy of some biopesticides and modern synthetic pesticides against tea mosquito bug, Helopeltis theivora Waterhouse (Hemiptera: Miridae). *Res Crops.* 9:165-171.

Roy, S., Mukhopadhyay, A and Gurusubramanian, G. 2010. Field efficacy of a biopesticide prepared from Clerodendrum viscosum Vent. (Verbenaceae) against two major tea Pests in the sub-Himalayan tea plantation of North Bengal, India. J. *Pest Sci.* 83:371-377.

Induced Membrane Stability and Antioxidant Enzyme Activity through Auxin and Salicylic Acid Nanoformulations in Tomato under Drought Stress

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Keywords: *PGRs, Nanoformulations, Drought, Antioxidants and Membrane Protection*

Introduction

Tomato (*Lycopersicon esculentum*), one of the commercial and productive vegetable crop produced by small and medium scale farmers for its growing demand. Drought stimulated flower shedding and fruit drop causes yield loss in tomato. The PGRs viz., Auxin and Salicylic acid plays an important role in maintaining water balance, osmolyte accumulation, reducing oxidative damage, preventing flower and fruit drop under stress condition. Based on this understanding, auxin and salicylic acid nanoformulations were applied to evaluate the membrane protection through the changes in the levels of lipid peroxidation. And also, the application of auxin and salicylic acid nanoformulations alters the total antioxidant activity which is responsible for mitigating drought in tomato.

Methodology

The tomato seedlings (hybrid 'Sivam') were transplanted at 21 days after sowing in a large size pots containing soil, sand and vermicompost. The drought was imposed at 50 percent flowering and foliar application of Naphthalene acetic acid (NAA), Salicylic acid (SA) and their nanoformulations were given when the soil moisture reduction reaches less than 20 percent. The plants were maintained for absolute control and drought control. Membrane Stability Index (MSI) determines the membrane damage in percentage using Electrical Conductivity (EC) by placing the sample in water bath at 40^0C for 30 mins (C1) and 100^0C for 15 mins (C2) (Sairam, 1994). According to *Hodges et al*., (1999), the levels of malondialdehyde content was measured to assess the membrane damage and the result was expressed in µmol g^{-1} of fresh weight. The total antioxidant activity was measured by DPPH radical scavenging assay using methanol and DPPH as described by Mahakunakorn *et al*., (2004) method and was expressed in per cent inhibition

Results and Discussion

The membrane deterioration was inferred based on the results of membrane stability index. Irrespective of the days, foliar application of 20 ppm NAA combined with 50 ppm SA as nanoformulations recorded with higher membrane stability index (63.4%) due to its reduced level of malondialdehyde content (0.40 µmol g^{-1} of FW) and increased antioxidant activity (63.6%) followed by salicylic acid nanoformulation under drought condition. Similar results were addressed by Naghashzadeh (2014). The present study exhibited higher level of malondialdehyde content and low antioxidant activity in drought control (T7) which determines excessive ROS production that causes membrane damage. Similar findings were also reported by Sarker and Oba (2018).

Table 1. Effect of NAA and SA nanoformulations on MDA content (µmol g-1 of FW)

Treatments	Days after foliar spray (DAF)			Mean
	1st	2nd	3rd	
T_1 - NAA nanoformulation @ 20 ppm	0.38	0.46	0.54	**0.46**
T_2 - SA nanoformulation @ 50 ppm	0.34	0.41	0.52	**0.42**
T_3 - NAA nanoformulation @ 20 ppm + SA nanoformulation @ 50 ppm	0.32	0.39	0.50	**0.40**
T_4 - Normal NAA @ 40 ppm	0.40	0.49	0.56	**0.48**
T_5 - Normal SA @ 100 ppm	0.35	0.44	0.53	**0.44**
T_6 - Irrigated control	0.22	0.24	0.25	**0.24**
T_7 - Drought control	0.45	0.56	0.62	**0.54**
Mean	**0.35**	**0.43**	**0.50**	**0.43**
	T	**D**	**T *D**	
S. Ed	0.013	0.008	0.022	
CD (P ≤ 0.05)	0.025**	0.016**	0.044**	

*** Mean of four replications**

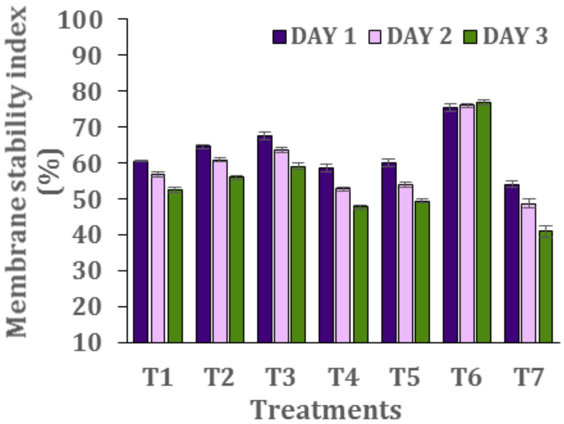

Fig 1: Effect of NAA and SA nano formulations on membrane stability index

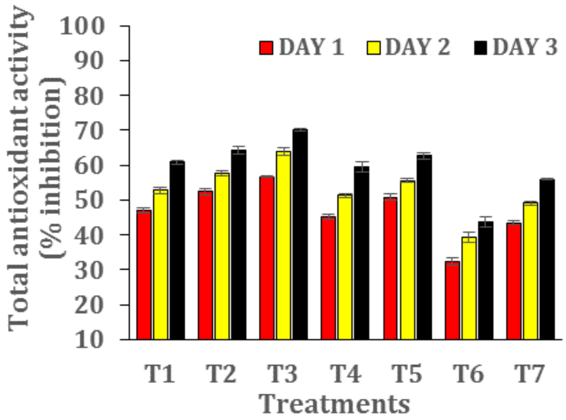

Fig 2: Effect of NAA and SA nano formulations on total antioxidant activity

Reference

Hodges, D.M., J.M. DeLong, C.F. Forney, and R.K. Prange. 1999. Improving the thiobarbituric acid-reactive-substances assay for estimating lipid peroxidation in plant tissues containing anthocyanin and other interfering compounds. Planta. 207 (4): 604-611.

Mahakunakorn, P., M. Tohda, Y. Murakami, K. Matsumoto, and H. Watanabe. 2004. Antioxidant and free radical-scavenging activity of Choto-san and its related constituents. *Biological and Pharmaceutical Bulletin*. 27 (1): 38-46.

Naghashzadeh, M. 2014. Response of relative water content and cell membrane stability to mycorrhizal biofertilizer in maize. *Electronic Journal of Biology. 10* (3): 68-72.

Sairam, R. 1994. Effect of moisture-stress on physiological activities of two contrasting wheat genotypes. *Indian Journal of Experimental Biology*. 32: 594-594.

Sarker, U., and S. Oba. 2018. Drought stress effects on growth, ROS markers, compatible solutes, phenolics, flavonoids, and antioxidant activity in Amaranthus tricolor. *Applied biochemistry and biotechnology*. 186 (4): 999-1016.

Nanopolymer Matrix for Effective Delivery of *Bacillus Subtilis* in Soil and Plant Eco Systems

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Keywords: *Nanofilm, PVA, PVP, Bacillus, Encapsulation*

Introduction

Bacillus subtilis belongs to plant growth promoting rhizobacteria and plays a major role in enhancing N fixation, solubilization of soil P, siderophores production and inducing systemic resistance against biotic and abiotic stress. Even though *Bacillus subtilis* has numerous applications in agriculture, a suitable delivery mechanism using advanced carrier material could ensure effective biofertilization programme. Nano carriers and nano encapsulation have tremendous potential for the effective delivery of microbial cells in soil and plant ecosystems. In this study, a novel delivery mechanism for *Bacillus subtilis* using nano composite film has been developed and the process has been validated under *in* vitro and in vivo conditions.

Methodology

Bio-nano composite film was prepared by blending the polymers and nutrient sources. Solution A: Poly vinyl alcohol (PVA) 10% solution was prepared by dissolving in DM water and stirred continuously for 3hrs. Poly vinyl pyrrolidone (PVP) 2% solution was ultrasonicated for 10 minutes and added drop by drop to the PVA solution under constant stirring. Solution B: The 5% nutrient source was prepared by dissolving in DM water and added with two drops of glycerol, which acts as plasticizer and stabilizer for bacteria. Added solution B drop by drop to solution A and autoclaved at 121^{0}C for 20mins. *Bacillus subtilis* broth was centrifuged and the pellets were collected for freeze drying. After freeze drying, the bacterial pellet was mixed in the polymer composite solution and stirred at low rpm for 1hr. Then this final solution was casted in the 9 cm pertiplate and dried at 40^{0}C. Bio-nano composite film was characterized by Scanning Electron Microscope (SEM) and FTIR. Bacteria viability was tested for a period of 6 months.

Results and Discussion

SEM micrograph confirmed the loading of *Bacillus subtilis* in bio-nano composite film which was absent in control. FTIR spectra of bacteria loaded film showed the amide and phosphate groups of bacteria, while those groups were absent in control. Similarly, Chun *et al*., (2021) reported that Bacillus subtilis was successfully loaded in sodium alginate film, which was confirmed by SEM image showing filled voids in the cross section of film. The bacterial colony count was dropped from 10^{-14} cfu to 10^{-10} cfu at the end of sixth month. Similar trend was followed in *L. plantarum*, 10^3 cfu was recorded at the end of 24 weeks (Skrlec *et al.*, 2019). The results confirmed that nano polymer matrix could be an effective carrier for the successful delivery of probiotic microbes in agriculture.

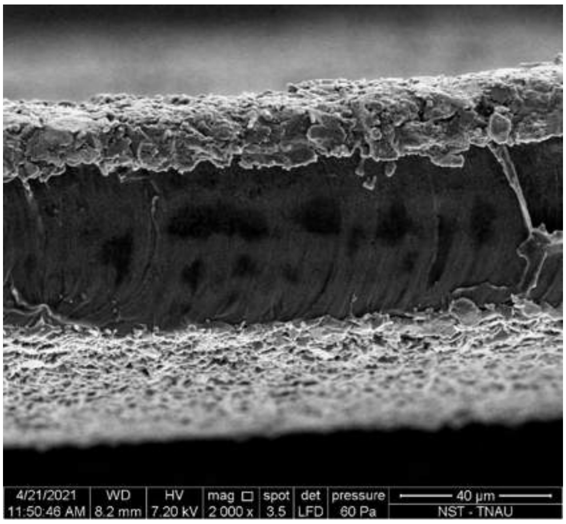

Fig 1: SEM image of bio-nano composite film

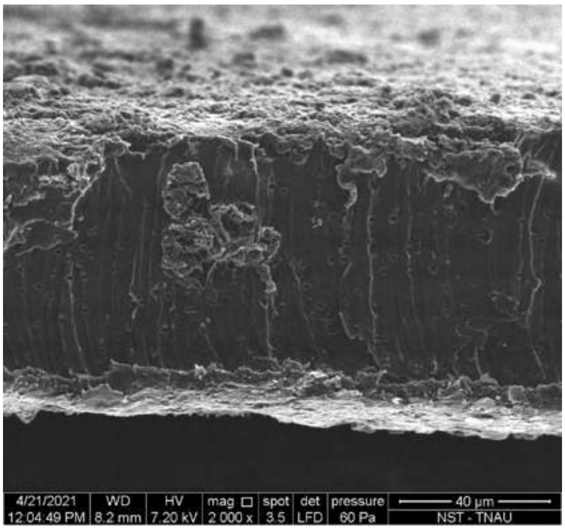

Fig 2: SEM image of Bacillus subtilis loaded bionano composite film

Reference

Škrlec, K., Zupančič, Š., Mihevc, S. P., Kocbek, P., Kristl, J., & Berlec, A. (2019). Development of electrospun nanofibers that enable high loading and long-term viability of probiotics. *European Journal of Pharmaceutics and Biopharmaceutics*, 136, 108-119.

Wai Chun, C. N., Tajarudin, H. A., Ismail, N., Azahari, B., & Mohd Zaini Makhtar, M. (2021). Elucidation of Mechanical, Physical, Chemical and Thermal Properties of Microbial Composite Films by Integrating Sodium Alginate with Bacillus subtilis sp. Polymers, 13(13), 2103.

Nutricapsule for Slow Release of Multi Nutrients for Balanced Crop Nutrition

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Keywords: *Nano fertilizer, slow-release fertilizer, nano zeolite*

Introduction

Nano-fertilizers are customized nutrient inputs intended to improve nutrient use efficiency without associated environmental hazard. Zeolites are crystalline, hydrated aluminosilicates with internal network of pores and channels. Zeolites have a high cation exchange capacity and these unique properties of zeolites make it a suitable carrier material for developing slow-release fertilizers. Zeolites in micro range are brought to nano scale structures by top-down approach using high energy ball milling. N, P, K and Zn nutrients were loaded into the surface modified zeolite (Subramanian *et al.*, 2015). Nutrient fortified nano-zeolite is analysed to find out nutrient content of the composite fertilizer. The slow-release tendency of the fabricated fertilizers was studied through specially designed percolation reactor system. The nutrient loaded in nano zeolite substrate was briquetted into a capsule using automatic tablet punching machine.

Methodology

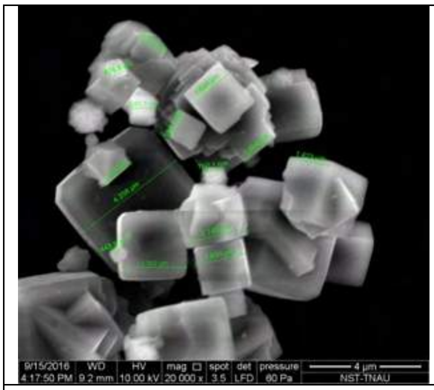
Nano-zeolite was synthesized using top-down approach (physical synthesis). For the size reduction of zeolite, samples were rotated at 600 rpm for 6 hours in half cycle pause time of 10 minutes per 30 minutes interval (On - Off cycle) in High-Energy Ball Milling to achieve nano-dimensions *i.e.,* <100 nm. Zeolite is negatively charged particle which had to be surface modified partially to positive charge in order to fortify anionic nutrient ions on the adsorptive sites. Hexadecyltrimethyl ammonium bromide (HDTMA-Br) a long chain cationic surfactant with a critical micelle concentration of 0.9 mM was used to surface modify the zeolites. NH4H2PO_4, Ca $(NO_3)_2$, KNO_3 and $ZnSO_4$ salts were used as nutrients source to fortify the nano-zeolite. zeolite before and after ball milling were characterized using particle size analyser, zeta analyser, powder X-Ray diffraction, FT-IR, Raman spectroscopy, scanning electron microscope, transmission electron microscope (Manikandan and Subramanian 2014). The same procedure was adopted for fabricated fertilizers as well. To study nutrient release pattern, the percolation reactor experiment was conducted with 10 g of soil and fertilizers (Urea, Single Super Phosphate, Muriate of potash, Zinc Sulphate and slow-release Nano-fertilizer). Leachates were collected to determine ammonium, nitrate, phosphate, potassium and zinc ions concentration.

Results and Discussion

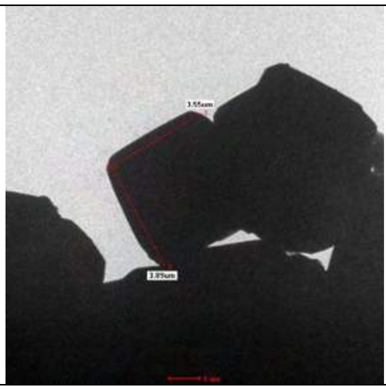
The physical properties of zeolite, nano zeolite and slow-release fertilizer were given in the Table 1. Scanning electron microscope operated in ESEM mode revealed the size shape and surface morphology of zeolites before and after ball milling. SEM images clearly show the size reduction of zeolites after ball milling. Elemental composition of zeolite was determined by energy dispersive X-ray spectroscopy (EDAX). Zeolite comprises carbon (61.8%), oxygen (36.6%), nitrogen (3.41%), magnesium (1.85%), aluminium (0.64%) and silica (2.84 %). Whereas the nano fertilizer composition is nitrogen (22.38 %), oxygen (55.69%), zinc (2.85 %), aluminium (2.59 %), silica (1.15 %), phosphorus (2.32 %), chlorine (4.29 %), potassium (6.59 %) and calcium (2.15 %) which clearly indicates the loading of nutrients into the surface modified nano zeolites (Fig. 1). The percolation reactor study data revealed that the conventional fertilizers Urea, SSP, MOP and Zinc Sulphate were able to release the nutrients up to 216, 360, 264 and 480 hours respectively. Whereas the composite Nano fertilizer is capable of releasing nutrients slowly up to 720 hours under ambient conditions.

Table 1. Physical properties of zeolite and nano zeolite

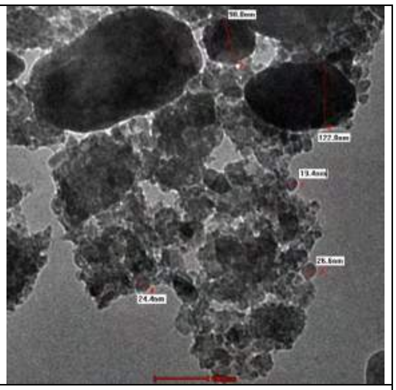
	Particle size (PSA)	Zeta Potential (PSA)	Particle size (SEM)	Particle size (TEM)
Zeolite	1 to 4.5 µm	-16 mV	1.5 to 4 µm	3.8 µm
Nano zeolite	40 to 150 nm	+9 mV (Surface modified)	150-300 nm	20 nm to 122nm
Slow-release Nano fertilizer	210.1 nm	-5.96 mV	300-600 nm	57.8 nm to165 nm



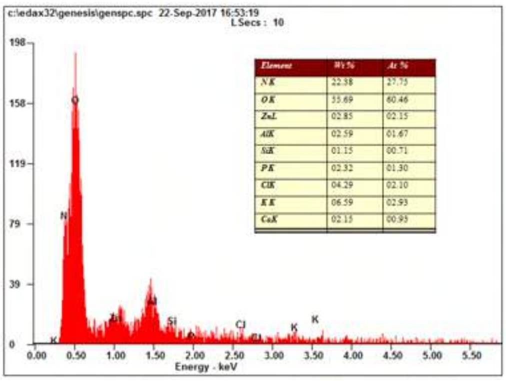
Zeolite SEM



Zeolite TEM



Nano zeolite TEM



EDAX Nano fertilizer

Nano fertilizer capsules

Fig 1: Characterization of zeolite and nano zeolite

Reference

Manikandan, A. and K. S. Subramanian. 2014. Fabrication and characterisation of nanoporous zeolite based N fertilizer. *African Journal Agricultural Research,* 9: 276–284.

Subramanian, K.S., A. Manikandan, M. Thirunavukkarasu and C.S. Rahale. 2015. Nano-fertilizers for Balanced Crop Nutrition (Eds) Rai, M et al., Springer International Publishing Switzerland. pp 69-80

Phytochemical and *In-Silico* Evaluation of the Pharmaceutical Important Biomolecules Present in Leaf and Seed Extracts of *Mucuna Pruriens.*

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Keywords: *Mucuna pruriens, GC-MS, biomolecules, Ligand-based docking, Type-2 diabetes, parkinson's disease.*

Introduction

Human beings have used plants and plant-based formulations for treatment of diverse ailments for thousands of years. Most populations of the world still rely on traditional/herbal medicines for their health requirements. *Mucuna pruriens* is a twinning annual crop belonging to the family of *Fabaceae*. The seeds, stems, roots and leaves contain a number of bioactive substances used for various drug formulations. The present research was undertaken to identify the bioactive compounds present in two varieties of *M. pruriens var utilis*: (IIHR Selection 3 and Arka Dhanvantari).

Methodology

The pharmaceutical importance of the two *M. pruriens* varieties used for this study was evaluated through phytochemical and *in-silico* screening. Detection of the various compounds present in the methanol seed extract was carried out via GC-MS. Identification and interpretation of the mass spectrum of each compound was carried out using the database of National Institute Standard and Technology available in the instrument. The PUBCHEM database and Kyoto Encyclopedia of Genes and Genomes was used for *in silico* analysis of the identified biomolecules. Three-dimensional (3D) structures of the biomolecules having enzymatic inhibitory activity for parkinson's disease and diabetes were obtained from PUBCHEM compound-specific database, while screening of the pharmacological activity for the selected structures was carried out using the QikProp module from the Schrodinger 9.3 and Prediction of Activity Spectra for Substances (PASS), followed by Ligand-based docking for ligands of parkinson's disease and diabetes using GLIDE (Grid-based Ligand Docking with Energetics).

Results and Discussion

The phytochemical screening of the leaf and seed extracts revealed the presence of alkaloids, tannins, flavonoids, phenols, proteins, terpenoids, reducing sugars, glycosides, carbohydrates, steroids and saponins. A total of 43 compounds were identified in the GC-MS analysis and the identified biological active compounds were used for *in-silico* analysis. The glide docking output for anti-diabetic and anti-parkinson's activities of 7 selected biomolecules is recorded in Table 1. *In-silico* docking study revealed potent inhibition of the selected compounds: alpha-D-glucopyranoside, ethyl iso-allocholate and sitosterol against uncoupling protein2 receptor (UCP2) involved in type 2 diabetes (Fig 1), showing that the binding profiles towards key amino acid residues in the active site were similar to that of the commercial alpha-amylase inhibitors: voglibose, acarbose and glibenclamide. Furthermore, the potent inhibition of another selected compound: 3-(4-hydroxyphenyl) propanoic acid against DJ-1 receptor (PARK7) involved in parkinson's disease was determined by docking study and it was observed that the binding profile towards key amino acid residues in the active site was similar to that of commercial levodopa (Fig 2). Therefore, *Mucuna pruriens* extracts can be recommended in the management of type-2 diabetes and parkinson's disease.

Table 1. Glide docking output for anti-diabetic and anti-parkinson's activities

S/No	PUBCHEM ID	Entry name	Glide score (Kcal/mol)	H-bond
1	6047	Levodopa (L-DOPA)	-3.101	5
2	6560213	Alpha-D-glucopyranoside	-4.879478	4
3	6452096	Ethyl iso-allocholate	-3.96628	2
4	222284	Sitosterol	-3.058685	2
5	41774	Acarbose	-5.597681	6
6	444020	Voglibose	-4.146658	4
7	3488	Glibenclamide	-3.96628	2

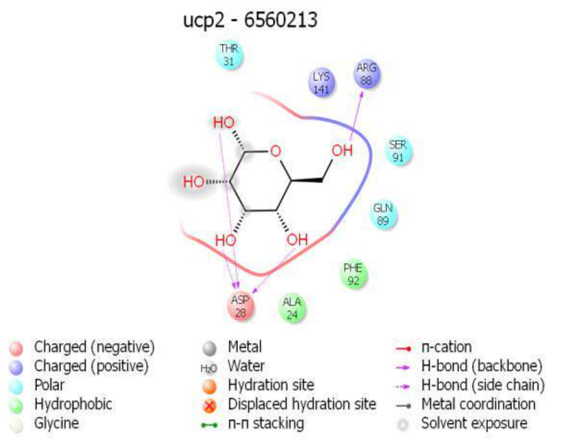

Fig 1: Ligand interaction showing best ligand for anti-diabetic drug with the targets

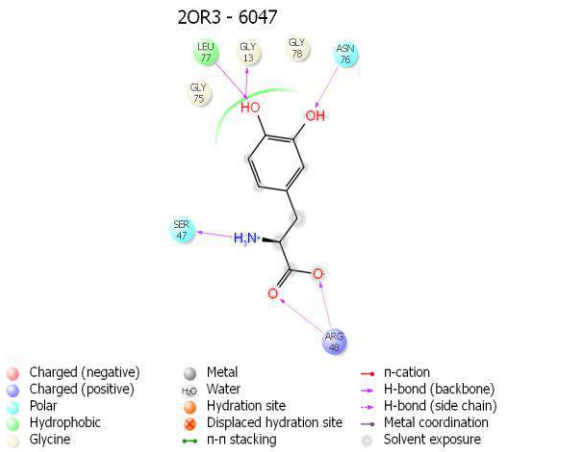

Fig 2: Ligand interaction showing best ligand for anti-parkinson's drug with the targets

Reference

Hussein RA, El-Anssary AA (2018). Plants Secondary Metabolites: The Key Drivers of the Pharmacological Actions of Medicinal Plants. In: Herbal Medicine. IntechOpen publishers. Pp 12-30.

Wang T, Mian-Bin W, Jian-Ping L, Li-Rong Y. (2015). Quantitative structure-activity relationship: promising advances in drug discovery platforms Expert *Opin Drug Discov*. 10(12):1283-300.

Sheeja RR, Lawrence B (2018). Phytochemical Screening of Stevia Rebaudiana-Bertoni, A Rare Sweetner. *Inter. J. Recent Sci. Research.* 9: 11(B): 29579-29581.

Synthesis of Nano Lignin from Sugarcane Bagasse

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Keywords: *Organosolv, nano lignin, nanoencapsulation, baggase, extraction*

Introduction

Sugarcane bagasse is a byproduct left after juice extraction from sugarcane. The amount of lignin present in bagasse is in the range of 20-25%. Lignin is the second most abundant natural macromolecule present next to cellulose and acts as the main structural component. This green molecule has several properties like anti-inflammatory, antioxidant, antimicrobial activity, anticarcinogenic, and also acts as a platform for aromatic molecules. In plants, it provides structural support, protection from chemical and biological attacks, and efficient water transportation in vascular tissues. Even though lignin has several benefits, it has low solubility, high complexity, and heterogeneity at the macromolecule level. The potential applications and properties of lignin have been amplified when converted into nano lignin. Lignin nanoparticles serve as biodegradable carriers for biocidal actives with minimal environmental footprints. In this study, nano lignin was extracted from sugarcane bagasse by organosolv method and characterized with particle size analyzer, UV-V is spectrophotometer, and scanning electron microscope.

Methodology

Lignin was extracted using the traditional organosolv extraction method. Bagasse powder (10g) was taken in a round bottom flask and add 60:40 (% v/v) ethanol: water. The extraction of lignin was catalyzed by adding 37% HCl and boiled at 70^{0}C for 3 hrs in the heating mantle with a reflexed condenser setup. This setup helps in retaining the evaporated ethanol into the solution for better extraction of lignin. The obtained liquor was filtered in a muslin cloth and washed with ethanol. Add ice-cold water for the precipitation of lignin and collected it by centrifugation at 7000 rpm for 10 min. The collected lignin was oven-dried at 60 ^{0}C and stored for future applications.

Results and Discussion

The absorption spectra of extracted lignin were 270 nm, confirmed by UV-VIS. The synthesized nanolignin has a spherical shape and size in the range of 360 nm to 1.6 µm, whereas raw bagasse was micro flakes in structure. The nanolignin synthesis from plants was based on the strength and ability of the solvent to permeate the inner part of the tissue and carrying the lignin out of it (Chauhan *et al.*, 2020). The size of synthesized lignin particles are in nano range, and amenable for surface modification and hence be used for encapsulation of various functional molecules in agriculture to enhance the use efficiency. The nanoencapsulation helps in the slow release of inputs and protection against unfavorable conditions (Tang *et al.*, 2020).

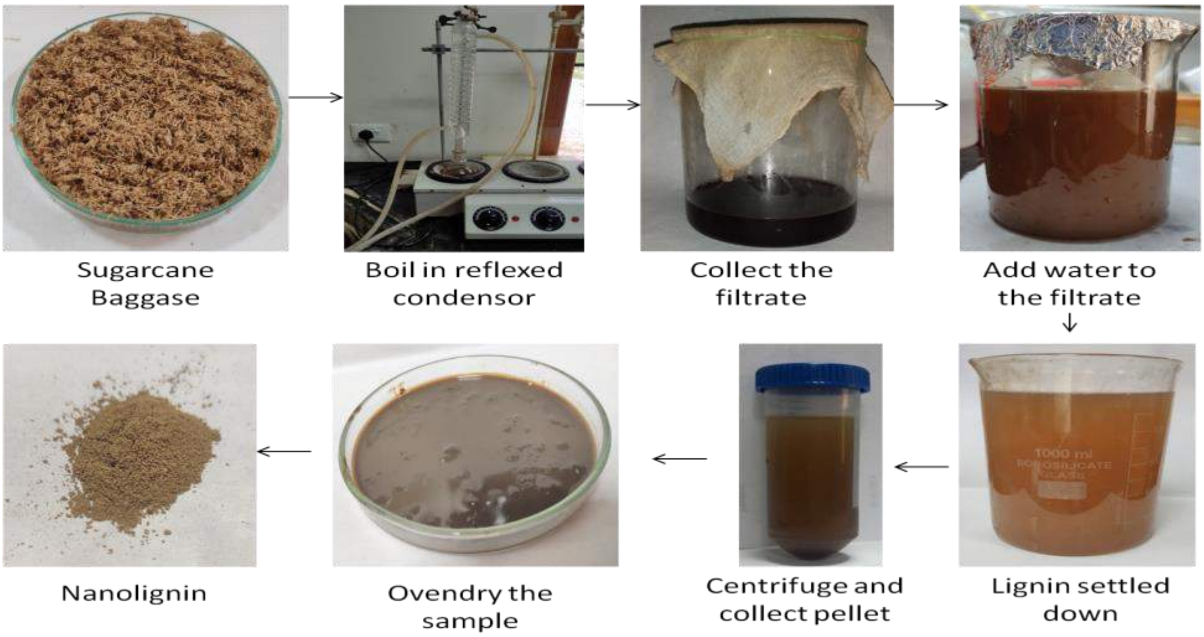

Fig 1: Organosolv extraction of lignin

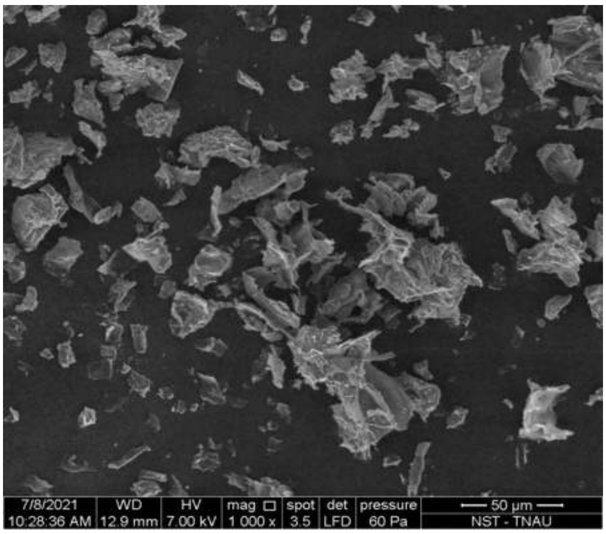

Fig 2: Scanning electron microscope image of raw baggase

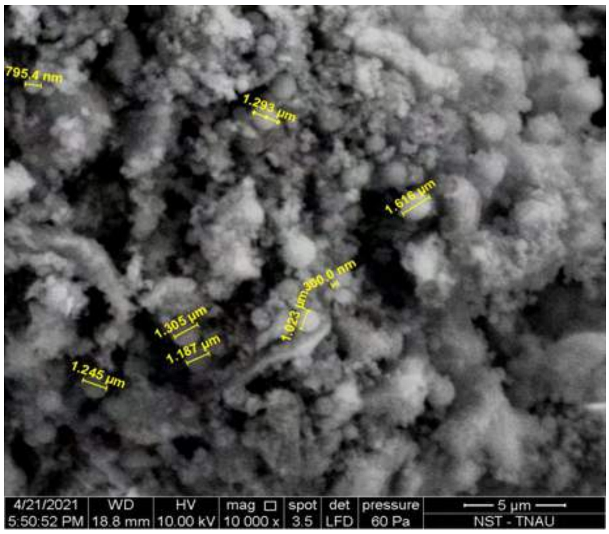

Fig 3: Scanning electron microscope image of synthesized organosolv nano lignin

Reference

Chauhan, P. S. (2020). Lignin nanoparticles: Eco-friendly and versatile tool for new era. *Bioresource Technology Reports,* 9, 100374.

Tang, Q., Qian, Y., Yang, D., Qiu, X., Qin, Y., & Zhou, M. (2020). Lignin-based nanoparticles: a review on their preparations and applications. *Polymers,* 12(11), 2471.

Zinc Oxide Nanoparticles as a Seed Protectant Against *Sitophilus Oryzae* in Maize

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Keywords: *ZnO nanoparticles, Sitophilus oryzae, Maize, Seed, Protectant*

Introduction

Maize (*Zea mays*) is known as queen of cereal crops because of its highest genetic yield potential. It stands third in the staple food crops next to rice and wheat and meets the demand of undernourished children particularly in India. The major limitation is significant during storage by insect pests. Maize seeds are more prone to storage pests as they are rich in nutritive endosperm. Among the various storage pests of maize, *Sitophilus oryzae* L. a primary internal feeder is being considered as a more devastating one and has the ability to cause 20-100 per cent loss. In order to control the pest, several insecticides and botanicals have been employed and resistance, residue problems were also encountered. Hence, there is a need for novel method to manage this deadly pest. The present study reported that zinc oxide nanoparticles could act as a seed protectant against *S. oryzae* in maize.

Methodology

ZnO nanoparticles were chemically synthesized through sol-gel method (Hasnidawani *et al.,* 2016). Zinc acetate dihydrate was used as precursor and NaOH as reducing agent. The resultant nanoparticles were characterised through Scanning electron microscope (SEM), Transmission electron microscope (TEM), particle size analyser, zeta potential analysis, Fourier-transform infrared spectroscopy (FTIR), UV-V is spectroscopy and X-ray powder diffraction (XRD). The uniform aged adults from mass culture were used for bioassay studies. Bioassay was performed in a small plastic container with 100g of maize seeds within which they were treated with different doses of ZnO nanoparticles (Subramanyam and Roesli, 2000). Insect mortality was recorded at 24 h intervals for seven days. The corrected mortality was worked out by Abbott's formula. The observation on the percent mortality was subjected to probit analysis and LD_{50} value was worked out.

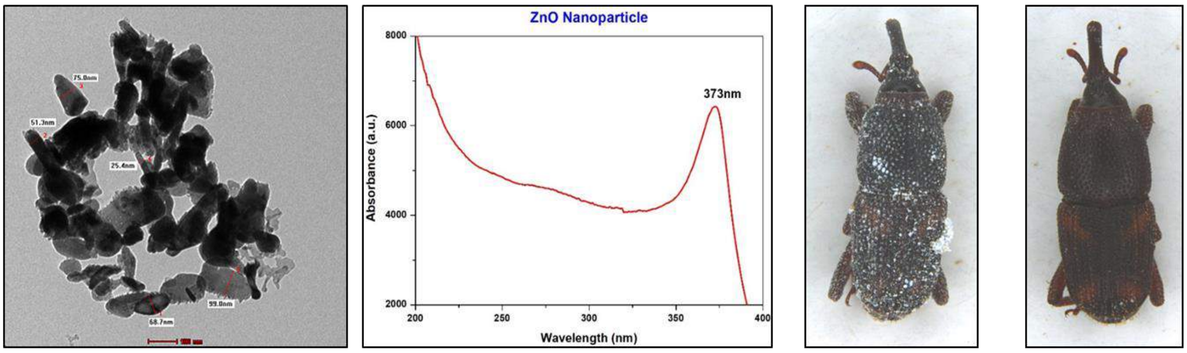
Results and Discussion

The results on the physical and chemical properties of ZnO nanoparticles revealed rod shaped uniformly dispersed nanoparticles with average diameter of 63.88 nm (Fig.1.). The UV-V is absorption spectrum showed a strong absorption band at 373 nm and had zeta potential value of -51.4 mV attributing to their excellent stability. XRD pattern showed the single-phase crystalline nature. The peaks were indexed as (101), (002), (101), (102), (110), (103), (200), (112) and (201) from which the Full Width at Half Maximum (FWHM) was determined for the most prominent peak (101). FTIR spectra showed peaks at 875 cm^{-1} corresponding to C=C bending in alkene group, 1434 cm^{-1} due to Zn-O stretching vibration, 2850 $cm^{-1}$and 2924 cm^{-1} related to C-H stretching, 3655 cm^{-1} and 3708 cm^{-1} attributing to O-H stretching of alcohol group. Bioassay studies revealed that the LD50 values as 20.992 (mg/100g) for ZnO nanoparticles and 46.046 (mg/100g) for malathion 5D. (Table. 1) ZnO nanoparticles exhibited 80% mortality at the dose of 100 mg/100g after 7 days of exposure. Hence, ZnO nanoparticles be used as effective seed protectant against *Sitophilus oryzae*. The results are in agreement with the findings of Rajesh *et al.,* (2012); Hasnidawani *et al.,* (2016) and Subramanyam and Roesli (2000), who reported similar observations on the physical and chemical properties and insecticidal toxicity of ZnO nanoparticles to insect pests.

Table 1. Comparative probit regression analysis of mortality data against rice weevil, *Sitophilus oryzae* in maize

S.No.	Particulars	LD_{50} mg/100 g of seeds (95 % fiducial limits)	LD_{95} mg/100 g of seeds (95 % fiducial limits)	Slope	$\chi2$*	Degrees of freedom
1.	ZnO nanoparticles	20.99 (8.31-53.05)	15930.73 (142.94-1775524.25)	0.729	2.399	6
2.	Malathion 5D	46.05 (37.37-56.74)	227.74 (115.41-449.39)	2.729	3.880	6

*** - In each case calculated $\chi2$ value was less than the tabular value (p=0.05), indicating that the data fit the probit model.**



TEM image of ZnO nanoparticles | **UV-Vis spectrum of ZnO nanoparticles** | **ZnO nanoparticles treated rice weevil** | **ZnO nanoparticles untreated rice weevil**

Fig 1: ZnO nanoparticles characterization and their toxicity on rice weevil in maize

Reference

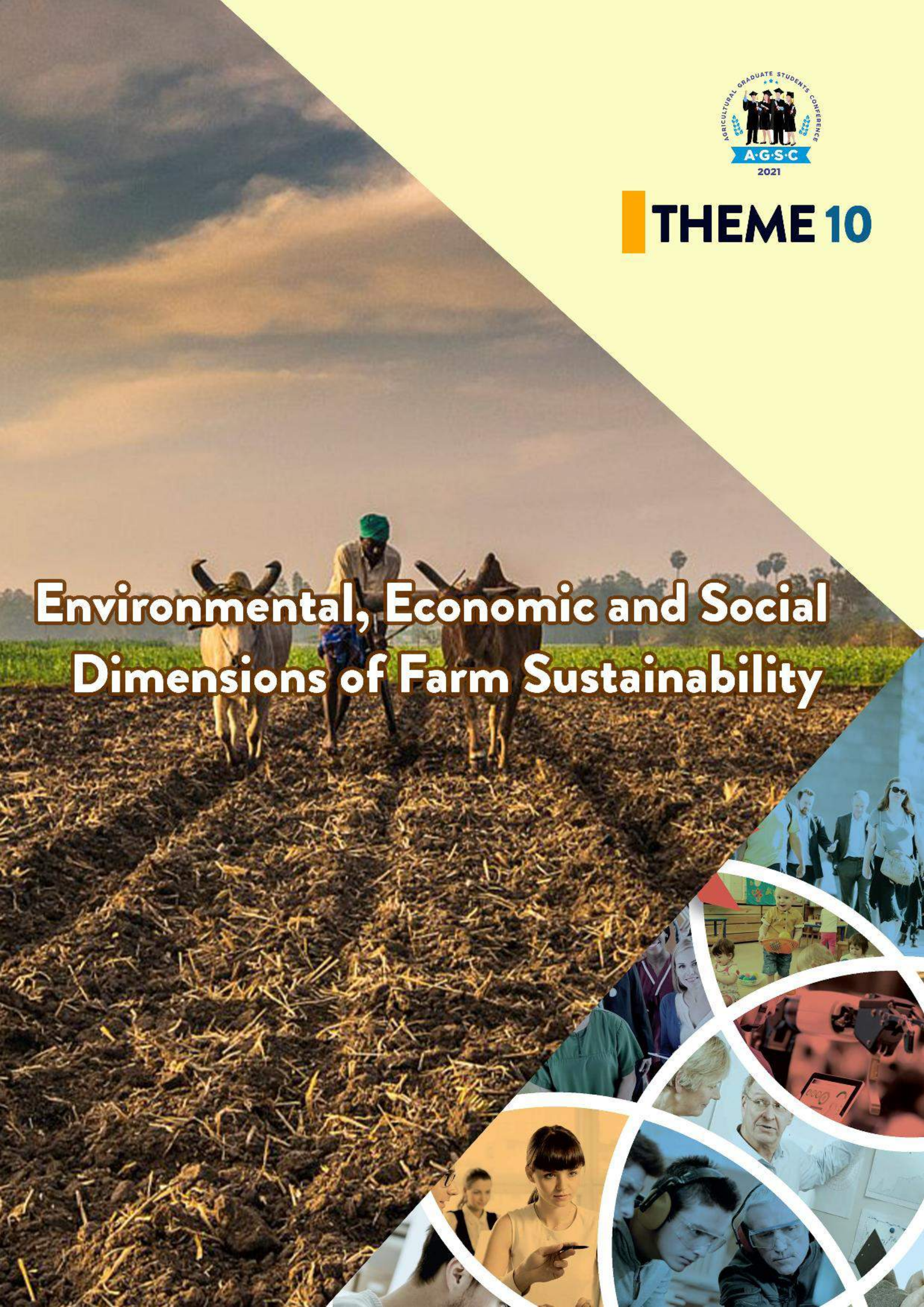
Hasnidawani, J, N. Azlina, H, N. Norita, H. Bonnia, N, N. Ratim, S. Ali, E, S. 2016. Synthesis of ZnO Nanostructures Using Sol-Gel Method. *Procedia Chemistry*, 19: 211-216.

Rajesh, D. Vara Lakshmi, B. Sunandana, C, S. 2012. Two-step synthesis and characterization of ZnO nanoparticles. *Physica* B, 407: 4537-4539.

Subramanyam, B. Roesli, R. 2000. Inert dusts. Alternatives to pesticides in stored-product IPM, Springer: 321-380.

THEME 10

Environmental, Economic and Social Dimensions of Farm Sustainability



Agriculture Waste Management - A Case Study on Bowenpally Mandi

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Keywords: *Waste management, Mandis, Sustainable, Biofuel.*

Introduction

This year 2021, was declared an International year of fruits and vegetables by the United Nations to raise awareness of health benefits and nutritional aspects of fruits and vegetables. It also addresses food loss and waste (FLW) (30 percent of all food globally), impacting food security and contributing to greenhouse gas emissions. Technically, food loss and food waste are different. Food loss is the reduction in quality and quantity from post-harvest up to retailing (excluding it), i.e., during the supply chain process. An estimated loss of 50 % of food happens even before reaching the consumers in the supply chain, says the Food and Agriculture Organization (FAO). Food waste means the reduction in quality and quantity at retailers to consumers, i.e., food left unsold at retail outlets (malformed shape, vagaries in colour, products crossing expiring date), leftover food at households. A tabular representation of crop wise food loss percentage across the world

Mr Trilochana Mohapatra, Director General of ICAR, mentioned in the foreword for 'Creating wealth from agri waste' that India generates about 350 million tons of agriculture waste per annum. Only 5 percent of it is recycled, 18 % is composted, the rest 77% is directly reaching the landfills (prone to leaching on precipitation contaminate the groundwater, on decomposition release vast amounts of Greenhouse gases (CO_2, CH_4)).

Methodology

This study focuses on one of the sustainable initiatives taken in the Telangana State Bowenpally Vegetable market. The researcher conducted an empirical inquiry to understand biogas production from vegetable waste, a phenomenon, which has vast scope and practicability. Data was collected primarily by having an interview with Secretary and Grade- III Secretary of Bowenpally market Mr. Srinivas, Mr. Satya Narayana, and staff of Ahuja engineering services. The secondary data taken from newspaper articles, the Mann ki Baat Radio program by the Prime Minister of India, articles related to waste management. The case study is presented in the form suggested by Spicer (1952) - Problems, the course of events, relevant factors and, the outcome and analysis.

Results and Discussion

Problems

Markets send the total waste generated to landfills for disposal. Bowenpally Market officials stated that every day on average, 10 tons of waste will be generated. This quantity of waste has the potential to generate approximately 6,290 kg of CO_2 per annum. To limit this, under Swachh Bharat Mission (SBM - launched by GOI in 2014 to solve the problems of sanitation and waste management), they have installed an '**anaerobic gas lift reactor'** - patent of Council of Scientific & Industrial Research- Indian Institute of Chemical Technology (CSIR - IICT)

The course of events

The installed reactor cost Rs. 3 crores were funded by the Department of Biotechnology (2 crores) and Department of Agriculture marketing (1 crore) Telangana, under technical supervision CSIR- IICT executed Ahuja Engineering Services.

The procedure of waste management activity- *Bio methanation.*

All the waste generated (rotten + vegetables left unsold) in the Bowenpally market and nearby yards are collected. The giant vegetables are chopped into convenient pieces and run over the Conveyor belt to the **shredder.** Followed by **grinding** tend to form slurry, is sent to digesters. **Anaerobic digesters** are the large tanks that allow the bacteria to survive in oxygen-lacking areas to decompose nutrient-rich waste and release methane and carbon dioxide (biofuel). The gas generated is collected and stored in **ballons** until its further use. Bio Manure is obtained, apart from the gas, as a by-product.

Relevant factors

The Prime Minister acknowledged the installation of the unit in the Mann ki Baat radio program, which brought the limelight towards this feasible biogas plant. The market committee reported - 'as of February 2021 - 1,400 tons of vegetable wastes were digested that produced 32,000 units of electricity, 7,000 Kilo Litres of bio manure.' On seeing the efficiency of it, DBT announced further funding to establish five more similar plants in different market yards with varying capacities (Gudimalkapur, Gaddiannaram - 5 tons/day, Erragadda, Alwal, Sarrornagar- 500 kgs/day) suitable to the generated market waste.

The outcome and Analysis

Around 30 kg of biofuel generated per day is supplied to the kitchen facilities 400-500 m away from the unit[11].
Fostering 400- 500 units of electricity, this powers the administrative building, markets water supply network, about 100 streetlights, and 170 stalls of the market. Setting up this biogas unit helped reduce the electricity bill by half (previously Rs. 3 lakhs per month on an average).
Usage of produced liquid bio manure as fertilizer in the farmers' fields.
Lastly, usage of large amounts of waste sustainably.

Table 1 FAO. 2020. World Food and Agriculture: Statistical Yearbook 2020. Rome.

Food Group	Food loss percentage
Roots, tubers and oil-bearing crops	25
Fruits and vegetables	22
Global losses for all commodities	14
Meat and animal products	12
Other	1
Cereals and pulses	9

Reference

Express News service. (2021). 'Power of innovation': Pm Modi praises Bowenpally vegetable market. *The New Indian Express*.

F.A.O. Food loss and food waste. Retrieved from http://www.fao.org/food-loss-and-food-waste/flw-data)

F.A.O. 2020. World Food and Agriculture: Statistical Yearbook 2020. Rome.

Geetanath, V. (2021). Bowenpally vegetable market generates own green power. *The Hindu*. Retrieved from https://www.thehindu.com/news/national/telangana/bowenpally-vegetable-market-generates-own-green-power/article33600682.ece

Spicer, E.H. (1952). Human Problems in Technological Change: A case book. John Wiley and Sons Inc., New York.

Trilochanana Mohapatra. (2020). Foreword in Creating Wealth From Agricultural Waste, Indian Council of Agricultural Research, New Delhi. p. 172

An Analysis on Growth and Instability of Organic Food Production and Export in India

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Keywords: *Organic Production, export, Growth rate, Cuddy-Della Instability Index*

Introduction

India ranks 8th in the world in terms of organic agricultural area and 1st in terms of world's total number of organic producers (Source: FIBL & IFOAM Year Book, 2020). Organic product exports from India are gaining momentum. the study addresses the specific objectives which includes (i) To analyze the trend in area under organic farming, number of organic producers in India; area, production in major states and export of organic products in India and (ii) To analyze reasons for changes in area, production and export under organic farming in major states in India (iii) To compare instability in area under organic farming of India with that of leading countries in the world and to analyze the instability in area and production of organic products of major states in India, export of major organic products category-wise.The present study attempts to analyse growth and instability in area and production of organic products in India and of major states in India. The trend in export of major organic products from India was studied for which Cuddy-Della Valle Instability Index (CDVI) and Compound Annual Growth Rate (CAGR) are worked out.

Methodology

The study is based on the secondary data. Area under organic farming for top ten countries in the world for the period 2000 to 2019 was collected from FiBL 2020 statistics. Organic Area, production and export of organic products in India were collected from National Programme for Organic Production (NPOP), Agricultural and Processed Food Products Export Development Authority (APEDA), Ministry of Commerce & Industries, GoI.

The Compound annual growth rate of area and production of organic products and for category-wise export products has been calculated using the following exponential function:

$X_t = ab^t$

$\text{Log } X_t = \text{Log } a + t \text{ Log } b$

$b = (1+r)/100$

Where,

X_t =Area/Production of organic products in years.

t = time element which takes the value 1, 2, 3,......,n

a = intercept

b = regression coefficient

C.G.R = (antilog b-1) x100

The Cuddy-Della Valle Instability Index was used to compare the variability in organic area among top ten countries in the world and variability in area and production of organic products in major Indian states. CDVI was also used to analyse the stability in category-wise export of major organic products from India. CDVI is given by,

Cuddy - Della Valle Instability Index (%) = $(C.V \times \sqrt{(1-R^2)}) *100$

Where, CV = Coefficient of variation, R^2 = Coefficient of determination.

Results and Discussion

The area under organic farming in India has increased from 2775 ha in 2000 to 22.99 lakh ha in 2019 with 27.74% CAGR unlike any other leading organic producing country in the world. The number of organic farmers in India has tremendously risen from 1426 in 2000 to 1366226 in 2019 with CAGR 41.3% topping the world. During 2012-2019, Meghalaya exhibited drastic increase in area under organic production (96.54% CAGR). Export of Spices and condiments has grown from 2014-2019 with 28.32% CAGR. CDVI Index for area under organic production for India is 40.70% for 2000-2019. CDVI Index for export of processed food is extremely high (173.31%).

Reference

Parliament of India Rajya Sabha, Department related Parliamentary Standing committee on Commerce, Report No. 150 Export of Organic Products: Challenges and Opportunities (2019)

Potential for Trade of Organic Products from India, Occasional Paper No. 174, Export-Import Bank (Exim) Of India

APEDA (https://apeda.gov.in/apedawebsite/organic/data.htm)

FiBL (https://statistics.fibl.org)

Assessment of Honey Market Opportunities and Constraints in Kanyakumari District

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Keywords: *Honey bee, Constraints, Opportunities, Market*

Introduction

Beekeeping, also known as Apiculture. According to Cadwallader *et al.* (2011), it is the practice of raising and harvesting bees in order to collect honey and other beekeeping products such as bees wax. Bees pollinate many of our favorite fruits and vegetables, and we in turn plant the crops that allow the bees to produce their primary food source, honey. China is the world's largest producer of honey, the largest beekeeping country, the largest exporter, and the largest consumer of honey. India is the world's seventh largest producer of honey. Every year, the country produces 68157 Metric tonnes of honey.

Eighty percent of the honey produced in Kanyakumari District does not meet the special grade quality standards. This is due to the fact that it contains more than 22% moisture. Camphor is used in smokers by some beekeepers. This has an impact on honey production because it reduces livestock in the hive. The main objectives of the study to identify honey market constraints and opportunities facing by honey producers.

Methodology

Random sampling technique was used to collect the sample from the respondents. In Kanyakumari district 107000 honey producers are there from that 60 bee keepers were selected at randomly for the purpose of this study. Primary data were collected from the bee keepers in Vilavancode and Kalkulam Taluk of Kanyakumari District. The data collected from honey producers, village traders and processors.

Tools of analysis

Garrett's Ranking Technique

To rank the preference indicated by the respondents on different factors. Constraints perceived and the measures for improvement suggested by the producers in production and marketing of honey were prioritized by using Garrett's ranking technique by using the following formula:

Per cent Position = $100 (R_{ij} - 0.50) / N_{ij}$

Where, R_{ij} is the rank given to i^{th} item by the j^{th} individual, and N_{ij} is the number of item ranked by the j^{th} individual.

The percentage position of each rank was converted into score using Garrett's table by Garret and Woodworth (1969). For each constraint, score of individual respondents were added together and were divided by the total number of respondents for whom scores were added. Thus, mean score for each constraint was ranked by arranging them in a descending order.

Results and Discussion

Constraints in Production

The major problem faced by the beekeepers in production of honey was prioritized by using Garrett ranking technique. Most of the beekeepers being poor, had to face production problems in their endeavor. Sometimes, because of spread of diseases and pests, certain fatal the whole colony dies.

Constraints in Marketing

The beekeepers have to face many problems in marketing out their produce. The transportation problem of honey was the most important problem in the perception of the beekeepers. Mekonene (2017) the lack of containers for storing, transporting, and marketing honey was a critical marketing constraint for producers. The intervention should take the form of training in order to address the honey market constraints that both producers and traders face.

Opportunities

- Making the carrier development.
- It helps to increase the farmers' income.
- It helps to increase the quality of honey production.
- Beekeeping is also beneficial to our ecosystem.

Table 1: Constraints in Production

Particulars	Garrett ranking	Rank
Diseases and pests of honey bees	67.22	1
Impact of climate	64.42	2
Low price for honey	56.67	3
Lack of training on beekeeping	47.15	4
Migration	34.58	5
Others	28.97	6

Table 2: Constraints in Marketing

Particulars	Garrett ranking	Rank
Transportation problem	62.72	1
Problems in management	57.93	2
Lack of storage facilities	52.07	3
Lack of sugar syrup	42.75	4
Lack of knowledge about market area	32.53	5

Reference

Cadwallader, A., Victoria, H., Santiago, I., and Evren, S. 2011. Supporting Urban Beekeeping Livelihood Strategies in Cape Town: An Interactive Qualifying Project, Polytechnic Institute, South Africa.

Garrett, E. Henry and Woodworth, R.S 1969. Statistics in psychology and Education. Vakils, Feffers and Simons pvt. Ltd., Bombay, pp. 329.

Mekonene 2017. Assessment of Honey Market Opportunities and Constraints in Masha District - South West Ethiopia, *International Journal of Management and Social Sciences Research* (IJMSSR), Volume 6, No. 8.

Assessment of Influential Factors for Farmers towards Arecanut (*Areca catechu*) Cultivation in Tamil Nadu

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Keywords: *Arecanut, Cognizance, Decisive, Functional, Influential factor*

Introduction

In India, one of the most important cash crops is Arecanut (*Areca catechu*) and is referred as a traditional medicine in Indian Ayurveda texts. Arecanut gained commercial, economic importance in India, China and South East Asia. India ranks first in area and production of arecanut accounting of 54.07 per cent of its world production (FAO, 2017). In Tamil Nadu arecanut is cultivated in 6,884 ha of area with 35% area is under Salem district. The repeated failure of monsoon in the past years causes arecanut trees to wither in this district and this causes decline in the area of arecanut. So it is important to know the influential factors for farmers to increase the area under arecanut cultivation. The financial support alone is not enough to motivate farmers' participation, as a much wider range of factors must be taken into account (Blazy et al., 2011; Reimer et al., 2014). Socio-economic factors including farmer age, farm financial status and farmer education, access to non-farm income and technical information are often included in studies of farmers' adoption of NBMPs (Prokopy et al., 2019). For these reasons, the identification of influential factors is important and this study suggests that policy makers, program developers should be cognizant that policies or actions that increases a farmer's livelihood

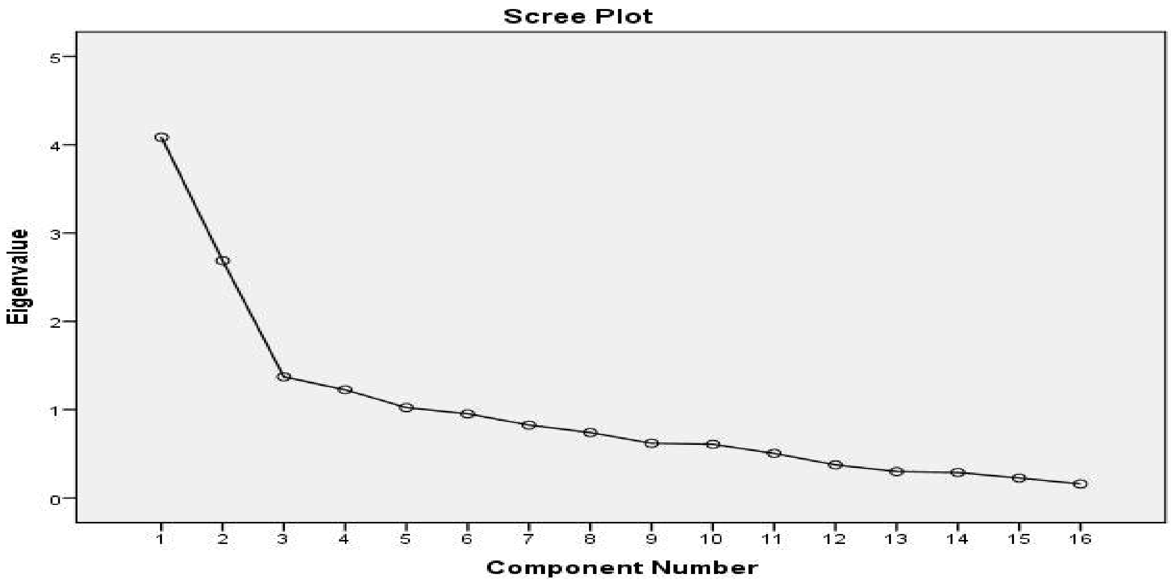
Methodology

This study was undertaken in Tamil Nadu and Salem district has 2,421 ha of area under arecanut in Tamil Nadu. From this district Peddanackenpalyam, Valapady, Gengavalli and Attur blocks were selected based on the major area under arecanut crop covering the area of 87.28 per cent of total area under arecanut in this district. The sample size of 120 arecanut farmers was selected for the study by using proportionate random sampling technique. To find out the influential factors of farmers towards arecanut cultivation, the statistical tool exploratory factor analysis was analyzed with software of SPSS. The suitability of the data was checked by Bartlett's test of sphericity and sample adequacy was checked with Kaiser-Meyer-Olkin (KMO) value.

Results and Discussion

KMO Measures the sampling adequacy, for the present study the value was 0.717, which signifies the sample is adequate and middling as used by most scientists. Bartlett's test of sphericity is 676.687 with 1% significance implies the variables are adequate for the study. From the sixteen components with Eigen values and factor loadings **(Figure 1)**, five factors were extracted with the total variance of 64.95 per cent. The functional factor had high variance of 18.32% with seven factor loadings, cognizance factors with 15.30% variance with six factor loadings followed by empirical factor with 15.12% variance for three factor loadings, household factor having variance of 8.48% with two factor loadings and decisive factor having variance of 7.71% with three factor loadings. Most of the respondents in the study area where innovative farmers with good social participations in village institutions, they are ready in adopting the scientific technologies and seeks additional information from the both institutional and media sources. This study concludes that identification of influential factors for farmers is pivotal in the adoption of improved technologies and expansion of area under arecanut cultivation. Finally, this study suggests promoting improved methods of cultivation at farm level for increasing the household income, and for expansion of arecanut areas.

Figure 1. *Scree plot with factor loadings*



Reference

Blazy, J.-M., Carpentier, A., Thomas, A., 2011. The willingness to adopt agro-ecological innovations: application of choice modelling to Caribbean banana planters. Ecol. Econ. 72, 140–150. https://doi.org/10.1016/j.ecolecon.2011.09.021.

FAO. 2017. *FAO Statistical Yearbook 2017, World food and agriculture*. Rome 2017: Food and agriculture organization of the united nations.

Prokopy, L.S., Floress, K., Arbuckle, J.G., Church, S.P., Eanes, F.R., Gao, Y., Gramig, B.M., Ranjan, P., Singh, A.S., 2019. Adoption of agricultural conservation practices in the United States: evidence from 35 years of quantitative literature. J. Soil Water Conserv. 74, 520–534.

Reimer, A., Thompson, A., Prokopy, L.S., Arbuckle, J.G., Genskow, K., Jackson-Smith, D., Lynne, G., McCann, L., Morton, L.W., Nowak, P., 2014. People, place, behavior, and context: a research agenda for expanding our understanding of what motivates farmers' conservation behaviors. J. Soil Water Conserv. 69, 57A–61A. https://doi.org/10.2489/jswc.69.2.57A.

Characterization of Oleaginous Microalgal Culture *Chlorella* sp. in Different Physiological Conditions to Enhance Biomass Productivity for Bioenergy Application

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Keywords: *Biofuel, Growth, Chlorella, Temperature, Salt*

Introduction

Microalgae have received the center of attention during the past decades for its potential renewable sources of feedstock for biofuel production (Razon & Tan, 2011) Microalgae have the ability to grow fast, synthesize and accumulate a higher amount of lipids with very high photosynthetic returns than other terrestrial crops as it does not require any agricultural lands (Forján et al., 2015). Though microalgae production is much better, however still it remains a barrier to the commercialization of algae-based biofuels. Various physiochemical parameters *viz*., pH, salinity and temperature are known to improve the growth characteristics of microalgae to meet the rising energy demand (Rai, Gautom, & Sharma, 2015) With this view, the study was carried out to evaluate the growth pattern of microalgae *Chlorella* sp at different physiological conditions.

Methodology

Microalgal culture *Chlorella* sp (KM504965) was sub cultured in BG-11 media at 25 ± 1ºC under cool white fluorescent lamps at an intensity of 3500 lux in 16:8 h light-dark cycles. The purity of the culture was ensured by regular observation under microscope. The culture was grown in different physiological conditions such as different temperatures, pH and salt levels. Around 2-3% of initial inoculum *Chlorella* sp (KM504965) was precultured in 250 ml Erlenmeyer flasks containing 100 mL BG-11 culture medium. For analysis of the salt effect, cells were cultivated in fresh medium containing sodium chloride (0.25M and 0.5M)). For analysis of pH effect, cells were cultivated in fresh medium at pH 4.0 (acidic condition) and pH 10.0 (alkaline condition). To study the effect of temperature, microalgae cultures were grown in three different cultivation conditions. The growth was monitored at one day intervals in terms of cell population, absorbance at 680nm and dry biomass production. Growth was monitored spectrophotometrically by means of optical density at 680 nm. The cell growth was measured using a hemocytometer. Dry weight of the biomass was measured gravimetrically (Schlesinger, Molot, & Shuter, 1981). Using the data, generation time, specific growth rate (μ (day^{-1})) and biomass productivity (mg L^{-1} day^{-1}) were calculated.

Results and Discussion

Effect of different pH, Salinity and temperature conditions on growth of Chlorella sp (KM504965)

The result from physiological studies that the biomass of *Chlorella* sp (KM504965) was greater in cultures grown at 25ºC and in outdoor conditions. The effect was more pronounced when the culture medium was supplemented with 0.25M salt and maintained at neutral pH. Maximum biomass (1.15±0.046 gL^{-1}) and cell population (15.35±0.61x10^{6}cells/mL) was evidenced in cultures grown in outdoor condition at neutral pH. But maximal biomass productivity was achieved when the cultures were grown either in acidic (61.0 ± 2.44 mgL^{-1}d^{-1}) or in alkaline conditions (59.5±2.38 mgL^{-1}d^{-1}) with 0.25M salt under outdoor conditions. The generation time of *Chlorella* sp grown in outdoor condition was also very short (3 days) compared to 7 days at 25oC in neutral pH. To conclude, *Chlorella* sp could be grown in outdoor conditions with pH 7.0 + 0.25M salt to achieve maximum biomass production. (Figure 1,2,3).

Figure 1. Effect of various pH and salt concentrations on the growth of *Chlorella* sp (KM504965) incubated at 25⁰C for 21 days

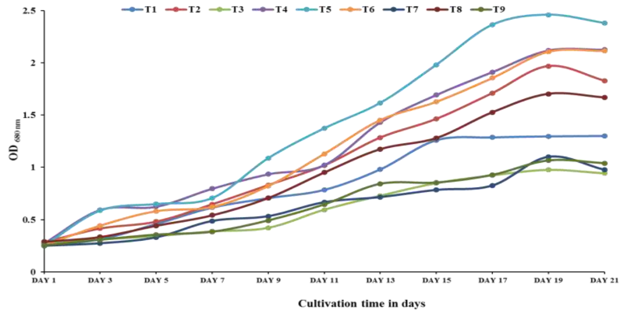
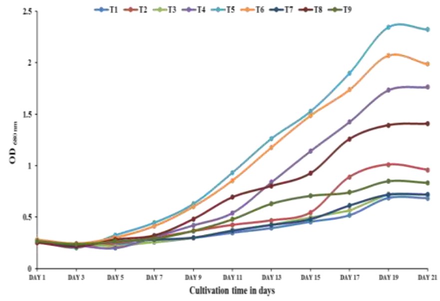
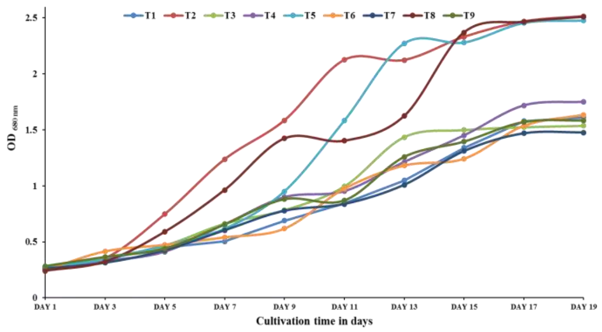


Figure 2. Effect of various pH and salt concentrations on the growth of *Chlorella* sp (KM504965) incubated at 35⁰C for 21 days





T_1 - pH -4 (Without salt)
T_2 - pH -4 (0.25 M NaCl)
T_3 - pH -4 (0.50 M NaCl)
T_4 - pH -7 (Without salt)
T_5 - pH -7 (0.25 M NaCl)
T_6 - pH -7 (0.50 M NaCl)
T_7 - pH -10 (Without salt)
T_8 - pH -10 (0.25 M NaCl)
T_9 - pH -10 (0.50 M NaCl)

Figure 3. Effect of various pH and salt concentrations on the growth of *Chlorella* sp (KM504965) grown under outdoor conditions for 19 days

Reference

Forján, E., Navarro, F., Cuaresma, M., Vaquero, I., Ruíz-Domínguez, M. C., Gojkovic, Ž., . . . Bermejo, E. (2015). Microalgae: fast-growth sustainable green factories. *Critical Reviews in Environmental Science and Technology, 45*(16), 1705-1755.

Rai, M. P., Gautom, T., & Sharma, N. (2015). Effect of salinity, pH, light intensity on growth and lipid production of microalgae for bioenergy application. *OnLine Journal of Biological Sciences, 15*(4), 260.

Razon, L. F., & Tan, R. R. (2011). Net energy analysis of the production of biodiesel and biogas from the microalgae: Haematococcus pluvialis and Nannochloropsis. *Applied Energy, 88*(10), 3507-3514.

Schlesinger, D., Molot, L., & Shuter, B. (1981). Specific growth rates of freshwater algae in relation to cell size and light intensity. *Canadian journal of fisheries and aquatic sciences, 38*(9), 1052-1058.

Comparative Studies on Air Pollution Tolerance Index of the Selected Fruit Crops Over Polluted and Non-Polluted Areas

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Keywords: *Fruit crops, Polluted area, Less polluted area, Air Pollution tolerance index*

Introduction

Air Pollution is associated with high discharge of pollutants and also aggregated by some adverse meteorological conditions. The use of vegetation can be a cheap method for pollution control when the appropriate species is chosen. Phytoremediation includes a lot of techniques that use plants to clean up polluted sites or render harmless environmental contaminants (Wong, 2003). Phytostabilization is a common phytoremediation technique that uses plants to clean up metal contaminated soils it has been proposed as a cost effective, environmentally friendly alternative technology (Lasat, 2002). When plants are exposed to the pollution range which is not in the physiologically acceptable level, photosynthesis gets inactivated (Sumitra *et al.*, 2013). Hence this research was taken up to find out the impact of air pollutants on physiological and biochemical characters of the selected plant species from the selected study areas.

Methodology

The present investigation deals with a comparative study of Air Pollution Tolerance, among the fruit crops from polluted and less polluted areas. This study was conducted in the Dharmapuri main town (Highly polluted area) and Morapur (Less polluted area). The selected plant species are as follows: *Mangifera indica, Achras sapota, Psidium guajava, Citrus spp, and Syzygium cuminii*. The leaf samples were collected during January to April 2019, and analysed for pH, relative water content, total chlorophyll content and ascorbic acid content. Air Pollution Tolerance Index (APTI) values were calculated by using the formula,

APTI = A (T+P) +R/10

A= Ascorbic acid content of leaf in mg/g on dry weight basis

T= Total chlorophyll of leaf in mg/g on dry weight basis

P= pH of leaf extract

R= Relative water content (g)

Results and Discussion

Air pollution tolerance index (APTI)

The APTI values of the selected plant species varies among themselves with respect to the study areas as *Syzygium cumini* recorded high APTI (3.70) value at Dharmapuri main town followed by *Mangiferae indica* (3.21), *Citrus sp (2.68), Psidium guajava* (1.86) and *Achras sapota* (1.03). The higher APTI values obtained during the month of March when compared to January and February in both study areas.

The plants with high and low APTI can serve as tolerant and sensitive species respectively (Jyothi and Jaya, 2010). In the present investigation among the selected tree species, *Syzygium cumini* has the highest APTI at Dharmapuri main town and also in the Morapur area (Less polluted area) in all the months. This indicates, *Syzygium cumini* is the tolerant species among the others to vehicular air pollution.

Table 1. APTI values of the selected tree species in Polluted and Less polluted areas

Less polluted area – Morapur area					
Month	Mango	Sapota	Guava	Citrus	Jamun
JAN	2.22	1.21	0.98	1.41	2.37
FEB	2.26	1.28	0.78	1.28	1.38
MAR	1.69	1.55	1.21	3.30	3.51
APRIL	1.29	1.02	0.58	2.53	2.20
Polluted Area – Dharmapuri Town					
Month	Mango	Sapota	Guava	Citrus	Jamun
JAN	2.69	0.88	1.49	1.09	2.06
FEB	3.21	1.03	1.86	0.91	1.48
MAR	2.35	0.88	1.56	2.68	3.70
APRIL	1.87	0.91	0.76	2.06	1.33

Reference

Jyothi, S. J., and D. S. Jaya. 2010. Evaluation of air pollution tolerance index of selected plant species along roadsides in Thiruvananthapuram, Kerala. *Journal of Environmental Biology,* 31(3): 379-386.

Lasat, M. M. 2002. Phytoextraction of toxic metals: a review of biological mechanisms. *Journal of environmental quality*, *31*(1): 109-120.

Sumitra,G., D. Shrivastava, K. Deshmukh, and P. Dubey. 2013. Effect of air pollution on chlorophyll content of leaves. *Current Agriculture Research Journal*, *1*(2): 93-98.

Wong, M. H. 2003. Ecological restoration of mine degraded soils, with emphasis on metal contaminated soils. ***Chemosphere*, *50*(**6): 775-780.

Comparison of cost and returns of hybrid maize production in Andhra Pradesh

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Keywords: *Cost and Returns, Hybrid Maize, Profitability*

Introduction

Maize (Zea mays L) is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions. Globally, maize is known as queen of cereals because it has the highest genetic yield potential among the cereals. The importance of maize lies in its wide industrial uses besides serving human food and animal feed and fodder. Bulk of the maize production in India, approximately 47%, is used as poultry feed, of the rest of the produce, 13% is used as livestock feed and food purpose each, 12% for industrial purposes, 14% in starch industry, 7% as processed food and 6% for export and other purposes. Among the maize growing countries India rank 4th in area and 7th in production, representing around 4% of world maize area and 2% of total production. During 2018-19 in India, the maize area has reached to 9.2 million ha (DACNET, 2020).

Methodology

The present paper addresses the cost difference among difference farms size in hybrid non hybrid maize production in Andhra Pradesh using the plot level cost of cultivation data (CCS) for the latest available period 2014-16. The CCS published plot level maize data were regrouped in to hybrid and non-hybrid based on the seed rate and seed value which gives clear difference between the hybrid and non-hybrid maize seed used in the maize cultivation. The cost and return analysis were compare among difference agricultural production zones in the state to assess the profitability and efficiency in maize production to suggest further improvement in farm income. CCS cost concept of A_1, A_2 B_1 B_2, C_1, C_2 and C_3 were estimated for two groups.

The Cost A1: All actual expenses in cash and kind incurred in production by owner which includes: (i) Value of hired human labour (ii)Value of owned machine labour (iii) Hired machinery charges (iv) Value of seed (both farm produced and purchased) (v)Value of insecticides and pesticides (vi)Value of manure (owned and purchased) (vii)Value of fertilizers viii. Irrigation charges (ix) Depreciation on implements & farm buildings (x) Land Revenue and other tax (xi) Interest on working capital (xii) Miscellaneous expenses (artisans etc.). They are all referred as paid out cost.

Cost A2: Cost A1 + Rent paid for leased- in land Cost B1: Cost A1 + interest on fixed capital (excluding land) Cost B2: Cost B1 + Rental value of owned land + rent paid for leased in land

Cost C1: Cost B1 + imputed value of family labour

Cost C2: Cost B2 + imputed value of family labour

Cost C3: Cost C2 + 10 percent of Cost C2 as management cost.

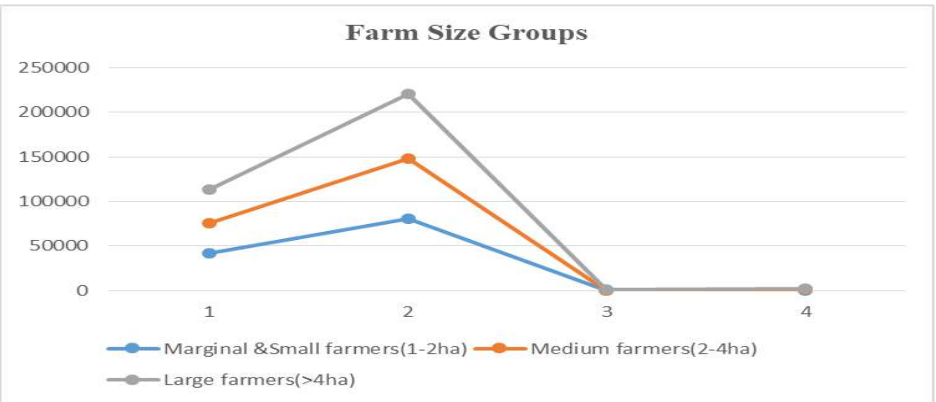
Results and Discussion

Here, from above table we can observe small farmers and marginal farmers are getting higher cost (41715.63) accordingly getting high yield and getting profit comparing to other classified groups. Plot level data considered for three years so Minimum support prices for three years (2014-16) (1310, 1325, 1365 = (avg (1333.333)) whereas, 795.64 is the profit per quintal which is gained by marginal and small farmers.

Table 1: Cost incurred in different farm groups

S.No	FarmSize	CostA1	CostC3	CopA1	CopC3	Profit*
1	Marginal &Small farmers(1-2ha)	41715.63	80130.21	264.87	537.69	795.64
2	Medium farmers(2-4ha)	34044.18	68466.9	261.57	547.33	786.00
3	Large farmers(>4ha)	37332.13	71712.83	387.47	708.76	624.57
	Total	37659.19	72981.88	332.8	635.45	697.88

Figure 1: Cost incurred in different farm groups



Reference

Chahal, S. S., Katariya, P., 2005. Technology adoption and cost return aspects of maize cultivation in Punjab. Indian Journal of Agricultural Economics, 62(4), 241–247.

Choudhri, H. P. S., Singh, G. P., Singh, R., Kushwaha, P., Kumar, R., and Ranjan, A. K. (2018). Costs and Income Analysis of Maize Cultivation in Bahraich District of Uttar Pradesh, India. Int. J. Curr. Microbiol. App. Sci, 7(2), 1060-1065

Murthy, C., Vilas, K., and Kerur, B. P. (2015). Cost and return structure of maize production in North Karnataka. International Research Journal of Agricultural Economics and Statistics, 6(2), 364-370

Narayanamoorthy, A., 2013. Profitability in crops cultivation in India: Some evidence from cost of cultivation survey data. Indian Journal of Agricultural Economics, 68 (1), 104-121.

Documentation and Adoption of Indigenous Technical Knowledge (ITK) Practices in Sorghum

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Keywords: *Indigenous Technical Knowledge, Sorghum, Documentation, Adoption, Madurai*

Introduction

Millets are our traditional crops also called "Super crop of our ancestors" is gaining momentum due to its high beneficial values. Sorghum is classified under major millets. Since, it was our staple crop before 50 years. As the attention is slowly turning towards organic agriculture to maintain sustainability Indigenous Technical Knowledge (ITKs) are gaining momentum. ITKs are farmers-oriented which is developed by the farmers and ITKs are location specific. The ITK is gaining its momentum these days because ITKs use organic inputs which are cheaper and easily available. Since, it is developed through "trial and error" method and it is more suitable to agro-climatic conditions. It is imperative to blend ITKs with modern technologies to maintain sustainability. So, the policy makers and extension workers are heading off the ITKs, which is a very good alternative for this modern agriculture.

Methodology

This study was conducted in Madurai district to document and find the adoption of ITKs in sorghum. Madurai district has 13 blocks. Among them two blocks namely Sedapatti and T.Kallupatti were purposively selected as they had highest area, production and productivity under millets. Two villages from each block namely Athipatti and Vitalpatti from Sedapatti and Silaimalaipatti and Sandhaiyur from T. Kallupatti were selected for the study. A pre-survey was conducted among 40 non-sample respondents who were old and had high experience in farming to document Indigenous Technical Knowledge (ITKs) in Sorghum. Thirty respondents were selected from each block based on random sampling technique.

Results and Discussion

A total of 28 ITKs were documented in Sorghum and were classified under 13 categories namely land preparation, seeds, sowing, irrigation, manuring, weeding, pest management, bird management, rodent management, harvesting, post-harvest, storage for consumption, storage for livestock etc. Cent percentage of the farmers adopted ITK-12, ITK- 13 and ITK- 28.

Many of the ITKs are cost effective, locally available and has less side effects. But it is not used all over the country. Lack of documentation is one of the major constraints in adopting ITKs. Also, most of the ITKs have scientific base. ITKs are very good supplement to modern technologies. Hence, steps have to be taken to document, rationalize and refine the ITKs. The present documentation would be greatly useful for future projects.

Reference

Sakeer Husain, A, and M Sundaramari. 2013. "Constraints Faced by Farmers in the Adoption of Indigenous Horticultural Practices." *Journal of Extension Education* 25 (4):6.

Siranjeevi, K , and P Shanmugaraja. 2017. "Indigenous Tribal Farming Practices in Kolli Hills, Tamil Nadu." *Life Sciences International Research Journal* 4:3.

Venkatesan, P, and M Sundaramari. 2017. "Indigenous Technical Knowledge in little millet cultivation among Malayaali tribes of India." *Journal of Environmental Biology* 38:6. doi: 10.22438/jeb/38/6/MRN-499.

Dryland Farmers' Adaptive Behaviour Towards Climate Variability

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Keywords: *Climate variability, dryland farmers, adaptive behaviour, impacts*

Introduction

Climate change is projected to have significant economic, social and environmental impacts on agrarian communities. Smallholder farmers in developing countries who heavily depend on rainfed agriculture were worst hit as they are very sensitive to climate variability and change (Anderson *et al*, 2010). Impacts of climate change are felt more severely in semi-arid and arid areas (Otto *et al*, 2015). At present, the potential adverse effects of climate change on the nations agricultural sector is a major concern. Farmers in developing nations are developing resilience to climate change-related risks like droughts and floods through practicing diverse adaptation strategies. Hence, a better understanding of the farmers' adaptive behaviour to climate change is critical to develop well-targeted adaptation policies at farm level.

Methodology

The study was conducted in Tiruppur district of Tamil Nadu. Palladam block was purposively selected based on the existence of typical dry farming condition. Five villages were randomly selected for the study. The sample of 120 respondents was selected from the five villages by using proportionate random sampling. By discussion with the local extension functionaries and local progressive farmers, the possible adaptation measures towards climate variability were collected. The data regarding the adaptation strategies were collected with the help of a well-structured and pre-tested interview schedule. The collected data were analysed with suitable statistical tools.

Results and Discussion

The study indicates that, the farmers had taken many adaptive measures with respect to crop diversification, cropping intensity, farm operations, soil and water conservation measures and animal husbandry (Table 1).

The findings revealed that majority of the dryland farmers had practiced different adaptation strategies such as cultivating climate resilient crops, crop rotation, changing the timing of farm operations, use of organic manure, changes in cropping system, off season tillage, reducing the number of cattle, etc to combat the adverse effects of climate variability.

Reference

Anderson S, Morton J, Toulmin C. 2010. Climate change for agrarian societies in drylands: implications and future pathways. In: Mearns R, Norton A, editors. Social dimensions of climate change: equity and vulnerability in a warming world. World Bank Publications; p. 199–230.

Otto FE, Boyd E, Jones RG, Cornforth RJ, James R, Parker HR, Allen MR. 2015. Attribution of extreme weather events in Africa: a preliminary exploration of the science and policy implications. ***Clim Change***. 132(4):531–43.

Table 1. Distribution of respondents based on their adaptive behaviour

S.No.	Particulars	Number	Per cent
I	Crop Diversification		
	Cultivating climate resilient crops	120	100
	Adoption of drought tolerant varieties	13	10.83
	Genetic diversity in monoculture	52	43.33
	Inter cropping	38	31.67
	Integrated farming system	53	44.17
	Crop rotation	86	71.67
II	Changes in Cropping Intensity		
	Changes in cropping system	92	76.67
	Leave the land fallow	78	65.00
	Mid season correction	103	85.83
III	Changes in Farm Operations		
	Changing the timing of farm activities	108	90.00
	Adoption of seed hardening techniques	20	16.67
	Changes in the use of fertilizers	66	55.00
	Use of organic manure	112	97.50
	Changes in marketing behaviour	19	15.83
IV	Soil and water management practices		
	Summer ploughing	73	49.17
	Off season tillage	90	75.00
	Broad beds and furrows	8	6.67
	Compartmental bunding	17	14.17
	Mulching	12	10.00
	Farm pond construction	3	2.50
V	Animal husbandry		
	Changes in cattle breed	27	22.50
	Changes in number of cattle possession	73	68.33
	Adjustment in livestock management practices	26	21.67
	Adaptation to thermal stress	37	30.83
VI	Income Diversification		
	Adapt to alternate livelihoods like dairy, poultry, etc.	25	20.83
	Undertake non-farm economic activities	38	31.67
	Salaried employment	7	5.83
	Temporal migration to other places for livelihood	0	0

Effect of Amendments and Treated Effluent on Soil Health and Sesamum Yield (*Sesamum indicum*)

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Keywords: *Pulp and paper industry, Treated effluent irrigation, soil health and sesamum yield.*

Introduction

Every day man's needs have been increasing in an exponential rate after the industrial revolution. This has simultaneously resulted in the generation huge quantities of wastes which have resulted in the pollution of air, water, soil, etc. These polluting substances disturb the balance in food chain and hence the food web. Paper and pulp industry is considered to among the highly polluting industries as almost ninety per cent of its wastewater is allowed to mix with nearby water bodies. India has more than 550 paper mills that have a capacity of nine million tonnes of paper in a year (Gupta *et al.,* 2019).

Methodology

Present work was aimed at studying the impact of treated paper mill effluent as a source of irrigation under the application of various amendments on sesamum and their impact on the soil health. Treated paper mill effluent samples were collected from TNPL, Kagithapuram, Karur district. The physico-chemical analyses of amendments, soil and effluent were carried out in the Department of Environmental Sciences, Tamil Nadu Agricultural University, Coimbatore in accordance with the standard methods of analyses (APHA, 1980). Key observations of the sesamum crop were done at critical stages of growth for instance plant height, number of its branches, number of capsules per plant, etc.

Results and Discussion

Characteristics of treated effluent:

The treated paper mill effluent of TNPL, Karur was slightly brown in colour with neutral pH and an electrical conductivity of 1.68 dSm^{-1}. It had a BOD and COD of 26 and 235 mg L^{-1}. It also contained appreciable quantity of calcium, magnesium, ammonical nitrogen and phosphorus. Further, it was noted to have 29.41×10^{6} CFU ml^{-1} of bacteria, 16.33×10^{4} CFU $ml^{-1}$of fungi and 12.58×10^{3} CFU ml^{-1} of actinomycetes populations.

Effect of Amendments and Effluent Irrigation on Soil Quality:

Various soil amendments such as ETP sludge, flyash, pressmud, biocompost and vermicompost applied along with treated paper mill effluent had substantially improved the soil pH, EC during different stages of the crop growth in sesamum. It was clearly evident from the observations that the organic carbon content of the soil had increased during the crop duration irrespective of the type of amendment. Among the treatment combinations, the treatment with vermicompost @ 5 t ha^{-1} + 100% GR + NPK was noted to have higher organic carbon content. Also there was an increment in the available NPK content in the field soil owing to the application of soil amendments supported with treated effluent irrigation. Also, incorporation of vermicompost @ 5 t ha^{-1} + 100% GR + NPK had statistically improved the exchangeable cations followed by the treatment that received biocompost @ 5 t ha^{-1} + 100% GR + NPK. The highest crude protein content (14.53 per cent) was recorded in Vermicompost @ 5 t ha^{-1} + 100% GR + NPK treatment, while the lowest crude protein content was observed in control with 13.55 per cent. Similarly, the oil content of sesame was the highest in the same treatment with 42.43 per cent and the lowest oil content was observed in control (36.21 per cent). These observations were in accordance with the findings of Ponmani *et al.* (2014).

Table 1. Effect of treated paper mill effluent irrigation and soil amendments on soil organic content during critical growth stages, crude protein and oil content of sesamum

Treatments	Organic carbon content @ 30 DAS (per cent)	Organic carbon content @ 60 DAS (per cent)	Organic carbon content @ harvest (per cent)	Crude protein (per cent)	Oil content (per cent)
T_1	0.40	0.41	0.52	13.55	36.21
T_2	0.46	0.50	0.61	13.79	40.24
T_3	0.41	0.44	0.53	13.59	38.12
T_4	0.43	0.47	0.55	13.71	40.16
T_5	0.49	0.54	0.62	14.02	40.23
T_6	0.54	0.61	0.71	14.12	41.00
T_7	0.58	0.71	0.73	14.53	42.43
Mean	**0.47**	**0.53**	**0.61**	**13.90**	**39.77**
SEd	**0.02**	**0.02**	**0.03**	**0.11**	**0.32**
CD (0.05)	**0.04**	**0.05**	**0.06**	**0.25**	**0.69**

T_1 - Control (100% NPK) T_2 - FYM @ 12.5 t ha $^{-1}$ + 100% GR + NPK

T_3 - Flyash @ 5 t ha^{-1} + 100% GR + NPK T_4 - ETP Sludge @ 5 t ha^{-1} + 100% GR + NPK

T_5 - PM @ 6 t ha^{-1} + 100% GR + NPK T_6 - Biocompost @ 5 t ha^{-1} + 100% GR + NPK

T_7 - Vermicompost @ 5 t ha^{-1} + 100% GR + NPK   GR - Gypsum Requirement, PM - Pressmud,

ETP Sludge- Effluent Treatment Plant Sludge, FYM - Farm Yard Manure, NPK: 35: 23: 23 kg ha^{-1}

Reference

APHA (1980). Standard methods for examination of water and waste water. American Public Health Association, Washington, U.S.A. p.83.

Gupta, G. K., Liu, H., & Shukla, P. (2019). Pulp and paper industry–based pollutants, their health hazards and environmental risks. *Current Opinion in Environmental Science & Health*, *12*, 48-56.

Ponmani, S., Udayasoorian, C., Jayabalakrishnan, R. M., & Kumar, K. V. (2014). Vermicomposting of paper mill solid waste using epigeic earthworm Eudrilus eugeniae. *Journal of Environmental Biology*, *35*(4), 617.

Effect of Organic and Amino Acids on Solubilization of Zn in Soils with Varying Levels of Calcareousness

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Keywords: *Organic acids, amino acids, Zn solubilization, calcareous soils*

Introduction

Calcareous soils are the soils with higher amount of free $CaCO_3$ (%), which increases the soil pH and in turn reduces the availability of applied fertilizer nutrients due to fixation and conversion into unavailable forms (Goa *et al*., 2020). Dissolution of this locked up nutrients in calcareous soils through various mechanisms is highly useful, rather than dumping fertilizers. In this context organic acids (OA) are capable of solubilizing the fixed nutrients from calcareous soils and are the major part of plant's root exudates. Solubilization of nutrients by the organic acids is mainly due to complex formation between organic acids and nutrients. Amino acids are also a constituent of root exudates, but its role in nutrient solubilization in not clearly known and hence in this study the effect of various organic and amino acids on Zn solubilization in calcareous soils was studied.

Methodology

An incubation experiment was conducted in the Department of Soil Science and Agricultural Chemistry, Tamil Nadu Agricultural University, Coimbatore to study the effect of various organic and amino acids on Zn solubilization in calcareous soils. Five soils having various levels of Free $CaCO_3$ content (S1- 1%; S2-7.5%; S3-12.5%; S4-17.5% & S5- 21.5%) was chosen for conducting the incubation experiment. Four organic acids (citric, malic, oxalic acids, acetic acid) and two amino acids (glycine and lysine) were used for studying the Zn solubilization potential. Organic and amino acids were prepared at different concentrations (0, 10, 20, 40, 60, 80 and 100 mM) and incubated for 24 hours (1440 mins). After the expiry of time, the DTPA extractable Zn was determined in all the calcareous soils to know the Zn solubilization efficiency of organic and amino acids.

Results and Discussion

The solubilization efficiency decreased with increasing soil calcareousness (Table 1). Out of the different organic and amino acids tested, higher Zn solubilization was observed with citric acid and the values ranged from 2.13 to 4.29 mg L^{-1} irrespective of soils. This was followed by malic and oxalic acid (1.91 to 4.09 mg L^{-1} and 2.03 to 4.07 mg L^{-1} respectively). Poor solubilization was observed with amino acids (1.06 - 3.88 mg L^{-1}). The Zn solubilization efficiency of the acids was ordered as: Citric acid > Malic acid > Oxalic acid > Acetic acid > Glycine > Lysine. In case of time dependent solubilization efficiency of organic and amino acids (Figure 1), increasing incubation time intervals increased the solubilization of Zn in all the soils and higher Zn solubilization was noted in soils having lesser free $CaCO_3$ (1%). Organic and amino acids has shown beneficial effects in solubilizing Zn in soils having lesser calcareousness and the effect decreased with increasing soil calcareousness. The observations on Zn solubilization at different incubation times also confirmed the above said impact by registering higher Zn solubilization after 24 hours of incubation. The order of increasing solubilization in soils having different free $CaCO_3$ (%) was:1.0 > 7.5 > 12.5 > 17.5 > 21.5 % free $CaCO_3$.There was a 10 fold increase in Zn solubilization after 24 hours as against observations made at 5 mins and similar result was reported by Strom *et al.* (2005).Organic acids considerably increases the solubilization of Zn in all the soils which might be attributed to the dissolution of Fe- and Mn- oxide bound Zn (Hussain *et al*.,2014). Substantially the study concluded that incubation of calcareous soils with citric acid at 100 Mm increases the solubilization of Zn followed by malic > oxalic > acetic acid. Between the organic and amino acids, organic acid were highly suitable for releasing the fixed Zn from calcareous soils.

Table 1. Effect of different organic and amino acids on Zn solubilization in calcareous soils

Organic acid	Soils					Mean
	S1	S2	S3	S4	S5	
Citric acid	4.29	3.27	2.09	1.91	2.13	2.74
Malic acid	4.09	3.14	1.88	1.84	1.91	2.57
Acetic acid	3.93	3.09	1.74	1.80	1.80	2.47
Oxalic acid	4.07	3.22	1.50	1.89	2.03	2.54
Glycine	3.88	3.03	1.35	1.77	1.55	2.31
Lysine	3.77	3.00	1.40	1.75	1.06	2.20
Mean	4.01	3.12	1.66	1.83	1.75	2.47
	O	S	OXS			
SEd	0.014	0.013	0.032			
CD	0.028	0.026	0.063			

***SEd- standard error of difference; CD- Critical difference;Organic/amino acid & S-Soil**

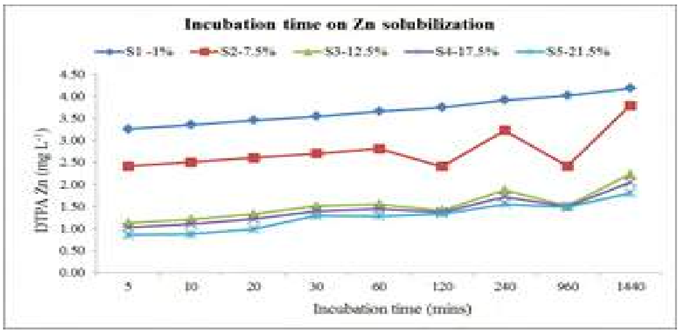

Figure 1. Zn solubilization by organic and amino acids at different time intervals in calcareous soils.

Reference

Gao, X. Peng, Y. Guo, L. Wang, Q. Guan, C. Y. Yang, F. and Q. Chen. 2020. Arsenic adsorption on layered double hydroxides biochars and their amended red and calcareous soils. ***Journal of Environmental Management***, 271, 111045.

Hussain, S. Maqsood, M. A. and Rahmatullah. 2011. Zinc release characteristics from calcareous soils using diethylenetriaminepentaacetic acid and other organic acids. ***Communications in soil science and plant analysis***, 42(15), 1870-1881.

Ström, L. Owen, A. G. Godbold, D. L. and D. L. Jones. 2005. Organic acid behaviour in a calcareous soil implications for rhizosphere nutrient cycling. ***Soil Biology and Biochemistry***, 37: 2046-2054.

Estimation and Prediction of Potential Evapotranspiration using Statistical Modelling in Trichy

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Keywords: *Potential evapotranspiration, FAO Penman-Monteith, Modified Penman*

Introduction

The Estimation of Potential evapotranspiration (PET) plays a significant role in the ecological process, hydrologic processes, crop production, and irrigation management. Potential evapotranspiration is the basis of the combination of energy balance and mass transfer methods. Potential evapotranspiration serves as a crucial contributor of moisture back into the atmosphere. By estimating the PET value, we can determine the drought and analyze the climatic variations of soil and ecosystems. It helps the farmers to know the water requirements for irrigation and water losses from the fields.

Methodology

Potential evapotranspiration is to determine the amount of water from the soil surface and the plant surface. It is the combined process of both evaporation and transpiration. The potential evapotranspiration is estimated using these parameters like rainfall, maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity, wind speed, sunshine hours, and extraterrestrial radiation. Weekly Potential evapotranspiration value is to be calculated for Tiruchirapalli in 2019 by six different methods like FAO Penman-Monteith, Modified Penman method, Penman method, Priestley Taylor, Hargreaves Method, and Blaney Criddle (temperature and radiation-based methods) using the MS-XLS.

After estimating the PET value, we have to predict the PET value for 2020 using Multiple linear regression. Multiple linear regression is a statistical technique to model the linear relationship between the dependent and several independent variables. For calculating the MLR, we have to use the dependent variable as an estimated PET value from the different methods and the independent variables like rainfall, maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity, wind speed, and sunshine hours. Further, we have to predict PET for the year 2020 using R software.

Results and Discussion

Estimation of PET:

The PET value was higher in the 17th and 20th weeks because of the influence of the temperature, humidity, and sunlight.

The PET was lower in the 48th and 49th weeks due to the wind speed reduction.

Multiple Linear Regression

The Model 6 shows a good fit for the Trichy meteorological data in 2019. Model 6 has the lowest RMSE and RSE value with the highest correlation coefficient among other methods.

The Model 4 to be the second fit for the Trichy Meteorological data in 2019, which shows the lowest RMSE and RSE value with the highest correlation.

Table1. Estimation of PET using MLR

S.NO	Model Structure	Multiple R^2	Adjusted R^2	RMSE	RSE
1.	Model6=$-5.713+0.317T_{max}-0.1913T_{min}+0.0004RF+0.3063R_a$	0.99	0.99	0.0757	0.0077
2.	Model4= $-4.829+0.044T_{max}+0.043T_{min}+0.012RH_{max}+0.011RH_{min}-0.002WS+0.037SSH+0.0004RF+0.114R_a$	0.97	0.96	0.1281	0.02997

Figure 1. Graphics of Residuals vs Fitted values of Model 6

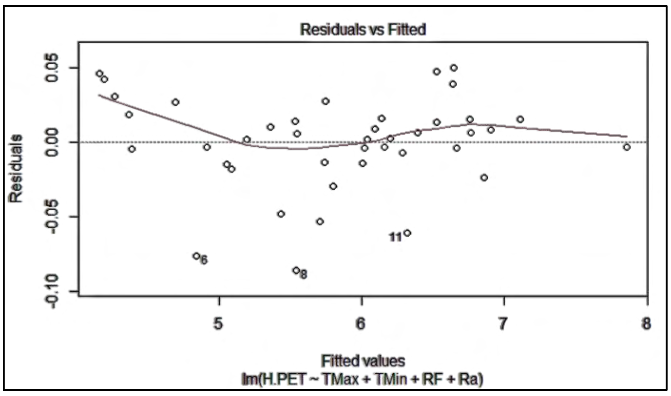
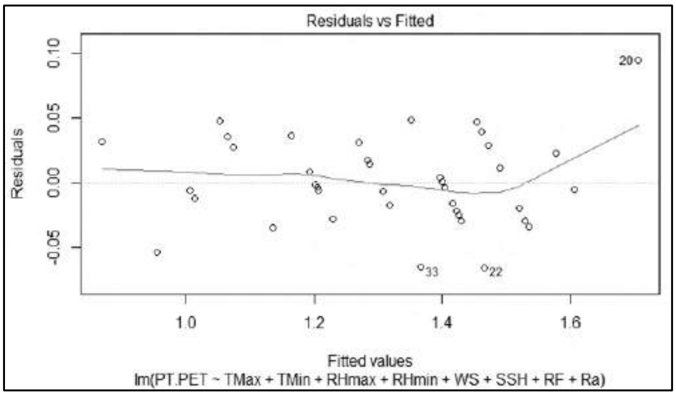


Figure 2. Graphics of Residuals vs Fitted values of Model 4



Reference

Rajasekhar, Siddhardha, M.Anjaneya Prasad, P.Sundar Kumar, Raghavendra and Naresh Kumar, 2015. Comparison of Different Methods for Estimating Potential Evapotranspiration in a Regional Area of Andhra Pradesh. International Journal of Earth Sciences and Engineering, Volume 08, No. 02, P.P.149-152 , ISSN: 0974-5904.

Helder J. F. da Silva, Marconio S. dos Santos, Jório B. Cabral Junior, Maria H. C. Spyrides, 2016. Modeling of reference evapotranspiration by multiple linear regression. Journal of Hyperspectral Remote Sensing, v.6, n.1. 44-58, ISSN:2237-2202.

Saeed Sharafi and Mehdi Mohammadi Ghaleni, 2021. Evaluation of multivariate linear regression for reference evapotranspiration modeling in different climates of Iran. Theoretical and Applied Climatology, 143:1409–1423.

Evaluating the Potential of *Sesuvium Portulacastrum* in Reclamation of Paper and Pulpmill Effluent Irrigated Soils

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Keywords: *Phytoremediation, Halophyte, Paper and pulp mill, Effluent irrigation*

Introduction

Fresh water availability for agriculture is reduced drastically over the decades and it is bound to decrease further due to global warming and other anthropogenic activities. Hence utilization of wastewater as an irrigation source after proper treatment is a viable alternative due to the nutrient content. Tamil Nadu Newsprint and Papers Limited (TNPL), an agro-based pulp and paper industry located at Kagithapuram, discharges 27 cu. m liters of treated papermill effluent every day and is utilized for irrigating 1750 acres of rainfed dryland region called as "Treated Effluent Water Lift Irrigation Society" (TEWLIS) since 1993. Long term application of the effluent has changed the cropping pattern, soil fertility, and land use of TEWLIS area (Iniyalakshimi, 2016). In current scenario, the lack of availability of good quality water for irrigation is challenging to overcome the buildup of salts and increase in soil ESP. The pulp and paper mill effluent contains organic pollutants along with the sodium and other salts. Owing to the above facts, the phytoremediation strategy with a hyper accumulating halophyte, Sesuvium portulacastrum was evaluated to prevent the increase in soil EC and ESP under pulp and paper mill effluent irrigation.

Methodology

The field experiment was conducted on 470 m2 of TEWLIS area with a halophyte 'Sesuvium portulacastrum' as phytoremediant for a period of 90 days. The Sesuvium portulacastrum was laid out as intercrop in the coconut plantation since 93% of study area was dominated by coconut as monocrop or intercrop with fodders. The split plot design was adopted with amendments as main plot treatment and phytoremediant (Sesuvium portulacastrum) as subplot treatment. The field was divided into four splits for imposing main plot treatments. Main plot treatments were Control, gypsum, poultry manure with 0.1% PPFM (Pink pigmented facultative methylotroph) as foliar spray and pressmud compost along with CSR BIO 35 kg ha-1. The impact of crop spacing is not yet evaluated in earlier studies of reclamation using Sesuvium portulacastrum. Hence, sub plot size was fixed at 4 m2 and Sesuvium portulacastrum was planted in two spacings of 10 x 10 cm and 5 x 5 cm. Two sequences of crops (i.e., the S. portulacastrum was cultivated in treatment T2 and T3 after 30 days for first sequence) were cultivated to estimate the impact of phytoremediation.

Results and Discussion

Dry matter production (kg ha-1) and Ion uptake (kg ha-1) by Sesuvium portulacastrum

The DMP ranged from 1568 kg ha-1 (T3A1) to 1900 kg ha-1 (T3A3). The treatment plot T3A3 has yielded high dry matter content (1900 kg ha-1), followed by the treatments T5A4 (1847 kg ha-1) and T3A4 (1822 kg ha-1) (Fig.1). There was increase in biomass and dry matter production and other growth parameters in *Sesuvium portulacastrum* with the application of amendments. The saline-sodic nature of long-term treated effluent irrigated soil favors the growth of halophytes like Sesuvium portulacastrum (Ramasamy et al., 2017). The increased fresh biomass of *S. portulacastrum* might be due to increase in leaf thickness and the accumulation of ions and water in the tissues. The sodium uptake by *S. portulacastrum* were analyzed and salt removal was worked out. The uptake of Cl was highest among the ions (Na, Ca, Mg, Cl and SO4) analyzed. The monovalent nature of chlorine increases its availability in soils with neutral and alkaline pH. The uptake of Na by *S. portulacastrum* ranged from 215 to 226 kg ha-1 at first sequence and from 167 to 250 kg ha-1 at second sequence, respectively. There was 38.89 % higher uptake by *S. portulacastrum* due to application of amendments compared to unamended soil at first sequence, whereas it was 49.7 % at second sequence. This is due to the release of the Ca^{+} ions from the amendments applied that could have repaced the Na^{+} bonded in the soil matrix.

Effect of S. portulacastrum and amendments on soil properties

After second sequence, the EC of the soil ranged from 1.32 (T3A4) to 2.25 dS m-1(T1A1). It indicated there was drastic decrease in EC due to the cultivation of phytoremediant and application of amendments. In the end of second sequence, the exchangeable Ca, Na and ESP ranged from 10.22 (T2A1) to 10.66 (T5A2) Cmol (p+) kg-1)), 1.38 (T3A4) to 2.42 (T1A1) Cmol (p+) kg-1) and 9.00 (T3A4) to 15.09 per cent (T1A1) (Fig. 1). These results were in line with the results of Rabhi et al. (2010a), and they reported 37.0 per cent decrease in soil EC due to desalinization by S. portulacastrum alone. The application of gypsum along with organic amendments as supplement of calcium prevented increase in the soil ESP, which was again encouraged by S. portulacastrum by ion uptake. Based on the results of EC and ESP reduction in soil, it can be confirmed that S. portulacastrum is a high sodium ion accumulating crop and when cultivated with Pressmud compost and CSR-BIO, it could be used to prevent the increase in soil ESP when irrigated with pulp and paper mill effluent.

Reference

Iniyalakshimi , B. R., M. Baskar , P. Balasubramaniam & T. Ramesh. (2016). Response of rice for micronutrients under different amendments in sodic soil. Green Farming, 7 (4), 946-949.

Rabhi, M., Ferchichi, S., Jouini, J., Hamrouni, M. H., Koyro, H.-W., Ranieri, A., Abdelly, C., & Smaoui, A. (2010a). Phytodesalination of a salt-affected soil with the halophyte Sesuvium portulacastrum L. to arrange in advance the requirements for the successful growth of a glycophytic crop. Bioresource technology, 101(17), 6822-6828.

Ramasamy, J., Periasamy, K., & Venugopal, B. (2017). Phytoremediation Potential of Sesuvium Portulacastrum on Remediating. Current World Environment, 13(2).

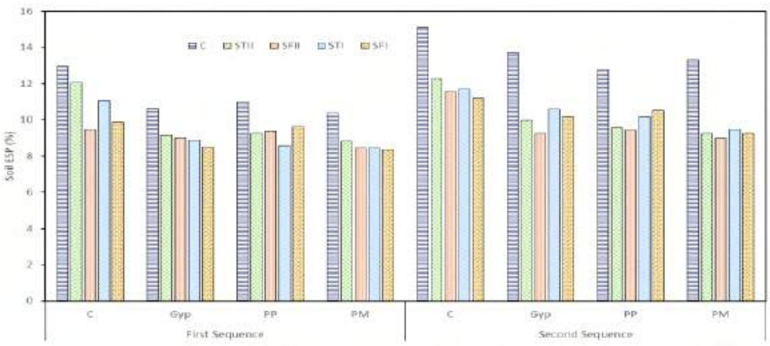

Figure 1. Changes in soil ESP (%) after first and second sequence of *S. portulacastrum*

Farmers' Willingness to Pay for Extension Services-Enhancing Pluralistic Extension Network

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Keywords: *Willingness to pay, Pluralism, Private extension*

Introduction

Pluralism in agricultural extension - the existence of variety of agencies, service providers, models and institutional arrangements (public, private, community based, NGOs etc.) catering to the information, advisory and support service needs of farmers-is a reality in Indian context. The heydays of public extension system are over and in the present day Indian context, extension is a complex web of many actors in agricultural innovation system.

Pluralism slowly rose to prominence and received policy level support to fill up the vacuum created by the public extension. Private extension providers gained more ground with diversification and commercialization of agriculture. With such a transformation, it's important to study the contemporary situation involving farmers and extension personnel. It is essential to know whether the farmers are ready for this transformation and their willingness to move towards a money-oriented system.

Methodology

The study was conducted among the farmers in Pongalur block of Tiruppur district, where the project of Doubling Farmer's income is undertaken. A sample of 60 respondents was selected based on Simple random sampling from four villages namely Ammapalayam, Thottampatti, Kattupalayam, Katturpudur. A semi structured interview schedule was prepared and the respondents were personally interviewed. Statistical tools such as percentage analysis and Binary LOGIT regression were applied for data interpretation.

Results and Discussion

The social characteristics of the farmers were studied, as it would serve as a base for clear and thorough understanding about their status. These variables depict how the farmers were oriented towards the society and their contribution as the member of the society. Further they were interrogated about their willingness to pay for the extension services and regarding the components for which they are willing to pay for. It was found that two-thirds (66.67 %) of the respondents were willing to pay for extension services while one-third (33.33 %) weren't willing to do so.

It is evident that the components regarding choice of seed, disease control, marketing prospects and pest control were the most preferred among farmers who were willing to pay for specific services.

Table. 1 Willingness to pay for extension services

S.No.	Category	Frequency	Percentage
I	Willingness to pay for extension services		
1	Willing	40	66.67
2	Not willing	20	33.33
II	Willingness to pay for different information	Willing (*Multiple responses)	
1	Seed	36	90.00
2	Disease	35	87.50
3	Marketing	31	77.50
4	Pest	30	75.00

Determinants of Farmers' WTP for extension services:

Logit results show that the model 3 was considered as the best fit among the selected models, since the probability of LR Statistics was lesser than one.

Among the selected variables, it was evident that education, income and farming experience had significant effect on farmers' willingness to pay for the extension services. It could be understood from the fact that farmers with better educational exposure and long experience in farming tend to follow diversified farming practices that requires persistent extension support.

Conclusion & Way forward

While global studies are advocating fee based services for enhancing pluralism and extending the scope of extension services, it is important to understand the relevancy of pluralism in Indian context. Findings indicate that farmers have their own preferences that may influence their decision making while their socio personal characteristics such as education, income and experience in farming determine their willingness to pay for the extension services. The best way forward is to allow public extension to lead while private extension can be utilized for backward linkages initially. Role space of each extension service provider needs to be defined and farmers' WTP environment requires a boost, in case of making pluralism a practical probability.

Table 2. Logit results for the Determinants of Farmers' WTP

Variables	ß	Ex(ß)	SE	P
Age				
Gender				
Education	0.256	1.291	0.104	0.014
Income	0.065	1.067	0.02	0.001
Farm Size				
Farming Experience	0.013	1.013	0.007	0.059
Constant	-3.65	0.026	1.156	0.01
LL = -26.80 LR Statistic = 33.61 p> LR = 0.000 Pseudo R^2= 0.385				

Reference

Uddin *et al.* (2014). Crop Farmers' Willingness to Pay for Agricultural Extension Services in Bangladesh: Cases of Selected Villages in Two Important Agro-ecological Zones. Journal of Agricultural Education and Extension

Temesgen, Daniel and Teferi Tola (2015). Determinates of small holder farmers willingness to pay for agricultural extension services: A case study from Eastern Ethiopia. African Journal of Agricultural Research. Vol. 10(20), pp. 2152-2158, 14 May, 2015

V.K. Sajesh, R.N. Padaria and V.V. Sadamate (2018), Pluralism in Agricultural Extension in India: Imperatives and Implications, Vol. 63, No. 4, pp. 1017-1025

Forecast of Drought Using Statistical Approach For Erode District

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Keywords: *Drought Forecasting, SPI, ANFIS, RMSE*

Introduction

Drought plays a crucial role in the field of agriculture especially in farming and also has a major impact on the environment. It leads to huge losses in the agricultural sectors and their related sector. Looking towards the importance of drought, foretokening possible drought will lead to early awareness for the farmers. This study of forecasting of the drought was done based on sustainability in farming.

Methodology

Standardized Precipitation Index (SPI) value is the index to measure the drought occurrence at different time scales. SPI is calculated by dividing the difference between precipitation and mean to standard deviation in a specific duration (McKee et al 1993). Since Tamil Nadu mainly depends on the North- East Monsoon, SPI at a 3-month scale were computed for the district of Erode for 39 years (i.e.) from the year 1981 to 2019 with monthly precipitation value using the command prompt SPI_SL_6.exe file. The computed value was categorized based on the SPI scale. Further for the forecasting of drought, different models are build using the SPI value and precipitation value of its precursory time period as suggested by Bacanli UG et al. (2008). The constructed models are analyzed using the Adaptive Neuro-Fuzzy Inference System (ANFIS) method which is the combination of Artificial Neural Network and Fuzzy logic in the software MATLAB version R2021a. For the analysis of the data, the total dataset was divided into two subsets, namely, Training set data and Testing set data at the percentage of 80 and 20. For this study, Sugeno-Takagi fuzzy inference system is used for the entire analysis. In this study, the grid partition membership function is used.

Results and Discussion

Standardized Precipitation Index value

In Erode among the year from 1981 to 2019,

- Moderately drought occurred in the year 2012.
- Severe drought occurred in the years 1988 and 2009
- Extreme drought occurred in the years 2002 and 2016.

Adaptive Neuro-Fuzzy Inference System (ANFIS)

On comparing the forecasted and the observed value of the twenty different forecasting ANFIS model, the model with the input of a combination of six previous years of SPI, six previous years of Rainfall, and a combination of five previous years of SPI with a single previous year of the rainfall shows the minimum number of changes with the observed scale and also possess the minimum RMSE value.

Table 1: Model Input Structure with their RMSE value

No	Model Structure	RMSE
Model 1	SPI(t-1),SPI(t-2),SPI(t-3),SPI(t-4),SPI(t-5),SPI(t-6)	1.23827x10-5
Model 2	R(t-1),R(t -2),R(t-3),R(t-4),R(t-5),R(t-6)	5.434x10-5
Model 3	SPI(t-1),SPI(t-2),SPI(t-3),SPI(t-4),SPI(t-5)R(t -1)	2.64368x10-5

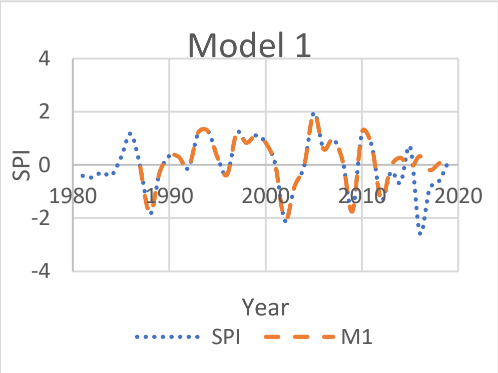

Figure1: Graphical Representation of Model 1

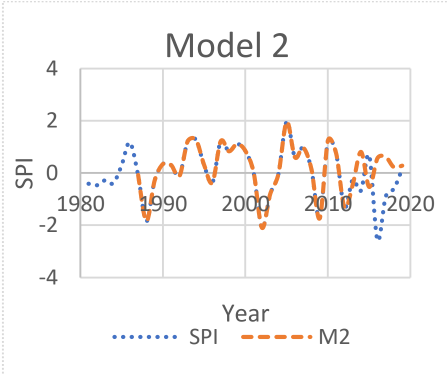

Figure2: Graphical Representation of Model 2

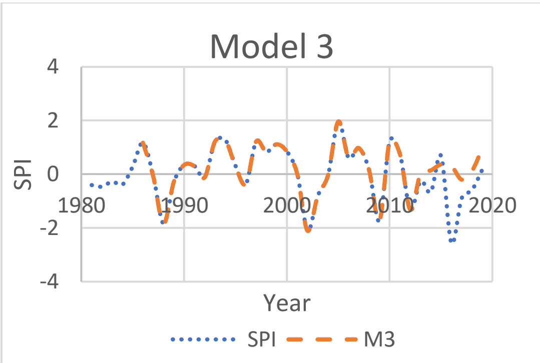

Figure3: Graphical Representation of Model 3

Reference

Anshuka, A., van Ogtrop, F.F. and Vervoort, R.W., 2019. Drought forecasting through statistical models using standardised precipitation index: a systematic review and meta-regression analysis. *Natural Hazards*, 97(2), pp.955-977.

Bacanli, U.G., Firat, M. and Dikbas, F., 2009. Adaptive neuro-fuzzy inference system for drought forecasting. *Stochastic Environmental Research and Risk Assessment*, 23(8), pp.1143-1154.

McKee, T.B., Doesken, N.J. and Kleist, J., 1993, January. The relationship of drought frequency and duration to time scales. In Proceedings of the 8th Conference on Applied Climatology (Vol. 17, No. 22, pp. 179-183).

Mishra, A.K. and Desai, V.R., 2005. Drought forecasting using stochastic models. *Stochastic environmental research and risk assessment*, 19(5), pp.326-339.

Hydrothermal Carbonization of Paper Mill ETP Sludge and Its Potential Applications

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Keywords: *Hydrothermal carbonization, hydrochar, ETP sludge and nutrient dynamics*

Introduction

Hydrothermal carbonization (HTC) is a new process for converting wet biomass into a coal-like substance called hydrochar at relatively low reaction temperatures. The conversion is carried out at temperatures ranging from 180°C to 260°C for half an hour to 10 hours, with feedstocks to water ratio of 1:92 (Oumabady *et al.*, 2020). During the HTC process, pathogens will be destroyed and thermally labile pollutants can be degraded. HTC can convert organic waste / biomass into bio-coal (carbonized material) which its application is found to be diverse and a study was made for utilization of hydrochar as coal and as adsorbents to extract emerging contaminants (Wang *et al.*, 2018). The hydrolysis and dehydration process during the hydrothermal carbonization of biomass leads to the production of oxygenated functional groups thus making it an effective precursor as a chemically activated carbon (Jain *et al.*, 2016).

Methodology

Pulp and paper mill sludge were collected and characterized. Hydrochar was produced from Effluent Treatment Plant sludge (ETP sludge) through hydrothermal carbonization under different temperature and residence time. BET surface area was analyzed for hydrochar samples of different temperatures. The optimization of process parameters was done by Response Surface Methodology (Oumabady *et al.*, 2020). Based on the BET surface area, the best sample was selected and taken for soil application in bhendi crop under different treatments (Control, 1%, 2%,3%, 4%,5%). The soil nutrient dynamics (N, P, K) was also examined.

Results and Discussion

Paper mill ETP sludge, a semi-solid substance derived as a waste from the effluent treatment plants of paper mill. The main composition of paper board mill sludge includes the organic complexes derived as a result of microbial metabolism. These complexes include cellulose, hemicellulose and other derivative materials. The characterization of sludge depicted its potential for its usage because of its carbon content (23.68%). The pH of the paper board mill sludge was neutral with an electrical conductivity of 5.24 dS m^{-1}. The pH of the hydrochar was decreased from 6.49 to 5.63 after hydrothermal carbonization of ETP sludge which depicts slightly acidic nature of hydrochar. This reduction was due to the production of organic acids during hydrothermal carbonization process (Table.1).

The SEM images of paper board mill ETP sludge and its derived hydrochar were taken at a high voltage of 8kV with 10,000 x magnifications and appraised for surface modifications. It was seen that hydrochar has formed a coarser surface as compared to its smooth surface of raw biomass. These rugged surface formations were clearly visible from the micrographs wherein the size reductions of particles (3.806µm to 496nm) were also observed after hydrothermal carbonization. Moreover, the surface of hydrochar exhibits particle dispersions in the form of fluffy sponges and spherically shaped particles with deeper fragmentation.

The FTIR spectra of paper mill sludge and hydrochar depicted a broad band with variable stretching around 3200-3600 cm^{-1} which was due to the presence of cellulose in the paper mill sludge. A rounded tip band at 3260 cm^{-1} corresponded to the OH stretching of phenolic OH groups. The band around 2800 to 3000 cm^{-1} attributed to the vibration of aliphatic methyl groups wherein a centroid at 2920 cm^{-1} represented the vibration of asymmetric C-H stretching thereby indicating the presence of amino acids.

The process temperature and residence time served as important factor for hydrothermal carbonization. The optimization was carried out using different levels of temperature (180, 200, 220, 240, 260 and 280 °C) and time (1,2,3,4, 5,6, 7 and 8 h) with the help of response surface methodology. The optimization mechanism was carried out based on the requirement of target parameters that includes higher surface area, higher pore volume, lower H/C ratio and lower O/C ratio so as to fulfill the predicted energy and surface properties of hydrochar. The optimized temperature and time for the production of hydrochar from paper board mill ETP sludge were obtained as 200°C and 10 h, respectively. The produced hydrochar was utilized for pot culture experiment. The mean germination percentage of bhendi CO4 hybrid was noticed as 80%.

Table 1: Characterization of raw and hydrochar of paper mill ETP sludge

Parameters	Treated ETP sludge	Hydrochar
pH	6.49	5.63
EC (dS m^{-1})	5.24	6.78
Bulk density (gcm^{-3})	0.91	0.82
Particle density(gcm^{-3})	1.54	1.57
Porosity (%)	40.91	37.73
Volatile matter (%)	55.6	49.6
Ash content (%)	32	34.6
Organic carbon (%)	23.68	32.0
Nitrogen (%)	1.89	3.21
Phosphorus (%)	1.58	2.01
Potassium (%)	0.92	1.02
Sulphur (%)	0.86	0.68

Reference

Jain, A, R Balasubramanian, and M Srinivasan. 2016. "Hydrothermal conversion of biomass waste to activated carbon with high porosity: A review." *Chemical Engineering Journal* 283:789-805.

Oumabady, S., Kamaludeen, S. P., Ramasamy, M., Kalaiselvi, P. and Parameswari, E. 2020. Preparation and characterization of optimized Hydrochar from paper Board Mill Sludge. *Scientific reports*, *10*(1), 1-12.

Wang, T, Y Zhai, Y Zhu, C Li and G Zeng. 2018. "A review of the hydrothermal carbonization of biomass waste for hydrochar formation: Process conditions, fundamentals, and physicochemical properties." *Renewable and Sustainable Energy Reviews* 90:223-247.

Impact of Bt Cotton Technology in Indian Cotton Production System: A Comparative Econometric Analysis Between Maharashtra and Tamil Nadu

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Keywords: *Bt Cotton, Productivity, Frontier approach, Technical Efficiency*

Introduction

Cotton the one of the important commercial crop of India, often referred as the White Gold. India has the largest area under cotton cultivation with relatively low productivity primarily due to the large area under rainfed cultivation with inadequate supply of inputs, which implies that the inappropriate use of the resources. By using the inputs accordingly, we can increase the productivity and will influence the global cotton trade with the better quality of cotton. The study measures the technical efficiency of Bt Cotton production of Tamil Nadu in comparison with one of the major cotton producing state, Maharashtra.

Methodology

The present study used the published plot level information from Directorate of Economics and Statistics, New Delhi for both Tamil Nadu and Maharashtra for the year 2002 and 2017. Using the input usage pattern revealed and output, the cost and return were analysed separately for Bt and non-Bt cotton activation for the selected two states suing the plot level production information collected from plot level Cost of Cultivation Scheme data (Directorate of Economics and Statistics, Government of India). The technical efficiency was estimated by stochastic frontier approach using Stata. The technical efficiency evaluated the farm's ability to attain the maximum possible output from a given level of resources. This takes a general form as:

$$Y = f(X)\, e^{(\mu)}$$

where, Y = Output (dependent variable); X = Vector of inputs (independent variables); μ = Error-term. This function in loglinear form would be:

$$\ln Y = \ln a + \sum b_i \ln X_i + \mu$$

Results and Discussion

The efficiency analysis for Bt cotton production is estimated the farm specific Technical Efficiency separately for Tamil Nadu and Maharashtra for the year 2017 in comparison with the year 2002. In Tamil Nadu during 2017, 24 per cent of Bt cotton producing farmers were still less efficient category which implies the need of training in Bt cotton technology. Result exposes that in Tamil Nadu, 41 per cent of farmers were in the more efficient category (>90) and 59 per cent farmers were in 60-90 category during the year 2002. From the table, during the year 2002, 8 per cent farmers were in the more efficient category (>90), 58 per cent farmers were lies between 60-90 category and 34 per cent accounts under less efficient category (<60) in Maharashtra. 90 per cent of Bt cotton farmers falls under 60-90 efficient category in Maharashtra during the year 2017. Frontier efficiency analysis clearly indicated reduction in Mean Technical Efficiency (MTE) i.e., 76 per cent for Tamil Nadu and 79 per cent for Maharashtra, in case of Bt cotton in comparison with non Bt cotton due to lack in adoption of Bt cotton, hence, training may be given to reduce the inefficiency in both the state.

Farm size wise MTE analyses for Bt cotton farms in 2017 were presented in Table 2. The results indicated, most of the marginal and small farmers were still in low efficiency category, and indicated further scope to increase the efficiency. Farm having less efficiency than 60 per cent were getting lower yield than the highly efficient farm. The gap between the highly efficient and less efficient farm is too large in case of Maharashtra and it need to be examined.

Frontier production function analysis has revealed that the efficiency of two-third farmers was more than 60 per cent and hence output of cotton can be increased by improving the technical efficiency of less efficient farms through suitable extension services delivery.

Table 1. Technical Efficiency of Bt and Non-Bt Cotton in Tamil Nadu and Maharashtra during 2002 & 2017

Efficiency categories (%)	Tamil Nadu			Maharashtra		
	2002	2017 Non-Bt	2017 Bt	2002	2017 Non-Bt	2017 Bt
< 60	-	-	17(24)	115(34)	4(16)	27(8)
60 – 90	13(59)	-	34(48)	196(58)	11(44)	292(90)
> 90	9(41)	24(100)	20(28)	28(8)	10(40)	7(2)
Total farmers	22(100)	24(100)	71(100)	339(100)	25(100)	336(100)
Mean TE	**99.6**	**94.2**	**76.2**	**71.90**	**97.3**	**79.06**

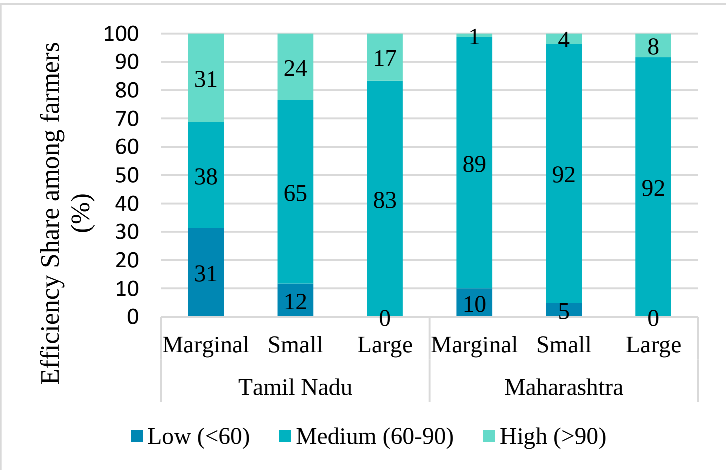

Figure 1. Mean Technical Efficiency share among Bt Cotton farmers of Tamil Nadu & Maharashtra, 2017

Reference

Dominic Tasila Konja, Franklin N. Mabe & Hamdiyah Alhassan. (2019). Technical and resource-use-efficiency among smallholder rice farmers in Northern Ghana. Cogent Food & Agriculture. 5:1, DOI: 10.1080/23311932.2019.1651473.

Prathap, P. M. D. P. (2017). Technical Efficiency of Sugarcane Farms: An Econometric Analysis. Sugar Tech, 19(2), 109–116. DOI: 10.1007/s12355-016-0456-8.

India's Trade Potential and Export Opportunities for Spices

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Keywords: *Comparative Advantage, Spice, Trade, Tariff*

Introduction

Trade is considered one of the most important engines of economic development. Spices have a long history of being highly traded commodity. Developing countries including India are a dominant source which is the leading producer and exporter of spices in the world **(Fig 1.)**. The demand for Indian spices has gone up in United States of America, Vietnam, United Arab Emirates, and United Kingdom etc. The theory of comparative advantage is the cornerstone for measure of welfare gains in trade.

Methodology

This study is based on secondary data consisting of panel data from 2000 to 2019. To estimate the revealed comparative advantage data regarding export, import of major exporting countries of pepper, cardamom and turmeric were extracted from World Integrated Trade Solutions (WITS). The Revealed Comparative Advantage (RCA) index proposed by Balassa (1965) and Revealed Symmetric Comparative Advantage (RSCA) were used in this paper. RCA index express the share of a given commodity in total countries export to world.

$$RCA_{ij} = \left(\frac{X_{ij}}{X_{it}}\right) / \left(\frac{X_{nj}}{X_{nt}}\right)$$

The value of this index ranges from 0 to infinity. The value greater than 1 indicated that the country is comparative advantage in that commodity. The gravity model is from *universal gravitation law* of Newton (1687). The Tinbergen (1962) and Poyhonen (1963) applied the gravity model on trade flow analysis in international trade. T_{ij} states the trade flow between the i and j countries economic size of i[th] country GDP is equal to multiple of their economic size of j[th] country GDP and negatively related to the bilateral distance (D_{ij}).

$$T_{ij} = C\,\frac{(GDP_i GDP_j)}{D_{ij}}$$

The model specification of the gravity model is expressed below which would be estimated in logarithmic function

$$lnT_{ij} = \alpha_0 + \alpha_1 \ln(GDP)_i + \alpha_2 \ln(GDP)_i j + \alpha_3 \ln(DIST)_{ij} + \alpha_4 \ln(EXC)_i$$

Results and Discussion

Revealed Comparative advantage

The results indicate that India is losing its comparative advantage in export of Black Pepper with a gradual decrease in trend. Among the exporting countries Vietnam is comparatively advantage in export of Pepper and countries like Germany, China and Germany has lost its comparative advantage in export as the value of RSCA index is negative (Table 1).

Impact of tariff on Trade

The effect of tariff reduction on imports either by agreement have trade creation and trade diversion effect. With the reduction of tariff by Germany had increased the import by 9.52 thousand USD in India followed by 5.58 thousand USD in Brazil and 1.86 thousand USD in Indonesia. The trade diversion effect was higher than trade creation in all the exporting countries which leads to export of commodity by less efficient countries, and the loss of revenue by reducing tariff was 112.33 thousand USD for Germany (Table 2). The consumers in Germany will have access to commodity at lower prices.

Table 1. Revealed Comparative Advantage and Revealed Symmetric Comparative Advantage (Pepper)

Year		India	Vietnam	Germany	China	Brazil
2015	**RCA**	5.16	35.08	0.47	0.03	8.20
	RSCA	0.67	0.94	-0.35	-0.93	0.78
2016	**RCA**	3.53	39.60	0.53	0.03	6.52
	RSCA	0.55	0.95	-0.29	-0.92	0.73
2017	**RCA**	3.06	35.01	0.57	0.04	8.49
	RSCA	0.50	0.94	-0.26	-0.91	0.78
2018	**RCA**	2.91	31.22	0.60	0.08	8.54
	RSCA	0.48	0.93	-0.24	-0.84	0.79
2019	**RCA**	2.90	29.63	0.52	0.07	9.37
	RSCA	0.48	0.93	-0.31	-0.86	0.80

Table 2. Impact of tariff on trade

Importing country	Exporting country	Trade creation in 1000 USD	Trade diversion in 1000 USD	Revenue effect in 1000 USD	Consumer Surplus in 1000 USD	Export Before in 1000 USD	Export after in 1000 USD
	Indonesia	1.86	6.71			183.26	191.84
Germany	India	9.52	34.14	-112.33	0.219	935.92	979.59
	Brazil	8.58	30.78			843.51	882.88

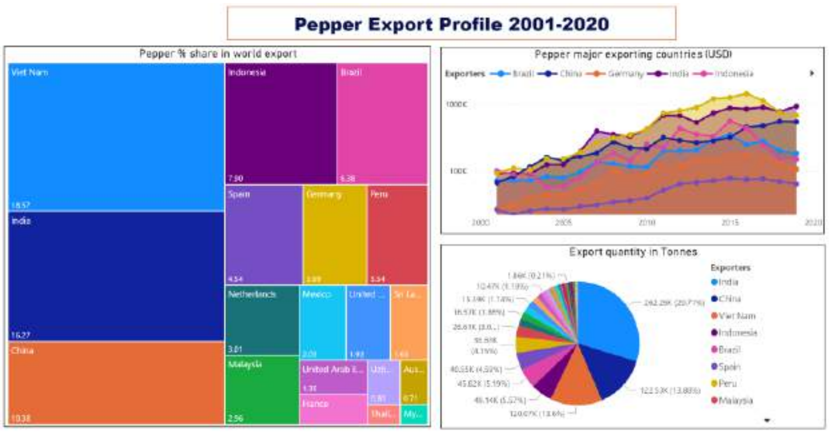

Fig 1. Export Profile of Pepper

Reference

Balassa, B (1965). Trade Liberalization and Revealed Comparative Advantage. *The Manchester Sch. Econ. Soc. Stud.* 33(2): 99-123.3

Tinbergen (1962) Shaping the World Economy: Suggestions for an International Economic Policy. *New York: Twentieth Century Fund.*

Intra-Seasonal and Seasonal Transition Variation of Aerosol Black Carbon Over High Altitude Region of Southern India, Ooty, Tamil Nadu

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Keywords: *Aerosol Black carbon, Winter season, Transition month, diurnal variation, MERRA-2*

Introduction

Aerosols were produced from different natural and man-made activities (Ranjan *et al.*, 2007). Among those aerosols, Aerosol Black carbon which has originated from the incomplete combustion of fossil fuels or biomass, has get significant scientific interest among the scientists because of its unique nature in terms of its fine size, inert chemical character, short atmospheric lifetime, and high solar radiation absorbing potential (Singla *et al.*, 2019). Aerosol Optical Depth (AOD) is an important optical parameter for assessing the impact of aerosols and to understand their characteristics over the atmosphere (Kuniyal *et al.*, 2009). In this paper we present the results for the Black carbon concentration over a high-altitude region over the period of winter and the transition month and their variability in respect with the meteorological parameters.

Methodology

The study site "Ooty" (11.42° N, 76.72° E) located from 2520m AMSL near to the Doddabetta.

Instrumental Measurement

BC mass concentrations were measured by the Seven-Channel Aethalometer which measures attenuation of optical beam at seven different wavelengths (370, 470, 520, 590, 660, 880 and 950 nm), among those wavelengths BC is the chief absorber at 880nm (Udayasooriyan *et al.*, 2014). The empirical formula to calculate the true BC mass concentration (M_{BC}) is

$$M_{BC} = M^{*}_{BC} [P_0 T / P T_0]^{-1}$$

Where, M^{*}_{BC} denoted to the Raw mass concentration of BC measured at ambient condition, P_0 and P are denoted to Standard and Ambient pressure, T_0 and T are denoted to standard and Ambient temperature respectively.

Satellite Retrieval – MERRA-2 Model

The monthly averaged MERRA 2 data was downloaded for the study period (January to March, 2021) at 550 nm wavelength from the MDISC site, GES and DISC.

Results and Discussion

BC Monthly variation

In the winter season (January and February), the BC concentration of the January month was 0.44±0.32 µg m^{-3}, the concentration during the February month was 1.34±0.52 µg m^{-3}, the average BC concentration for the Winter season was 0.89±0.26 µg m^{-3}, whereas the transition March month has recorded higher BC concentration of 1.46±0.62 µg m^{-3}.

BC Diurnal Variation

Black Carbon shows significant variation in diurnal as well as in seasonal wise transition (Fig.1). In entire winter season, the BC concentration has been increased during the forenoon hours (09:00 to 12:00 LT), and the concentration attained the peak during the evening hours (17:00 to 20:00 LT). In the transition month the BC concentration follows the bimodal peak, the concentration reached the peak during the early forenoon hours (09:00 LT) and reach the peak during the night hours (21:00 LT).

Effect of Meteorological parameters on the BC concentration

BC concentration has positively correlated with the temperature at both winter season (R^2 = 0.65) and March month (R^2 = 0.77), meanwhile the Wind speed has positively correlated during the March month (R^2 = 0.74), but it has negatively correlated during the winter season (R^2 = -0.72). The rainfall was negatively correlated with the early winter BC concentration (R^2 = -0.37) (Safai *et al*., 2014).

Aerosol Optical Depth and Black Carbon Concentration

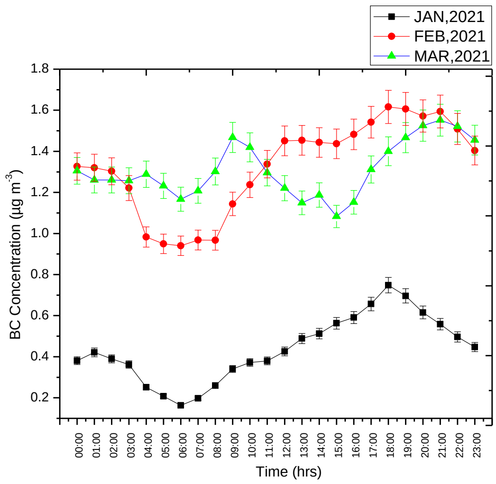

Fig.1. Diurnal Aerosol Black Carbon Variation during Entire study period

The study shows that the BC concentration has increased with the increase in Aerosol Optical Depth which denotes that the Black carbon was one of the possible contributors to the atmospheric aerosols over the study region.

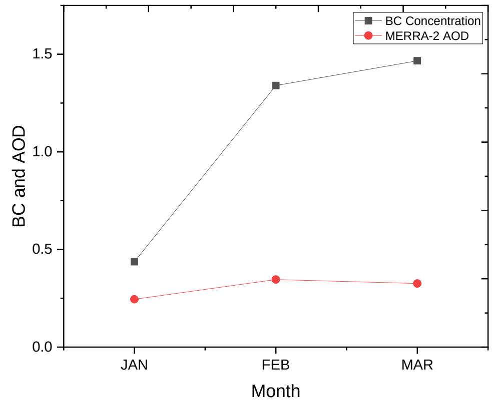

Fig. 2. Comparison of AOD and BC concentration

Reference

Kuniyal, J. C., Thakur, A., Thakur, H. K., Sharma, S., Pant, P., Rawat, P. S and Krishna moorthy, K. (2009). Aerosol optical depths at Mohal-Kullu in the northwestern Indian Himalayan high altitude station during ICARB. *J. Earth Syst. Sci.*, 118(1), 41–48

Ranjan, R. R., Joshi, H. P., & Iyer, K. N. (2007). Spectral variation of total column aerosol optical depth over Rajkot: a tropical semi-arid Indian station. *Aerosol and Air Quality Research*, *7*(1), 33-45.

Safai, P. D., Devara, P. C. S., Raju, M. P., Vijayakumar, K., & Rao, P. S. P. (2014). Relationship between black carbon and associated optical, physical and radiative properties of aerosols over two contrasting environments. *Atmospheric research*, *149*, 292-299.

Singla, V., Mukherjee, S., Kashikar, A. S., Safai, P. D., & Pandithurai, G. (2019). Black carbon: source apportionment and its implications on CCN activity over a rural region in Western Ghats, India. *Environmental Science and Pollution Research*, *26*(7), 7071-7081.

Udayasoorian, C., Jayabalakrishnan, R. M., Suguna, A. R., Gogoi, M. M., & Suresh Babu, S. (2014). Aerosol black carbon characteristics over a high-altitude Western Ghats location in Southern India. *Annales Geophysicae*, 32(10),1361-1371..

Introduction of Bt Cotton and Its Implication on Cotton Production System in India

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Keywords: *Cotton, Growth rate, Bt Technology, Area, Production, Productivity*

Introduction

Cotton is a vital crop for India's long-term economic viability and the livelihood of the country's cotton farmers. India contributes 37.5 percent of global cotton area and 26 percent of global cotton production. The production of Cotton increased as a result of widespread use of related inputs such as fertilizers, insecticides etc. Over time, the benefits of hybrid culture began to fade, and it began to show indications of exhaustion in terms of boosting production. Increased insect attack was one of the main factors. The American Bollworm was the most commercially significant pest that attacked cotton crops. As a result, cultivators used a lot of pesticides, which increased the cost of farming, polluted the environment, harmed human and animal health and so on. Genetically engineered Bt hybrids, which were first developed in 2002, were an environmentally friendly technological solution to this problem. Cotton cultivation grew significantly as a result of these technological developments. In this context, the present study examines the growth in cotton area, production, and productivity in India in relation to Bt technology.

Methodology

The study is based on secondary data. The time series data on area, production, productivity of cotton in India was collected from 1966-67 to 2017-18. The data required for the study was collected from the Department of Agriculture and Cooperation, Ministry of Agriculture and Farmers' Welfare, Government of India, New Delhi. The analysis was done using Stata Software. In order to fulfill the objective, the annual compound growth rate of area, production and productivity were estimated. The growth rates were estimated by fitting exponential type growth function of the form:

$$Y = ab^t e^t$$

Where, Y-Dependent variable for which growth rate is estimated, a- Intercept, b-Regression coefficient, t- Time variable and e-Error term

The above equation is estimated by transforming in to log form as follows:

$$\log Y = \log a + t \log b + \log et$$

Compound annual growth rate (per cent) will be calculated by using the following relationship:

$$r = \{\text{antilog of } (\log b) - 1\} * 100$$

Results and Discussion

To ascertain the growth in area, production and productivity of cotton during pre and post introduction of Bt technology, the area, production and productivity of cotton was estimated for three periods viz., period I (1966-67); period II (1991-92) and period III (2017-18). Table 1 depicts the percent change in the area, production and productivity of cotton from period one to another. It can be observed from the Table 1 that there was decline in area from period I to period II *i.e.,* before introduction of WTO (World Trade Organization) and there is a significant increase in area from period II to period III *i.e.,* after introduction of Bt technology. So, it can be concluded from the Table 1 that there is a significant increase in area, production and productivity of cotton after introduction of Bt technology.

The compound growth rates of area, production and productivity of cotton for Period I, Period II and Period III were estimated for India is presented in Table 2. It is evident from the table that during the period III, the area, production and productivity of cotton in India showed a positive growth of 6.09 per cent per annum, 11.55 per cent per annum and 5.35 per cent annum, respectively.

The present study analyses the growth in area, production and productivity of cotton in India with respect to Bt technology and establishes that the introduction of Bt technology invariably increased the yield. According to the study, in order to achieve significant growth with stability, modern technology should be made affordable and accessible to a wide number of farmers. Currently, the seed requirement for Bt cotton is largely met through private seed production and delivery systems. Therefore, ensuring an efficient seed delivery system would help to meet the surging demand for quality seed.

Table 1: Impact of Bt Technology on Cotton Production System in India (in %)

	1966-67	1991-92	2018-19	change in P2	Change in P3
	P1	P2	P3		
Area (mha)	7.81	7.60	11.63	-2.77	53.09
Production(mt)	5.50	10.32	33.74	87.70	226.78
Yield	119.67	231.00	494.50	93.04	114.07

Table 2: Annual Compound Growth Rate of Area, Production and Productivity of Cotton in India (in %)

Annual compound growth rate*	1966-67 to 1990-91 (Period I)	1991-92 to 2001-02 (Period II)	2002-03 to 2017-18 (Period III)
No of years	25	12	15
Area	-0.38	-4.87	6.09
Production	7.12	-4.32	11.55
Yield	7.27	0.56	5.35

Reference

Manickam, S. Gururajan, K.N. and N. Gopalakrishnan. 2014. Bt Cotton India-Prospects and problems. *Central Institute for Cotton Research, Regional Station, Coimbatore.*

Ramesh, Krishnamurthy, K.N., Naveenkumar, G.S., Narasamma and G. Avinash. 2020. Growth in Area, Production and Productivity of Cotton Crop in Selected Districts of Karnataka, India. *Int. J. Curr. Microbiol. App. Sci.,* 9:689-694.

Suresh, A., Palanisamy, R., Samuel, J. and S. Wankhade. 2013. Impact of technology and policy on growth and instability of agricultural production: The case of Cotton in India. *Ind. J. Agri. Sci.,* 83:939-948.

Measuring Efficiency in Agriculture Sector in India: A Stochastic Frontier Approach

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Keywords: *Stochastic Frontier Approach, Agriculture NSDP, Technical efficiency and inefficiency*

Introduction

In the Indian context, agriculture is of paramount importance. The contribution of Agriculture and allied sector to the national GDP in has increased to 19.9 per cent in 2020-21 from 17.8 per cent in 2019-20. The share of agriculture in gross domestic product (GDP) has almost reached one fifth for the first time in the last 17 years, making it the sole bright spot in GDP performance during 2020-21, according to the Economic Survey 2020-2021. As a result, examining the inefficiency of agricultural production units in India is an important topic for any policy suggestion concerning poverty and hunger in Agricultural sector particularly. In general, inefficiency in the any production system has a number of key consequences, including low output for a given input, under utilization of resources, and an increase in production costs.

Methodology

The agricultural net state domestic product (NSDP) vary by the individual states based on their level and performance in their agricultural production system. In order to address the state specific contribution and their level of inefficiency in agricultural production system, this paper has attempted to estimate the state specific inefficiency in agricultural production using 30 years panel data and examine the performance over years. State specific information on variables such as Share of agriculture NSDP to total NSDP for states, Cropping Intensity, Share of Gross Irrigated Area (GIA) to Gross Cropped Area (GCA), Share of Net Sown Area to Geographical Area, Share of Land put to Non agricultural area to Geographical Area, Total Cereal Productivity, Total Pulse Productivity, Milk Production liter per ha GCA, Total number of Livestock per ha GCA were the major drivers for agricultural NSDP. Data were collected from 1988 to 2017-18 to fit the stochastic panel frontier model to assess the state specific inefficiencies. The information on Sex ratio, Literacy, Population density per sq.km, Number of Commercial bank branches, Number of Persons Below Poverty Line in Rural, Credit to Agriculture, are used to explain the differences in the inefficiency if exist in agricultural production contribution by the state.

The technical efficiency is studied for the specified regions of India with respect to the agricultural sector using time varying Stochastic Frontier Analysis (SFA) with the help of *Battese and Coelli (1995),* Cobb-Douglas production function which is one of the most commonly used production functions.This enables us to simultaneously measure state specific technical inefficiency and to test the impact of a few (selected) state specific characters and exogenous factors on the level of technical inefficiency.

The stochastic frontier production functions to be estimated are:

$$\ln(Y_{it}) = \beta_0 + \beta_1 \ln(X_1) + \beta_2 \ln(X_2) + \beta_3 \ln(X_3) + \beta_4 \ln(X_4) + \beta_5 \ln(X_5) + \beta_6 \ln(X_6) + \beta_7 \ln(X_7) + \beta_8 \ln(X_8) + V_{it} - U_{it} \quad \text{….(1)}$$

where the technical inefficiency effects are assumed to be defined by,

$$U_{it} = \delta_0 + \delta_1 (Z_1) + \delta_2 (Z_2) + \delta_3 (Z_3) + \delta_4 (Z_4) + \delta_5 (Z_5) + \delta_6 (Z_6) \quad \text{….(2)}$$

Xi in model (1) account the drivers of Agricultural NSDP as a measure of performance in last three decades; Zi are factor explain the inefficiency if exist, in model (2)Where ln denotes the natural logarithm (i.e. logarithm to the base e)

Results and Discussion

Time varying SF model results revealed the significant reduction in inefficiency in most of the states. From the below figure, depict that for the past years the agricultural inefficiency has been reduced among all the states in India except Bihar and Himachal Pradesh had increase in Agricultural inefficiency. It shows the good sign of agriculture growth in the country for past decades. The factors contribute to the agricultural inefficiency are Population density and Agricultural credit will reduce the inefficiency level in Agricultural NSDP. Special program to increase Agricultural efficiency in Bihar and Himachal Pradesh can done by rising the Agricultural Credit.

Table.1 Technical inefficiency in Agricultural NSDP State wise in between 1988 and 2017

State	1988	2017
Andhra Pradesh	0.229	0.125
Assam	0.225	0.154
Bihar	0.125	0.190
Gujarat	0.192	0.130
Haryana	0.789	0.111
Himachal Pradesh	0.203	0.264
Jammu & Kashmir	0.539	0.104
Karnataka	0.994	0.135
Kerala	0.818	0.134
Madhya Pradesh	0.146	0.126
Maharashtra	0.197	0.151
North Eastern	0.235	0.116
Odisha	0.864	0.101
Punjab	0.472	0.123
Rajasthan	0.190	0.191
Tamil Nadu	0.814	0.130
Union Territory	0.361	0.179
Uttar Pradesh	0.288	0.124
West Bengal	0.873	0.114
Total	0.766	0.142

Reference

Battese, G. E., & Coelli, T. J. (1995). A model for technical inefficiency effects in a stochastic frontier production function for panel data. *Empirical economics*, *20*(2), 325-332.

Economic Survey 2020-2021

Non Performing Assets in India

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Keywords: *Non-performing assets, scheduled commercial banks, private sector banks, Net non-performing assets, Gross non-performing assets*

Introduction

The Reserve Bank of India has defined 'non-performing asset' (NPA) as a credit facility in respect of which the interest and/ or instalment of principal has remained 'past due' for a specified period of time. The overdue period was framed as 90 days from March 31, 2004 (RBI Report on Prudential Norms on Income Recognition, Asset Classification and Provisioning - Pertaining to Advances). It is essential to study the NPA of India because it affects not only the particular bank but also to the whole economy of the country. The objectives of the study are (i) to analyse the non-performing assets position in scheduled commercial banks in India; (ii) to study the growth of non-performing assets in Indian Banks; (iii) to study the relationship between net profit and net non-performing assets; and (iv) to know the factors contributing to non-performing assets in India.

Methodology

To attain the objective of the study, secondary data has been collected from the publications of Reserve Bank of India and World Bank. Statistical tables related to non-performing assets, lending's of the bank, fiscal deficit, Gross Domestic Product, exchange rate and inflation were collected from the publications. Various statistical tools such as trend analysis, exponential growth rate, correlation and multiple regression (Das and Dey, 2019) has been used to analyse and interpret the data.

Results and Discussion

On comparing the non-performing asset position between different banking sectors for the years 2004 to 2019, public sector bank has highest NPA when compared with the private sector banks and foreign banks in India which is shown in the figure. Among the public sector banks, State Bank of India has the highest NPA of Rs. 1,72,750.36 crores followed by Punjab National Bank which was same as the study conducted by Narula and Singla (2014). In case of private sector banks, NPA is highest in IDBI and ICICI banks.

Exponential growth rate was used to study the growth of non-performing asset of the Indian Banks for the years 2004 to 2019. The growth rate of gross NPA (GNPA), net NPA (NNPA), additions and reductions to NPA were increasing exponentially over the years. All the variables were higher in public sector banks when compared to other banks. Highest concern should be given to public sector banks to reduce the growth rate.

Correlation is used to study the relationship between net profits and net NPA for the years 2004 to 2019. The table shows the significant relationship between the net profit and net NPA. The increasing net NPA reduced the net profit of the public sector banks. There is significant positive relationship between net profit and net NPA for the private sector banks and foreign banks.

Factors contributing the NPA were analysed using multiple regression. Non priority sector lending, GDP and fiscal deficit were significantly influencing the NPA. NPA was negatively influenced by non-priority sector lending, restructuring of loans and fiscal deficit. Priority sector lending, GDP and inflation were positively influencing the NPA in India.

It is concluded from the study that both gross and net NPA is increasing over the years and particularly Net NPA is the serious problem. NPA is higher in Public sector banks especially in SBI. In case of private banks IDBI and ICICI banks are leading. Growth rate of net NPA is higher in public sector banks and private sector banks than foreign banks.

Increase in NPA affects the net profits of the banks. Non priority sector lending, GDP and fiscal deficit are significantly influencing the NPA.

Table.1 Exponential growth rate of Indian Banks (2004 - 2019)

Bank groups	GNPA	NNPA	Additions to NPA	Reductions to NPA
Public sector banks	28.82	32.13	29.40	15.15
Private sector banks	22.13	23.41	27.43	19.11
Foreign banks	16.16	6.89	12.21	6.51

Table.2 Relationship between net profits and net NPA

Bank groups	Correlation
Public sector banks	-0.80**
Private sector banks	0.62**
Foreign banks	0.46*

Table.3 Factors contributing to NPA in India

Particulars	Co-efficient	Standard Error
Constant	-135.2***	36.79
Priority sector lending	0.20	1.13
Non priority sector lending	-1.75	0.57
Restructuring of loans	-0.03	0.06
GDP	5.36***	1.48
Exchange rate	2.60	2.32
Inflation	0.38	0.34
Fiscal deficit	-1.36**	0.53
R^2	0.73	
Adjusted R^2	0.66	

Reference

Das, J. K., & Dey, S. (2019). Factors Contributing to Non-Performing Assets in India: An Empirical Study. *Review of Professional Management*, *16*(2), 62-70.

Narula, S., & Singla, M. (2014). Empirical study on non-performing assets of bank. *International Journal of advance Research in Computer science and management studies*, *2*(1).

RBI report on Prudential Norms on Income Recognition, Asset Classification and Provisioning - Pertaining to Advances. (DBOD No. BP.BC/ 20 /21.04.048 /2001-2002).

Non-Destructive Determination of Ozone Stress Assessment Using Spectral Reflectance in Rice Cultivars

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Keywords: *Rice cultivars, Ozone stress, Ozone injury symptom, Spectral refectance*

Introduction

Tropospheric ozone (O_3) is the most important phytotoxic air pollutant causes extensive risk to food production. Globally, ozone induced stress studies on economically important crops showed its sensitivity in various ways. Generally, foliar ozone injury is used to assess ozone sensitivity in crops which is considered as time consuming method in large assessment. An alternate to this method, studying leaf optical properties which is nondestructive, precise and rapid technique using remote sensing technology has been demonstrated to assess ozone stress in various plant species (Gosselin *et al*. 2020).

Methodology

An experiment was conducted in the wetland of Tamil Nadu Agricultural University, India (11.00° N, 76.92° E) to assess the impact of tropospheric ozone on rice cultivars. The rice cultivars chosen for the study are, TRY(R)2, ADT43, ADT(R)48 and Anna(R)4, which are grown under ambient and elevated ozone condition in Open Top Chambers (OTCs). Ethylene diurea (EDU) was used as protectant. Rice cultivars were exposed to average ozone concentration of 100 ppb from 10.00-17.00 h over 30 days (from 51 days after sowing to 80 days after sowing). A leaf ozone injury percentage (LIP) ranging from 0 to 100 and a modified leaf bronzing score (LBS) ranged from 0 to 10 was assigned to each plant to evaluate leaf visible symptoms. Spectral reflectance values of the rice leaves were measured using portable spectroradiometer (GER 1500) which covers 451 channels ranging from 391.07 – 1093.50 nm with spectral resolution of 1.72 nm. Measurements of the rice leaves from all treatments were taken after thirty days of ozone exposure (80 DAS) and each measurement taken at fully expanded young leaves.

Results and Discussion

Leaf visible symptom

The rice cultivars displayed different levels of leaf injury percentages (LIP) and leaf bronzing score (LBS) under 100 ppb ozone exposure and EDU treatment. The test cultivars, TRY(R)2, ADT43, ADT(R)48 and Anna(R)4 developed brown flecks on the leaf surface during ozone exposure (Table 1).

Spectral measurements

Spectral reflectance values of the rice leaves (under ozone exposure) in sensitive rice cultivar (TRY (R) 2) depicted higher reflectance in visible region (400 to 700 nm) compared to tolerant cultivar (Anna (R) 4), might be due to higher reduction in chlorophyll pigments and lower photosynthetic capacity (Figure 1). Moreover, overall absorption of light in visible region were decreased in TRY (R) 2 might be due to decrease in contents of light-absorbing pigments (chlorophyll 'a' and 'b') compared to tolerant cultivar Anna (R) 4. Similar observations were made by Ghulam *et al*. (2016), who revealed ozone stress induced difference in reflectance pattern of five soybean cultivars were seen in visible region and Peng *et al*. (2017) reported chlorophyll content were more sensitive in spectral range of 400-700 nm with a peak at ~ 550 nm ranges. In present study, the strong correlation was observed in mid-500 nm, mid-750 nm and mid-900 nm spectral regions were highly applicable for broad band satellite based observations (Figure 2). Moreover, these regions are good indicators for photochemical and physiological stress identification studies. Hence, the present experiment on ozone stress detection using spectral reflectance would poses great potential for diagnosing ozone-induced damage and for distinguishing ozone sensitive and tolerant rice cultivars at large scale without destructing the crop.

Table 1. Leaf injury percentage (LIP) and leaf bronzing score (LBS) of rice cultivars exposed to control and elevated ozone condition applied with and without EDU

Particulars	Leaf injury percentage (%)		Leaf bronzing score (nos.)	
	Ozone	Ozone+EDU	Ozone	Ozone+EDU
TRY (R) 2	60.0	47.0	6	5
ADT 43	52.3	43.7	6	5
ADT(R) 48	44.0	35.3	5	4
Anna (R) 4	31.7	24.3	4	3

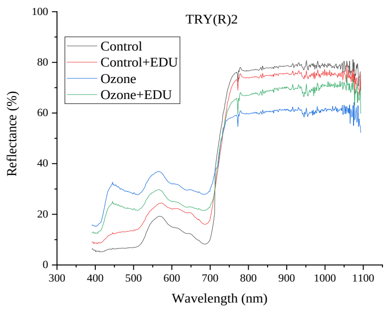

Figure 1. Spectral reflectance of rice cultivar TRY(R)2 exposed to control and elevated

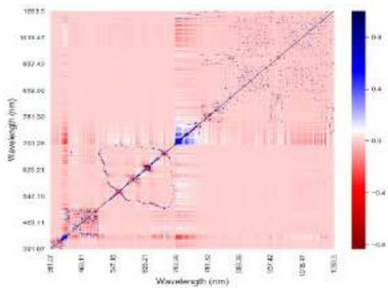

Figure 2. Heatmap of Pearson's correlation coefficient for normalized difference

Reference

Gosselin, N., V. Sagan, M. Maimaitiyiming, J. Fishman, K. Belina, A. Podleski, M. Maimaitijiang, A. Bashir, J. Balakrishna, and A. Dixon. 2020. Using Visual Ozone Damage Scores and Spectroscopy to Quantify Soybean Responses to Background Ozone. *Remote Sensing,* 12 (1):93.

Ghulam, A., J. Fishman, and M. Maimaitiyiming. 2016. Spectral separability analysis of five soybean cultivars with different ozone tolerance using hyperspectral field spectroscopy. IEEE International Geoscience and Remote Sensing Symposium (IGARSS).

Peng, Y., A. Zeng, T. Zhu, S. Fang, Y. Gong, Y. Tao, Y. Zhou, and K. Liu. 2017. Using remotely sensed spectral reflectance to indicate leaf photosynthetic efficiency derived from active fluorescence measurements. *Journal of Applied Remote Sensing,* 11 (2):026034.

Prospects of One District One Product Scheme in Tamil Nadu - An Analysis

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Keywords: *Indigeneous, Craft works, Tamil Nadu, ODOP scheme, Perception*

Introduction

ODOP is a new scheme and its primary focus is developing clusters that would be manufacturing one product identified for the district. The scheme is being implemented through District Industries Centre. This scheme was first implemented in Uttar Pradesh in 2018. Due to this scheme MSME sector forms the backbone of economic progress and development of Uttar Pradesh, because of its contribution to industrial productivity, employment generation, versatile nature, adaptability and contribution in export. Due to the success of this scheme in Uttar Pradesh, Government of India has implemented this scheme all over the states in 2020 which has highlighted in Union budget of 2020. In Tamil Nadu, the products were identified by the district officials based on the higher coverage of the product and finalized by the Directorate of Agriculture, Tamil Nadu.

Methodology

This study mainly focused on the perception of government official towards the One distrct One Product scheme. All the 36 districts in Tamil Nadu were selected. One Agricultural Officer/ Horticulture Officer who involved in the implementation of this scheme were contacted. The questionnaire (google form) has been developed and mailed to the respondents. The total number of responses received were 32 hence the sample size was 32. To study the perception of this scheme, 15 statements were used. The collected data were analysed using statistical tools viz percentage method, mean score to study the perception towards the ODOP scheme.

Results and Discussion

Relationship among cultivated and wild species

The Mean score was calculated by dividing the total scores given by all the respondents to the statement by total number of respondents. Based on the mean score value, the ranking was given. Here the perception indicates the views of the respondents towards this scheme. From the above table, majority of the respondents stated that this scheme would help in transforming the products in an artistically, it can be either through packaging or branding (4.29). Most of the respondents expressed it helps to promote entrepreneurship (4.28) and farmer welfare oriented scheme (4.12). They also revealed that this scheme would improve product quality and skill development would be a result of this scheme (4.07) and increases access for the enterprises, to professional and technical support (4.06). The respondents also stated it is useful in preservation and development of traditional products / local crafts (4.04) and helps in accessing marketing and export facilities (4.03)

Table 1. Perception of government officials towards the One district One Product scheme

S.No	Statements	Mean Score	Rank
1.	It helps in transforming the products to artistically (it can be either through packaging or branding)	4.29	I
2.	It helps to promote entrepreneurship	4.28	II
3.	It is farmer welfare oriented scheme	4.12	III
4.	Improvement in product quality and skill development would be a result of this scheme	4.07	IV
5.	It increases access for the enterprises, to professional and technical support	4.06	V
6.	It is useful in preservation and development of traditional products / local crafts	4.04	VI
7.	It helps in accessing marketing and export facilities	4.03	VII
8.	It aids in increase in local employment	3.96	VIII
9.	It doesn't improve farmers family additional income	3.96	VIII
10.	Supporting the upgradation and formalization of the enterprises	3.71	IX
11.	It would not be more benefit to individual farmers	3.53	X
12.	It results in the decline in migration in search of employment	3.43	XI
13.	It helps to resolve the issues of economic differences along with regional imbalances among states and district	3.34	XII
14.	It helps the farmers to take high risk in adopting new technology in particular product	3.28	XIII
15.	It may leads to monocropping or producing only single product	2.31	XIV

Reference

Lata Bajpai Singh. 2020. ODOP scheme for local craft governance : Chikankari Entrepreneurs perspective. *Global research foundation for corporate governance*, 2 (1).

Suresh Kumar. 2011. An Analysis of Farmers' Perception and Awareness towards Crop Insurance as a Tool for Risk Management in Tamil Nadu. *Agricultural Economics Research Review*, 24(37).

The Indian Express. 2020. Taking a leaf from UP, Centre topush for 'One District-OneProduct' scheme across country by Express News service dated on August 24,2020.

To What Extent Non-Tariff Measures Affect the Exports of Indian Beverages?

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Keywords: *Beverage Exports, Non-Tariff Measures, Export Restrictions, Trade Policy*

Introduction

In recent past, agricultural exports especially plantation crops which are the backbone for economy of the developing economies like India are subjected to a lot of Non -Tariff Measures like Sanitary and Phyto Sanitary measures, Technical Barriers to Trade, Special Safeguard Provisions, Country of Origin etc. Plantation crops have the greater economic importance and play a crucial role in economy of India (Deepika, 2017). In total export of agricultural commodities, 15 per cent are contributed by tea, coffee and rubber. It acts as the livelihood for small, marginal farmers and plantation workers. India is the second largest country in terms of area and production of tea, which contributed 19 per cent and 24 per cent respectively in world level. Liberalization of trade polices under World Trade Organisation (WTO) has adversely affected the plantation commodities like tea, coffee in India coined by Goldar and Bishwanath (2005).

Since the trade liberalisation has led to integration of global commodity markets, the developing countries are much affected by these trade barriers significantly which indirectly hurt the millions of plantation owners, processors and workers. Traditionally, India is well known for its exports of beverages like tea and coffee to USA, EU, Russia, Gulf countries, Japan. Though the tariff on beverages is well within the stipulated WTO guidelines, often the exports from India suffered from Non-Tariff Measures of various sort. Hence, the present research study is attempted to analyse the impact of non-tariff measures on the domestic and export prices of beverages and the loss in revenue to the beverage industry of India under partial equilibrium setting.

Methodology

The data on production, consumption, export, import, supply, tariff and non-tariff barriers, production price, consumption price, export price and international prices of tea and coffee were obtained from their respective commodity boards and also from FAO, UNCTAD and APEDA, WTO, Ministry of Commerce and Industry, GOI, UN-COMTRADE for the year 2016. Coffee and tea commodities were chosen for the current research study and information of elasticities on demand, income, export demand, price are obtained from the earlier literature and studies.

Results and Discussion

Indian Scenario of Beverage Sector

The production of tea has shown an increasing trend from 1267.36 million kgs to 1389.70 million kgs. In the same way, consumption of tea also has shown an increasing trend. In case of coffee, the production and consumption was decreased from 2016 to 2019. The production, consumption and export for Indian beverages are presented in below Table.

Plantation economy is the main stay for most of the developing and emerging economics which are mostly tropical countries vulnerable to production and market risks. Non-tariff measures further aggravate the crisis of these countries to have a proper access to the world markets. The study advocated that the Non-Tariff Measures kindles as well as deters the flow of trade. The developed capital economies are the major importers of these beverages often distorting the global trade in plantation crops which affect the livelihood and the economy adversely. Indian coffee trade is complained about traceability issues and adulteration with powdered coffee husk and Indian tea is rejected mostly due to the misconception of presence of Anthraquinon. But proper trade negotiation with the importing countries, adopting WTO standards and proper awareness about the traceability issues of global order would save millions of rupees to Indian beverages industry.

Table 1. Production, consumption, and export of beverages (million kgs)

Commodity	Year	Production	Consumption	Export
Tea	2019	1389.70	1146.50	243.20
	2018	1338.63	1082.57	256.06
	2017	1321.76	1069.85	251.91
	2016	1267.36	1044.91	222.45
Coffee	2019	313.24	79.48	233.76
	2018	305.07	73.96	231.11
	2017	345.97	82.27	263.70
	2016	369.66	118.24	251.42

Reference

Deepika, M.G. 2017, Export Performance and Factors Affecting Competitiveness of Plantation Commodities in India. Ind. J. of Ag. Eco., 72(4): 587-604.

Goldar and Bishwanath. 2005. Impact on India of Tariff and Quantitative Restrictions under WTO Working Paper No. 172, New Delhi, ICRIER.

Optimization of Process Parameters on Production of Wine from Sapota Fruits

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Keywords: *Sapota, fermentation, optimization, refrigeration, ageing*

Introduction

Sapota is a long lived evergreen tree which belongs to the family *Sapotaceae*. India is the major producer and exporter of sapota fruits and these fruits are susceptible to low temperature and hence cannot be stored in cold storage for a long period due to its high perishability. Fermentation is a potential tool in the development of new products from fruits with modified physicochemical and sensory qualities especially flavor and nutritional components. Fruit wines are fermented alcoholic beverages and known for its impact on health and the most important being the prevention of cardiovascular disease and cancer. In order to reduce the wastage of Sapota fruits, they can be utilized for making wine. Since fermentation is energy less process for value addition, the present study was aimed to optimize the fermentation conditions necessary for production of quality sapota wine for product diversification and to cater the needs of medium scale industries as well as sapota growers.

Methodology

Fully ripened sapota fruits were procured from Orchard at Tamil Nadu Agricultural University, Coimbatore. The ripened fruits were pressed with the help of juice press to obtain clear juice and another lot of fruits was prepared by pulping the juice. Sapota juice and pulp was pasteurized at 72°C for 15 minutes and 82°C for 20 minutes respectively to inactivate the enzymes and micro organism. Five litres of pasteurized sapota juice was added to the sterile fermenter vessel and the juice was inoculated with the starter culture NCIM 3215, 3281, 3304 and natural strain isolated from sapota skin at 5% inoculum level. Fermentation was carried out with a stirrer speed of 100 to 1300 rpm and aeration rate of 1-5 lpm at 28±2°C so that dissolved oxygen can be maintained from 1-20 mg/l. the wine subjected to continuous agitation and aeration leads to oxidation. After 25 days of fermentation, juices obtained from pressed juice was subjected to ageing process for 2 months at room temperature (28±2°C) and refrigerated condition (5±2°C). The physicochemical properties such as alcohol content, total soluble solids, pH, titratable acidity, colour and dissolved oxygen were measured on periodic intervals during fermentation and ageing periods.

Results and Discussion

Physicochemical qualities of Wine

The fermentation process was enhanced by providing aeration (1.5 lpm) and agitation (200 rpm) for 15 minutes initially at a constant temperature of 28±2°C. From the preliminary trials, the NCIM 3304 yeast strain used for wine making recorded higher alcohol content, less acidic, high pH after fermentation. The changes in physiochemical parameters after a fermentation period of 25 days is presented in the table.

From the Table it can be concluded that at the end of fermentation, the wine made from pressed juice contained a pH, TSS, TA, DO and Alcohol content of 3.87, 15.0°brix, 0.306(%), 2.80(mg/l) and 13.2(%v/v), respectively. The effect of ageing on physiochemical characteristics of sapota wine made from pressed juice kept in glass bottles under two storage conditions is presented in the table.

There was a significant change on physiochemical properties due to storage temperature and duration of the ageing process in sapota wine. It can be concluded that, sapota wine prepared from pressed juice using NCIM 3304 yeast strain with a fermentation period of 25 days and ageing period of 60 days at refrigerated condition recorded good physiochemical and organoleptic properties.

Fermentation duration (days)	Pressed juice					Pulped juice				
	pH	TSS (°brix)	TA (%)	DO (mg/l)	Alcohol content (% v/v)	pH	TSS (°brix)	TA (%)	DO (mg/l)	Alcohol content (% v/v)
0 (Initial)	4.35	25.0	0.150	4.72	7.0	4.30	26.5	0.167	5.63	8.0
5	4.18	15.0	0.190	4.10	7.6	4.12	17.4	0.197	4.55	9.0
10	4.03	14.5	0.220	3.75	8.0	3.97	16.3	0.230	4.01	10.1
15	3.94	14.0	0.264	3.20	8.8	3.92	15.7	0.285	3.48	11.2
20	3.92	13.7	0.297	2.96	9.5	3.89	15.4	0.304	3.15	12.5
25	3.89	13.5	0.300	2.55	10.0	3.87	15.0	0.306	2.80	13.2

Parameters	Ageing Duration (days)							
	Room Temperature				Refrigerated temperature			
	0	20	40	60	0	20	40	60
pH	3.89 ± 0.05	3.67 ±0.08	3.47 ±0.07	3.21 ±0.07	3.89±0.06	3.79 ±0.07	3.61 ±0.04	3.43 ± 0.02
TSS (°brix)	13.7 ± 0.17	12.0 ±0.30	10.9 ±0.34	9.4 ±0.03	13.7 ±0.37	12.5 ±0.14	11.3 ±0.13	10.8 ± 0.33
TA (%)	0.35 ± 0.01	0.32 ±0.01	0.29 ±0.01	0.25 ±0.02	0.35 ±0.01	0.34 ±0.01	0.30 ±0.01	0.27 ± 0.01
Alcohol content (% v/v)	13.0 ± 0.36	13.1 ±0.27	13.3 ±0.43	13.5 ±0.16	13.0 ±0.19	13.1 ±0.09	13.2 ±0.25	13.3 ± 0.06
L	18.47 ±0.50	15.23 ±0.30	14.87 ±0.47	13.67 ±0.31	18.47 ±0.37	15.50 ±0.47	14.90 ±0.36	14.0 ± 0.35
A	1.40 ± 0.01	1.56 ±0.01	2.94 ±0.07	3.17 ±0.03	1.40 ±0.02	1.50 ±0.03	2.41 ±0.01	2.98 ± 0.09
B	10.64 ±0.11	7.73 ±0.22	5.47 ±0.01	4.98 ±0.02	10.64 ±0.11	7.91 ±0.02	6.19 ±0.11	5.21 ± 0.08

Reference

Sandeep, K. P., Umesh, C. S., Sunil, K. B., Ramesh, C. R. (2014). Fermentation of sapota (Achras sapota Linn.) fruits to functional wine. Nutrafoods. DOI 10.1007/s13749-014-0034-1

Ramulu, P., and Rao, P.U. (2003). Total, insoluble and soluble dietary fibre contents of Indian fruits. *J Food Comp Anal*. 16:677–685

Inactivation Kinetics and cell damage of *Escherichia coli* (MTCC 433) in Tender coconut water by intense pulsed light

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Keywords: *Inactivation kinetics, cell damage, Escherichia coli (MTCC 433), Tender coconut water*

Introduction

India is one of the leading producers of coconuts in the world producing 14682 Million tonnes of nuts Tender coconut water is the juice in the endosperm of young coconut.The water is one of the nature's most refreshing drinks consumed worldwide for its nutritious and health benefiting properties. Tender coconut water has limited shelf life once it is extracted; it gets attacked with microbes and lost its natural taste and flavor. Heat treatment is the common traditional method of preservation but it effects the nutritional and sensory properties of the drink. Hence in order to obtain both safety and quality of the drink, the non-thermal method of pulsed light could be an alternative method of preserving the tender coconut water.

Methodology

The sterilized tender coconut water was inoculated with *E. coli* of 10^6 to 10^7cfu/ml and treated with batch type intense pulsed light treatment system. Treatment system consist of clear 75mm long transparent quartz Xenon Lamp (Make: Hereus Noblelight Ltd., U.K.) which had a bore diameter of 3 mm. The treatment of 60, 120,180, 240 flashes thus resulting in an overall fluence in the range of 4.8, 9.6, 14.4 and 19.2J/cm^2. The treated samples were covered carefully and transferred to aseptic laminar air flow chamber where they were bottled in glass bottles (100ml). The treated samples were examined for the growth of *Eschericia coli* by the serial-spread plate method using petri flims.

All the microbial counts cfu per g obtained after treatment were log transformed (log10 cfu/ml) . The log transformed data were then fitted for modelling of survival of E.coli MTCC 433 strains using GInaFIT version 1.6 developed by Dr. Annemie Geeraerd at Katholieke Universiteit, Leuven, Belgium (Geeraerd et al., 2005). The log linear plus tail (Geeraerd et al., 2000), Weibull models (Mafarat et al., 2002) and biphasic model (Cerf, 1977) were selected for the study. Morphology of the *E.coli* after intense pulse light treatment was examined using Field Emission Scanning Electron Microscope (FE-SEM, Carl Zeiss microscopy, Ltd, SIGMA, UK).

Results and Discussion

The inactivation data obtained at different fluence rate of 4.8, 9.6, 14.4 and 19.2 J/cm^2 were fitted with Weibull, Biphasic and Log linear plus tail model. The higher fluence of 19.2 J/cm^2 resulted in 5.2 log reduction. These results suggest that the level of inactivation was limited by the absorption of light.
The log linear plus tail model was appropriate for representing survival of *E.coli* in tender coconut water in which estimated parameters showed a significant effect ($p<0.01$). The model showed that survival curve of *E.coli* with tails exhibited a sigmoidal shape with tail. Inactivation rate (K_{max}) of the log linear plus tail is increased as the pulsed light intensities increased and were found as 0.61, 3.37, and 3.42 for tender coconut water at 9.6, 14.4 and 19.6 W/cm^2 (treatment) respectively. If it is desired to reach minimal counts, it is unnecessary to prolong a treatment beyond the indicated dosage because no additional inactivation would be achieved. As the pulsed light intensity increased, residual population density got reduced. The $logN_{res}$ values were calculated as -2.98,-4.28, -4.75 for 9.8, 14.4 and 19.6 W/cm^2 (treatment) respectively by log linear plus model.

Weibull model was applied to the inactivation data by pulsed light treatment in liquid foods. The shape parameter (p) exhibited an $p<1$ at all tested intensities and an upward concavity was observed ($p<0.01$). The scale parameter (δ) represents the dosage for the first decimal reduction and was found as.20, 0.22, 0.26 at different intensities.

The biphasic model was applied to the inactivation data by pulsed light treatment in liquid foods. The 'f' value represents the fraction of pulsed light sensitive population after treatment. This fraction varied from 0.94, 0.99, 0.99 for tender coconut water at different PL intensities. The kinematic parameter K_{max1} was always greater than the K_{max2} indicating higher inactivation rate during first seconds of treatment. The required pulsed light dose to achieve an inactivation of 4 log units was found as 14.4, 5.6 W/cm² in all models. The biphasic model showed best performance with smaller RSME values of 0.1149, 0.0299 & 0.0286 for different intensities of 9.6, 14.4 and 19.6 W/cm² respectively.

The image shows the structural differences between the untreated and treated *E.coli* cells (Fig.1). The pulsed light treated cells lost their membrane integrity which let to flattening out of the cells from the edges. Their results revealed the destruction of cellular structures such as cell wall and cytoplasmic membrane and ultimately cell death. From the images, it was clearly seen that the pulsed light effect was more in tender coconut water since it has 89 per cent of transmittance which allowed the light to pass much deeper.

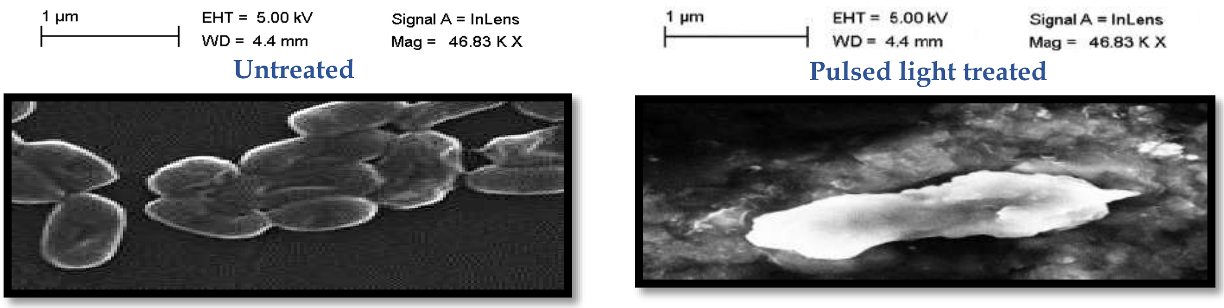

Fig.1 SEM image of pulsed light treated *E.coli* MTCC 433 inoculated in tender cocount water

Reference

Cerf, O. 1977. Tailing of survival curves of bacterial spores. *Journal of Applied Microbiology*. 42: 1–19.

Geeraerd, A.H., V.P. Valdramidis and J.F. Van Impe. 2005. GInaFiT, a freeware tool to assess non-log-linear microbial survivor curves. International Journal of Food Microbiology. 102: 95–105.

Mafarat, P., O. Couvert, S. Gaillard and I. Leguerinel. 2002. On calculating sterility in thermal preservation methods: application of the Weibull frequency distribution model. International Journal of Food Microbiology. 72 (1): 107–112.

Printed @ TNAU Offset Printing Press,
Directorate of Extension Education,
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ISBN 978-93-918450-0-1