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TRIVENI DEVI BHALOTIA COLLEGE

Book of Abstracts-cum-Souvenir

Global Conference on Emerging Agricultural Research to Endure the Predicament of COVID-19 Pandemic (GCEAREPCP-2020)

December 12-13, 2020

Organised By

Agricultural Economics and Social Science Research Association (AESSRA), New Delhi

In collaboration with

IQAC, Triveni Devi Bhalotia College

Kazi Nazrul University

Paschim Barddhaman, West Bengal, India

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Message from the Principal, Triveni Devi Bhalotia College, Raniganj

On behalf of the Organizing Committee and as Patron of the Conference, we warmly welcome you to the Global Conference on "Emerging Agricultural Research to Endure the Predicament of COVID-19 Pandemic" during December 12-13, 2020 at Triveni Devi Bhalotia College, Kazi Nazrul University at Raniganj, Paschim Bardhaman, West Bengal.

With COVID-19 now spreading all over the world, massive consequences to health and livelihoods are feared, and the several governments have imposed lockdown to limit further virus transmission. Given the precarious livelihoods of many people, agriculture, food security, and safety net policy and programme responses are also urgently required. The wonderful thing about the Agricultural Economics and Social Science Research Association (AESSRA), New Delhi to bring all the academicians throughout the globe to these important discussion.

We are looking forward to an excellent conference with great scientists from different countries around the world and sharing new and exciting results in agricultural research to endure the predicament of COVID-19 pandemic.

I wish all the success of the conference.

Asish Kumar Dey

Dr. Asish Kumar Dey
Patron
Global Conference on Emerging Agricultural Research to Endure the Predicament of COVID-19 Pandemic (GCEAREPCP-2020)
December 12-13, 2020

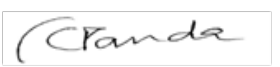
Principal
Triveni Devi Bhalotia College
Raniganj, Paschim Bardhaman

From the Desk of the Organizing Secretary. . .

World is passing through the most challenging hardship ever due to COVID-19 pandemic. All the sectors have faced and are facing a number of constraints in this new normal. According to WTO "*World trade is expected to fall by between 13% and 32% in 2020 as the COVID 19 pandemic disrupts normal economic activity and life around the world*". Agriculture is perhaps the major area which needs to be safe guard to endure food and nutritional security. The truism that food is the most fundamental need requires that farmers and agricultural workers are placed on the same footing as health workers engaged in fighting COVID-19. Equally, global and national food systems should be regarded as on a par with health systems in ensuring that hunger and poor nutrition problems are not allowed to escalate. Agriculture should not be thought in isolation, the whole gamut includes teaching, research, extension and training. All these domains are under new normal and try to cope with the context which is varied as the cases of COVID-19 is increasing alarmingly. This pandemic had hit all the nations irrespective of developed, developing and underdeveloped. However, mostly its effect will be on developing and under developed nations because of their limited economic resiliency. So, it is a big challenge to sustain human civilization under this new normal of COVID-19 pandemic. Under this backdrop such an important Global Conference on *"Global Conference on Emerging Agricultural Research to Endure the Predicament of COVID-19 Pandemic*" is pressed for conglomeration of scientists, experts, researchers, students, NGOs, Civil Society, farmers for their findings, views and opinions.

This global conference is an paramount platform for the scientists, scholar, researchers, planners, policy makers and donor agencies to exchange their findings, views, vision to cope the people in new normal and keeping the sustainable food production system around the world. This Book of Abstracts has vision of scientific community to safe guard the agricultural production system and continuing the path breaking researches in agriculture and allied sectors. Besides the editorial teams, I place on record the valuable contribution of Dr. Asish Banerjee, Minister-in-Charge, Department of Agriculture, Government of West Bengal, India; Prof. Sadhan Chakraborti, Vice-Chancellor, Kazi Nazrul University, Paschim Barddhaman, West Bengal, India; Dr. R.K. Sohane, Director, Extension Education, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India; Dr. Asish Kumar De, Principal, Triveni Devi Bhalotia College; Paschim Barddhaman, West Bengal, India; Prof. Ram Singh, Central Agricultural University, Umiam, Meghalaya, India; Dr. Sarbendu Bikash Dhar, Triveni Devi Bhalotia College, Kazi Nazrul University, Paschim Barddhaman, West Bengal, India; international and national advisory boards members.

I hope this endeavor succeeds in creating milieu for creating wider platform agricultural research in agriculture and allied sectors.



(Chandan Kumar Panda)

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Modelling Release Kinetics and Path Analysis of Soil Phosphorus in Acid Soil Applied with Phosphorus Solubilizers

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Abstract

Application of chemical (citric acid, CA) and microbial (*Bacillus polymyxa*, PB) phosphate solubilizers and lime ($CaCO_3$, LI) in acid soils may enhance phosphorus (P) availability to plants by reducing the fixation of applied P and by unlashing difficultly available fractions of P. Comparative evaluation of these solubilizers in five different combinations (CA, PB, LI, CAPB, PBLI) along with a control (CO) in three contrasting acid soils belonging to Alfisols, Entisols and Inceptisols were conducted for studying the release kinetics of P, Al, Fe and change in different P-fractions in a cylindrical column leached with 0.01*M* $CaCl_2$ solution at 20, 40, 60, 80, 100 and 120 days interval at a constant flow rate (40 ml hr^{-1}). The concentration of P, Al, Fe in soil solution was measured for release kinetics and the soil samples collected after the experiment were analyzed for pH, N, P, K, P-fractions, microbial biomasses (MBC, MBP, RMC), phosphatase (PMEase). Most of the kinetic equations were fitted well in first order kinetics for P, zero order kinetics for Al, and power function for Fe. The maximum released P, Al, and Fe were recorded as 0.6-1.4 mg kg^{-1}, 3.6-11.9 mg kg^{-1}, and 0.22-0.75 mg kg^{-1}, respectively. Maximum released P is mainly influenced by aluminium-P (AlP), calcium-P (CaP) and saloid-P (SaP). Iron-P (FeP) was the dominant fractions in these soils and had significant and positive path coefficient with available P (AvP). All the treated soils showed 3-50%, 3-20%, 1-18%, 1-23% decrease in SaP, AlP, FeP, and CaP (except LI and PBLI) with respect to CO. FeP and AlP had significant and negative correlation with CaP, while SaP had significant and positive correlation with FeP, CaP and AvP. The principal component analysis indicated the dominancy in contribution of FeP to AvP. Individual factor map revealed that the solubilization of P was more influenced by soil type rather than the amounts and distributions of P fractions. Among the solubilizers, the highest PMEase, MBP and RMC was observed in PBLI, while among the soil the highest MBC and RMC was found in Alfisol. Combination of the solubilizers (CAPB and PBLI) was found performing better than individual application (CA, PB and LI) of P solubilizers. Irrespective of soil type, CAPB and PBLI were most suitable for on-farm application.

Efficacy of Zinc Binding Activity of Different Exo-Polysaccharides in Whey and Their Stability Evaluation

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Abstract

Complexing zinc has been reported to enhance its bio-accessibility. Present investigation was undertaken to evaluate the zinc binding ability of two exo-polysaccharides in whey, a dairy by-product. Zinc sulphatehepta-hydrate ($ZnSO_4.7H_2O$) was used as a source of zinc. β-glucan had higher zinc binding capacity than dextran. Addition of exo-polysaccharides resulted into significant ($p<0.05$) changes in instrumental color and viscosity of whey. Zinc complex with β-glucan was subjected to stability evaluation against different pH, salt (NaCl) and spice (cumin and black pepper) concentration, simultaneously. Highest complex stability (72.52%) was obtained at 5.5 pH, 0.5% NaCl and 0.4% spice concentration. Zinc complex stability decreased with increasing salt concentration and decreasing pH. Spices increased the zinc complexing. Among the three treatments, zinc complex stability was mostly affected by pH followed by salt concentration.

Variation of Functional Diversity of Soil Microbial Community in Ramie Based Cropping System

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Extended Abstract

Introduction

Soil microbial community plays a major role in sustaining agroecosystems and maintaining soil health and quality. Soil microorganisms play essential role in soil organic matter dynamics, nutrient cycling and have been used as soil quality indicator. The functional diversity of soil microorganisms provides vital information about the soil biological quality and is ecologically more relevant. Assessment of metabolic reactions performed by the microorganisms is essential for knowing and managing the ecosystems. The response of soil microorganisms to land use is complex and impacts of ramie based cropping system on soil microbes are largely unavailable. Therefore, the study was conducted with the following aims (i) to assess the long term sustainability of ramie cultivation in terms of soil fertility and (ii) to investigate the carbon utilizing pattern of microbial communities associated with ramie based systems and the effects of ramie based cropping systems on functional diversity of soil microbial communities. The Biolog Eco-plate technique and indices, such as average well-colour development (AWCD), McIntosh (U) and Shannon (H) diversity were employed to study the diversity of soil microorganisms.

Materials and Methods

The present study comprised of six treatments *viz*., sole ramie-5 years, sole ramie-10 years, sole ramie-15 years, intercropping with arecanut, intercropping with pine apple and fallow. Alkaline potassium permanganate oxidizable soil N ($KMnO_4$-N) as an index of available N was determined as per the procedure given by Subbiah and Asija (1956). Available phosphorus was determined spectrophotometrically on soil extracted with 0.5 *M* $NaHCO_3$ at pH 8.5 (Olsen *et al* 1954). Available potassium was extracted with neutral 1N ammonium acetate (NH_4OAc-K) (Hanway and Heidel 1952) and estimated by a flame photometer; oxidizable organic C content was determined by wet oxidation method of Walkley and Black (1934). Dehydrogenase activity (DHA) was estimated based on the

reduction of 2-p-iodophenyl-3-p-nitrophenyl-5-triphenyl tetrazolium chloride (TTC) into triphenyl formazan (TPF) and subsequent colorimetric quantification at 485 nm (Tabatabai 1982). Fluores-cein diacetate hydrolytic activity (FDHA) was determined by following the standard procedure of Schnurer and Rosswall (1982) in which released fluorescein was quantified spectrophotometrically at 490 nm. Functional diversity of soil microorganisms was expressed by Shannon Weaver (H) and Mcintosh (U) indices which were derived from absorbance obtained from Biolog Eco-plates. Shannon Weaver index is sensitively affected by species richness of the microbial community while Mcintosh index (U) is one of the measurements of species evenness of the community.

Results and Discussions

The results indicated that sole ramie 15 years proved to be better and sustainable for soil quality point of view having high soil organic carbon (including labile carbon), available nitrogen and high soil enzymatic activities. Profiling of carbon source utilization by microbial communities present in different treatments in ramie soil was generated from Eco-plates. We observed a unique pattern in the utilization of six major carbon groups (carbohydrates, carboxylic, phenolics, amines, amino acids, and polymer) by microbial communities within and between the treatments. Results revealed that phenolic, amines and amino acids consuming microorganisms are dominant irrespective of treatments. During incubation, the capacity of soil microorganisms for using carbon sources was low among all treatments upto 24 hours. Shannon index was greater in sole-ramie (15 years) as compared to fallow.

Conclusions

The present investigation concludes that ramie cultivation improved the soil fertility and soil quality and there was a variation in functional diversity of soil microbial community in ramie based cropping system.

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Agro-Techniques to Moderate Greenhouse Gas Emission from Cropping Systems

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Extended Abstract

Introduction

Greenhouse gases are natural part of the atmosphere. These gases absorb and irradiate the solar radiation and maintain the earth's surface temperature at anoptimum level to support life. Nowadays, their concentrations have been increased substantially (CO_2~35%, CH_4~148% and N_2O~18%) due to anthropogenic activities, which will provoke global warming if we are not looking after to mitigate their emission rate. The major factors responsible for increase in carbon dioxide concentration are fossil fuel burning and land-use changes. However most of the increase in CH_4 and N_2O concentration is supposed to be originated from agricultural activities (IPCC 2007). Traditional crop establishment technique *i.e.* massive puddling followed by transplantation of rice crop (Rao *et al* 2017) is not only water exhaustive but also energy consuming and laborious process. Besides, the indiscriminant use of nitrogenous fertilizer and wetter and denser soil condition with less porosity are mainly responsible for nitrous oxide (N_2O) by escalating the process of denitrification. Therefore, to combat the rising challenge of climate change *viz-a-viz* global warming compelled us to intervene the existing management practices.

Materials and Methods

A field experiment was conducted during 2016-19 at the experimental farm of Bihar Agricultural University, Sabour, Bihar. The experiment was laid out in split plot design, having two tillage operations *i.e.* zero tillage (M_1) and conventional tillage (M_2) as main plot, and four N management treatments in sub plots *viz.*: 100% N through Neem coated urea (N_1), SPAD based N management (N_2), 75% N through urea + 25% N through vermicompost (N_3), ¼ of N as basal and rest in 3 equal split at 20,40 and 60 DAS in rice and wheat and 35,70 and 105 DAS in maize (N_4).The greenhouse gases *i.e.* CH_4, N_2O and CO_2 were collected from the crop field through Pyrex glass gas closed chamber. The Gas samples were analyzed for CH_4, N_2O and CO_2 concentrations by a gas chromatograph.

Results and Discussion

The positive effect was observed in zero tilled based cropping system in reducing greenhouse gases throughout the phonological growth stage of the crops. Total seasonal emission of CH_4, CO_2 and N_2O was lower under zero tilled as compared to conventional tillage (Table 1). The treatment combination of zero tillage with split application of nitrogenous fertilizer emitted lowest CH_4 (41.6 kg ha^{-1}) in *kharif* and (5.5 kg ha^{-1}) in *rabi* season, CO_2 (32.41 kg ha^{-1}) in *kharif* and (134.14 kg ha^{-1}) in *rabi* season although, combination of zero tillage with SPAD based N management produced lowest emission of N_2O (1.4 kg ha^{-1}) in *kharif*and (19.2 kg ha^{-1}) in *rabi* season. Under this relative study, it was interestingly found that the contribution of CH_4 during *kharif* season and N_2O during *rabi* season was maximum to global warming potential. Zero tillage attributed to 15.17% lower global warming potential as compare to conventional tillage. Greenhouse gas intensity was also lowered under the same. Between two cropping system rice- maize cropping system emitted more greenhouse gases than rice-wheat cropping system. Rice- maize system had 39.2% more global warming potential than rice-wheat system.

Table 1: *Seasonal GHGs emission from cropping system influenced by agronomic management practices*

Tillage	Nutrient Management	Total CH_4		Total CO_2 Kg ha^{-1}		Total N_2O		GWP (Kg CO_{2eq} ha^{-1})		
		Kharif	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	**System**
M_1	N_1	48.7	6.98	35.71	166.20	1.83	27.25	1607	8880	10487
	N_2	50.7	5.70	39.09	157.11	1.40	19.20	1562	7670	9232
	N_3	54.5	7.35	46.04	166.93	1.69	23.58	1542	6365	7907
	N_4	41.6	5.50	32.41	134.14	1.47	20.31	1451	6142	7593
M_2	N_1	72.6	6.57	51.48	156.85	2.33	28.72	2296	8393	10689
	N_2	74.4	6.13	55.55	161.24	1.82	19.76	2217	7317	9534
	N_3	77.3	6.92	64.45	175.69	2.15	24.81	2231	6567	8798
	N_4	69.2	5.47	48.40	138.40	1.96	20.96	2202	5993	8195
SEm (±)		0.87	0.16	0.61	1.30	0.02	0.04	17.32	11.62	20.34
CD ($p<0.05$)		2.55	0.47	1.79	3.81	0.05	0.10	50.55	33.92	59.37

M_1: Zero tillage M_2: Conservation tillage; N_1: *100% N through Neem coated urea,* N_2: *SPAD based N management,* N_3: *75% N through urea + 25% N through organic,* N_4: *¼ of N as basal and rest in 3 equal split at 20,40 and 60 DAS in rice and wheat and 35,70 and 105 DAS in maize*

Among the nitrogen management practices split application of nitrogenous fertilizer emitted lower emission of CH_4 and CO_2 however, SPAD based nitrogen management made lower N_2O emission. This is because of that split application of nitrogenous fertilizer had lowest nitrous oxide emission at each stage of crop growth, as application of adequate quantity of nitrogen at right time is one of the most important factors for highest nitrogen use efficiency and lower loss as denitrification. Side by side, SPAD based nitrogen management save 24% of applied N in rice and 27% of applied N in wheat and maize. That also restricts extra

input supply for N_2O emission. Splitting of N-fertilizer reduced the GWP by 22 and 26% as compared to the 100% N through neem coated urea and 75% N through Urea + 25% N through vermicompost, respectively. The split dose of N fertilizer was a lower contributor to global warming potential than other N management practices.

Conclusions

Thus under zero tillage, no disturbance of the soil causes less exposure soil organic matter resulted in lower chance of methane emission as the methane oxidation potential would diminished by repetitive tillage operation. Under aerobic condition non-microbial emission is common from wheat and maize crop. Besides this, conventional tillage increases the porosity of the soil by intensive ploughing which also favors the respiration of aerobic microorganism by recovering movement of water and air within the soil that augment carbon dioxide emission. Therefore, numerous new agronomic practices should be endorsed to reduce the emission of mainly methane, nitrous oxide and carbon dioxide from agricultural system. Thus, rice-maize system under zero tilled condition with ¼ of N as basal and rest in 3 equal split at 35, 70 and 105 DAS was the climate resilient system under lower emission scenarios.

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Long Term Integrated Nutrient Management Improves Soil Health, Carbon Stock and Fruit Yield in a Subtropical Mango (*Mangiferaindica* L.) Orchard

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ABSTRACT

Perennial trees especially fruit trees are considered to be the most competent biological system where atmospheric carbon dioxide is transformed into long lived soil carbon despite their nutritional and exportvalue. Higher carbon stock helps to sustain production and soil ecosystem services. Better crop nutrition promote carbon stock. Feasibility of integrated nutrient management in carbon sequestration needs to be evaluated under subtropical humid condition. Hence, an experiment was carried outin randomized block design to study the feasibility of integrated nutrient management for improving soil properties, nutrient availability, fruit yield and carbon stock in mango (*Mangiferaindica* L.) (cv. Langra) orchard under subtropical condition. Various combinations of integrated (farm yard manure, vermicompost, straw mulch, biofertlisers) nutrient management practices were evaluated in consecutive two year in a thirty years old mango orchard. The results revealed that the organic mulching with straw and conjoint application of farm yard manure and vermicompost improves nutrient availability, microbial activeness (29-44%) and carbon stock (~40%) in soil at 0-60 cm soil depth which ultimately improves fruit yield (26-34%). Hence, adoption of integrated nutrient management practices with though the application of conjoint application of FYM, and vermicompost and organic mulching with straw would uphold the fruit yield and carbon stock insoil and also promote CO_2 sequestration in soil and less greenhouse gas emission, which paved viable economic options to mitigate climate change.

Effect of Long-Term Fertilization and Manuring on Sorption-Desorption Behavior of Zinc

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Abstract

Zinc (Zn) is essential to plantsdue to its role in carbohydrate metabolism, maintenance of cell turgidity, protein synthesis, auxin regulation and pollen formation. The present study was carried out to study the adsorption-desorption behavior of soil Zn as affected by 46 years of continuous application of manures and fertilizers. The surface soil samples (0-15 cm) were collected from seven nutrient management treatments *viz*., control, N alone, NP, NPK, 150% NPK, NPK+Zn and NPK+FYM, of long-term fertilizer experiment (LTFE) maintained at research farm of ICAR-Indian Agricultural research Institute, New Delhi, India under the aegis of All India Coordinated Research Project on LTFE. Results indicated that adsorption of Zn were significantly affected by different nutrient management and followed the order: control >N alone > NP > NPK > 150% NPK >NPK+FYM >NPK+Zn. This adsorption data were well fitted in Langmuir and Freundlich adsorption isotherms. Zinc adsorption maxima and affinity coefficient of Langmuir equation followed the order: control =N alone > NP = NPK > 150% NPK > NPK+FYM = NPK+Zn. Adsorption parameters of Freundlich isotherm showed similar trends. Maximum buffering capacity (MBC) was highest under N alone, with values ~127% higher compared to Zn treated plots. The cumulative desorption of adsorbed Zn was highest under NPK+FYM, whereas control had the lowest value. Desorption index calculated from the exponents of Freundlich isotherms for adsorption and desorption, showed higher values under control followed by N alone treatment, indicating less reversibility of Zn adsorption due to no or imbalanced fertilization. Therefore integrated nutrient management with balanced doses of fertilizers and manures needs to be followed for maintenance/improvement of soil Zn.

Populations of Culturable Microbes in Soils of Different Agro-Ecological Sub-Regions of West Bengal

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Abstract

Soil harbours a very complex, inter-related community of microorganisms which influence physico-chemical properties and *vice-versa*. A deeper understanding of soil microbial population and its structure is necessary to explain agroecosystem functioning. This study was undertaken to enumerate the culturable populations of various agriculturally important microorganisms from the soils of West Bengal. Three agro-ecological sub-regions (AESRs) were considered for this study, namely: AESR 12.3 (Chhotanagpur Plateau), AESR 15.1 (Ganga Eastern Plain) and AESR 18.5 (Eastern Coastal Plain). These AESRs show variation in cropping systems, physiography, climate and environment. Higher bacterial and actinomycetes populations were observed in soils from AESR 15.1, while in AESR 18.5 a higher fungal population was observed. This reflected the general observation that these two regions are more fertile than AESR 12.3, which is predominantly hot and dry. In AESR 12.3 and AESR 15.1, the abundance of actinomycetes in soil was found to be higher than that of fungi, indicating a significant influence of weather on the culturable microbial populations. Diversity indices were used to quantify and compare the populations of various microbial groups like bacteria, fungi and actinomycetes. It was noticed that the Ganga Eastern plain showed the highest Shannon-Wiener index (0.302) while the Chhotanagpur plateau showed the lowest value (0.286). The Eastern coastal plain displayed the highest Simpson's index of diversity (0.373) whereas the Ganga eastern plain showed the lowest value (0.350), indicating varying patterns of species richness and evenness among the three regions. This study reinforces soil microbial populations to be a dynamic property, subject to various environmental factors. We need to embark on more comprehensive studies to investigate how land-use changes and agricultural interventions influence the soil microbiomes.

Mineralogical Analysis, Spatial Variability of Nutrients and Generation of Prediction Map Through Universal Krigging in Banana Growing Soils

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Abstract

Banana is an important fruit crop of India used for both food staple as well as income generation source, grown in the region where water availability is sufficient. However, its production is affected due to low soil fertility, a consequence of continuous nutrient mining by the grown crop. Consideration of ongoing challenges taking into account, the present investigation was planned, and for this, total 52 representative soils samples as well as one profile study was investigated to validated to optimized the production potential and productivity of banana crops. The X-ray diffraction peak have also been observed at different peculiar peak to justify the various mineralogical composition predominate in soil fractions, and results indicated that mica (38%), kaolinite (33%), chlorite (16%) and smectite (13%), respectively were predominate in these soils. Apart from that, spatial variograms indicated that, nugget/sill ratio value were 0.60, 0.37 and 0.34, respectively for major nutrients N, P, K, respectively which was cross-validated through generation of prediction map through the predication maps generated could be used as guide site-specific micronutrient management at precise level in the study region. The spatial distribution of major nutrients was clearly evident that geographical setting shows wide heterogeneity towards estimation of nutrients at field level after imposing the universal kriging method. This technology would be highly beneficial for better understanding the spatial variability of major nutrients, and assessed the potential for refining the agricultural management practices at wider scale.

Climatic Change and its Effect on Saffron Crop in Jammu and Kashmir

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Introduction

In the recent years climate change is one of the major threat faced by the world. In India, the annual mean temperature has risen by 0.56°C over the period from 1901-2009 and the annual mean temperature has been generally above normal (normal based on period, 1961-1990), since 1990 (IMD, 2009). Despite the fact that temperature has been increasing, there were declining trend in *kharif* rainfall by 22 mm during 1969-2005 in India and in the past 100 years, the moderate rainfall and number of wet days had declined (Rupa *et al* 2006). J&K is well known for saffron cultivation in the world and ranked first in global saffron producing area (3715 ha). Although it ranked first in area under saffron, the productivity is very less (1.40 kg/ha) compared to global productivity (5.06 Kg/ha). The present study analyzed the wet and dry period in J&K using Standardize Precipitation Index (SPI) and estimate the effect of drought on yield of saffron.

Materials and Methods

Daily rainfall and temperature data (1975-2019) were extracted from high resolution 0.25°×0.25° and 1°×1° daily gridded data, respectively obtained from India Meteorological Department to study rainfall and temperature variability and to analyze drought situation in J&K. Secondary data on yield of saffron (1990-2018) were collected from State Agriculture Department, J&K to analyze effect of drought on yield of saffron.

SPI was used to analyze wet period and dry period in the study area. There were many indices used by researchers for analyzing drought. Among such indices, SPI is one index which is simple but statistically relevant and meaningful and can analyzed both wet period and dry period using only rainfall data. To estimate the effect of drought on yield of saffron, log-linear regression model was used.

$$\log Y = \log a + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 + \mu$$

Where,

Y = Annual yield of saffron (kg/ha)
x_1 = August rainfall (mm)
x_2 = September rainfall (mm)
x_3 = October rainfall (mm)
x_4 = November rainfall (mm)
μ = Error term

Results and Discussions

In J&K, saffron is grown during the month August to November. During the study period (1075-2019) there were increasing trend in August and September rainfall while there were declining trend in October and November rainfall. The 1-month SPI analysis showed that there were occurrence of extreme wet (2.99%), very wet (4.49%), moderate wet (10.68%), extreme dry (2.56%), very dry (4.27%) and moderate dry (11.75%) during the study period 1975-2019 in J&K. The frequency of total wet and total dry period were 18.16% and 18.58%, respectively and the remaining 78.63% were near normal.

The 6-month SPI compares the rainfall for the period of 6-month over a total period of 6-month included in the historical data and indicates seasonal to medium term trend in rainfall. The 6-month SPI analysis indicated that there were occurrence of extreme wet (21.94%), very wet (45.83%), moderate wet (11.02%), extreme dry (1.94%), very dry (4.97%) and moderate dry (11.23%) during the study period 1975-2019 in J&K. The total wet and total dry period during the study period were 18.79% and 18.14%, respectively and the remaining 78.62% were near normal.

The study showed that rainfall during the month of August (0.29) and October (0.36) had positive correlation with yield of saffron while September (-0.05) and November (-0.08) had negative correlation.

The average annual yield of saffron during the study period was 2.64 kg per ha. The state experienced an annual rainfall of 175.80 mm, 108.18 mm, 30.51 mm and 24.86 mm during August, September, October and November, respectively. The log-linear regression model showed that October rainfall had positive and significant (5% level of significance) effect on yield of saffron which implied that with increase in October rainfall yield of saffron increased. About 29.52 per cent of the variation in the yield of saffron was explained by the variables included in the regression model.

Conclusions

Saffron is the major crop grown in J&K and is sown during August and harvested in November. The state received and annual rainfall of 1172.22 mm during the study period. Over the years (1975-2019) there was increasing trend in August and September rainfall while there was declining trend in October and November rainfall. The drought analysis using SPI showed that the state receive extreme conditions of wet and dry period during the study period and this extremes conditions will have negative effect on yield of saffron. The study showed that October rainfall has significant and positive effect on yield of saffron which indicates that with increase in October rainfall, yield of saffron also increases.

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Crop Productivity, Nutrients Uptake and Soil Properties are Influenced by The Tillage Practices Under Maize Based Cropping Systems

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Extended Abstract

Introduction

Traditional maize cultivation is a tillage intensive practice. It adversely impacts the soil and crop management practices and hence, alternative tillage practice is required to retain long-run sustainability. Conservation agriculture has drawn the attention of researchers to minimize the production cost and other constraints associated with land preparation. Conservation tillage practices (CT) used for conserving resources, soil quality maintenance and farm productivity (Gathala *et al* 2013). Nutrients uptake and soil properties changed due to long-term tillage practices in several cropping systems have been reported by several researchers. Keeping all these facts in mind the present study was designed to study the long-term outcome of tillage practices on crop productivity, nutrients uptake and soil properties under maize based cropping systems in Eastern India.

Materials and Methods

This study was initiated in the project of the continuing Conservation Agriculture experiment on "Resource conservation technologies for stabilizing yield under different cropping system" which was started in *Kharif* 2011 at Sabour. The research was carried out in a split plot design, which contained three main plots of tillage practices *viz*. Zero tillage (ZT), Permanent raised bed (PRB) and Conventional tillage (CT) and in subplots with three cropping sequences: maize-maize (M-M), maize-wheat (M-W) and maize-chickpea (M-C). Maize crop was harvested on 8th crop cycle at maturity and the plant and soil samples were analyzed for nutrient uptake and soil properties.

Results and Discussion

The grain yield was significantly higher in conservational tillage practices (ZT and PRB) over the conventional tillage practice (ZT >PRB > CT) and in case of cropping systems the trend was M-C >M-W >M-M (Figure 1).

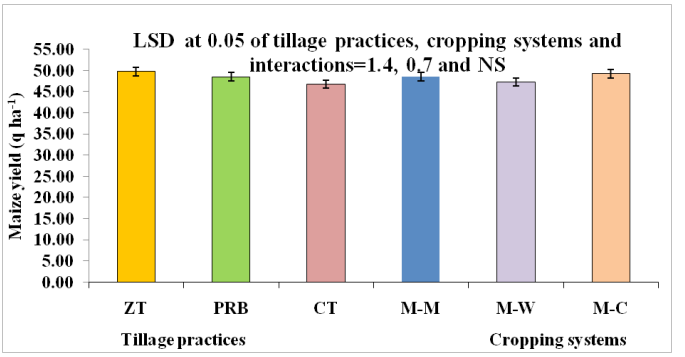

Figure 1: *Effect of tillage practices and cropping systems on maize yield during 8th crop cycle in alluvial soil*

The nutrients (nitrogen, phosphorus and potassium) uptake was found in the similar trends as a yield of maize. Among soil properties, there was a non-significant change in soil reaction and electrical conductivity over the treatments and the initial soil test value but soil organic carbon (SOC) was increased in the treatments over the initial value. SOC was increased by 5.47 % in the ZT over the initial value. Among cropping systems, M-C has shown increased SOC than the other cropping systems. Soil available nitrogen, phosphorus and potassium showed the significant relationship with cropping sequences and tillage systems. The highest nutrients content was found in ZT and the M-C cropping system showing the effect of conservation tillage practices and legume crop rotation.

Conclusions

Conservation tillage practice had shown a positive effect on crop productivity, nutrient uptake and soil properties over the conventional tillage practice. Soil organic carbon and nutrient availability was built up more in zero tillage as compared to other tillage practices resulted better crop growth environment and ultimately sustained maize yield. Among all treatments, ZT with M-C cropping system was found to be the best treatment for improving maize productivity and maintaining as an overall finding.

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Impact of Lignite Coal Derived Humic Substances on Quality and Nutrients Uptake by Spinach (*Spinaciaoleracea* L.) in Inceptisol of Eastern Uttar Pradesh, India

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Abstract

Humic acid (HA), a virtually well-known product of decomposed organic matter that consequently accumulates in ecological systems, that enhances plant growth, yield and nutrient uptake by chelating unavailable nutrients. A pot experiment was carried out in the net house of the Department of Soil Science & Agricultural Chemistry, Banaras Hindu University, Varanasi, Uttar Pradesh during rabi season of 2017-2018, to study the impact of lignite coal derived humic substances on quality and nutrient uptake by spinach (*Spinaciaoleracea* L.) in an inceptisol of eastern Uttar Pradesh, India with six doses of lignite coal originated humic acid [*i.e.* 0.0 (H_0), 0.5 (H_1), 0.75 (H_2), 1.5 (H_3), 2.5 (H_4) and 5.0 (H_5) mg HA kg^{-1} of soil] and four doses of N (urea) fertilizer [0.0 (N_0), 18.50 (N_1), 27.80 (N_2) and 37.0 (N_3) mg kg^{-1} soil] in different combination. The plant yield parameters (*viz.* fresh weight & dry weight), biochemical parameters (*viz.* chlorophyll, protein content and ascorbic acid) and content and uptake of nutrient (N, P & K) in spinach were taken at 30, 45 and 60 days after sowing. The highest values of qualities parameters, nutrients contents and uptake were recorded in the treatment, where higher level (5 mg kg^{-1} soil) of humic acid was applied with full dose of nitrogen (37.0 mg kg^{-1} soil) through urea fertilizer. The application of humic acid with nitrogen fertilizers in soil was noticed to be promising technique in increasing yield, quality and nutrients uptake by spinach.

Determination of Suitable Extractant for Plant Available Micronutrients Under Long-Term Fertility Experiment

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Abstract

Micronutrient deficiency is a widespread phenomenon throughout the world. They are significant important for maintaining soil health and increasing productivity. In India, intensive cropping of high yielding varieties, use of micronutrient free high-analysis fertilizer, coarse texture sandy soil, low soil organic matter content and calcareous nature of some soil cause micronutrients deficiency. Long-term fertility experiments (LTFE) provide unique opportunity to evaluate the influence of different management practices and agro-climatic conditions on extractable micronutrients status in soil. Knowledge regarding depth-wise distribution of extractable cationic micronutrients in soil would help to understand the inherent capacity of the soil to supply these nutrients to the plants, which in turn, may vary with changes in soil type, cropping pattern and management practice imposed. Keeping all these in view the present investigation was carried out to study the depth distribution of extractable micronutrients (Zn, Cu, Fe and Mn) content in soils using four extractants *viz.*, DTPA, AB-DTPA, Mehlich-3 and 0.1*N*HCl and their suitability in relation to the cationic micronutrient concentrations in soils and plant. The soil samples were collected from at 0-0.2, 0.2-0.4 and 0.4-0.6m depths from long-term experiment operating at Sabour, Bihar having the treatments control, 50% NPK, 100% NPK, 50% NPK + 50% N FYM, 50% NPK + 50% N wheat straw, 50% NPK+ 50% N GM and farmer's practice. The available cationic micronutrients content were estimated using four different universally accepted extractants *viz.,* DTPA, AB-DTPA, Mehlich-3 and 0.1*N*HCl. Finally, the relationships between the extractable cationic micronutrient content in soils and their uptake by plants as influenced by different management practices used in this LTFE was established. Result showed that long-term application of organics in the forms of FYM or green manuring or crop residues brought considerable changes in the stock of micronutrients in soil (0-0.6m). The overall extractability of the extractants for Zn, Cu, Fe and Mn followed the order: Mehlich-3 >HCl> AB-DTPA > DTPA. Among all extractants, DTPA was found to be better estimator of plant available micronutrients compared to other three extractants. All these results give clues for improving micronutrient availability in soil and its nutrition of crops under long-term conjoint application of nutrients.

Effect of Pore Size Distribution on Soil Carbon Mineralization Under Conservation Agriculture Practices

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Abstract

Pore size distribution (PSD) regulates soil organic matter (SOM) content in soil pores and impacts SOM turnover in the soil. The PSD have not been studied directly due to paucity of information on 3D structure of the soil pore network. An experiment was conducted in maize-wheat cropping system at Indian Agricultural Research Institute (IARI), New Delhi to study the influence of PSD on soil organic carbon mineralization in two contrasting treatments i.e. conventional tillage (CT) and permanent broad bedalong with crop residue (PBB+R). For 3D visualization of PSD in soil sample X-ray Computed Tomography was used and the carbon mineralization study was done by incubation study for 28 days and carbon dioxide concentration was measured using Gas Chromatography. Soil structural stability (*i.e.* mean weight diameter, MWD) and total organic carbon (TOC) were significantly greater in PBB + R than CT. After the analysis of 3D image of soil core, all the pores were classified into 4 classes *i.e.* Class 1: 60-100 µm; Class 2: 110-500 µm, Class 3: 510-1500 µm and Class 4: >1500 µm. The class wise contribution of pore number in CT was 32, 67, 0.5, 0.1% for Class 1, 2, 3 and 4 respectively, for PBB + R was 64, 35, 0.16 and 0.01 % for Class 1, 2, 3 and 4 respectively at 0-5 cm soil depth similar trend also followed in 5-15 cm depth. In 15-30 cm soil depth pore number contribution in Class 1 was 84% in CT and 81% in PBB + R, in 30-45 cm soil depth also class 1 contribution was more. The depth wise increment in cumulative mineralization (mg/100g) in PPPB + R compared to CT was as follows 86, 105, 117, and 120% for 0-5, 5-15, 15-30 and 30-45 cm soil depth. The rate of carbon mineralization and pore number in different class was correlated and it was seen that class 1,2 and 3 was positively correlated and negatively with class 4. It can be concluded that PBB + R improved the PSD and TOC and MWD in soil.

Effect of Plant Population and Fertility Levels on Performance of Rainfed Pearl Millet

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Extended Abstract

Introduction

Bajra popularly known as Pearl millet, cattail millet or bulrush belongs to the family Graminea. Pearl millet is commonly grown in dryland regions and rainfed conditions. Generally, crops are grown for fodder as well as grain, even as pasture crop, rural poor community used in their food. In India, bajra occupies area of 6.93 million ha with productivity of 1243 kg ha^{-1} during 2019-20. Fast growing short duration pearl millet crop need to uptake more nutrient from the soil as compare to the other course cereal crops. Adequate nutrient cause better growth of parameters like plant height, number of tillers $hill^{-1}$, dry matter accumulation (g m^{-1}) which are responsible for performance of the by accumulation of photosynthates. The optimum population and adequate nutrient availability are essential for good growth of the crop. Generally, under optimum spacing root system zone will always be maximum, and hence, uptake of nutrients will also turn out to be maximum. So, keeping those views in mind, the present study was proposed to find out a suitable optimum population and nutrient level for better growth attributing characters and fodder yield of pearl millet.

Materials and Methods

The conducted during kharif 2018-19 at BAU, Sabour. Under split plot design, three main plots were plant spacing viz. 45 cm x 20 cm, 50 cm x 20 cm and 50 cm x 25 cm and three sub-plots were fertility levels viz. $N_{90}P_{45}K_{45}$ kg ha^{-1}, $N_{120}P_{60}K_{60}$ kg ha^{-1} and $N_{150}P_{75}K_{75}$ kg ha^{-1} were taken into consideration. Fertilizer applied at basal ($1/3^{rd}$ N, full dose of P and K) and remaining nitrogen was applied in two equal splits each at knee high stage and panicle initiation stage. Transplanting was done at first mid fortnight of August with 20 days seedlings of Proagro 9450. Field data of growth parameters and fodder yield were taken. The data were analysed statistically by applying "Analysis of Variance" (ANOVA).

Results and Discussions

It has been observed from two years of experimentation that Plant population didn't have any significant effect on plant height. However, plant population level of 45 cm x 20 cm performed better in plant height of 88.42 cm, 202.57cm and 234.07cm of pearl millet as compare to other plant spacing at 30 DAT, 60 DAT and at harvest respectively (Table 1). Among various growth attributing characters M1 (45 cm x 20 cm) was significantly superior for dry matter accumulation (248.2g m^{-2},954.32g m^{-2} and 1238.86g m^{-2}) among other plant population levels at 30 DAT, 60 DAT and at harvest respectively (Table 2). The interaction effect of plant population and fertility levels on dry matter accumulation at harvest was found to be significant (Table 3). The maximum dry matter accumulation at harvest was 1281.43g m^{-2} with the treatment combination of M1S3, hence; it was statistically comparable with M_1S_2 with the value of 1251.40g m^{-2}. In regards to fodder yield, M_1 (45 cm x 20 cm) was significantly superior for green fodder yield and dry fodder yield (green fodder yield was 295.32 q ha^{-1}, dry fodder yield was 68.43q ha^{-1}) over M_3 (50 cm x 25 cm) (Table 4). Mainly, wider plant spacing would not be beneficial for crop cultivation due to higher amount of unutilized nutrient was remained in the soil. Increase the availability and absorption of nutrients from the soil which enhance metabolic activity, translocation and synthesis of nutrients resulted in higher crop growth and yield (Singh *et al*. 2017).

Further, S3 (N150P75K75 kg ha^{-1}) was significantly higher for all growth parameters such as plant height and dry matter accumulation. The maximum plant height 91.63 cm, 210.83 cm and 236.14cm was obtained at 30 DAT, 60 DAT and at harvest respectively under S3 treatment (table 1). The maximum dry matter accumulation at 30 DAT, 60 DAT and at harvest were 235.10 g m^{-2}, 872.68g m^{-2} and 1177.30 g m^{-2} respectively under fertility levels of $N_{150}P_{75}K_{75}$ kg ha^{-1}. Besides growth parameters, green fodder yield and dry fodder yield were significantly higher under S3 ($N_{150}P_{75}K_{75}$ kg ha^{-1}) although, that were statistically comparable with S2 ($N_{120}P_{60}K_{60}$kgha^{-1}). Basically, good growth of the crop due to effective utilization and absorption of nutrients through extensive root system developed by the crop with application of adequate nutrient supply through optimum inorganic fertilization (Chandana *et al.* 2018).

Conclusions

Based on this research, it can be summarized that spacing of 45 cm x 20 cm among all plant population levels and $N_{150}P_{75}K_{75}$ kg ha^{-1} among other fertility levels was the superior one in respect to all growth parameters as well as fodder yield of the plant. From the experimental findings, it can also be concluded that optimum plant population attributed to maintain intra-species competition which aids in proper utilization of space, light, nutrition and moisture. Wider plant spacing would not be beneficial for pearl millet cultivation due to higher amount of unutilized nutrient was remained in the soil. Therefore, pearl millet would be transplanted at 45 cm x 20 cm spacing with the fertilizer dose of $N_{150}P_{75}K_{75}$ kg ha^{-1} to get maximum growth and fodder yield under rainfed condition.

Table 1: *Effect of plant population and fertility levels on plant height (cm) of pearl millet*

Treatments	30 DAT (cm)	60 DAT (cm)	At harvest (cm)
Plant population			
M1 (45 cm x 20 cm)	88.42	202.57	234.07
M2 (50 cm x 20 cm)	87.81	201.83	231.24
M3 (50 cm x 25 cm)	87.42	200.82	230.02
SEm±	0.31	0.40	0.83
CD (P=0.05)	NS	NS	NS
Fertility level (kg N: P_2O_5: K_2O ha^{-1})			
S1 ($N_{90}P_{45}K_{45}$)	85.04	192.68	227.46
S2 ($N_{120}P_{60}K_{60}$)	86.97	201.71	231.73
S3 ($N_{150}P_{75}K_{75}$)	91.63	210.83	236.14
SEm ±	0.27	0.58	0.53
CD (P=0.05)	0.82	1.78	1.63
Interaction M x S	NS	NS	NS

Table 2: *Effect of plant population and fertility levels on dry matter accumulation (g m^{-2}) of pearl millet*

Treatments	30 DAT (g m^{-2})	60 DAT (g m^{-2})	At harvest (g m^{-2})
Plant population			
M1 (45 cm x 20 cm)	248.28	954.32	1238.86
M2 (50 cm x 20 cm)	219.41	847.80	1142.81
M3 (50 cm x 25 cm)	197.36	749.21	1042.48
SEm±	1.29	2.61	3.62
CD (P=0.05)	5.08	10.25	14.20
Fertility level (kg N: P_2O_5: K_2O ha^{-1})			
S1 ($N_{90}P_{45}K_{45}$)	210.78	825.68	1098.39
S2 ($N_{120}P_{60}K_{60}$)	219.17	852.98	1148.46
S3 ($N_{150}P_{75}K_{75}$)	235.10	872.68	1177.30
SEm ±	2.24	2.37	4.75
CD (P=0.05)	6.91	7.31	14.63
Interaction M x S	NS	NS	S

Table 3: *Interaction effect of plant population and fertility levels on dry matter accumulation (g m^{-2}) at harvest*

Treatments	S_1 ($N_{90}P_{45}K_{45}$) g m^{-2}	S_2 ($N_{120}P_{60}K_{60}$)	S_3($N_{150}P_{75}K_{75}$)	Mean
M1 (45 cm x 20 cm)	1183.73	1251.40	1281.43	1238.86
M2 (50 cm x 20 cm)	1119.57	1144.50	1164.37	1142.81
M3 (50 cm x 25 cm)	991.87	1049.47	1086.10	1042.48
Mean (g m^{-2})	1098.39	1148.46	1177.30	
	M x S			
SEm (±)	7.63			
C.D at 5%	23.50			

Table 4: *Effect of plant population and fertility levels on green fodder yield and dry fodder yield of pearl millet*

Treatments	Green Fodder Yield (q ha^{-1})	Dry Fodder Yield (q ha^{-1})
Plant population		
M1 (45 cm x 20 cm)	295.32	68.43
M2 (50 cm x 20 cm)	294.84	66.32
M3 (50 cm x 25 cm)	289.06	61.78
SEm±	2.07	0.27
CD (P=0.05)	6.12	0.84
Fertility level (kg N: P_2O_5: K_2O ha^{-1})		
S1 ($N_{90}P_{45}K_{45}$)	285.81	62.26
S2 ($N_{120}P_{60}K_{60}$)	293.87	67.29
S3 ($N_{150}P_{75}K_{75}$)	296.55	70.31
SEm ±	2.16	0.22
CD (P=0.05)	6.33	0.79
Interaction M x S	NS	NS

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Track 02
Horticulture for Nutrition and Self-Reliance

Role of Mycorrhizal Fungi in Sustainable Horticultural Production Under Abiotic and Biotic Stress Situations

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Abstract

Soil harbours several symbionts and free-living beneficial microbes apart from different flora and fauna. Mycorrhizae, arbuscular mycorrhizal fungi (AMF) represent symbiotic association between plant roots and certain soil fungi of order Glomales. This symbiotic association plays a major role in nutrient and moisture management under varied ecosystems and also has the major role in inducing protection against environmental and biotic stresses. Today it is well known that about 80% of the plant species existing on Earth are colonized by mycorrhizae, hence their proper use can boost the production even in marginal, depleted or degraded soils and thus assist in mitigating the harmful effects of different biotic and abiotic stresses. It is well known that abiotic and biotic stresses hamper plant growth and productivity. Even agricultural malpractices like excessive use of fertilizers and pesticides have aggravated the effects of abiotic stresses on crop productivity and degraded the ecosystem. There is an urgent need for environment-friendly management techniques such as the use of arbuscular mycorrhizal fungi (AMF) for enhancing crop productivity. It is now proven that AMF biotechnology is wedded with horticultural crops right from transplant stage in plug plant production in several horticultural/ forestry nurseries. Mycorrhizal symbiosis is also known for affecting plant growth and health (as bio-fertilizers & bio-protectors). Mycorrhization has shown effective results in plants for mitigating different types of stresses. AMF provides tolerance to host plants against various stressful situations like heat, salinity, drought, metals, and extreme temperatures. AMF may both assist host plants in the up-regulation of tolerance mechanisms and prevent the down-regulation of key metabolic pathways. AMF-mediated promotion of crop quality and enhanced productivity has been achieved in eco-friendly safe production strategies in different horticultural plants is needed. With rapid molecular and biotechnological gains, AMF symbiosis has become more advanced not for their taxonomic studies besides beneficial effects on plant where different gene(s) responsible for successful harnessing of such as host-bioagent association can be better understood under soil microbiome situations.

Entrepreneurial Opportunities Through Value Addition in Horticultural Crops

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Entrepreneurial opportunities are usually defined as situations where products and services can be sold at a price greater than the cost of their production. Post harvest technology of horticultural crops presents several avenues to take up entrepreneurship activities. The following write-up throws light on a few of the plentiful opportunities.

(1) Artificial Ripening of Fruits

Ripening of fruits is an important part of post-harvest processing. Artificial fruit ripening is a complex issue, especially for the developing countries, where farmers apply unregulated artificial ripening techniques to satisfy local and international demand. The use of calcium carbide has several negative effects. Although the cosmetic appearance of the fruits improve, they become overly soft, inferior in taste, have a shortened shelf life and most importantly have toxic effects on human health. Calcium carbide has been banned for artificial ripening under the PFA Rules, 1955 and the Food Safety and Standards (Prohibition and Restriction on Sales) Regulations, 2011. Developed countries have proper guidelines for the use of ethylene as ripening agent. These standards can be adopted by other countries or can be used to set up an international standard under the framework of WHO/FAO.

Low cost ripening chamber

Ethylene generator

Ethylene tin

Artificial ripening is done to hasten the process and produce more uniform ripening characteristics. Ethylene gas can be used to artificially ripen mangoes and bananas without any of the harmful effects of calcium carbide. It is also permitted by the Government. However, this requires enhanced infrastructure in the form of ripening chambers and the requisite skills for operating them. There are about 21 large scale ripening chambers

in India. Low cost ripening structures with ethylene generator or ethylene tin may be employed by small entrepreneurs.

(2) Onion storage as an entrepreneurship

Onion is important constituent of our daily diet and its demand remains same round the year. Thus a considerable quantity of onion is stored to fulfill the domestic and export demand during the lean season. Non-availability of storage facilities at farm level forces farmers to sell their produce immediately after the harvest to save further deterioration during rains. In return, they get the most depressed prices and the middlemen in the trade get the advantage of volatility of prices of this essential commodity.

Seasonality of onion production introduces volatility in its prices and often leads to major consumer resentment, when it goes up farmers will be in profit and proves disastrous for farmers when price crashes due to over-production. Onion, with appropriate scientific storage, can be stored for up to six months. The total storage losses are comprised of physiological loss in weight (PLW) i.e. moisture loss and shrinkage (30-40%), rotting (20-30%) and sprouting (20-40%). The PLW can be minimized by harvesting at right time, proper curing of onion bulbs and subsequent storage at desired temperature and humidity conditions.

Conventional storage structure

Improved (scientific) storage structure

Storage

For onion storage, technology may be either with natural ventilation or with forced ventilation. Although cold storage systems are used in certain countries for onion, this is normally not adopted in many developing countries. But building up of the cold storage unit would minimize the waste up to the level of 3 to 4% that would in turn help the onion growers, and stabilize onion prices in market for all types of consumers. Onion storage in ventilation condition is quite satisfactory when the temperature is maintained between 25^{o}C to 30^{o}C with a relative humidity range of 65% to 70%. This environment reduces the storage losses, which are in the form of physiological loss in weight, rotting and sprouting.

Onions are stored either loose or in bags. It is advised to sort the onions prior to storage and thereafter at least once in thirty days to take out the rotten/ infected onions in order to avoid further spread of diseases/ losses. Generally, a loss of about 20-30 % is there during

a storage season in the form of weight loss of onions which can be controlled with proper care. However, the other types of losses can be controlled to a greater extent if the structure is designed to facilitate maximum natural ventilation through the stored onion and sorting is done at regular intervals.

In Hiware Bazaar village in Ahmednagar district of Maharashtra more than 40 farmers have erected onion storage structures having capacity of 25 MT each. Together, these farmers stored over 1100 MT Rabi onion and released their stock in the market during August, 2010 fetching a price of ₹800 per quintal as against ₹400-500 prevalent after the harvest in May, 2010. With onion cultivation turning profitable for the farmers of Hiware Bazaar, reverse migration has started. Farmers now find their agriculture lands providing better living to them compared to doing manual labour in Mumbai.

Role of Entrepreneur in onion storage

Storage of onions could be an entrepreneurship activity to take advantage of storage problems with the farmers. An entrepreneur can erect the storage structures (ventilated/ cold storage) offering them for use by the farmers on rental basis. Facilities should be created to avoid distress sale so that the same can be sold after 4 months of storage which may fetch higher return which will strengthen the economic condition of the farmers as well as habituate them for grading, drying, sorting and storage in racking system of onion storage structure. Alternatively, an entrepreneur may buy onion produce from the growers and hoard them for some time after harvest and release periodically to the market. Taking up onion storage as an entrepreneurship will benefit both consumers and farmers.

(3) Fresh produce handling

Fruits and vegetables are produced seasonally, but the market requires products throughout the year. Once harvested, it is very difficult to keep fruits and vegetables fresh. As technology is improved and consumer incomes are increased, it became possible to provide fresh produce year-round. In this regard, supermarkets are major suppliers of fresh fruits and vegetables. Supermarkets have been spreading very rapidly in developing countries for the past decade. Bringing fruits and vegetables to market requires special handling. In order to preserve quality and maintain marketability, each crop must be harvested, prepared for market, packaged, and shipped in a definite way. Entrepreneurs may need to have contract with the large number of growers to ensure the availability of fresh fruits and vegetables. To secure high quality, the entrepreneur need to directly source fresh produce from farmers through collection centers. With this concept, one can build a business model generating shared value that links the company supply chain more closely to poor farmers in India or other developing countries. In this way, the entrepreneur may be able to provide a guaranteed market for the farmers' produce, reducing transaction costs and training the farmers in better and sustainable farming practices.

Existing fresh produce handling units in India: ITC' Choupal Fresh, Heritage's Fresh@, ABRL's More, RPG's Spencer's Retail, Reliance Fresh's Ranger Farms, Big Bazar, Namdhari Fresh, Big basket and Metro.

(4) Minimal processing

Fresh-cut products are fruits or vegetables that have been trimmed, peeled and/or cut into a fully usable product. It is subsequently packaged to offer consumers a high nutrition, convenience and flavour while maintaining freshness. The market for chilled fresh-cut produce has witnessed dramatic growth in recent years, stimulated largely by consumer demand for fresh, healthy, convenient and additive-free foods which are safe and nutritious. The food industry has responded to this demand with creative product development, new production practices, innovative use of technology and skillful marketing initiatives.

Fresh-cut produce is sold in open-air markets and food stands in many Asian countries and is increasingly being sold in supermarkets. Fresh-cut fruits, in particular, have gained popularity in urban centres. The production of traditional dishes in most developing countries necessitates a variety of fresh ingredients. The drudgery of peeling vegetables, shelling peas and trimming herbs and vegetables, and then combining these ingredients, often deters the busy housewife from preparing these traditional foods. Similarly the difficulty of peeling fruits such as pineapple, pomegranate, jackfruit and sometimes their large size discourage the consumer from purchasing them. Fresh-cut processing addresses all of these issues by making products available in a convenient, easy-to-use format with minimal waste. Packs of fresh-cut fruits and vegetables are increasingly being prepared by cottage industry suppliers in many developing countries and are being sold in markets in response to consumer demand for produce in a ready-to-use format.

Cottage industries and small vendors are still the major supplier of fresh-cut fruits and vegetables in most developing countries. Food caterers often supply fresh-cut fruit packs for school feeding programmes. Supermarkets in most developing countries produce fresh-cut fruits and non-leafy fresh-cut vegetables on site to meet consumer demand. Bagged leafy vegetables are supplied primarily by small enterprises engaged in fresh-cut production. Growth in the fast food sector and in the food service industry of many developing countries has also increased market opportunities for many small producers of fresh-cuts. Developed countries are constantly looking for innovative products, providing potential for tropical fresh-cut fruits and vegetables to fill a gap. Food products offering new colours, flavours and textures, if creatively packaged, would be welcome additions to the fresh-cut industry in developed countries.

Equally profitable would be the sale of fresh-cut tropical fruits and vegetables in the urban centres of developing countries. The convenience of preparing traditional meals from locally-grown ingredients would preserve culinary traditions, promote the consumption of local produce and allow consumers to eat the foods they enjoy. As the fresh-cut fruit and vegetable industry has been so profitable in developed countries, it is anticipated that the same level of growth would take place in urban centres of developing countries enjoying income growth, whose citizens have less time for meal preparation.

Fresh cut mixed vegetables

Fresh cut mixed fruits

(5) Processing

Papaya

Papaya fruit is the most economically important fruit. Fruit preservation has an important role in the conservation and better utilization of fruits in order to avoid wastage of fruits. Therefore, there is great scope for processing of papaya fruits to curtail the post harvest losses. The various products such as jam, jelly, candy, nectar, puree, concentrate, toffee, tutti-fruity, freeze dried chunk, dried rolls, dried slices and pickles can prepared. These products have good consumer demand because of nutritional and medicinal value. Other commercial processed products of papaya are frozen papaya cubes, tutti-frutti, ascetically canned papaya pulp, papaya ice cream and papaya kulfi.

Jamun

Jamun is a healthy fruit with absolutely no trace of sucrose. It is therefore, the only fruit with minimum calories. The juicy fruit pulp contains resin, gallic acid and tannin. The ripe fruits are used for health drinks, making preserves, squashes, jellies and wine. In association to its dietary use, all parts of the tree and, importantly the seeds are used to treat a range of ailments, the most important being *diabetes mellitus*. The sweetened Jamun juice is a delicious fruit beverage. Jamun RTS beverage alone or as blended beverage with other fruit juices can also find good acceptability. Jamun squash or syrup are the other products that can be produced as products for commerce.

Tomato

Tomato is one of the most important food crops in India and many countires. Tomato is a rich source of vitamins A, C, potassium, minerals, and fibers. Tomatoes are used in the preparation of soup, salad, pickles, ketchup, puree, sauces and also consumed as a vegetable in many other ways. Tomato processing industry is huge. The ketchup and sauce market in India is pegged at ₹ 1,000 crore and growing at around 20% year-on-year. There is a big market for the processed tomato products. The market scenario has revealed a positive indication for the specially packed tomato sauce in local as well as outside market. Rapid urbanization has increased the use of processed tomato products.

There is ample scope for a unit to come up in this product sector to cater especially to the suburban and rural sectors of India. Increase in the number of teenagers and youngsters with higher spending power as well as an increase in working population (especially women), is fuelling the growth of Fast food industry in India and globally. Tomato products are one of the most important ingredients in ready to eat or fast food products thus increasing its usage as an important tastemaker/enhancer and flavoring ingredients.

Processed tomato products have good export potential, especially in the Middle East. Many units are operating in the small scale sector in the country. Initiating a small scale tomato processing unit, focusing on a single product is the financially viable investment opportunity.

Pickles

Pickling is the process by which fresh fruits and vegetables are preserved and with the addition of salt, chilly and spices, a tasty preparation known as "Pickles" is made. Pickles are also good appetizers and digestive agents. There are several varieties of pickles and they are consumed throughout the year by people from all walks of life. Unimaginable quantities of pickles are consumed round the year. On an average, each family in India consumes about 2 kgs of pickles every year.

Beverages

Fruit juice production and packaging are a profitable business in every country. Within the beverages market, the packaged fruit juice is one of the fastest growing products. It has grown at a CAGR of over 30% over the past decade in India. The rising number of health-conscious urban consumers is giving a boost to fruit juices. Growing affordability and rising disposable income are also responsible for the growing demand of fruit juices in the Indian market. There are three types of fruit juices available in the market. Fruit drinks, which have a maximum of 30% fruit content, are the highest-selling category. Fruit Juices, are 100% composed of fruit content and claim a 30% market share at present. In contrast, nectar drinks have between 25-90% fruit content but account for only about 10% of the total market.

Dehydrated onion slices, powder

Onion is one of the most important commercial vegetable crops grown in India. Both immature and mature bulbs are used as vegetable and condiment. It contains vitamin B and a trace of vitamin C and also traces of iron and calcium. The outstanding characteristic of onion is its pungency, which is due to a volatile oil known as allyl-propyl disulphide. Onions compared with other fresh vegetable are relatively high in food energy, intermediate in protein content and rich in calcium and riboflavin. Onion is dried / dehydrated to largely increase its shelf life. Dehydrated onion is used mainly for making soup in Europe and USA. Dehydrated onion is used as condiment and flavoring agent in manufacturing of tomato ketchup, sauces, salad, pickles, chutneys, meat sausages, masala breads and buns, pizza, breakfast food etc.

Jackfruit

Jackfruit is not easy to eat out of hand owing to morphological and/or biochemical hindrances associated with the fruit. Such indigenous or under-utilized fruits which are not easily marketed in the fresh form should be processed into acceptable products. Jackfruit is gaining popularity even in the United States due to emerging ethnic and mainstream marketing opportunities. Product diversification in jackfruit helps in popularising the fruit among the masses as it removes difficulty in separating the bulbs from rind.

Converting jackfruit bulbs into chips add variety to 'salty snacks', a popular group of food item. Papads are traditional savoury preparations whose quality depends much on the base raw material. Beside papads and chips, jackfruit can be processed in to various products. Jackfruit jam, jackfruit powder, biscuits, dehydrated jackfruit, jackfruit leather, jackfruit seed products, jackfruit seed coffee are some of the value added products with potential for entrepreneurship activity. Vegetable jackfruit popularly known as 'vegetable meat' is another product with considerable potential to be an alternative to meat.

(6) UHS, Bagalkot technologies with entrepreneurship potential

Green chilli powder

Chillies are the green or dried ripe fruits. Green chillies are an indispensible adjunct in several dishes in India and many other tropical countries. India is one of the major chilli producing countries in the world. It is very difficult to prolong its life for long by any means of storage. It has been found possible to convert green chillies in to powder. Green chilli powder is more shelf stable and can be used in place of green chillies in several culinary dishes.

Spice mixture for butter-milk

'Spiced Buttermilk' is a traditional beverage made. It is a favourite and refreshing health drink consumed not only during summers but also as a part of meals especially as post meal drink. Ingredients of this product have cooling properties, promote health and digestion. The drink is easily affordable to all sections of people.

The product of UHS, Bagalkot is quite different from the ready Spiced Buttermilk available in the market. It is spice mixture that can be simply mixed to butter milk at home to make *Instant Spiced Buttermilk*. The spice mixture is produced by careful combination of green chillies and spices to experience maximum sensorial quality.

Banana-Almond-powder

Banana when ripened is a soft and delicate fruit with a post-harvest shelf life of 5-10 days. Hence, it has always been considered a 'problem fruit' with respect to transportation. Therefore, it is important to overcome this problem by exploring possibilities of converting banana in to shelf stable products of commercial interest.

Banana is available throughout the year. An entrepreneurship activity based on banana has assured availability of raw material all through the year. Banana-almond powder

making commercial activity requires minimum investment. This product can be generally consumed by mixing in milk

Green chilli powder

Spice mixture for butter milk

Ready-to-use banana powder mixture

Drumstick leaf powder

Drumstick leaves are highly nutritious and are rich source of beta carotene. Dried and powdered drumstick leaf is in good demand for various food uses. Drumstick leaf powder decoction makes a healthy herbal drink. Mixing the powder in traditional foods enhances nutritional value of these foods. Drumstick leaf powder production, enriching traditional foods using the powder has commercial potential.

Drum stick leaf powder

Dosa mix and papad with drumstick leaves

Qualities of an entrepreneur

An 'entrepreneurial opportunity', thus, is a situation where entrepreneurs can take action to make a profit. A successful entrepreneur should ideally possess nine characteristics to start and run a own business: They are (1) Motivation (2) Entrepreneurs are enthusiastic, optimistic and future-oriented (3) Creativity and Persuasiveness (4) Versatility (5) Superb Business Skills (6) Risk Tolerance (7) Drive (8) Vision and (9) Flexibility and Open-Mindedness.

Watermelon Trichome GWAS Identified Tetratricopetide-Repeat Gene Involved in Trichome Morphogenesis, Growth and Development and Seed Size

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Abstract

Trichomes are the specialized hair-like appendages on the aerial epidermis that protect plants from herbivory, biotic and abiotic stresses. The trichome morphology and the metabolites stored vary greatly across plant species, and the underlying molecular mechanism of such variation in water melon (*Citrullus lanatus*) is currently unclear. We analyzed the significant variation in trichome length among nearly 156 watermelon accessions. Genome-wide association mapping identified that the trichome length phenotype-associated SNP (single nucleotide polymorphism) is located in the gene that encodes for Tetratricopetide-Repeat Thioredoxin-Like protein. Here we show, that the mutant of Arabidopsis *TPR* displays a distorted and shorter trichome phenotype. Genetic crosses with other trichome mutants showed that TPR regulates the trichome cytoskeleton. Co-expression, yeast two-hybrid, and transcriptome analyses revealed TPR interactions with the trichome morphogenesis, cell wall, seed size, and cuticle lipid-related functions. Our results suggest TPR interacts with exocyst complex proteins to facilitate polar growth, cell wall maturation, and seed coat mucilage formation. Interestingly, TPR also showed interactions with TEOSINTE BRANCHED 1, CYCLOIDEA, PCF transcription factors, cell-vesicle transport, and cell wall-related proteins, supporting its role in trichome-morphogenesis and cell wall maturation. Together, we showed that the scaffolding protein TPR has multifaceted roles in plants.

Jute Non-Woven Agrotextile: A Sustainable and Ecofriendly Technology for Improved Production of Summer Tomato

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Extended Abstract

Introduction

Crop yields are generally limited by several factors like water, soil nutrients availability, proper managements etc. Tomato is one of the most popular vegetable crops all over the world. Tomato has a significant role in human nutrition because of its rich source of lycopene, minerals and vitamins which promote good health (Gerster, 1997). Mulching manipulates the crop-growing environment to increase crop yield and improve product quality by controlling soil temperature, retaining soil moisture and reducing soil evaporation. A major limitation of polyethylene mulch involves disposal of mulch, if not properly disposed-off can fragment, and cause damage to environment i.e. land and water resources. The appropriate mulching materials, by controlling soil temperature and conserving soil moisture, can provide suitable soil microclimate for summer crops (Chakraborty *et al.*, 2008). Jute based mulch can be a sustainable alternative of synthetic mulch. The following study attempts to address the above issue.

Materials and Methods

Jute based agro-textiles were engineered using 50% pure jute with 50% caddies (waste jute) on weight basis. For the experiment, six different categories of jute non-woven having 100% jute of 250, 450, 650 GSM and 50% jute plus 50% caddies of 250, 450, 650 GSM with synthetic and rice straw as mulch were used. The research study was conducted at the experimental field of ICAR-CISH regional station, Malda on summer tomato crop (Desi variety). Various properties of mulch materials, soil and crop growth were measured using standard estimation protocols. Soil and crop growth parameters were measured multiple times at important growth stages of summer tomato. Tomato yield and different important fruit quality parameters were estimated after final harvesting.

Results and Discussion

The results on different mulch properties showed that the tenacity of the nonwoven materials with the caddies was almost similar or sometimes better due to the backing cloth which result the lower breaking elongation values of the nonwoven made with caddies. Thickness is more in 50:50 (Jute: Caddies) non-woven mulches than the 100:0 (Jute:Caddies) non-woven, which results more thermal insulation and less air permeability. There was no significant difference in apparent opening size for both types of non-woven fabrics. Various soil parameters have been improved, evaporation losses were restricted, weeds growth has been controlled and water use efficiency (WUE) has been improved significantly. Soil heat flux as well as soil temperature showed similar trend of diurnal variation, both reaches maximum around 1-2 PM. Soil temperature decreases as the depth increases. Soil temperature throughout the depth for all mulch treatments was lower over the control and for 650 GSM, it was the lowest. Every mulch materials showed improvements in tomato yield, fruit quality parameters over control. Among all the mulch materials, 650 GSM, 100:0 followed by 250 GSM, 50:50 and 450 GSM, 100:0 performed well over all others mulching materials in terms of tomato yield and fruit quality parameters. General quality parameters of tomato fruit showed that fruit color at maturity as mostly red, fruit depression at peduncle end as medium, fruit firmness as medium and fruit shape at blossom end as indented to flat. Fruit weight, fruit height, fruit diameter and total soluble solid (TSS) are significantly higher under mulched treatments over control. The increase in yield of summer tomato crop for mulch treatments varied between 30-80% over control.

Conclusions

Various mulch materials has different type of impacts on tomato yield and tomato fruit quality parameters due to differences in mulch properties and its interactions with soil, crop and weather parameters. Among all the mulch materials, 650 GSM, 100:0 followed by 250 GSM, 50:50 and 450 GSM, 100:0 performed well over all others mulching materials in terms of tomato yield and fruit quality parameters. Jute Mulch treatments showed better impacts on tomato yield and fruit quality as well as nutritional values than other treatments. Therefore, it may contribute to narrowing the yield gap between actual yield and attainable yield. So the study showed that this particular production system considerably improved tomato yield and fruit quality with nutritional values.

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Integrated Nutrient Management for Sustainable Production of Coconut (*Cocos nucifera* L.)

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Abstract

Integrated nutrient management in coconut is an innovative, profitable and sustainable technology to enhancing the yield and productivity of coconut without having any negative impact on soil and environment. The present experiment was conducted with the objective to evaluate the substrate dynamics for INM in coconut based multi-storeyed cropping system with four different treatment combinations. After collection of soil as well as leaf sample from the experimental plots, analysis of soil samples for different soil physico-chemical parameter was done. Experimental results revealed that all the soil physico-chemical (pH, EC, SOC as well as nutrient status) and biological properties (dehydrogenase, urease, ß-glucosidase, phosphatase and FDA activity) decreased gradually with the increasing soil depth with maximum at surface soil (0-15 cm soil depth). At 0-15 cm soil depth, soil pH and EC was recorded maximum (7.58 and 0.32 dsm^{-1}, respectively) in 100% RDF treatment (T1) with minimum (6.88 and 0.19 dsm^{-1}, respectively) in T4 (100% Organic recycling with vermicompost + Vermiwash application + In situ green manuring + Green leaf manuring + Compost); however soil organic carbon was recorded maximum in T4 (5.68 g Kg^{-1}) followed by T3 (50% RDF + Organic recycling with vermincompost + In situ green manuring) treatment (3.90 g Kg^{-1}). Available N, P and K in the soil was recorded significantly higher in T1 (221.5, 31.2 and 102.9 kg ha^{-1}, respectively). Similar pattern was also observed in soil micronutrient content. On the other hand, at 0-15 cm soil depth, dehydrogenase, urease, ß-glucosidase, acid and alkaline phosphatase and FDA activity was estimated maximum in T4 followed by T3 and T2 (75% RDF + Organic recycling with vermicompost) with minimum in T1.

Further, leaf N and K content was recorded maximum in T1 (2.37% and 1.29%, respectively) with minimum in T4; however, values of leaf phosphorous as well as micro-

nutrient content were statistically non-significant among the treatments. The data collected on nut yield revealed that the T3 had maximum nut yield followed by T2 (4031 and 3375 nuts/ha) over the last two years while correlation study between soil nutrient dynamics with nut yield not showed any significant correlation. Hence, from the experiment, it can be concluded that 100% RDF increases the available N, P and K. Treatments with organic amendments are having less available nutrients. It can be considered as sustainable because these are basically stored as organic forms and will be released with time. The enzymatic activities were improved in the organic treatments reflecting the importance in maintaining a favourable environment of biological reactions associated with the release of nutrients. However, other yield driving factors are to be considered to find the perfect relation with yield.

Induction of Haploid Plants in Citrus Through Gamma Irradiated Pollen and Ascertain of Ovule Age for Maximum Recovery of Haploid Plantlets

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Extended Abstract

Introduction

Fruit trees like Citrus and other woody perennials are characterized by high degree of heterozygosity due to their nature of cross pollination. In conventional breeding programme, the only way to overcome this problem is to develop inbred line by selfing each parental population for at least 7-8 generations which not only increases the breeding cycle in varietal improvement programs but also is a cumbersome method. To overcome this problem, production of haploid progenies is of utmost importance. Hence, the present study was carried out to induce haploid plants in citrus through irradiated pollen technique.

Materials and Methods

Pollination of *Citrus grandis* was done with gamma irradiated pollen of *C. limetta* and *C. sinensis*, treated with 50, 100, 200, 300 and 400 Gy irradiation doses. After fruit setting, *in vitro* ovule culture was carried out at 20, 35 and 50 days after pollination (DAP). In addition, embryo culture of mature seeds of both the cross combination was also doe under *in vitro* condition. After regeneration of plantlets from ovule culture, ploidy level of *in vitro* raised plantlets was determined using root tips. Further, SSR markers (microsatellites) were used to analyze the parental status of those in vitro raised citrus plantlets.

Results and Discussion

Ovule culture at 50 DAP was found optimum for the maximum recovery of *in vitro* raised plantlets as compared to 35 and 20 DAP. Ovule culture at 50 DAP, gave the highest frequency of embryoid formation, embryo germination and plantlets regeneration than ovule culture at 20 and 35 DAP. Now, the fertilization process within the ovules of citrus

started only after 25 DAP and after fertilization, it may take some more days to develop the embryo within the ovules. Hence, ovules cultured at 20 DAP following pollination with irradiated pollen may devoid of fertilized embryo, resulting very low frequency of embryoid formation and degeneration of those embryoids at early stage before their germination. At 50 DAP, irrespective of pollen parent, plantlets regeneration capacity decreased at 300 and 400 Gy irradiation treatment (0.62% and 0.60%, respectively) with maximum recovery at control (3.07%). This might be due to increasing sensitivity of Citrus pollen to higher irradiation doses resulting in abnormal meiosis, irregular gametes formation and significant change in pollen properties (Nepi and Pacini, 1993). Chromosome counting from actively growing root tips of all the *in vitro* raised ovule cultured plantlets, revealed that two haploid plants with nine chromosome number were induced in *C. grandis* from the ovule culture, established at 50 DAP following pollination with irradiated pollen of *C. sinensis* at 400 Gy and *C. limetta* at 300 Gy. However, irradiation doses below 300 Gy were incapable to induce any haploids in either cross combinations. Higher irradiation dose of 300-400 Gy might have inactivated the generative nucleus and was unable to fertilize the egg cell, although these irradiated pollen grains were genetically inert, physiologically active; could easily germinated on the stigma and stimulated parthenogenesis by interrupting normal double fertilization process resulting the production of parthenogenetic haploids (Kundu *et al.*, 2017). Similarly all the plantlets regenerated from *in vitro* embryo culture of mature seeds were found diploid in nature, irrespective of whatever the pollen parent and irradiation doses were. Molecular analysis of those *in vitro* raised haploid and diploid plants, using SSR marker confirmed the maternal origins of those haploid plants; however, the diploid plants were found zygotic in nature with one allele from seed parent and the other one from pollen parent.

Conclusions

Pollination with gamma irradiated pollen in citrus at 300-400 Gy can promote the development of parthenogenesis, giving rise to the formation of haploid embryos by interrupting normal double fertilization. The optimum condition for induction of haploid plants through in situ parthenogenesis is pollination with irradiated pollen at 300-400 Gy followed by in vitro ovule culture at 50 DAP. However, for the maximum regeneration of plantlets in citrus through in vitro ovule culture, early recovery of ovules at 50 DAP has been found optimum as compared to collection at 35 and 20 DAP.

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Integrated Nutrient Module can Reduce Fertilizer Dose in Cape Gooseberry (*Physalis peruviana* L.) in Sustainable Manner

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Abstract

An experiment was conducted to substitute mineral fertilizers with biofertilizer in cape gooseberry to work out the yield, quality of cape gooseberry and soil fertility status. It was observed that the vegetative growth in terms of plant height, leaf area, total leaf count of cape gooseberry had improved significantly by 100% RDF + Azotobacter, PSB and KSB @ 10 g plant^{-1} each treatment. Physiological growth characters *viz*. leaf relative water content, specific leaf weight, leaf chlorophyll content was also obtained maximum in 100% RDF + Azotobacter, PSB and KSB @ 10 g plant^{-1} each treatment. However, the reproductive growth with respect to precocity in flowering and fruiting with longest flowering, fruiting and harvesting span was obtained in 60% RDF + Azotobacter, PSB and KSB @ 10 g plant^{-1} each treatment. On the other hand, total harvestable fruit plant^{-1} with highest yield plant^{-1} was recorded in 90% RDF + Azotobacter, PSB and KSB @ 10 g plant^{-1} each treatment with par value in the module comprising 60% RDF + Azotobacter, PSB and KSB @ 10 g plant^{-1} each. The quality attributes of ripped cape gooseberry fruit was also improved significantly in integrated treatment of 60% RDF + Azotobacter, PSB and KSB @ 10 g plant^{-1} each with respect to TSS (15.90 °B), TSS:Acid ratio (21.08%), total sugar content (11.29%), ascorbic acid (60.03 mg 100g^{-1} FW), carotenoid (49.25 µg 100g^{-1} FW), flavonoid (50.16 µg g^{-1} FW), phenol (5.83 mg Gallic acid equiv. g^{-1} FW) and antioxidant capacity (22.54 µmol Trolox equiv. 100 g^{-1} FW). Soil pH, EC, organic carbon content and available phosphorous of the cape gooseberry field under the current research work not varied significantly over control as well as the initial reading. While, available soil N and K was decreased marginally with the reduction of NPK doses under different treatments. However, microbial population viz. bacteria, fungi and actinomycetes count was improved significantly in all the bio-fertilizer applied nutrient modules. Hence it can be concluded that the integrated nutrient module comprising 60% RDF of NPK + Azotobacter, PSB and KSB @ 10 g plant^{-1} (T_6) is the best treatment to improve the production system of cape gooseberry in sustainable manner for long run without hampering the soil health and quality.

Foliar Feeding of Micronutrients: An Efficient Tool for Sustainable Production of Sweet Orange (*Citrus sinensis* (L.) Osbeck) cv. Mosambi Under Non-Traditional Citrus Growing Track

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Abstract

Calcareous and alkaline soil is the major drawback for low yield and poor fruit quality of mosambi with increased granulation problem because such types of soil hinders the smooth micronutrient up take to the plants. Hence, impact of foliar feeding of micronutrients on granulation and fruit quality of sweet orange (*Citrus sinensis* (L.) Osbeck) cv. Mosambi was initiated. Zn @ 0.5% + Fe @ 0.2% + B @ 0.3% + Cu @ 0.1% followed by B @ 0.3% + Fe @ 0.2% and Zn @ 0.5% + B @ 0.3% were found effective for improving physiological growth. The yield was also obtained maximum in Zn @ 0.5% + Fe @ 0.2% + B @ 0.3% + Cu @ 0.1% (19.92 t ha^{-1}); however, maximum fruit weight and volume was obtained in B @ 0.3% + Fe @ 0.2% treatment (173.80 g and 190.53 cc, respectively). Further, fruit quality attributes in terms of TSS:acid ratio, sugar and phenol content of the fruit was recorded maximum with Zn @ 0.5% + Fe @ 0.2% + B @ 0.3% + Cu @ 0.1% spray. In addition, minimum incidence of granulation was observed in Cu @ 0.1% spray (1.96%) with at par result in Zn @ 0.5% + Fe @ 0.2% + B @ 0.3% + Cu @ 0.1% (2.33%). Therefore, three foliar spay of Zn @ 0.5% + Fe @ 0.2% + B @ 0.3% + Cu @ 0.1% from May-July may be recommended to get maximum yield of better quality, granulation free fruit from mosambi orchard under non-conventional citrus growing track having calcareous and alkaline nature of soil.

Exogenous Brassinosteroid Application Improves Growth, Yield and Quality of Strawberry Grown in Subtropics

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Extended Abstract

Introduction

The main drawback for the strawberry grows under subtropical plain is the inferior fruit quality over temperate region. Moreover, the productivity is too low in India (5 t/ha) than other strawberry growing countries. Hence, the key challenge in front of fruit researches is to increase productivity of strawberry with improved fruit quality especially under subtropics. It was observed that the alternation of endogenous brassinosteroid (BS) level is effective for improving quality of different fruit crops. Further, it also found that BS is involved in the growth and development of fleshy fruit and ripening of different crops. Hence, impact study of foliar feeding of BS on strawberry under subtropical region is foremost important. Therefore, the current experiment was formulated to evaluate the effect of BS on growth, yield and quality of strawberry cv. Winter Dawn grown under subtropics.

Materials and Methods

Healthy saplings of uniform growth of strawberry (*Fragaria* × *ananassa* Duch.) cv. Winter Dawn were used as the experimental materials. BS at 0.1, 0.2 and 0.3 ppm concentrations were sprayed on experimental strawberry plants only at vegetative; vegetative and flower initiation; vegetative and fruit setting; vegetative, flower initiation and fruit setting stage. The control plants were sprayed with water. The experiment was laid out in randomized block design (RBD) having three replications. Physiological as well as reproductive growth pattern of all the experimental plants were observed. After harvesting, yield attributing characters were also measured. Thereafter, biochemical analyses of ripe strawberry fruits were carried out.

Results and Discussion

The physiological growth (leaf area, leaf area index, leaf area duration and total chlorophyll content) was significantly improved by BS application at vegetative, flowering and again at fruiting stage, irrespective of concentration applied. The highest number of flower and yield per plant (37.67 and 574.76 g, respectively) was recorded with three BS spray at vegetative, flowering and fruiting stage (0.2 ppm each). BS spray (0.3 ppm) at vegetative, flowering and fruiting stage also resulted the highest fruit weight (17.89 g). While BS (0.2 ppm) at all three growth stages resulted the highest TSS (11.30ºB) and sugar content (7.72%). However, control fruits recorded the highest juice recovery (74.16%) with the highest acidity (1.09%). BS application at all three growth stages significantly improved the fruit quality with increased health promoting compounds such as ascorbic acid, anthocyanin, flavonoid and antioxidant capacity. This improved physiological growth with three application of brassinosteroid is mainly due to the long lasting action through repeated application before they started to mobilize reserved photosynthetic assimilates from source to sink. Further, the increased leaf area in all the brassinosteroid treatment as compared to control might be due to the stimulative role of brassinosteroid to activate meristematic tissues of the plant. In addition, it also helps to increase number and size of the cell resulting increased photosynthetic surface area of the leaf (Munoz *et al.*, 1998). However, the increase in TSS by brassinosteroid application may be due to mobilization of metabolites from source (leaf) to sink (fruit) and also rapid conversion of starch and acids into sugars which are the major part of soluble solids (Barkule *et al.*, 2018).

Conclusions

The action of brassinosteroid is very quick and it also degrades very quickly. Therefore, repeated application of brassinosteroid reflected its long lasting action for improving physiological growth of strawberry cv. Winter Dawn with increased yield of better quality fruit in terms of higher TSS, total sugar, anthocyanin, flavonoids content and antioxidant capacity. Further, among three different concentration (0.1, 0.2 and 0.3 ppm), repeated foliar spray of brassinosteroid at vegetative, flowering and fruiting stage with 0.2 ppm and 0.3 ppm showed at par results for improving all the yield and quality attributes of strawberry cv. Winter Dawn. Hence, from the present experiment, it can be concluded that the foliar feeding of brassinosteroid @ 0.2 ppm each at vegetative, flowering and fruiting stage is the best treatment to increase the yield potentiality of strawberry cv. Winter Dawn with improved fruit quality under subtropical condition of Bihar, India.

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Edible Coatings for Fresh Fruits and Vegetables

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Extended Abstract

Introduction

Fruits and vegetables are the essential part of human diet. However, they are highly perishable in nature and to reduce the extent of postharvest losses and maintain the quality of fresh fruits and vegetables, various postharvest technologies were practiced. Edible coatings are one of the promising postharvest technologies which maintain quality and enhance shelf life. Edible coatings can substantially reduce the rate of respiration, transpiration and various other metabolic activities, which lead to the natural deterioration of the produce. The effect of edible coatings is similar to modified atmospheric storage owing to modification of internal gas composition of the produce. Apart from extending shelf life and sensory quality, it also provides the nutritional security, as many types of nutrients, vitamins and other ingredients can be incorporated with it. Some common types of natural edible coatings are chitosan coatings, corn-zein coatings, mineral oil coatings, wax coatings, whey protein coatings and carbohydrate lipid coatings (prolong, semperfresh), etc.

Materials and Methods

Edible coatings can be applied by different methods such as dipping, brushing, spraying, extrusion and solvent casting. Among all of these methods, dipping the fresh fruits and vegetables in edible coating solution for 5-30 sec is most common. On the contrary, brushing method is highly effective in providing the desired benefit of edible coatings in various fruits and vegetables like beans, strawberries, beans etc. For the industrial purpose, extrusion method is more suitable than any other method. However, its effectiveness is determined on the thermoplastic characteristics of edible coatings. Other methods such as spraying and solvent casting are also used in food industry.

Results and Discussion

Application of edible coatings increase shelf life and effectively maintained the quality of fresh fruits and vegetables by delaying the rate of respiration and transpiration which in

turn delays the degradation of organic acids, sugars, chlorophyll, ascorbic acid, phenols, flavonoids and other organic compounds during the period of storage. It also reduces the production of ethylene gas which accelerates the process of senescence in fresh fruits and vegetables, thus reduces shelf life. It addition, it also retards the oxidative processes, and restricts the gaseous exchange between environment and the produce as well as seals the various volatile compounds. It protects the outer tender surface of horticultural produce by mechanical injury during postharvest handling which subsequently delays the decay loss. Edible coatings act as a carrier for various beneficial compounds like antioxidants, anti browning agents, nutrients, vitamins, minerals which enhance the nutraceutical value of the fruits and vegetables. Apart from being nutritive, it also enhances the aesthetic appeal of fresh fruits and vegetables by providing the shiny and smooth surface with the retention of colour and flavour. Moreover, it minimizes the cost of synthetic packaging as it is ecofriendly, edible along with the fruits and vegetable and relatively cheaper and easily available in the market.

Recently many natural edible coatings possess the antimicrobial properties as the biological compounds present in these coatings restrict the penetration and growth of several microorganisms. Apart from that, it also reduces the storage diseases and disorders, chilling injury of fresh fruits and vegetables. However, the effectiveness of edible coatings can be enhanced with low temperature storage compared to the ambient condition. Nowadays, edible coatings are commercially practiced in various fruits and vegetables such as orange, apple, grapefruit, cherry, papaya, lemon, strawberry, berries, mango, peach, tomato, cucumber, capsicum, cantaloupe, brinjal, etc.

Conclusions

Edible coatings are the postharvest technology which is found promising in increasing shelf life, maintaining postharvest quality and marketability of the fresh fruits and vegetables. It significantly restricts the up surging respiration, transpiration, ethylene production rate, thus further delays the utilization of chlorophyll, organic acids, acidity, sugars, ascorbic acids, phenols, flavonoids and other biochemical compounds. Edible coatings are a good carrier of various vitamins, organic acids, minerals, antioxidants and anti browning agents etc. thus increase the nutritive value of any fruits and vegetables. Moreover, edible coatings also decrease the decay loss, storage diseases and disorders, chilling injury during the postharvest storage. Edible coatings are directly consumed by the consumer with the fruits and vegetables, thus eliminate the need of synthetic packaging. Overall, edible coatings increase the aesthetic appeal and sensory quality of the fruits and vegetables.

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Harnessing Atmospheric Gases for Enhancing Storability of Fruits and Vegetables

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Extended Abstract

Introduction

Horticultural crops have shorter shelf life during storage due to higher respiration rate and moisture loss. Controlled atmosphere (CA) and modified atmosphere (MA) storage are the advanced technology which is used for increases postharvest life by modifying atmospheric composition like CO_2, O_2, ethylene, and other gases. CA storage are precise and costly method; strictly controlled concentrations of CO_2 and O_2 whereas, MA storage were initially modified and the concentrations of CO_2 and O_2 changes by respiration of produce. An increases in concentration of carbon dioxide and oxygen gases, creates a modified environment which is decreases the respiration rate and ethylene production. The modified atmosphere gases decrease the respiration rate of many fresh horticulture produce, inhibit production of ethylene, response for rapid senescence processes, etc.CA and MAP storage is suggested for various crops like mango, banana, apple, pears, avocado, cherry, chestnut, peach, plum, kiwifruit, lettuce, asparagus, broccoli, cabbage, tomato, etc.

Materials and Methods

Generally, CA storage strictly control the CO_2 (1-10%) and O_2 (1-20%) for most of the commodities at low temperature throughout the storage period. The composition of gases monitored frequently by advanced mechanism and maintained at their suggested limit. During fresh product storage, modification of atmospheric composition of MA storage at the initial stage by transfer of gases or middle of the storage by respiration of product. In both type storage different type of scrubbers is used (O_2- oxygen generator, nitrogen separator; CO_2- hydrated lime, activated charcoal; C_2H_4- $KMnO_4$, dry ice, etc.) for maintains the level of gases.

Result and Discussion

Controlled atmosphere (CA) and modified atmosphere (MA) storage not only increases shelf life but also maintains the quality of fruits and vegetables during the period of postharvest

storage. They modifies the surrounding atmospheric composition of fruits and vegetables which leads to the lower respiratory and transpiration rate. This modified atmosphere lower the transpiration rate, maintains turgidity and freshness of fruits and vegetables can be prolonged for the longer period of time relative to storage at both ambient and low temperature conditions. Both storage has reduces degradation of color, flavor, texture, and vitamins. Higher rate of CO_2 (1-10%) and O_2 (1-20%) reduces rate of synthesis and action of ethylene which ultimately delays the ripening of climacteric fruit and vegetables. Low oxygen and high carbon dioxide reduced the production of some organic acids, decreases the activity of enzymes which responsible for breakdown of chlorophyll and pectin. The anaerobic condition increases the efficiency of retarding the growth of microorganism on the stored commodity. In Controlled atmosphere and modified atmosphere storage, maximum fruits and vegetables stored at low temperature except tropical fruits and vegetables under modified atmospheric condition decreases the metabolic activity and delay the ripening. The fruits and vegetables quality parameters like weight loss, total soluble solids, titratable acidity, chlorophyll content degradation, synthesis of anthocyanin and carotenoids content and softening has been slightly affected and maintained their level throughout the storage in CA and MA storage. During the storage, it's help to alleviation of chilling injury and reduced the pathological attacks, thus helps in reducing decay loss. The elevated concentration of CO_2 and low concentration of O_2 helps to prevents browning, loss of flavor during throughout the storage. Nowadays, controlled atmospheric and modified atmospheric storage practices are popular in various fruits and vegetables such as apple, peach, nectarines, banana, tomato, cabbage, cauliflower, capsicum, etc.

Conclusions

Storage life of horticultural commodities such as fruits, vegetables, flowers, etc. inversely correlated with respiration rate to be exact, the stored commodity becomes more perishable and shorter shelf life when higher rate of respiration and ethylene production. Controlled atmosphere (CA) and modified atmosphere (MA) storage are the advanced technology which improves postharvest life of horticultural commodities by modifying atmospheric composition like CO_2, O_2, ethylene, and other gases. The quality of fruits and vegetables are maintained by low oxygen and alleviated CO_2 by inhibiting the production and action of ethylene and reducing the respiration rate under low temperature condition. The metabolic activity of fruits and vegetables reduces during throughout the storage. In future, CA and MA storage becomes leading next generation storage system for better postharvest management of horticultural commodities.

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Effect of Climate Change on Fruit Quality

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Extended Abstract

Introduction

Temperature increase and the effects of greenhouse gases are among the most important issues associated with climate change. The quality of fresh fruits can be directly or indirectly affected by several climatic variables like high temperatures, exposure to elevated levels of carbon dioxide, sunlight, ozone, rainfall, etc. Temperature increase affects fruit quality by accelerating ripening, colour development, alterations in sugars, firmness, accumulation of bioactive compounds and antioxidant activity (Moretti *et al.*, 2010). High carbon dioxide accumulation in the atmosphere directly affects fruit size, sugar concentration and inorganic elements in fruits like pear. Due to increase in light intensity day to day, it affects the quality of fruits by accelerating ripening in grapes, firmness in avocados and other associated quality attributes. Rainfall also affects the fruit quality by altering sugar content, weight and development of physiological disorder in peach and strawberry due to high soil moisture (Choi *et al.*, 2002). High concentrations of atmospheric ozone can potentially cause reduction in the photosynthetic process, growth and biomass accumulation. Ozone-enriched atmospheres increased vitamin C content and decreased emissions of volatile esters on strawberries. As the temperature, sunlight, levels of CO_2 will probably continue to rise due to climate change, it will have a direct impact on quality of fruits.

Elements involved in climate change

- **Temperature:** Greenhouse gases are trapping more heat in the Earth's atmosphere, which is causing average temperatures to rise all over the world.
- **Carbon dioxide:** Carbon dioxide (CO_2) is an important heat-trapping (greenhouse) gas, which is released through human activities.
- **Rainfall:** Changes in rainfall and other forms of precipitation will be one of the most critical factors determining the overall impact of climate change.
- **Sunlight:** The Sun powers life on Earth; it helps keep the planet warm enough for us to survive. It also influences Earth's climate.

- **Ozone:** Temperature, humidity, winds, and the presence of other chemicals in the atmosphere influence ozone formation, and the presence of ozone, in turn, affects those atmospheric constituents.
- **Relative humidity:** Any increases in surface water vapour (absolute humidity) will lead to greater warming aloft due to latent heating effects upon condensation.
- **Hail and frost:** Warmer temperatures will expand higher into the atmosphere, so falling hailstones have more time to melt before hitting the ground.

Climatic Variables Affecting Fruit Quality

- **Effect of temperature:** Greenhouse gases are trapping more heat in the Earth's atmosphere, which is causing average temperatures to rise all over the world. During fruit development, high temperatures can affect accelerate ripening, color development and accumulation of bioactive compounds, ultimately, reduced quality of fruits.
- **Effect of carbon dioxide:** Increased atmospheric carbon dioxide effects fruit quality by altering net photosynthesis, biomass production, sugars and organic acids contents, stomatal conductance, firmness, seed yield, light, water, nutrient use efficiency and plant water potential
- **Effect of Rainfall:** High Rainfall causes a poor quality and a physiological disorder by high soil moisture and insufficient sunshine in peach. Rainfall also effects fruit quality by altering the sugar content and weight of the fruits.
- **Effect of sunlight:** Due to increase in light intensity day to day it affects the quality of fruits. The surface of fruits caused by prolonged exposure to sunlight hastens ripening and other associated events. One of the classical examples is that of grapes, where berries exposed to direct sunlight ripened faster than those ripened in shaded areas within the canopy.
- **Effect of ozone:** Ozone enters plant tissues through the stomata, causing direct cellular damage, especially in the palisade cells. Visible injury symptoms of exposure to low ozone concentrations include changes in pigmentation, also known as bronzing, leaf chlorosis, and premature senescence. High concentrations of atmospheric ozone can potentially cause reduction in the photosynthetic process, growth and biomass accumulation.
- **Effect of relative humidity:** Extremely low or high humidity may affect yield through poor fruit set as it may cause poor pollination germination owing to drying or desiccation of stigmatic fluid and excessive drop of the fruits in oranges, mandarins and most of the subtropical and temperature fruit crops.
- **Effect of hail and frost:** *Hail* – In temperate fruit orchards, hail destroys all the flower buds and injuries almost all the developing fruits. *Frost* – causing regular/irregular damage. Spring frost is particularly harmful to the plant's intemperate climate. Frost may either kill the sexual organs of a flower or completely destroy the blossoms thereby influencing the fruit set.

Conclusions

- The quality of fresh fruits is directly and indirectly affected by several climatic variables like temperature, sunlight, CO_2, etc.
- Increase in temperature accelerates ripening, color development and accumulation of bioactive compounds.
- Elevated CO_2 concentration in the atmosphere increase fruit size, sugar content and inorganic minerals.
- Rainfall effects fruit quality by altering the sugar content and weight of the fruits.
- High intensity of sunshine increase firmness of fruits.
- Low ozone concentrations include changes in pigmentation, leaf chlorosis, and premature senescence. High concentrations of atmospheric ozone can potentially cause reduction in the photosynthetic process, growth and biomass accumulation.
- Extremely low or high humidity may affect yield through poor fruit set as it may cause due to poor pollination germination.
- Hail and frost effect fruit quality by destroys all the flower buds and injuries almost all the developing fruits.

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Studies on Fruit Physico-Chemical Characters of Some Jackfruit Genotypes

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Abstract

Jackfruit (*Artocarpus heterophyllus* Lam.) the largest known edible fruit bearing tree species, is one of the important crops of the tropics and subtropics of South East Asia. It is one important nutritious fruit. The western dry tract of West Bengal has the greater diversity of different fruit crops including jackfruit. Different types of jackfruits are available here with different size, shape, colour aroma, bulb and flake quality etc. The variation of different jackfruit genotypes in this zone is merely reported. Thus the present study entitled "Studies on Physico-chemical Characters of Some Jackfruit Genotypes" has been undertaken to reveal the diversity of fruits of jackfruit within available genotype resources during the period of 2018 to 2019 under Department of Horticulture & Postharvest Technology, Palli Siksha Bhavana (Institute of Agriculture), Visva Bharati, Sriniketan, West Bengal. The experiment was conducted by selecting twenty different jackfruit genotypes from Sriniketan and adjoining villages (*viz*. Surul, Ballvpur, Mouldanga, Raipur, Ruppur, Mahidapur, etc.) and bringing the fruits for physical and biochemical estimation at the laboratory of department. In the present study a wide and significant variation in fruit physical characters, bulb characters, seed characters as well as quality characters have been observed among twenty different jackfruit genotypes. Among different soft types jackfruit genotypes T2 possessed higher fruit size (45.4 cm in length and 23.9 cm and in diameter), fruit weight (11.135 kg), regular oblong shape, good bulb size (6.23 in length 3.17 cm in diameter), higher flake content (18.12 g), very high TSS (14.04^{o}Brix), TSS: acidity ratio (140.40), sugar content (total sugar 17.36% and reducing sugar 12.30%) as well as medium high flavour of pulp. Being soft flaked, T9 also has been recorded with good quality aspects like high TSS (15.47^{o}Brix), TSS: acidity ratio (140.63), sugar content (total sugar 16.68% and reducing sugar 13.05%) and strong aroma, although, it possessed medium fruit size and smaller bulb size. However, among different medium and semi-hard flaked jackfruit genotypes T12 has been recorded with medium fruit size (35.6 cm in length and 17.2 cm in diameter) and fruit weight (3.940 kg) with good bulb size (5.62 cm in length and 3.30 cm in diameter), bulb weight (25.48 g), flake content (20.64 g) and better fruit quality like high TSS (13.26^{o}Brix), TSS: acidity ratio (132.62), high sugar content (total sugar 17.11% and reducing sugar 12.24%) with medium high flavour. Thus from the overall result of the present study it can be concluded that jackfruit genotypes T2 and T9 out of the soft flaked type and T12 out of the medium and semi-hard flaked type can be considered as best genotypes.

Seabuckthorn: Boon to Boost Immunity Under Current Covid-19 Pandemic Situation

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Extended Abstract

Introduction

Seabuckthorn (*Hippophae* sp.), also known as wonder berry, grows wild at higher altitudes of Asia and Europe, and is also cultivated in different countries including China, Russia, and India. In India, seabuckthorn grows in high altitude, cold arid conditions of Ladakh (Leh and Kargil), Lahaul – Spiti, parts of Chamba (Pang) and upper Kinuar districts of Himachal Pradesh and Badrinath and Chamoli in Uttarakhand. Seabuckthorn has also been reported from Sikkim and in Dibang valley in Arunachal Pradesh. Since ancient times, seabuckthorn has been known for its immense nutraceutical medicinal, and ecological value. Seabuckthorn berries are a rich source of phytochemicals like vitamins (especially vitamin C and E), flavonoids, carotenoids, sugar, amino acids, organic acids, fatty acids, and mineral elements. Many research studies have reported diverse medicinal properties of seabuckthorn preparations, namely antimicrobial, antiulcerogenic, antioxidative, anticarcinogenic, radioprotective, hepatoprotective, antihypertensive, antiinflammatory, and immuno-modulatory properties. These medicinal properties of seabuckthorn are attributed to the presence of important bioactive compounds in different parts of the seabuckthorn plant, mainly in berries, leaves, and seeds. A large number of seabuckthorn products have recently acquired significant attention and gains in the health, cosmetics, and food industry.

Materials and Methods

Systematic searches were conducted using the authentic database without any restriction in year of publication. Keywords used include “seabuckthorn” and “seabuckthorn oil”. The criteria were research studies focused on determining the nutritive composition and its role in improvement of human health.

Result and Discussion

Results of analysis of Seabuckthorn growing in Leh valley of Trans-Himalaya showed the presence of high content of multivitamins including vitamin C (275 mg/100g), vitamin A (432.4 IU/100g), vitamin E (3.54 mg/100g), riboflavin (1.45 mg/100g), niacin (68.4 mg/100g), pantothenic acid (0.85 mcg/100g), vitamin B_6 (1.12 mg/100g), and vitamin B_2 (5.4 mcg/100g). Similarly, mineral elements composition revealed high amount of minerals including potassium (647.2 mg/l), calcium (176.6 mg/l), iron (30.9 mg/l), magnesium (22.5 mg/l), phosphorous (84.2 mg/l), sodium (414.2 mg/l), zinc (1.4 mg/l), copper (0.7 mg/l), manganese (1.06 mg/l) and selenium (0.53 mg/l). Stobdan *et al.* (2010) revealed that Seabuckthorn growing in Leh valley of Trans-Himalaya showed the presence of high content of multivitamins including vitamin C (275 mg/100g), vitamin A (432.4 IU/100g), vitamin E (3.54 mg/100g), Riboflavin (1.45 mg/100g), Niacin (68.4 mg/100g), Pantothenic acid (0.85 mcg/100g), vitamin B-6 (1.12 mg/100g), and vitamin B-2 (5.4 mcg/100g). Similarly, mineral elements composition revealed high amount of minerals including potassium (647.2 mg/l), calcium (176.6 mg/l), iron (30.9 mg/l), magnesium (22.5 mg/l), phosphorous (84.2 mg/l), sodium (414.2 mg/l), zinc (1.4 mg/l), copper (0.7 mg/l), manganese (1.06 mg/l) and selenium (0.53 mg/l). Seabuckthorn is rich in antioxidant vitamins including vitamin C, E, and A. In comparison to other fruits, seabuckthorn as a rich source of vitamin C is evident. Vitamin C is a natural water-soluble antioxidant which inhibits peroxidation of membrane phospholipids and acts as scavenger of free radicals. It also plays a major role in regeneration of vitamin E. Vitamin E is a fat-soluble vitamin known to be one of the most potent antioxidant. It breaks the propagation of the free radical chain reaction in the lipid of biological membrane. The seabuckthorn content of calcium, iron, sodium, zinc and manganese is much higher than mango, apricot, banana, orange and peach. Requirement of mineral is generally high at high altitude condition because of increased excretion of electrolytes. There is a greater requirement of selenium, copper, zinc and manganese at high altitude to prevent oxidative stress. Use of seabuckthorn as nutritional supplement can help to maintain a normal balance of most of the ions.

It is used in about two hundred industrial products including life saving drugs and herbs to treat cancer, heart ailments, ulcers, hepatic disorders, burns and brain disorders. Some of the health benefits cited for sea buckthorn berries products include: antiinflammation, antimicrobial action, pain relief, the promotion of tissue regeneration, boosting of the immune system, and protection against cancer and cardiovascular disease (Li *et al.*, 2003). For its hemostatic and anti-inflammatory effects, berry fruits are added to medications for pulmonary, gastrointestinal, cardiac, blood and metabolic disorders in Indian, Chinese and Tibetan medicines. Seabuckthorn berry components have a potential anticarcinogenic activity (Teng *et al.*, 2006; Zeb, 2006).

Seabuckthorn oil is very rich in fatty acids and could play an important role in several activities related to human health. Palmitoleic acid (PA) has an evident clinical application on skin and mucous disorders such as vaginal inflammatory atrophy, skin hyper pigmentation or wounds, infections. In addition, other different positive effects in hypercholesterolemia,

diabetes and liver dysfunction are demonstrated. The Oleic acid (OA) has a well founded indication in the protection of cardiovascular diseases. The omega-6 fatty acids (GLA and LA) may have clinical applications in skin disorders. Linoleic acid (LA) is beneficial in psoriasis and γ-Linolenic acid (GLA) in acne skin, atopic dermatitis and dry eye. In addition, LA seems to improve atherosclerosis condition. Large amount of experimental data evidencing those fatty acids could influence in a huge range of activities in human health being a possible candidate for several clinical application. It is possible to conclude that sea buckthorn oil is a promising product due to its diversity of fatty acids and its unique composition of omega-7 fatty acids group and these fatty acids have a strong relation with human health (Marsinach and Cuenca, 2019).

Scientists at Indian Institute of Technology, Mandi and CSK Himachal Pradesh Agriculture University Palampur, in collaboration with and five other institutes, have submitted a ₹7.5 crore research project proposal to Ministry of AYUSH, Government of India to develop seabuckthorn immunity booster and anti-COVID 19 drug. The fruit and leaves of seabuckthorn are quite rich in a variety of vitamins and antioxidants (vitamin C, A, E, K, carotenoids, polyphenols and sterols etc. The studies done in over 70 research organizations of India like Palampur University, DRDO, CSIR and AIIMS etc. have found its efficacy in gastric ulcer, diabetes, cardiovascular, wound healing and skin diseases etc, said Dr Virendra Singh, a seabuckthorn expert and General Secretary of Seabuckthorn Society of India.

Seabuckthorn has a great potential in boosting immunity, besides strong antivirus activity. Seabuckthorn naturally grows in cold desert and dry temperate regions of Himachal Pradesh (Lahaul-Spiti and Kinnaur), Ladakh, Uttarakhand, Sikkim and Arunachal Pradesh. The scientific studies on seabuckthorn fruit oil and leaf extracts done in Finland, Russia, India and China have proven its strong immunity boosting and anti-viral properties. Seabuckthorn has been found to have much stronger activity against a broad spectrum of viruses, as per a team of Russian scientists at All Russian Research Institute of Medicinal and Aromatic Plants, Moscow, in 2001. However, the first research breakthrough by using seabuckthorn against COVID 19 has been reported by South Korea, where a team of scientists at Ethwa Woman's University Medical Centre was successful in isolating anti-COVID19 compounds from seabuckthorn.

It is pertinent to mention that Indian private sector has also invested in seabuckthorn and established ultra-modern seabuckthorn processing industries at Baddi, Faridabad and Kochi and have launched over 120 sea buckthorn juice, cosmetics and oil health products in India. According to the Seabuckthorn Society of India, there are about 11,000 hectares natural forest of seabuckthorn in Ladakh, 1200 hectares in Himachal, 2000 hectares in Uttarakhand and about 1000 hectares in Sikkim and Arunachal Pradesh. The collection by local farmers is mere 800 tons and rest 20,000 tons goes waste, as it is very difficult to enter into the thick forest (The Tribune and Statesman News Service, 2020).

Conclusions

Seabuckthorn is a unique and valuable crop for cold arid region. It has potential to play a crucial role in the sustainable development of cold arid fragile areas. The fruit and seed are the main source of its nutritional and medicinal values. These beneficial effects have made Seabuckthorn products, especially its oil, desirable for medicinal and cosmetics purposes. Seabuckthorn has become a vital source for research and development works due to the presence of more than 300 bioactive agents. There is a need for novel techniques and approaches for integrated processing of Seabuckthorn berries into their nutraceutical and therapeutic products.

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Eco-friendly Management of Sucking Pests in Green Gram

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Abstract

Investigation on eco-friendly management of sucking pests in green gram, *Vigna radiata* (L.) Wilczek was carried out at Agronomy Instructional Farm, C.P. College of Agriculture, S.D. Agricultural University, Sardarkrushinagar-385506 during summer, 2019. Among various eco-friendly pesticides, *Lecanicillium lecanii* 1.15 WP 0.5% was the most effective treatment as it recorded lowest number of sucking pests *viz*., aphid (0.89/3 leaves), jassid (0.52/3 leaves), whitefly (0.99/3 leaves) and thrips (0.17/3 flowers) without interfering predatory fauna and also recorded with highest seed yield (978 kg/ha), increase in yield over control (82.12%) and highest gross realization (₹53790/ha) followed by azadirachtin 10,000 ppm 0.3% and *Beauveria bassiana*1.15 WP 0.5%.

Diversity Mapping and Data Base Development of Banana (*Musa* Spp.) Germplasm in Nagaland

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Abstract

A survey work was conducted to study the banana genotypes based on plant morphological and physico-chemical properties of fruits and also to assess the magnitude of variability among different genotypes. Eight (8) genotypes of banana were collected from various locations of Nagaland. The data was recorded based on NPBGR guidelines throughout the year in their natural population and the fruit samples were collected randomly, *in situ*. Accessions collected from different location showed a wide range of variability in their plant and fruit morphological characters. The experiment revealed that more pseudostem height was noticed in ACC-4 i.e. Bhimkol (4.67m) followed by ACC-3 i.e. Kandali (4.43m). The genotype ACC-3 (Kandali) recorded the highest girth size and petiole length and genotype ACC-7 (Latsa) showed the highest leaf blade length and width. Genotype ACC-2 (Monthan) recorded the highest fruit weight (166.00g) followed by ACC-5 i.e. Bharatmani (114.95g). The genotype ACC-1 i.e. Jahaji (46.00g) showed the highest peel weight followed by ACC-2 i.e. Monthan (45.00g). Regarding the fruit quality properties ACC-4 (28.33°B) showed more content of TSS followed by ACC-3 (27.03°B). Acidity content was maximum in ACC-2 i.e. Monthan (0.34%) and ACC-5 showed more content of reducing sugar (8.70%), total sugar (16.16%) and ascorbic acid (8.400 mg/100ml of juice). The GCV (49.60) and PCV (50.00) were observed highest in Ascorbic acid and followed by characters like pulp weight (GCV 44.43 and PCV 45.07) and peel thickness (GCV 27.48 and PCV 40.92). TSS was found to have highest heritability percentage (100.00%) and genetic advance was found to be highest in the Acidity (100.01%). The genotypes ACC-4 (Bhimkol), ACC-9 (Latsa), ACC-2 (Monthan) and ACC-1 (Jahaji) for plant and fruit characters and genotypes ACC-3 (Kandali), ACC-2 (Monthan) and ACC-5 (Bharatmani) for quality can be recommended for growing in this region.

Phytochemical Profiling, Antioxidant Activity and Micronutrient Content Determination from Tree Bean Vegetable (*Parkia roxburghii*) of North Eastern India

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Abstract

Parkia roxburghii (Family: Fabaceae) is an underutilized nutritious leguminous tree found abundantly in North-eastern states of India and other Southeast Asian countries. It is widely used as a popular vegetable in the north-eastern region of India. In this study we have attempted to investigate on nutrient profiling, antioxidant activity and micronutrient content estimation from different parts of *Parkia roxburghii.* Total protein content of different plant parts of the tree bean ranges from 19.65-12.03 mg BSA/g dry Tissue. Total proline content in terms of µmole/g dry tissue was estimated and the value ranges from 44.07 to 31.27. Pod showing significantly high amount of total phenolic content i.e. 2600.97 µg catechol/g dry tissue and seed having least amount of total phenolic content i.e. 55.38 µg catechol/g dry tissue. Estimation of total flavonoid content showed the similar trend, pod having highest amount of total flavonoid content and seed contains the lowest amount of total flavonoid content and the values are 620.76 and 20.32 µg catechin/g dry tissue respectively. Tree bean showed significant amount of antioxidant activity in terms of low IC_{50} value of ABTS and DPPH radical scavenging activity. Pod extracts exhibits highest antioxidant activity and leaf showed lowest amount of antioxidant activity. IC_{50} values of Pod and leaf extracts are 121.04 ppm and 209.17 ppm, respectively in case of DPPH radical scavenging activity. ABTS radical scavenging activity assay of tree bean showed that seed part is most potent source of antioxidant having 107.32 ppm as IC_{50} value and leaf part is the least potent

source of antioxidant due to its highest IC_{50} value, i.e. 176.09 ppm. Atomic Absorption Spectrophotometer (AAS) analysis of tree bean samples revealed that they are rich sources of different kind of minerals like- zinc, copper, iron and manganese. HPLC analysis of the crude methanolic extract of Tree bean revealed the presence of different therapeutically important phytochemicals like- gallic acid, catechin, caffeic acid, vallinic acid, t-cinnamic acid, p-coumaric acid, sinapic acid, quercetin and salicylic acid in considerably high amount. GC-MS analysis showed the presence of various bioactive compounds in the methanolic extracts, some of them are sulfur rich compounds. Due to the good amount of nutrient content along with higher amount of bioactive phytochemical content, hightened antioxidant activity, high amount of mineral content and medicinal importance tree bean have been selected for the value addition as well as metabolite analysis which can be utilized for the socio-economic upliftment of the resource poor people of North-East India.

Application of Plant Bioregulators to 'Beauty Seedless' Grape Berries in a Hot Subtropical Climate: Influence on Colour and Biochemical Characteristics

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Abstract

Five-year-old grapevines 'Beauty Seedless' spaced at 3 x 3 m distance and trained on the bower system at the experimental field of the Division of Fruits and Horticultural Technology, ICAR-Indian Agricultural Research Institute (IARI), New Delhi (India) were sprayed with different plant bioregulators such as abscisic acid (ABA), ethephon, benzothiadiazole (BTH) and prohexadione-calcium (Pro-Ca) during 2019-20 season at the veraison stage with aim of studying their influence on berry physical and biochemical characteristics as well as leaf physiological and biochemical characteristics. The experiment was arranged in the randomised block design with three replications for each treatment and treatments included ABA (200 & 400 ppm), BTH (0.3 & 0.6 mM), ethephon (200 & 400 ppm), Pro-Ca (200 & 400 ppm) and control (water spray). Several berry physical characteristics like weight, length, diameter and firmness were positively influenced except for ethephon (400 ppm) and ABA (400 ppm) treatments which reduced the berry firmness significantly. Berry biochemical parameters were also improved by almost all the plant bioregulators, especially ethephon (400 ppm) and ABA (400 ppm). Berry colour was highly influenced by different bioregulators. Uniformly coloured berries were due to higher accumulation of monomeric anthocyanins in berries with application of ethephon 400 ppm followed by ABA 400 ppm. Also, both ethephon 400 ppm and ABA 400 ppm treatments produced maximum total phenolics, total flavonoids content and also resulted in highest antioxidant capacity. The most prominent effects of ABA and ethephon were noted on the total anthocyanins content of the berries as their accumulation tend to reduce drastically under the warm subtropical conditions in coloured grape genotypes. Various leaf physiological and biochemical characteristics were positively influenced by all sprayed substances.

Effect of Polyamines Treatment on Quality and Senescence of Jamun (*Syzygium Cumini Skeels*) Fruit Stored Under Low Temperature

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Extended Abstract

Introduction

Jamun (*Syzygium cumini* L. Skeels) is an ovoid, dark purple to crimson red, underutilized fruit native to tropical and sub-tropical climate. It is an opulent source of antioxidants like phenolic acids (hydroxyl benzoic acid), flavonoids, tannins (hydrolyzable and condensed); pulp and seeds contain alkaloid jambosine and glycoside jamboline. These compounds cumulatively impart the nutraceutical and anti- diabetic property to the fruit. However, the fruit is highly perishable owing to its thin epicarp and deteriorates within 2 – 3 days of harvest if stored at ambient conditions. Excessive fruit drop and subsequent impact bruising after hitting the ground further limits its availability at consumer level. Its popularity as a natural medicinal source therefore calls for the urgent need to extend the storability and preserve delicacy of *jamun*. During past few decades, polyamines (free aliphatic bases ubiquitous in nature) due to its higher effectiveness and eco-friendly nature have attracted attention of researchers to utilize it for delaying postharvest ripening and senescence of fruits and vegetables. However, no research has been conducted so far to find out the efficacy of polyamine treatment for delaying senescence of *jamun* and preserve its functional and sensory properties. This necessitated carrying out the investigation to study the effect of polyamines treatment on quality and senescence of *jamun* (*Syzygium cumini* Skeels) fruit stored under low temperature.

Materials and Methods

Freshly harvested fully ripe *jamun* fruits free from defects were selected for the experiment. Uniform sized fruit were treated with putrescine (0.5 mM, 1.0 mM) spermine (0.5 mM, 1.0 mM) and distilled water (control). Fruit were air dried and then packed in LDPE film bags @ 10 fruit/ bag and stored at low temperature of (7 ± 1ºC). The control fruits were stored in open conditions without any packaging. Moreover, one lot of untreated fruits were packed in sealed LDPE film bags while, another lot were packed in LDPE film bags and stored in unsealed condition.

Results and Discussion

The control fruit (those without treatment and packaging) exhibited rapid upsurge in weight loss from the preliminary days of storage. The minimum weight loss of (1.64%) and minimum decay loss of (13.33%) at the final day of storage (40^{th} day) was noted in PUT (1.0 mM) + LDPE film packed fruit. Nevertheless, it did not differ significantly with SPM (1.0 mM) packed fruits. Better weight retention and lower spoilage in polyamines treated fruit can be attributed to the ability of polyamines to scavenge reactive oxygen species thereby contributing towards membrane stability. Its ability to conjugate with phenolics and hydroxy cinnamic acid amides (HCAAs) distrupted plant pathogen interactions thus imparting pathostatic effect (Walters, 2003). The total anthocyanin content and total phenolics in *jamun* fruit (both control and treated) increased rapidly up to 20 days of storage and declined thereafter owing to enzymatic oxidation. However, maximum retention of total anthocyanins (68.96 mg/ 100 g FW) and total phenolics (456.13 mg GAE/100 g FW) was noted in fruit treated with PUT (1.0 mM) + LDPE film. Marked decline in ascorbic acid content, flavonoids content and total antioxidant capacity was observed irrespective of the treatment with advancement of storage period. The maximum total flavonoids content (53.70 mg CE/100 g FW) was recorded in PUT (1.0 mM) + LDPE film treated fruits followed by spermine (1.0 mM) + LDPE film treated fruits. After 40 days of storage, the maximum total antioxidant capacity (5.20 µmol TE/ g FW) was noted in PUT (1.0 mM) + LDPE film treated fruits. The anti senescence property of polyamines delayed the oxidation of enzymes responsible for degradation of ascorbic acid, phenols and flavonoids thus promoting better retention (Lester, 2000). Low temperature delayed the metabolic processes and LDPE films subsequently aided the retention by modulating the atmosphere around the fruit.

Conclusions

Polyamines treatment altogether enhanced the shelf life of *jamun* up to 40 days under low temperature storage (7 ± 1ºC). LDPE film packs manifested synergistic effect on shelf life by creating high CO_2 and low O_2 atmosphere around the fruits. The outcome of the investigation will be useful to reduce postharvest loss, extending storability and distant marketing of highly perishable *jamun* fruit.

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Quality Assessment of *Litchi* cv. China as Influenced by Postharvest Treatments

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Abstract

A laboratory experiment was conducted during 2016-2017 and 2017-2018 at the Department of Horticulture, NU:SASRD, Medziphema Campus, Nagaland to study the effect of different chemicals on the post harvest quality of litchi fruits. The experiment was composed of 17 treatments with three replications in a 2 factor Complete Randomized Design (CRD). After harvesting the fruits, they were pre-cooled and fan dried thereafter, the fruits were treated with Lecithin @ 0.5% (T_1), Lecithin @ 1% (T_2), Hot Water (T_3), Hot Water + HCl @ 3% (T_4), Calcium Chloride @ 1% (T_5), Calcium Chloride @ 2% (T_6), Calcium Sulphate @ 1% (T_7), Calcium Sulphate @ 2% (T_8), Wax Emulsion @ 5% (T_9), Wax Emulsion @ 10% (T_{10}), Calcium Nitrate @ 0.5% (T_{11}), Calcium Nitrate @ 1% (T_{12}), Chitosan @ 1% (T_{13}), Chitosan @ 2% (T_{14}), Kaolin @ 1% (T_{15}), Kaolin @ 2% (T_{16}) and Control (T_{17}). After the treatment was given, fruits were kept in a basket and evaluated after 2, 4, 6 and 8 days. Among the various treatments, the pooled data showed that T_{12} (Calcium Nitrate @ 1%) recorded the maximum TSS (18.17ºB) with lowest acidity (0.42%) and T_{10} (Wax Emulsion @ 10%) recorded minimum physiological loss of weight (PLW) of 8.40% at 8 DAH.

Variability Analysis in Eggplant Genotypes

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Extended Abstract

Introduction

Eggplant is a popular fruit vegetable in South East Asia with high production and demand. In this study, we evaluated 23 eggplant genotypes for their antioxidant capacity, flavonoids, phenolics content and enzyme activity.

Materials and Methods

Antioxidant capacity was measured by DPPH assay, flavonoids by aluminium chloride method and phenolics content was determined by Folin-ciocalteau procedure. The study was aimed to investigate variations in functional quality attributes in eggplant to aid the development of new varieties with increased bioactive compounds.

Results and Discussion

The maximum phenolics content was recorded in Kashi Taru (81 mg GAE/100 g FW) which was about 4-fold higher than PB × Uttara (19 mg GAE/100 g FW). High phenolics content contribute to high antioxidant capacity. However, high phenolics content and polyphenol oxidase enzyme activity has been associated with a disagreeable feature i.e. flesh browning in such cultivars. The flavonoids content was recorded to be highest in Kashi Uttara × Navin (5.8 mg Rutin Equivalent/100 g FW) followed by Kashi Himani, Kashi Komal, PR-5 × P. Upkar and Kashi Taru. The lowest flavonoids content was recorded in PR-5 × BR-14 (1.9 mg RE/100 g FW). The variation observed in antioxidant capacity among the 23 genotypes studied ranged between 0.88 (PR-5 × BR-14) and 1.15 µmol TE/g FW (Kashi Taru), depicting only about 1.3-fold variation.

Conclusions

The mean value for free radical scavenging capacity in most of the genotypes was observed to be ~1.0 µmol TE/g FW, leading to the observation that despite higher variation in total phenolics and flavonoids; the antioxidant capacity showed similar potential for free radical scavenging. This might have been due to the antioxidant capacity generated by the ascorbic acid content and antioxidant enzymes including superoxide dismutase, catalase, ascorbate peroxidase, etc.

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Track 03
New Initiatives in Crop Protection

Use of Bio-control Agents in Managing Rugose Spiralling Whitefly in India

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Abstract

Alien Invasive Species as 'one which becomes established in natural or semi natural ecosystems or habitat, and threatens native biological diversity'. These invasive species are widely distributed in all kinds of ecosystems throughout the world and include all categories of living organisms. In spite of strict quarantine laws, various insect pests, diseases and weeds have entered our country through accidental introduction. These newly introduced species pose threat to the biodiversity of the introduced area. Recently Rugose spiralling whitefly *Aleurodicus rugioperculatus* Martin (Hemiptera: Sternorrhyncha: Aleyrodidae), fall army worm, *Spodoptera frugiperda* (J.E. Smith) and Bondar's Nesting Whitefly (*Paraleyrodes bondari* Peracchi Hemiptera : Aleyrodidae) were reported to enter India during 2016 to 2018. Rugose spiralling whitefly is polyphagous and mainly infests coconut, banana, guava and many other fruits and ornamental plants. RSWF feeding causes stress to the plant by removing nutrients and water. Besides, it excretes a sticky, glistening liquid substance (honeydew), which provides an excellent substrate for growth of sooty mold. Rugose spiralling whitefly was observed to be parasitized by *Encarsia guadeloupae* and *Encarsia dispersa.* However, *Pseudomallada* sp. (Neuroptera: Chrysopidae), *Cybocephalus* sp. (Coleoptera: Cybocephalidae), *Diadiplosis* sp. (Diptera: Cecidomyiidae) and *Jauravia pallidula* Motschulsky (Coleoptera: Coccinellidae) were the most predominant predators on the RSWF. This chapter mainly focused on the RSWF and its infestation level in coconut. Further, current management practices and future perspectives were discussed.

Keywords: Rugose spiralling whitefly, coconut, *E. guadeloupae, D. astur* and *I. fumasorosea.*

Introduction

The increasing demand to gain more production by adopting new technologies and changing agricultural practices results in new hazards to health that are readily able to cross borders.

This free trade and movement of plant materials across political and geographical borders has led to the introduction of certain plant, insect and pathogen species to new localities. Such non native species are termed as Alien species. Alien species are non-native or exotic organisms that occur outside their natural adapted habitat and dispersal potential. Many alien species support our farming and forestry systems in a big way. However, some of the alien species become invasive when they are introduced deliberately or unintentionally outside their natural habitats into new areas where they express the capability to establish, invade and outcompete native species. (Raghubanshi *et al.,* 2005). These species, if not accompanied by the natural enemies which keep them in check in their native range, can multiply in large proportion and cause damage to economically important plant species and crop plants which makes them invasive. Some examples are invasion of coconut eriophyid mite *Aceria guerreronis*, the cotton mealy bug *Phenacoccus solenopsis*, the papaya mealy bug *Paracoccus marginatus*, the eucalyptus gall wasp *Leptocybe invasa* and rugose spiralling whitefly *Aleurodicus rugioperculatus* Martin (Hemiptera: Sternorrhyncha: Aleyrodidae) (Ananthakrishnan, 2009). Recently, fall army worm, *Spodoptera frugiperda* (J.E. Smith) has been reported from maize fields in Karnataka (Ganiger *et al.*, 2018). Furthermore, ICAR-CPCRI has discovered a new invasive Bondar's Nesting Whitefly (*Paraleyrodes bondari* Peracchi Hemiptera: Aleyrodidae) from Kerala during December 2018. It was recorded from coconut gardens earlier infested by rugose spiralling whitefly (*Aleurodicus rugioperculatus* Martin) during 2016 (Anonymous, 2019).

International Union for Conservation of Nature and Natural Resources (IUCN) defines Alien Invasive Species as 'one which becomes established in natural or semi natural ecosystems or habitat, and threatens native biological diversity'. These invasive species are widely distributed in all kinds of ecosystems throughout the world and include all categories of living organisms. Nevertheless, plants, mammals and insects comprise the most common types of invasive alien in terrestrial environments. Many non-native plants have allowed increasing productivity in agriculture, becoming a fundamental part of human economy, whereas others have developed into serious ecological problems. However, besides non-native plants, potential bio-safety risk factors comprise two additional groups: (a) taxa resulting from traditional breeding, and (b) genetically modified plants (GMPs) (Hoenicka and Fladung, 2006). The spread of Invasive Alien Species (IAS) is now recognized as one of the greatest threats to the ecological and economic well being of the country.

These species are causing enormous damage to biodiversity and the valuable natural agricultural systems upon which we depend. The direct and indirect health effects are increasingly becoming serious and the damage to nature and environment is often irreversible. The effects are exacerbated by global change and chemical and physical disturbance to species and ecosystems.

Table 1: *List of some invasive alien insect pests (Sujay et al., 2010):*

Scientific name	Common name	Introduced from	Year of intro-duction	Host Plants
Eriosoma lanigerum (Hausmann)	Woolly apple aphid	China	1889	Primarily apple and pea
Quadraspidiotus perniciousus Comstock	San Jose scale	China	1911	*Populus spp.*; *Salix spp.*; *Aesculus spp.*; *Alnus spp.*; *Betula spp.*; *Celtis spp.*; *Fagus spp.*; *Fraxinus spp.*; *Morus spp.* It also damages species of *Aesculus, Alnus, Betula, Celtis, Fagus, Fraxinus and Morus.*
Orthezia insignis (Browne)	Lantana bug	Sri Lanka; West Indies	1915	Mainly lantana, Coffee, Jacaranda, Citrus, Sweet potato, Gumwood, Brinjal, Rose etc
*Icerya purchasi (*Maskell)	Cottony cushion scale	-	1921	*Acacia decurrens*; *A. dealbata* in addition to numerous other forestry and agricultural Plant species
Phthorimaea operculella (Zeller)	Potato tuber moth	Italy	1937	Tobacco, tomato & brinjal
Plutellc xylostella (Linnaeus)	Diamond-back moth	Europe	1941	Crucifers *viz*., cabbage, cauliflower, radish, knoll khol (rabi),turnip, beetroot, mustard.
Pineus pini (Macquart)	Pine woolly aphid	Australia, Europe, New Zealand	1970	*Pinus* spp.; *Pinus patula*
Heteropsylla cubana Crawford	Subabul psyllid	Sri Lanka	1988	Subabul
Liriomyza trifolii Burgess	Serpentine leaf miner	USA to Kenya & rest of the world	1990	It is a polyphagous species affecting more than 78 plant species, especially serious on greens, cucurbits, tomato, castor and ornamental plants (Srinivasan *et al*., 1995).
Hypothenemus hampei Ferrari	Coffee berry borer	Sri Lanka	1990	Both *arabica* and *robusta* types of coffee.
Aleurodicus disperses Russell	Spiraling whitefly	Hawaii to Srilanka and India	1994	It is a polyphagous affecting wide range of host plants – 481 plants
Bemisia argentifolii Bellows and Perring	Silver leaf whitefly	-	1999	It is associated with an outbreak of tomato leaf curl, virus disease (ToLCVD) which resulted in failure of tomato crop.

Quadrastichus erythrinae Kim	Erythrina gall wasp	May be Taiwan	2006	Black Pepper
Leptocybe invasa (Fisher and LaSalle)	Eucalyptus gallwasp	Australia	2006	*Eucalyptus camaldulensis; E. tereticornis; E. grandis; E. deanei; E. globules; E. nitens; E.botryoides; E. saligna; E.gunii, E. robusta; E. bridgesiana; E. viminalis*
Phenacoccus solenopsis (Tinsley)	Cotton mealybug	unknown	2008	Cotton, bhendi, tomato, potato, pomegranate, hibiscus, parthenium, etc
Paracoccus marginatus Williams and Granara de Willink	Papaya mealybug	unknown	2008	Papaya, citrus, yams, cassava, and hibiscus, and several other unconfirmed hosts.

Recently, Rugose Spiraling Whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Sternorrhyncha: Aleyrodidae) entered india infesting coconut plantations across Kerala, Tamil Nadu, Karnataka and Andhra Pradesh. Presently, infestation of RSW increased over the time and spread across the southern states in India and extending its host ranges at greater level which could be due to its polyphagous nature. Immature stages of RSW produce profuse quantity of wax filaments both tufts of fluffy and long crystal like glassy rods. Furthermore, RSW produce honey dew which results in development of sooty mould. The severity of infestation ranged between 40-60 % in coconut and 25-40 % of leaf in banana and population including all the immature stages varied from 18 to 43 nymphs/ sq.cm of leaf and very high at midrib region. Complete drying of banana leaves was also noted in several places in Tamil Nadu and Kerala (Selvaraj *et al.,* 2016).

Origin and Distribution

Rugose spiralling whitefly was initially reported from Miami-Dade County, Florida, United States of America from gumbo limbo, *Burera simaruba* (L.) Sarg in 2009 as a pest. However, it was originally described from Belize in 2004 on coconut (Martin, 2004) where its natural population was reported. This whitefly is believed to have originated from Central America and distribution of this pest in Central and North America is limited to Belize, Mexico, Guatemala and the United States (Evans 2008). In the continental United States, the first established population of rugose spiraling whitefly was reported from Florida in 2009, and since then its distribution range has expanded considerably within the state and subsequently, it has spread to 22 other countries in Central and South America, including Florida, USA. India is the only country in the Oriental region where the whitefly has been introduced. Initially, this whitefly was observed in several coconut farms in the Pollachi area of Coimbatore district, Tamil Nadu and first reported in Kottayam from Kerala during July – August 2016 (Sundararaj and Selvaraj, 2017). RSW was noticed on coconut palms, mango and guava at Changanassery, Kottayam District, Kerala in India through accidental introduction. The pest has also been recorded from in Kadiyapulanka nurseries in Coastal

Andhra Pradesh during October-November, 2016. The possible entry to Andhra Pradesh may be via coconut seedlings from nurseries in Tamil Nadu and Kerala .

Description and Biology

Rugose spiralling whitefly was first described by Martin in 2004 from samples collected in Belize on coconut palm leaves (Martin, 2004).

Adults: Rugose spiralling whitefly adults are about three times larger (approx. 2.5 mm) than the commonly found whiteflies and are lethargic by nature. Rugose spiraling whitefly adults can be distinguished by their large size and the presence of a pair of irregular light brown bands across the wings (Stocks and Hodges, 2012). Males have long pincer-like structures at the end of their abdomen.

Eggs: Females lay eggs on the underside of leaves in a concentric circular or spiral pattern and cover it with white waxy matter. Eggs are elliptical and creamy white to dark yellow in color.

Immature stages: Rugose spiralling whitefly has 5 developmental stages. The first instar, known as the crawler stage (because it is the only mobile immature stage) hatches out of the egg, and looks for a place to begin feeding with its needle-like mouth parts and sucks plant sap. Crawlers molt into immature stages that are immobile, oval and flat initially but become more convex with the progression of its life cycle (Mannion, 2010). Nymphs are about 1.1 - 1.5 mm long but may vary in size depending on instars. The nymphs are light to golden yellow in color, and will produce a dense, cottony wax as well as long, thin waxy filaments (Stocks and Hodges 2012) which get denser over time.

Puparium: This species is typically characterized by broadly cordate vasiform orifice, operculum ventro-basally spinulose and dorsally characteristically rugose, with a pair of ventro-median fine setae; lingula head protruding beyond vasiform orifice, finely spinulose, apically acute, its four setae situated close to apex.

Host range: It is a polyphagous pest feeding on a wide range of host plants including palms, woody ornamentals, and fruits (Mannion 2010). Florida Department of Agriculture and Consumer Services (FDACS), Division of Plant Industry (DPI) records from 2009 to 2015 identified rugose spiraling whitefly on at least 118 plant species, which include a combination of edibles, ornamentals, palms, weeds, as well as native and invasive plant species (Stocks, 2012). Further, host plants recorded from 2009 to 2012 at Florida shows that 22% of rugose spiraling whitefly affected hosts were palm species, 16% were gumbo limbo, 10% were *Calophyllum* spp., 9% were avocado, 4% were black olive, and 3% were mango varieties (Francis *et al.*, 2016). Within the family Arecaceae (palms), 44% of host records were from coconut. Based on incidence records, these plant species can be considered as primary or preferred hosts of this pest. However, all plant species reported have not been documented as true hosts of the pest and may not require management. An insect must be able to complete its entire life cycle (egg to adult) to be considered a true host plant. Some plant species may not support the complete development of rugose spiraling

whitefly but may still be used by adult whiteflies for feeding and laying eggs. Thus, the level of feeding by adult whiteflies and development of other stages will determine the impact the whitefly has on the host plant and if management is required. A total of 17 plant species under 11 families were recorded as preferred hosts of *A. rugioperculatus* at Kerala. (Shanas *et al.*, 2016).

Current status of Rugose spiralling whitefly in coconut growing regions of coastal Andhra:

Survey conducted in the month of February revealed that RSWF affected the coconut gardens in East Godavari, West Godavari, Krishna, Visakhapatnam, Vizianagaram and Srikakulam districts. In these districts, the host preference of *A. rugioperculatus* was also recorded by scoring the presence of live egg spirals on leaf and categorized as Low (10 egg spirals/ leaflet), medium (10-20 egg spirals/leaflet) and high intensity (>20 egg spirals/ leaflet).

Table 2: *Incidence and intensity of A. rugioperculatus on various plants in Andhra Pradesh:*

S. No	Common name	Scientific name	Spirals per leaflet/leaf	Intensity
1	Coconut	*Cocos nucifera*	>30	High
2	Oil palm	*Elaeis guineensis*	>30	High
3	Cocoa	*Theobroma cacao*	<10	Low
4	Banana	*Musa* sp	10 -20	Medium
5	Seethaphal	*Annona squamosa*	Spirals on entire leaf	High
6	Curry leaf	*Murraya koenigii*	Spirals on entire leaf	Medium
7	Jack fruit	*Artocarpus heterophyllus*	Lower no of spirals	Low
8.	Papaya	*Carica papaya*	<10	Low
9	Yam	*Colacasia* sp	<10	Low
10	Mango	*Mangifera indica*	Lower no of spirals<10	Low
Ornamentals				
11	Bird of paradise	(*Strelitzia reginae*)	<10 (Low)	
12	Fish tail palm	*Wodyetia bifurcata*		
13	Spider lily	*Lycoris* sp		
14	Areca palm	*Chrysalidocarpus lutescens*		
15	Cabbage tree	*Pisonia alba*		
16	Rose apple	*Syzigium malaccense*		
17	Heliconia	*Heliconia stricta var. Iris Red*		

Table 3: *Incidence of Rugose white fly, A. rugioperculatus in Andhra Pradesh*

District	Villages
East Godavari	Kadiyam, Kadiyapulanka, Pottilanla, Appanapalli, Kothapeta, Atryapuram, Vedireswaram, Mosalapalli, Pulletikurru, Ganagalakurru, Kadali
West Godavari	Kalavalapalli, Chikkala, Korumamidi, Chagallu, Neeladripuram, Ramannagudem
Vizianagaram	Chintapalli (Bhogapuram mandal)
Krishna	Nuziveedu
Srikakulam	Ravada, Tekkali

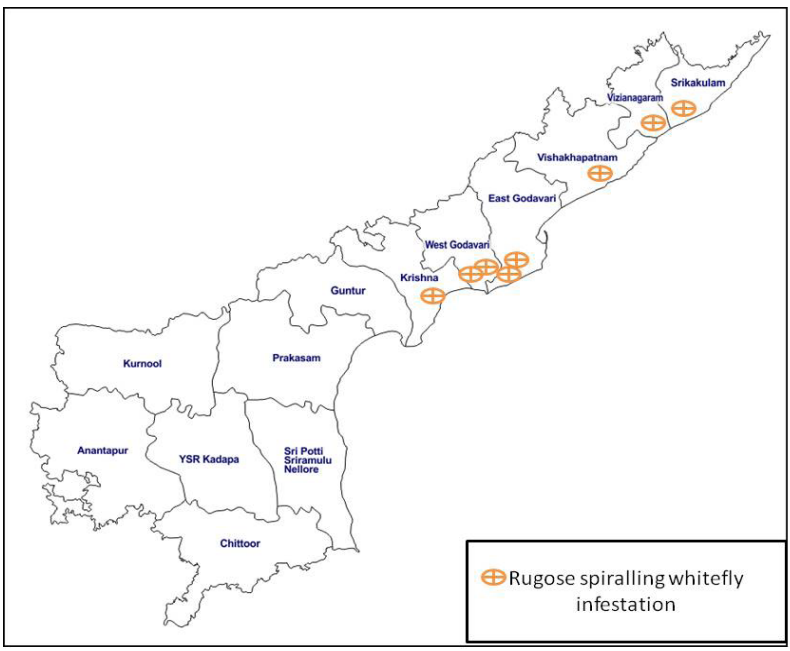


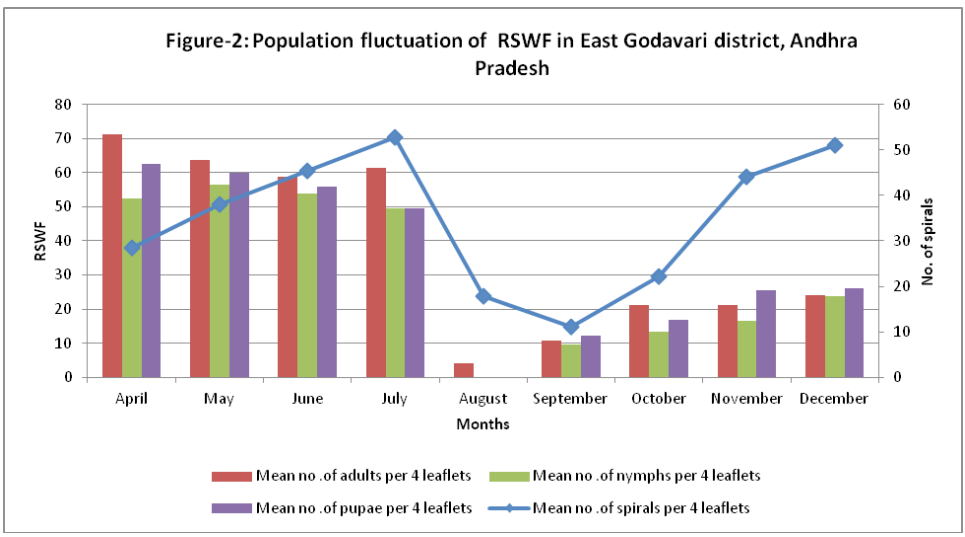
Figure 1: *RSWF affected districts of Andhra Pradesh (February 2019):*

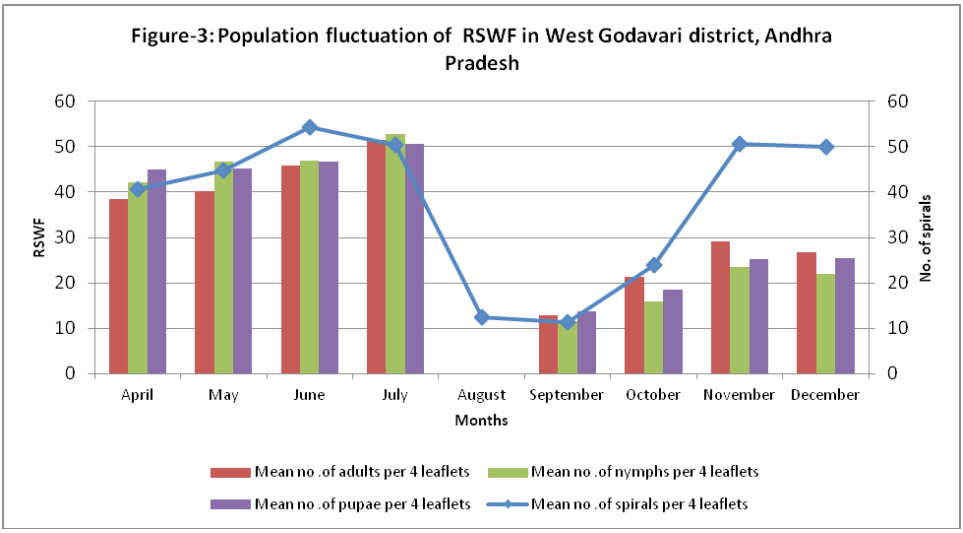
Table 4: *District wise area affected by RSWF:*

District	No. of villages	Area effected with Rugose spiralling whitefly		
		Coconut (ha.)	Oil Palm (ha.)	Grand Total area (ha.)
West Godavari	63	4428.20	9092.60	13520.80
East Godavari	155	1535.80	2461.50	3997.30
Krishna	1	2.80	0.00	2.80
Srikakulam	36	2185.25	129.00	2314.25
Vizianagaram	36	1336.0	45.00	1381.00
Visakhapatnam	28	738.20	16.00	754.20
Total	319	10226.25	11744.10	21970.35

Population fluctuation of RSWF:

Being an exotic pest, the data on the population fluctuation of RSWF was not yet documented under coastal Andhra Pradesh conditions. So to fulfil this *lacuna*, survey was conducted on monthly basis in the East and West Godavari districts. Three whitefly infested gardens were selected at three villages from each district. The number of spirals, adult, nymphs and pupae were counted from four leaf lets from five leaves of five palms in each garden. Further, per cent parasitisation of *E. guadeloupae* was calculated by counting the number of parasitized pupae and total number of pupae from the palms. The results of this experiment showed that during April, the mean number of spirals were 28.53 and 40.73 and the corresponding mean number of adult whiteflies were 71.36 and 38.58 in East Godavari and West Godavari districts, respectively. During May, the mean whitefly population per 4 leaflets was observed to be higher than the previous month and the population increase was continued till July. The adult population was 63.79 and 40.18 insects per 4 leaflets during May at East Godavari and West Godavari, respectively. Number of spirals and adults per 4 leaflets increased till July. During August, the whitefly population was observed to be 4.12 per four leaflets in East Godavari while no whitefly adults, nymphal and pupal stages were recorded in August. A very low whitefly population was recorded during September in both districts. The whitefly population was observed to increase from October with 22.16 and 24.02 spirals per 4 leaflets and the corresponding adult insect population was 21.22 and 21.38 per 4 leaflets at East Godavari and West Godavari districts, respectively. This increasing trend of population was continued till December (Figure 2 & 3).





Management

Mannion. 2010 of USDA advocated following management practices:

- Application of 1% starch solution on leaflets to flake out the sooty moulds.
- Spraying neem oil 0.5 %.
- Neonicotionoid insecticides can be applied with foliar, soil or trunk applications.
- Soil applications include drenching with water using granular formulations on the soil surface, or burying pellets.
- Trunk application includes basal bark sprays and trunk injection with systemic insecticides *viz.,* Acetamiprid, Clothianidin, Dinotefuran and Imidacloprid can be done (Mannion, 2010).

Central Plantation Crop Research Institute (CPCRI), Kasargod, has recommended the following measures:

- Spraying starch solution (1%) to dislodge the heavy sooty mould deposition on the leaves of infested plants.
- Use of yellow sticky traps to trap the adult whiteflies.
- In case of severe infestation, spray neem oil 0.5%.

Efficiency of current management strategies for Rugose spiralling whitefly:

The current management recommendations viz., spraying of Azadirachtin and installation of yellow sticky traps for management of RSWF needs to be evaluated under Andhra Pradesh conditions. For this purpose, following experiments were conducted.

a. Effect of Azadirachtin 1% EC on Rugose spiralling white fly:

An observation trail to study the efficacy of spraying of Azadirachtin 10,000 ppm @ 1ml on Rugose spiralling white fly was carried out in a 4 year old Godavari Ganga Hybrid coconut garden in Kalavalapalli village during October 2018. Three sprays were conducted on five palms with Azadirachtin 10,000 ppm @ 1ml at 20 day interval. The number of spirals per 10 leaflets in 5 palms before spray was 65.37±2.15 which was reduced to 29.52±1.48 (medium intensity) after first spray. After second spray12.63±1.27 spirals per 10 leaflets was observed which further reduced to 9.45±1.13 spirals per 10 leaflets. After third spray the mean number of egg spirals per 10 leaflets was reduced to 9.45±1.13 i.e low intensity which clearly shows that the regular spraying of Azadirachtin will reduce the intensity of whitefly incidence (Table 5).

Table 5: *Effect of Azadirachtin 1% EC on rugose spiralling whitefly:*

Mean no. of egg spirals per 10 leaflets in 5 palms			
Before spray	After first spray	After second spray	After third spray
65.37±2.15	29.52±1.48	12.63±1.27	9.45±1.13

b. Efficiency of yellow sticky traps in attracting Rugose white fly:

Use of locally made yellow sticky traps (yellow colour tarpaulin sheet used for fish pond bunds purpose available and sufficient to prepare 10 traps of 1 m x 1 m size smeared with castor oil at three days interval) was promoted instead of commercially available A4 size yellow sticky traps. The locally prepared yellow sticky traps were durable and cost effective. These yellow sticky traps were placed on tree trunks at 5 feet height. The adults, pupae and spirals per 20 leaflets in lower whorl coconut leaf were counted and compared to those on plams where sticky traps were absent. The observations from Vakkalanka village, the palms with yellow sticky traps recorded 17.00 + 1.53, 31.38 + 2.96 and 16.29 + 0.89 number of adults, pupae and spirals per coconut leaf, respectively. While the palms without yellow sticky traps had a significantly high number of adults, pupae and spirals. The number of adults, pupae and spirals per leaf on yellow sticky trap installed palms at Pulletikurru was 8.93 + 1.26, 39.56+ 2.34 and 18.62 + 1.73, respectively. Further, the palms without yellow sticky traps recorded significantly high number of 63.13 + 2.27 adults, 89.45 + 3.62 pupae and 27.39 + 1.13 egg spirals per leaf (Table 6).

Table 6: *Population of adult RSWF, Pupae and number of spirals in palms with and without yellow sticky traps*

(Average for 20 leaflets in lower whorl coconut leaf (Mean+ SE)

Vakkalanka, East Godavari	**Adults**	**Pupae**	**Spirals**
With Yellow sticky trap	17.09 + 1.53	31.38 + 2.96	16.29 + 0.89
Without Yellow sticky trap	57.43 + 3.95	73.65 + 5.13	24.37+ 1.21
Pulletikurru , East Godavari	**Adults**	**Pupae**	**Spirals**
With Yellow sticky trap	8.93 + 1.26	39.56+ 2.34	18.62 + 1.73
Without sticky trap	63.13 + 2.27	89.45 + 3.62	27.39 + 1.13

The results of these two experiments show that the Azadirachtin 1% and yellow sticky traps had significantly reduced the number of whiteflies per palm than the control palms. However, the RSWF infested palms has to be monitored continuosly for the population buildup of RSWF. The yellow sticky traps need frequent maintenance by cleaning and application of castor oil and the Azadirachtin sprays has to be given in 10-15 days intervals.

Biological control:

Parasitoids *viz., Encarsia guadeloupae* Viggiani (Hymenoptera: Aphelinidae) was known to parasitise *A. rugioperculatus* while Poorani and Thanigairaj, 2017 reported *Encarsia dispersa* Polaszek parasitizing *A. rugioperculatus* in surveys conducted at Tamil Nadu. A heavy parasitisation ranging from 40 to 70% was recorded on banana alone by *E. guadeloupae* (Poorani and Thanigairaj, 2017). However, survey conducted by Selvaraj *et al.* (2016) recorded 20–60% parasitism of *A. rugioperculatus* by *E. guadeloupae* on coconut in Tamil Nadu and Kerala. Among the two parasitoids, *E. guadeloupae* was more predominant, causing 60–70% overall parasitism while *Encarsia dispersa* was found in much fewer numbers compared to *E. guadeloupae* and the extent of parasitism was <5% (Poorani and Thanigairaj, 2017). A brief history of introduction and nomenclature and diagnostic details of *E. dispersa* are given in this chapter with notes on the predators of the rugose whitefly.

Encarsia guadeloupae:

Encarsia guadeloupae was first reported from Minicoy Island in the Lakshadweep in 1999 and later deliberately introduced into the mainland and established there (Ramani, 2000; Mani *et al.*, 2000a, b; Beevi & Lyla, 2001). It is likely these parasitoids migrated from the Maldives into Minicoy and other islands of the Lakshadweeps and later, assisted by the intentional release and colonization, spread to other areas of peninsular India (Ramani, 2000; Mani *et al.*, 2000b). It is also likely that the parasitoids were found only after their numbers increased phenomenally through breeding for several years on the expanding host population, although they had been introduced along with the host.

Key diagnostic characters of female *E. guadeloupae* are: body dark brown, except side lobes of mesoscutum and scutellum; mid lobe largely dark brown; axillae brown; TVII yellow or brown laterally; third valvula pale yellow. Wings hyaline, hind coxa and femur dark brown, legs otherwise pale yellow to white. Antennal formula, 1142; clava as long as last two funicle segments; mesoscutum with usually 9 pairs of setae (sometimes with variable number of setae, 15–20); scutellum with two pairs of setae; axillae normally with one setae each. Fore wing basal cell with 3 setae before parastigma. Mid tarsi-4 segmented; fore and hind tarsi-5 segmented. Similarly, *E. guadeloupae* and *Encarsia* sp. were recorded as potential parasitoids of many whiteflies including RSW (Evans, 2008: Taravati *et al.*, 2013; Francis *et al.,* 2016). Furthermore, the COI gene (658 bp) of the parasitoid was amplified, sequenced and deposited as *Encarsia* sp. (GenBank Acc. No. KY223606). The per cent parasitism ranged from 20.0-60.0 % in different locations, with highest parasitism recorded in Kerala as compared to other surveyed states (Selvaraj *et al.,* 2016).

Encarsia dispersa (Polaszek):

Encarsia dispersa Polaszek, is an exotic parasitoid of New World (Neotropical) origin. This species has been widely and erroneously referred to as *Encarsia haitiensis* Dozier, *Encarsia* sp. nr. *haitiensis* and occasionally as *Encarsia* sp. nr. *meritoria* Gahan by different authors from India (Ramani *et al.*, 2002) and elsewhere. It has been both deliberately and fortuitously introduced around the world for the biological control of spiralling whitefly, *Aleurodicus dispersus* Russell (Polaszek *et al.*, 2004). Polaszek *et al.* (1992) regarded *Encarsia haitiensis*, *Encarsia* sp. nr. *haitiensis* and *Encarsia* sp. nr. *meritoria* as distinct, though very closely related. Based on variations in DNA sequence data for the D2 region of 28S nuclear ribosomal genes, Polaszek *et al.* (2004) formally described this species as *Encarsia dispersa* and included it as part of the *luteola* species-group and the *Encarsia meritoria*-species complex and defined the species limits of *E. haitiensis, E. meritoria* and other related species. The widely introduced populations of *E. dispersa* probably originated from a single, or a few, original populations brought from Trinidad to Hawaii (Polaszek *et al.*, 2004). *Encarsia dispersa* was the first of two species of *Encarsia* accidentally introduced in South India along with its host, *A. dispersus*, in the late 1990s, the other one being *E. guadeloupae* (Ramani *et al.*, 2002). In an apparent case of competitive displacement, *E. guadeloupae* completely displaced *E. dispersa* within a short span of 2–3 years in most of the places in South India where it was colonized (Ramani *et al.*, 2002; Mani *et al.*, 2004; Mani, 2010).

Predators of Aleurodicus rugioperculatus:

Many indigenous predators have been observed feeding on *A. rugioperculatus* as in the case of *A. dispersus*. Poorani and Thanigairaj, 2017 collected predators of rugose whitefly on coconut at Kerala and Coconut Research Station (TNAU), Aliyar Nagar, were also brought to our attention. Among these, *Pseudomallada* sp. (Neuroptera: Chrysopidae), *Cybocephalus* sp. (Coleoptera: Cybocephalidae), *Diadiplosis* sp. (Diptera: Cecidomyiidae) and *Jauravia pallidula* Motschulsky (Coleoptera: Coccinellidae) were the most predominant.

Literature on the effect of parasitoid *E. guadeloupae* on rugose spiralling whitefly was scanty and the work on the per cent parasitisation by *E. guadeloupae* was yet to done. Keeping these point in view an attempt was made to study the per cent parasitisation of *E. guadeloupae* at Kalavalapalli village.

Per cent parasitization of E. guadeloupae on Rugose spiralling whitefly in coconut and oil palm:

The parasitisation by *E. guadeloupae* was not observed in the white fly infested gardens and nurseries in A.P. During December 2017 the parasitoids consignment were obtained from Coconut Research station, Aliyarnagar, TNAU. The first consignment of 150 numbers of *E. guadeloupae* parasitized pupae were released in coconut gardens in Kalavalapalli village of West Godavari district on 18-12-2017. Further on 08-1-2018 a second consignment of 250 numbers of *E. guadeloupae* parasitized pupae were released in Oil palm and Coconut gardens in Kalavalapalli and Chikkala villages in West Godavari district. The third

consignment of *E. guadelopae* parasitoid in higher numbers (3000 nos) were obtained and distributed for release in Kalavalapalli, Chikkala, Neeladripuram, Korumamidi and Chagallu villages in West Godavari and Kadiyapulanka and Pottilanka villages in East Godavari on 20.01.2018. The data recorded on parasitisation of Rugose whitefly by *E. guadeloupae* showed that during January, 20.01±1.69 per cent parasitized pupae were observed per 10 palms. Later the per cent parasitisation was increased to 72.06±3.15 during February which later decreased to zero during April till August. However, per cent parasitisation of 29.34±3.56, 42.38 ± 5.48, 69.49±4.94 and 68.83 ± 3.61 was observed during moths of September, October, November and December, respectively. Similarly on oilpalm, the per cent parasitization was 9.92±2.90 during January which declined to zero in April and no parasitisation was observed till August. During September, per cent parasitisation was 25.62 ± 1.84 which was observed to slowly increase to 49.16 ± 2.93 by December (Table 7).

Table 7: *Per cent parasitized whitefly pupae observed after parasitoid release on oil palm and coconut in Kalavalapalli village*

Month	Per cent parasitized whitefly pupae observed (For 10 palms at random)	
	Coconut (5 years old)	Oil Palm (15 years old)
January	20.01±1.69	9.92±2.90
February	72.06±3.15	59.97±3.65
March	52.81±3.07	33.01±4.09
April-August	Nil	Nil
September	29.34±3.56	25.62 ±1.84
October	42.38±5.48	33.87+2.26
November	69.49±4.97	46.71+2.48
December	68.83±3.61	49.16+2.93

Future perspective for management of RSWF:

Early recommendation for management of RSWF was spraying neem oil and installation of yellow sticky traps. Later the Aphenelid parasitoid *E. guadeloupae* was reported as effective measure for managing RSWF. However, the repeated sprays of neem oil is not feasible for the farmer due to labour constraints in Andhra Pradesh. Further, the parasitoid *E. guadeloupae* parasitisation is influenced by weather conditions which is evident from the Table 7. The establishment of the parasitoid is very slow and no parasitisation was observed during summer season (April to August). Under these conditions there is need for cost effective and feasible alternate approach for the management of RSWF. *Isaria fumosorosea* (Wize), entomopathogenic fungi was reported to be feasible for management of rugose spiralling whitefly. The culture of *Isaria fumosorosea* was procured from NBAIR, Bengaluru and sprayed at Kalavalapalli and Pulletikurru where it showed a promising results.

Pseudomallada astur:

Green lacewings with 4 clear wings. Most lacewings (also) feed on plant material, such as pollen. Particularly green lacewings (Chrysopidae) such as *Chrysoperla carnea*, *Mallada boninensis*, and *Mallada signata* are mainly predatory and very effective. They are relatively small (length up to 1.5 cm, including wings). Adults are active during the night, and may be attracted by flashlight. Most pesticides and high-copper fungicides are toxic to lacewings. A female lacewing may plant over 100 eggs on plants infested with aphids. These eggs hang on a thin 1 cm long stalk, most often under a leaf. The eggs hatch within 4 days. The larval period lasts 12 days, and the pupal period lasts about 9 days. The larvae have spines on their back that they impale the remains of their prey on, for camouflage.

The natural population of *D. astur* was observed feeding on the eggs and nymphs of RSWF at Kadiyam and Kadiyapulanka villages of East Godavari, Andhra Pradesh. *D. astur* grubs were collected from nursery at Kadiyapulanka. These grubs were reared at parasite breeding station, Horticultural Research Station, Ambajipeta using corcyra eggs. Grubs were reared in individual vials until pupation and then adults were transferred into the adult rearing cages. Adults insects were reared on artificial protein rich diet which is provided in semisolid paste. This diet consisted of equal parts of yeast, fructose, honey, Proteinex R and water. The adults lay eggs on the brown sheet provided on the lid of the rearing cage. The adults were collected on daily basis and transfered into fresh rearing cage with fresh food. From the old cages, the brown paper sheets along with *D. astur* eggs were removed and made into small pieces with 20-25 eggs. These small cuttings were pinned on the underside of RSWF infested coconut leaves. The eggs of *D. astur* are available in the HRS, Ambajipeta and the price is ₹ 150 for 1000 eggs.

Isaria fumasorosea (Wize):

It is an entomopathogenic fungus, formerly known as *Paecilomyces fumosoroseus*. It is a promising as a biological pesticide with an extensive host range.

Mode of action: When the spores of this fungus come in contact with the cuticle (skin) of the pest such as mites and insect, they germinate and grow directly through the spiracle in the cuticle in to the inner body of their host. The fungus proliferates throughout the insect's body, draining the mite and insect of the nutrients and the infected mite and insect eventually dies. *I. fumosoroseus* infects the mites and insects upon contact and does not need to be consumed by the host to cause infection.

Host Range of Isaria fumosorosea (Wize): It is commonly found in the soil (Cantone and Vandenberg, 1998) but has been reported on plants, in water, and less commonly, in air on every continent except Antarctica (Zimmermann 2008). It has been isolated from over 40 species of arthropods, representing 10 orders. Some of the more commonly known susceptible organisms include weevils, ground beetles, plant beetles, aphids, whiteflies, psyllids, wasps, termites, thrips, and a wide variety of butterflies and moths (Smith, 1993 and Hoy *et al.*, 2010).

Field demonstration on foliar applications of two formulations of *I. fumorosea* (Talc & rice grain based) was tested at Kalavalapalli, West Godavari and the results were found to be promising.

Farmer Training Programmes:

Under the present conditions the mass production of *I. fumorosea* for supplying farmer is very difficult. So as to meet the farmer's demand, one day training programs are being organized at Horticultural Research Station, Ambajipeta to train farmers for producing *I. fumorosea* on their own using rice grains. Farmers are provided with a kit and pamphlet as supplement to encourage them for producing this fungi. Further, demonstration on fungal spray to coconut trees was also given to farmers during the training program.

Conclusions

The current agriculture practices involve growing hybrid plants which require wide range of germplasm. The free movement of the plant material from one country to other for the purpose of breeding is unavoidable. The chances of introducing alien insect pests and diseases is high. Earlier Coconut eriophyid mite *Aceria guerreronis*, the cotton mealy bug *Phenacoccus solenopsis*, the papaya mealy bug *Paracoccus marginatus*, the eucalyptus gall wasp *Leptocybe invasa* entered India. Recently, rugose spiralling whitefly *Aleurodicus rugioperculatus* Martin was introduced Kerala during 2016. This insect pest later spread into coconut growing regions of Tamil Nadu, Karnataka and Andhra Pradesh. Being a polyphagous pest, this pest has wide number of plant species for multiplication there by posing threat to biodiversity of the introduced region. Spraying of neem oil 0.5% and installation of yellow sticky traps was recommended as management practice. The evaluation of these management practices showed that neem oil and yellow sticky traps offer better control. However, these management practices are not sufficient to bring heavy infestation of RSWF to normal level. Further, predatory insect *D. astur* and entomopathogenic fungi *I. fumasorosea* offer a better control. The integrated management involving *D. astur*, *E. guadeloupae, I. fumasorosea* along with neem oil and yellow sticky traps needs to be tested.

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Ecological Methods in Managing Plant Pathogens

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The global population increases from a rapid rate throughout the fast decades. Hence, there is an increasing food demand is existing to feed the increasing population in the world. The global food industry is basically depending on the agriculture commodities. Plant disease is one of the major threats faced by the agriculture industry. Due to the easiness for the farmers they mainly rely on usage of chemical control methods for plant disease control. But chemical control had hazardous effect on human health and environment. The low external input, as well as organic crop production is gaining momentum both globally and nationally due to verified negative effects of high input conventional crop production systems on human health and the environment (Reganold and Wachter, 2016). The transition towards more sustainable alternative crop production systems is required to cut down external inputs and substitute them with more ecological and biological approaches to manage biotic and abiotic stresses.

Ecological disease management concentrates on avoiding conditions that predispose plants to disease. In case of ecological based agricultural methods, factors in the disease triangle are much more important. Farmer usually has more control over the cropping environment such as increasing planting spacing, choosing the geographical location for cultivation. At the initial step, if farmer has the authority to make a correct decision. On the other hand, farmer often have less control of the host. But farmer has authority for usage of resistant cultivars, pathogen free planting material and practicing crop rotation. Ecological based agriculture with its goals of both high numbers and diversity of microbes in soil and on leaves, may increase its reliance on non-pathogens for disease control. Observation of climate and weather pattern is also important because in general, most plant pathogens like wet, warm weather with an abundance of free moisture on plant surface.

There are different ecological based disease management strategies which includes: crop rotation, soil amendments and organic amendments usage, biological control and natural compounds, weed control, and field nutrient management practices. Crop rotation is without a doubt a valuable method for plant disease management. In general, reducing or

excluding the initial inoculum is most effective for the management of monocyclic plant pathogens via crop rotation. That is associated with enhanced soil fertility, increased soil tilth and aggregation stability, improved soil water management, and reduce soil erosion.

Organic amendment usage is also a much applicable method. Compost and animal manure and compost are organic sources of nutrients that have been shown to increase soil organic matter and improve soil quality. Besides its nutrient components, those organic amendments, contain high number of beneficial organisms that prevent and help controlling soilborne diseases. It has multiple mechanisms of disease suppression: increased plant vigor caused by nutrient availability, presence of large populations of beneficial microorganisms, and increased drainage. Ammonia has been widely reported to adversely affect the survival or germination of certain soilborne fungi and nematodes.

There is an increasing interest in introducing biological agents and putting to use plant compounds as natural commercial products for managing plant pathogens. Various mechanisms are involved in the biological control of fungal pathogens. These mechanisms include: the production of secondary metabolites (antibiotics, siderophores, hydrolytic enzymes, volatile extracellular metabolites, hydrogen cyanide), parasitism, competition for nutrients, promotion of plant growth and, finally, induced resistance within the plants (Moeinzadeh *et al.*, 2010). Fungi belonging to the genus *Trichoderma* and bacteria such as *Pseudomonas*spp. or *Bacillus* spp. are the most widely using promising biocontrol agents. On the one hand, they stimulate plant growth, while on the other they eliminate plant pathogens by their unique antimicrobial activities, including the production of antibiotics and toxins to compete with pathogenic organisms.

Crops of the family Brassicaceae contain substances that have been associated with reductions in soilborne pathogens and pests. Brassica crops produce sulfur compounds called glucosinolates that release biologically active products during enzymatic hydrolysis. Isothiocyanates, the main metabolites of the glucosinolates hydrolysis are vapor compounds that are toxic to many soil organisms. They have been successfully used to reduce populations of soilborne pathogens in a process referred to as biofumigation. This approach can be use in the ecological based disease management system targeting g the effective suppression of soil born plant diseases.

Ecological based weed management and integrated soil nutrient management with less herbicides and fertilizers have become important in this scenario. Weed plants can significantly influence the disease incidence by acting as a pest itself, vector of a pathogen or a reservoir of a pathogen or its vector. Competition is also seen among the crop and

weeds for natural resources, which weakens the crop, resulting in increased probability of pathogen infection (Schreiber *et al.*, 2018). Therefore, effective weed management is much useful strategy in ecological disease management.Furthermore, increasing crop density by increasing seeding rates has been identified as one of the major ecological strategies to out-compete weeds in cereals as well as to increase resource use efficiency. The competitiveness of the crop can be increased by employing a high seed rate to facilitate a quick canopy closure and decreased weed growth. However, such ecological changes in the cropping systems can alter other biological and ecological process due to changes in the microclimate particularly by negatively influencing the disease development in the crop. The low availability of nitrogen can also influence disease dynamics in crops. Plant growth at high nitrogen availability may result in increased plant susceptibility to pathogens due to increased foliar nitrogen concentrations.

As a conclusion, all of these, used in combination, are viable as a part of IPM strategy, even though they do not completely eliminate pathogens from the soil. Initial results obtained by combining different methods for the control diseases imply a necessity to continue research in this area in order to insure long-lastingsustainability of crop protection in case of achieving sustainability of the cropping systems.

Sustainable Management of Groundnut Aphid (*Aphis craccivora Koch*.)

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Extended Abstract

Keywords: Aphid distribution, Microbial toxin, Plant extract, Organic cultivation

Introduction

Groundnut (*Arachis hypogaea* L.) family (Fabaceae) is an important legume crop of high nutritive value as well as being a source of edible oil. *Aphis craccivora* is a serious pest on cowpea, groundnut, yard-long bean, and peanut starting from the seedling stage to pod-producing stage. Severe aphid infestations cause stunting, crinkling and curling of leaves, delayed flowering, resulting in yield reduction. The botanical insecticide azadirachtin was found effective against aphid, achieving 59.23% suppression at three days after spraying (Ghosh *et. al.,* 2004). Ghosh (2015) reported that *Polygonum hydropiper* flower extract and tobacco leaf extract gave more than 70 % and 65 % aphid suppression respectively. Imidacloprid 30.5 SC @ 160ml/ha and Spinosad 45 SC @100ml/ha gave significant population reduction of aphid over control, providing 88.73% and 63.04% control respectively (Thakoor *et. al.,* 2019). Acetamiprid was found highly efficacious against aphid and found to suppress 85.11% aphids closely followed by *neem* + *Spilanthes* (73.29% control) (Ghosh, 2017). Synthetic insecticides, DDVP and malathion caused significantly higher killing (>50%) whereas botanical insecticide, neem caused lower killing (less than 40%) of the *Coccinella sp* (Ghosh, 2016). Chakraborty and Ghosh (2010) reported that neemactin based solution was less lethal to *Coccinella septempunctata*. Hence, the present research was taken to evolve a technically feasible, environmentally sound and economically viable safe pest management strategy of groundnut crops by using bio-pesticides.

Methodology

The experiment was conducted at Kalyani, West Bengal, India during the year 2018. The geographical location is 23° N latitude, 89° E longitude and 9.75 meter above mean sea level-MSL (Thakoor *et. al*., 2020). The soil of the area is gangetic alluvial soil (Entisol)

with sandy clay loam texture and moderate in fertility (Priyadarsini *et. al.,* 2019). The soil type of the study field was sandy loam with PH range 5.75 to 6.5 (Bala *et. al*., 2015). One microbial toxin, *Saccharopolyspora sponisa* (Spinosad 45 SC) , two botanical extracts viz tobacco (*Nicotiana tabacum)* leaf, and *Polygonum hydropiper* floral parts, one plant based insecticide formulation, azadirachtin (Nmarin1500 ppm) were evaluated and compared with the chemical insecticide, Imidacloprid (Confidor 17.8 SL). Some combinations of treatments i.e. mixed formulations are also used. The study during post-kharif-2018 was done as, date of showing on 12/08/2018 and date of harvesting on 30/12/2018. Three sprays were done at 11 day intervals. The polygonum (*Polygonum hydropiper*) floral parts, were extracted in methanol by following the standard method developed by Ghosh *et. al.* (2016). Tobacco (*Nicotiana tabacum)* leaves were extracted in water by following the standard method developed by Mandol *et. al.* (2016).

Results and Discussions

Aphid population was most densely populated in the upper canopy (47 % population approx) followed by middle canopy (44 % approx.) and lower canopy (8% approx). Ghosh (2018) supported this type of distribution. Imidacloprid was found most effectively against aphids providing 85 % suppression, closely followed by mixed formulation Azadirachtin+tobacco providing 81% suppression and imidacloprid + Polygonum (79 % suppression). From over all observation it was revealed that microbial toxin spinosad, mixed formulation Azadiractin+ polygonum, botanical pesticide Azadiractin and tobacco leaf extract gave moderate to higher results, recording about 77%, 76 %, 72% and 58 and 55 % aphid suppression respectively. However, extracts of *Polygonum* plant gave better aphids control, recording more than 60% suppression which is supported by Ghosh *et al*., (2009) where they reported that polygonum plant extracts provided 59.77% aphid suppression in ladysfinger field. Das *et.al.* (2010) and Ghosh *et al.,* (2012) reported that a rapid degradation of persistency was observed in imidacloprid and neem oil. So imidacloprid as small amount may be recommended mixing with plant based insecticides for general use of the farmers for its higher efficacy and rapid degradation. We can use plant based insecticides with plant extract as mixed formulations. Plant based insecticides or plant extract cannot give higher control when it is used individually but when it is mixed with other formulations it provides higher control. Plant extracts (bio-pesticides) having less or no hazardous effects on environment can be incorporated in Integrated Pest Management.

Conclusions

Aphid populations are mostly congregated on upper and middle canopy. So for aphid control special care should be taken to spray. Mixed formulation Azadirachtin+tobacco and imidacloprid + Polygonum providing higher aphid control which are at par with the chemical insecticide, imidacloprid. Small amount of chemical insecticide mixing with bio-pesticides are also less harmful. So they also are included for aphid control. Bio-pesticides

used under the present study are of biological origin having low or no hazardous effect on environment and health so can be incorporated in IPM programme for aphid management.

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Chilli Mite (*Polyphagotarsonemus latus Banks*) Management and Environmental Sustainability

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Extended Abstract

Keywords: Neem, avermectin, *Spilanthes*, plant extract, organic farming

Introduction

Chilli (*Capsicum annum* L.) is an important spice and vegetable crop, commercially grown in India throughout the year. India is the largest producer of dry chillies and peppers in the world (Priyadarshini *et al*., 2017) The plant is susceptible to various insect and mite pests of which yellow mite, *Polyphagotarsonemus latus (*Banks), (Tersonemidae: Acarina) is most predominant. The incidence of mite population always remained higher on the upper canopy of the plant (Ghosh, 2013). Neem, Pongamia, Adathoda, Turmeric, Tobacco, Indian privet, Chrysanthemum, Onion, Garlic, Ocimum, Custard apple, *Polygonum, Spilanthes,* Zinger are reported as most common plants having insecticide properties (Subba *et al.,* 2017). Mixed formulation of botanical pesticide, azadirachtin with chemical pesticide, dicofol provide best suppression of mite population on eggplant (71.41 %) (Ghosh and Chakraborty, 2014). The mite mortality percent on chilli crop was found high in Fenazaquin 10 EC treatment (Bala and Ghosh, 2016). Ten days after spraying against garlic mite *Aceris tulipae* it is found very low population (1.40 mites per sq. cm) in fenazaquin treatment as compared to untreated control (6.78 mites per sq. cm.) (Bala *et. al*. 2015). Ghosh *et al*. (2009) reported that avermectin provided 83.42 % mite control on lady'sfinger. The objective of this study is to determine the efficacy of microbial toxin, the plant extracts against mite and to formulate suitable control measure.

Methodology

The experiment was conducted at Kalyani, India during 2016-2017. The geographical details of the site are 23° N latitude, 89° E longitude (Thakoor *et. al*., 2020 ; Priyadarsini *et. al.,* 2019). The soil of the field was sandy loam with pH value 6.9 (Karmakar *et al.,* 2017). Chilli variety 'Bullet' was grown during 2016-2017 crop seasons. One microbial toxin avermectin (Vertimec 1.9 EC) @ 1ml/L, one botanical insecticide azadirachtin i.e.

neem (neemactin 0.15 EC) @ 2.5 ml/L, two botanical extracts viz. *Spilanthes paniculata* floral parts extract @ 7.0%, and garlic (*Allium sativum*) extract@ 7.0%, two treatments containing mixture of azadirachtin and *Spilanthes* @ 2.5 ml + 70 ml/L and mixture of azadirachtin and garlic @ 2.5 ml + 70 ml/L were evaluated and compared with Fenazaquin (Magister 10EC), @ 2ml/ L to control the mite pest. The polygonum (*Polygonum hydropiper*) floral parts were extracted in methanol by following the method developed by (Ghosh *et. al.* 2016; Mandol *et. al.* 2016; Ghosh and Chalraborty, 2012). Four sprays at 10 day intervals were made. Mite population was recorded 3, 6 and 9 days after each spraying with RBD design.

Results and Discussions

Population of mites were most densely populated in the upper canopy (58.35% population) followed by middle (31.23%) and lower canopy (10.42%) which is supported by (Ghosh, 2019). Among the seven treatments evaluated (table 1) microbial toxin- avermectin treatment resulted best suppression of mite population (86.32 % suppression), closely followed by chemical insecticide, fenazaquin and mixed formulation of botanical pesticide, azadirachtin with botanical extract, *Spilenthes* (73.07 % and 70.99% suppression respectively). However among the bio-pesticides including plant extracts avermectin was the most effective for mite control followed by mixed formulation of botanical pesticide, azadirachtin with botanical extract, *Spilenthes* and another mixed formulation azadirachtin with botanical extract, garlic (70.99% and 64.02% suppression respectively). Three days after spraying, avermectin treatment was found most effective (83.25% suppression) followed by fenazaquin (80.10 %) and mixed formulation of botanical pesticide, azadirachtin with botanical extract *Spilanthes* (73.42 %) against mite. The avermectin treatment is significantly different from all other treatments. Six and nine days after spraying the results of the different treatments evaluated followed the findings of three days after spraying. These biorationals like microbial toxin, botanical formulation can be used in combination for effective management. Therefore from the present investigations, it can be concluded that all the biorationals tested were effective in reducing the mite population and can form an integral part of integrated mite management and organic farming programmes.

Conclusions

Mites were most densely populated in the young and new leaves of chilli plant on upper canopy. So sprays should be carefully taken on the upper canopy. Avermectin and mixture of azadirachtin with botanical extracts gave moderate to higher mite suppression (more than 64% suppression). Considering moderate to higher efficacy as well as its low toxicity to natural enemies and minimum impact on human health microbial toxin, botanical insecticides, botanical extracts can be incorporated in future IPM and organic farming. Azadirachtin individually did not produce higher results but when mixed with botanical extracts gave higher results of mite control recording more than 64 % suppression. Plant based formulation and microbial toxin may be used as alternative of chemical pesticides

for eco-friendly management of insect pest in vegetable cultivation to avoid health hazards and environmental pollutions.

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Morphological Mechanisms in Insect Resistance: A Mini Review

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Extended Abstract

Introduction

The relationship between plants and insects is an ancient and fascinating one. Over the years plants have developed numerous strategies to make them resistant to predation by insect herbivores. To counter the herbivore attack, plants produce specialized morphological structures or secondary metabolites and proteins that have toxic, repellent and anti nutritional effects on the herbivores. Many plants have evolved adaptations that allow them to have insect resistance or the natural ability to defend themselves against insects. Plant morphology or the plant's structure is the first line of defense against insects.

Methodology

This review shows various mechanisms which are employed by plants as defense system against the attack of various insects pests. Plants confront the herbivores both directly by affecting host plant preference or survival and reproductive success (direct defense) and indirectly through other species such as natural enemies of the insect pests (indirect defense). Direct defenses are mediated by plant characteristics that affect the herbivore's biology such as mechanical protection on the surface of the plants or production of toxic chemicals that either kill or retard the development of the herbivores. Indirect defenses against insects are mediated by the release of a blend of volatiles that specifically attract natural enemies of the herbivores and/or by providing food and housing to enhance the effectiveness of the natural enemies.

Results and Discussion

Some plants have acquired morphological adaptations that make them at least partially resistant to insect predation. These adaptations can be broken down into the following categories.

Color: Certain colors are less attractive to certain insects. For example, imported cabbage worm is less attracted to red colored Brassica species (cabbages, broccoli, and related

species). Cucumber beetles do less damage on reddish colored varieties of leaf lettuce and are attracted to certain hues of yellow. Some birds preferred plums to green plums.

Shape: While it is impossible to generalize what shapes resist predation better, shape does play a role in avoiding predation. For example, one study noted that thick rooted turnips were less damaged by turnip maggots. Another study showed that onions with leaves having a narrow angle of contact are more attractive to thrips than onion varieties with looser leaves.

Thickening of cell walls and rapid growth: In response to predation some plants create tougher leaves or callous tissue. Both corn and soybeans have been noted to increase growth in response to feeding by certain aphids.

Hairiness: Many plants utilize trichomes (plant hairs) to protect themselves against predation. A few examples of insects that are at least partially suppressed by plant hairiness include bean aphid and potato leaf hopper on beans, two spotted spider mite on strawberry, and whitefly on tomatoes, peppers, and potatoes.

Surface waxes: Waxy leaf surfaces provide protection against some insects, cabbage flea beetle on Brassicas, for example, but may encourage other insects (i.e., cabbage aphids).

Conclusion

There is a need to understand the herbivore-specific signal molecules, their identification, mode of action and further signal transduction. Since a single attribute can affect the herbivores and natural enemies positively or negatively, understanding of the multitrophic interactions is important to know the consequences of supposed defensive traits of a plant for use in pest management. An understanding of induced resistance in plants can be utilized for interpreting the ecological interactions between plants and herbivores and for exploiting in pest management in crops. Since the biochemical pathways that lead to induced resistance are highly conserved among the plants, the elicitors of these pathways could be used as inducers in many crops. The future challenge is to exploit the elicitors of induced defense in plants for pest management and identify the genes encoding proteins that are up or downregulated during plant response to the herbivore attack which can be deployed for conferring resistance to the herbivores through genetic transformation. However before using an elicitor effectively in agricultural systems it isimportant to understand the chemical changes they induce in the plant, the effect of these chemicals on the herbivores especially in the field and to see if there is any alteration in plant growth and yield.

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Egg parasitoids of *Leptocorisa* spp. at Sabour, Bihar

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Keywords: *Leptocorisa*, Parasitoid, Rice, Bihar

Introduction

Leptocorisa spp. (Hemiptera: Alydidae) are one of the important grain sucking pests of paddy. It has been reported that out of the nine species of *Leptocorisa, L. oratorius* is the most important in tropical climates. The present study aims to record the availability of egg parasitoids (including percent parasitism) of *Leptocorisa* spp. at Sabour region of Bihar.

Materials and Methods

From seed production plots of paddy (*Variety*: MTU 7029) of Bihar Agricultural University Research Farm, Sabour, during the months of September-October, 2019, a total of 145 egg masses were collected. The un-emerged egg masses were separated from the emerged out egg masses and were kept in cotton plugged test tubes for further observations. Out of the 145 collected egg masses, 114 egg masses were already hatched out. Therefore, a total of 31 un-hatched egg masses were taken for further observation regarding field parasitisation by egg parasitoids of *Leptocorisa* spp. (irrespective of *L. oratorius* or *L. acuta*). The test tubes were then placed inside BOD incubator (at 27 °C). After keeping the egg masses in the individual test tubes for 12 days, the test tubes were observed regarding emergence of parasitoids/nymphs of *Leptocorisa*. The number emerged out *Leptocorisa* nymphs/ parasitods/un-hatched eggs were counted egg mass wise. After taking the count of emerged out egg parasitoid from individual egg masses, the adults of those were quickly preserved in 70% ethanol for identification of those.

Results and Discussion

Egg parasitoids of *Leptocorisa* spp. at Sabour

During the course of the laboratory study, two different species of egg parasitoids were found. The parasitoids belonged to the families Scelionidae (Hymenoptera) and Encyrtidae (Hymenoptera). The Scelionid parasitoid was identified as *Gryon* sp. and the Encyrtid parasitoid was *Ooenocyrtus* sp.

Observation regarding field parasitism rates by egg parasitoids

The number of eggs of *Leptocorisa* in the egg masses varied from 5 to 17 and the mean number of egg was 11.8 per mass. Number of field parasitized eggs (out of 31 studied egg masses) varied from 0-15 and the number of un-hatched eggs ranged from 0-7. The percent field parasitism (from the point of view of number of emerged out parasitoids from a single egg mass) was as high as 100 percent with minimum of 56.3 percent. The mean percent parasitism (where ever an egg mass was parasitized) was found to be very high which was 80.3. However, if the total number of eggs was considered, out of 366 individual eggs, 176 eggs, i.e. 48.1 percent of the total eggs were found to be field parasitized. As far as the number of egg masses parasitized was concerned, out of 31 egg masses, 15 egg masses were parasitized. Therefore, from the point of view of percent parasitization of the egg mass, it was 48.4 %.

Conclusions

From Tropical Asia, Barrion *et al.* (1981) reported three most prevalent egg parasitoids in that region, *Gryon* (*Hadronotus*) *nixoni* (*flavipes*) and *Telenomus camperei* under the family Scelionidae, and *Ooencyrtu smalayensis* under the family Encyrtidae. Purohit *et al.* (2013), from NAU, Navsari, Gujarat observed multiple parasitism of *Leptocorisa* eggs by two egg parasitoids viz. *Trissolcus* sp. (Hymenoptera: Scelinoidae) and *Oenocyrtus utetheisae* (Hymenoptera: Encrytidae) which occurred from last week of September and remained active till the third week of October with a peak in the second week of October. The present investigation reports two egg parasitoids of *Leptocorisa* spp. at genus level only i.e., *Gryon* sp. and *Ooenocyrtus* sp., *The present investigation registered an average of* 48.1% egg parasitism (irrespective of species) which is much higher than the available reports but the egg mass parasitism (48.4 %) was almost equal to the report of *Sands (1977)*.

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Is *Oomyzus Scaposus* an Enemy in Wheat Crop at Sabour?

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Extended Abstract

Introduction

Coccinellids are plagued by several parasitic insect species and one of the common larval-pupal parasitoids of coccinellids is *Oomyzus scaposus* (Thomson) (Hymenoptera: Eulophidae, Tetrastichinae), parasitizing the species of tribes Coccinellini, Chilocorini and Scymnini. The female lays eggs inside 3rd and 4th instar larvae and mature parasitoids emerge from pupae (Ceryngier *et al.* 2012). A parasitized ladybird larva usually develops to the pupal stage and then dies after turning darker in colour. Adult wasps emerge from one, or sometimes more, small openings bitten through the cuticle in the dorsal side of the pupa. If young larvae (first and second instar) are parasitized, wasps may emerge before the host pupates (Filatova 1974). In the complex natural organization of insect pests and their bio-agents, some species of parasitoids reduce the population of beneficial insects and this phenomenon (Hoogendoorn and Heimpel, 2002). Therefore, the present study was attempted to investigate the presence of parasitoid/s of the predatory ladybird beetles in wheat crop at Sabour, Bihar.

Materials and Methods

The untreated wheat crop raised in the experimental farm of Bihar Agricultural University, Sabour, Bihar, India during *rabi* season of 2018 was chosen for the study. To investigate the parasitism in coccinellid species, pupae of coccinellids viz., *Coccinella septempunctata, Coccinella transversalis* and *Menochilus sexmaculatus* were collected from the experimental field of wheat. A total 30 samples were collected. They were kept individually in glass vials in the laboratory (24±1°C, 65±5% RH and 12L: 12D photoperiod) till the emergence of parasitoids or the adults of the collected coccinellids. To maintain the aeration in the vials, lids were removed and the openings were covered with water soaked cotton. The data was formulated on the basis of percent parasitization of the collected coccinellids from wheat.

Result and Discussion

Pupae of coccinellids (*Coccinella septempunctata, Coccinella transversalis* and *Menochilus sexmaculatus*) were collected in the month of March 2018. The species of hyper-parasitoid

found was identified as *Oomyzus scaposus* emerging from pupa of coccinellids. The infestation of *O. scaposus* was recorded in March during the experimental year 2018. It was observed that the pupae of *C. septempunctata* were parasitized the most among all the coccinellid predators collected with percent parasitization of 53.3%, followed by the pupae of *C. transversalis* with percent parasitization 16.6%. Out of 30 samples, 9 samples remained unparasitized, from which one pupa emerged into adult of *Menochilus sexmaculatus*. From 1 pupa, adult didn't emerge even though the sample was not showing any symptoms of parasitization and from rest seven pupae, adults of *C. septempunctata* emerged. The parasitism of *O. scaposus* was observed to be the highest among *C. septempunctata* followed by *C. transversalis*.

Percent parasitization was calculated using the formula:

$$\text{Percent of Parasitization} = \frac{\text{Number of parasitized larvae}}{\text{Total number of collected larvae}} \text{x } 100$$

It was further observed that the hyper-parasitoid *Oomyzus scaposus* (Thomson, 1878) emerged from infected pupae of coccinellids was belonging to super family Chalcidoidea, family Eulophidae of order Hymenoptera by running the keys of T.C. Narendran (2007). The host preference as well as rate of infection varied among different species of ladybird beetles and highest parasitization was observed in *C. septempunctata* followed by *C. transversalis* and *Menochilus sexmaculatus*. The reason behind the maximum hyper-parasitization in *C. septempunctata* might be due to ubiquity of the species population in the wheat ecosystem. The detailed study of this parasitoid species is well studied by Yefremova (2004) and Narendran (2007).

Conclusions

Findings of the present investigation indicated that the predatory coccinellids (*C. septempunctata*, *C. transversalis* and *Menochilus sexmaculatus*) in the wheat crop at Sabour were not there on the topmost layer of the food chain as significant numbers of those were found to be parasitized by *Oomyzus scaposus*. The phenomenon was observed in both larvae and pupae of coccinellids. Although it reduced the population of predatory coccinellids, but simultaneously it showed the longer food chain to exist in the present location and crop and therefore, in spite of tagging the *Oomyzus scaposus* as negative biological control agent, the presence of that could be used as ecological indicator by the scientific community.

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Inappropriate Disposal of Beverage Cups An Emerging Threat to Bee Decline

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Extended Abstract

Introduction

Pollinators play an important role in preserving the world's flora and fauna. Insects conduct about 80% of total pollination activities, with bees being the top pollinators among them. Honey bees, such as *A. dorsata*, *A. cerana*, *A. mellifera*, and *A. florae*, are essential pollinators of crops in India. Although the services they bring to humanity are unavoidable, research suggest that over 40% of honey bees in India have vanished in the previous 25 years. The major reason for the extinction of these pollinators is habitat destruction, agricultural chemicals, pests and diseases. Recently new dimension of studies registering various inconceivable causes of honey bees' population decline, one among these is inappropriate use of treacle in sweet shops (Das *et al.*, 2021).

Materials and Methods

In quest of novel drivers of bee decline, a survey was undertaken in Mohanpur, Nadia, West Bengal (22056'38" N; 88031'57" E and 3.53 msl). Ten popular tea shops were chosen at random to see if waste cups from tea stalls have any impact on bee decline because waste cups contain leftover tea. The survey was carried out continuously for a period of one month, February 2020 at 9-10 am, peak foraging hours of pollinators. The data on diversity and abundance of dead pollinators were recorded for a period of 1 hour and also the percent mortality was calculated.

Results and Discussions

During entire survey, two honey bee species *viz*., *Apisceranaindica*, *A. dorsata* and a group of dipteran flies (Syrphids, house fly and fruit fly) were observed to visit the used tea cups in the dust bean. With an average of 46.7 (37-56) waste cups, a mean of 32.3 (28-36) *Apis*

cerana indica, 18.1 (12-23) *A. dorsata* and 26.8 (21-34) flies were found dead in an hour of a day per stall. Among the total mortality, 42% occurred in case of *Apis cerana indica* which was the highest followed flies (35%) and *A. dorsata* (23%) (Figure 1). The present findings corroborated the findings of Sandilyan, 2014 who have documented that *Melipona iridipennis* get attracted toward disposable cup and nearly 48 bees/10 min were found to have lost their lives in a single cup. The variation in number of dead bees observed here might be due to species variation. Similarly, Chandrasekaran *et al.*, 2011 recorded 25,211 dead bees in the coffee bars in one-month study.

Conclusions

The waste cups are appearing as artificial traps for pollinators and increase in their use seriously threatening the pollinators'abundance which ultimately challenging the sustainability of biodiversity and animal food security.

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Molecular Detection of Potyviruses Associated with Garlic Bulb and Their Field Response

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Extended Abstract

Introduction

An experiment was designed to detect garlic bulb associated viruses through RT-PCR and to evaluate the response of genotypes against viruses under field condition. The present study was conducted at Bihar Agricultural University, Sabour, Bhagalpur, Bihar during 2019-20 to study the incidence of bulb-associated Potyviruses in garlic through molecular diagnosis. The suspected leaves of genotypes were tested for the virus through RT-PCR assay. Majority of genotypes were found positive with potyvirus by producing 300 bp band. Under field condition, maximum genotypes showed the highest incidence at 90 days after sowing e.g. G-282 with 20.7 per cent followed by G-1 with 15.0 per cent disease incidence. Among all the entries, three genotypes, i.e., 499, 516 and 493 showed no any disease symptoms. The present study will be helpful to manage the crop by selecting virus-free garlic. Moreover, timely application of control strategies may be followed based on the field response of disease.

Methodology

(a) Molecular detection of Potyviruses in garlic

Suspected leaves from garlic genotypes were collected from the Vegetable Research Farm, BAU, Sabour. Total RNA of all the samples was extracted. One-step reverse transcription PCR (RT-PCR) was performed. A 25 µl reaction was prepared along with RNA templates. A set of Potyvirus specific primer oligo1n TGGTHTGGTGYATHGGARAAYGG and oligo2n TGGTHTGGTGYATHGGARAAYGG was used in RT-PCR (Marie-Jeanne

et al. 2000). The PCR was performed. The amplified products were analyzed by 1 per cent agarose gel electrophoresis.

(b) Field response of different garlic genotypes against viruses

Response of different garlic genotype against viruses was assessed in natural field condition. Under the study, 20 garlic genotypes were screened against viruses at periodic intervals.

Results and Discussions

(a) Molecular detection of Potyviruses in garlic

Garlic plants from all the genotypes showing abnormal mosaic and yellow streaks symptoms and twisting in the leaves were collected from the Vegetable Research Farm, BAU, Sabour. Each sample was tested against potyvirus using RT-PCR assay. In each genotype, the collected samples were found positive. The number of positive samples out of total tested plants was detected more in 5 genotypes namely G-1, G-189, G-282, G-323 and G-50 as compared to other genotypes. In G-1, out of 12 tested plants, 7 were found positive. Similarly, 10 out of 14 in G-189, 6 out of 9 in G-282, 7 out of 12 in G-323 and 8 out of 12 in G-50 were found positive.

(b) Field response of different garlic genotypes against viruses

Field response of each genotype against virus was assessed at periodic intervals. It was observed that G-1, G-189, G-282, G-50, 432, 141, BRG-13 and BRG-14 showed disease symptoms appeared after 30 days of sowing. Among them, genotype G-50 showed maximum disease incidence (6.7 per cent) on 30th day followed by genotype G-282 (5.3 per cent). After 45 days of sowing, genotypes G-323, IC-395680 and BRG-10 first showed disease symptoms. Among them, maximum disease incidence was observed for BRG-10 (2.6 per cent) followed by genotype IC-395680 (1.3 per cent). The genotypes BRG-8, 498, 305, 417, 352 and BRG-7 showed the delayed disease symptom, i.e., 60 days after sowing. The maximum disease incidence was found in BRG-8 with 2.7 per cent incidence followed by 352 (2.6 per cent), 305 (2.4 per cent), 417 (2.2 per cent) and 498 (2.0 per cent). Maximum genotypes showed the highest incidence at 90 days after sowing e.g. G-282 with 20.7 per cent followed by G-1 with 15.0 per cent disease incidence. Among all the entries, three genotypes, i.e., 499, 516 and 493 showed no disease symptoms.

Conclusions

Viruses hamper (up to 78 per cent) the quality production of garlic (Lunello *et al*. 2007). Among them, *Leek yellow stripe virus* and *Onion yellow dwarf virus* cause considerable yield loss. Abnormal pattern like mosaic, chlorotic streaking, twisting of leaves, stunting and reduced size of garlic cloves were typically observed. The presence of bulb-associated viruses was studied using RT-PCR assay. There were 20 genotypes under the study tested for the virus. Among the genotypes, maximum plants were found to be infected with potyvirus. However, plant samples of BRG-8, BRG-13 and BRG-14 produced less infection of viruses. The response of all genotypes against virus was assessed at periodic intervals. Genotype G-50 showed maximum disease incidence (6.7 per cent) on 30th day after sowing. Maximum genotypes showed the highest incidence at 90-DAS *viz*., G-282 with 20.7 per cent incidence. The explored finding will be the footstep to grow virus-free stocks and their promotion among growers community.

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Compatibility of Entomopathogenic Nematode, *Steinernema* sp. and Egg Parasitoid, *Trichogramma japonicum* with Insecticides

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Extended Abstract

Introduction

More rely on chemical insecticides has invited several ecological problems. Compatibility of bio-agents with insecticides may be great alternative approach for sustainable plant protection. The roles of two important bio-agents i.e. entomo pathogenic nematode (EPN), *Steinernema sp.* and egg parasitoid, *Trichogramma japonicum* are well known. Their efficacies have been proved majorly against lepidopteran insects. Conservation as well as population enhancement of these natural enemies is in urgent need by selection of soft insecticide. Novel insecticides having different mode of action are now widely used for insect pest management. Studies on their effects on above mentioned beneficial organisms are not sufficient. Their integration is possible only when natural enemies are protected from insecticides used against insect pests. So, it is essential to identify selective novel insecticides for incorporation in integrated pest management (IPM) programmes. Acknowledging this, an attempt has been made to understand the effect of some commonly used insecticides for survival of EPN (*Steinernema sp.*) and egg parasitoid (*Trichogramma japonicum*). This would enable the wise selection of safe insecticides to protect beneficial organisms and thereby to improve IPM.

Methodology

Steinernema sp. and *Trichogramma japonicum* were multiplied using larva and eggs of *Corcyra cephalonica,* respectively. Separate insecticide solution at recommended dose was made by using 5 granular and 10 different insecticides respectively for *Steinernema* and *Trichogramma* along with control. Approximately 100 EPNs are released for each

treatment with 6 replications. Similarly, trichocard having 100 pupa with 3 replications was dipped in each treatment and kept for adult *Trichogramma* emergence. Observation on survival of EPN was taken after 48 hours of treatment. Empty egg shells were considered to calculate percent adult *Trichogramma* emergence. All data were corrected using Abbott's formula. Insecticides were grouped according to *IOBC* (International Organization for Biological Control) protocols. Duncan's Multiple Range Test (DMRT) was followed to find out the statistical variations among the different treatments.

Results and Discussions

Among the five insecticides, Emamectin benzoate 0.25 + Cartap hydrochloride 7.5 G caused highest mortality (65.79 %) of *Steinernema sp.* at 48 hours after treatment followed by 34.12 % in Cartap hydrochloride 4 G. The lowest mortality (0.92 %) was observed in Chlorantraniliprole 0.4 G that was significantly at par with Carbofuran 3 G (2 %), Fipronil 0.4 G (2.82 %) and untreated control. Considering IOBC protocol, Emamectin benzoate + Cartap hydrochloride and Cartap hydrochloride were slightly harmful insecticides. Whereas, Chlorantraniliprole, Carbofuran and Fipronil belonged to harmless category of insecticides against EPN.

The role of Cartap as harmful and Fipronil as harmless on survival of EPNs is also reported by Chavan *et al.*, 2018.

Considering IOBC protocol apropos percent mortality in adult emergence of *Trichogramma japonicum*, Chlorpyriphos 20 EC (99.14 %) was grouped as harmful one in toxicity class 4. Lambda cyhalothrin 5 EC (86.80 %) belonged to toxicity class 3 (moderately harmful). Whereas, mortality in adult emergence was 51.97 and 38.36 % for the treatments Fipronil 5 SC and Imidacloprid 17.8 SL, respectively. Here, these two insecticides were sorted under toxicity class 2 (slightly harmful). However, the descending sequence of insecticides belonging to toxicity class 1 (harmless) was Azadirachtin 1 EC (24.02 %) > Spirotetramat 15 OD (23.27 %) > Chlorfenapyr 10 SC (18.09 %) > Emamectin Benzoate 5 SG (12.12 %) > Chlorantraniliprole 18.5 SC (6.37 %) > Flubendiamide 39.35 SC (1.83 %). Safety found in Chlorantraniliprole and Flubendiamide was statistically at par with untreated control.

The present findings with Chlorantraniliprole regarding percent adult emergence of *Trichogramma japonicum* is almost close to earlier worker Fontes *et al.* (2018) who reported 94.1 % adult emergence of *Trichogramma achaeae*.

Conclusions

Three granular insecticides viz. Chlorantraniliprole, Carbofuran and Fipronil caused significantly at par negligible mortality of EPN *Steinernema sp.* Such result suggests that entomopathogenic nematode *Steinernema sp.* is highly compatible with the said three insecticides which are used directly to the soil. If this information is applied, biodiversity of EPN in crop soil will not be in threat. On the other hand, there is huge possibility for integration of EPN with these granular insecticides for better sustainable management of different stages of soil inhabiting insect pests.

Similarly the results regarding lethal effect of 10 insecticides on percent mortality in adult emergence of *T. japonicum* suggests that most of the new generation insecticides like Flubendiamide, Chlorantraniliprole, Emamectin Benzoate, Chlorfenapyr, Spirotetramat and Azadirachtin are harmless. Extreme harmless effect towards *T. japonicum* is seen with Flubendiamide and Chlorantraniliprole. So, these harmless insecticides could be strongly recommended for field spray by integrating with *T. japonicum* for conservation or augmentation process of bio-control.

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Evaluating the Efficacy of Bio-control Agents and Fungicides against *Bipolaris Sorokiniana*

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Extended Abstract

Introduction

Wheat is the second most important cereal crop of India after rice. After the green revolution there was a sudden increase in production of wheat was recorded due to the cultivation of high yielding varieties and intensive use of synthetic fungicides and other chemicals, and because of this there was a sudden increase in incidence of different disease was also observed. Among different economically important disease of wheat crop, Spot blotch disease of wheat is also emerging as a serious problem in wheat growing areas of India, the causal organism *Bipolaris sorokiniana* (sacc.) shoem. This pathogen is both seed and soil borne. 15-20 % losses has been reported from Indian subcontinent having warm and humid climatic condition from rice-wheat growing cropping system , and in severe condition the losses could reaches upto 80 %. That's why it is important to search some better and eco-friendly management strategy for this pathogen.

Methodology

Experiment was conducted at Bihar Agricultural University, Sabour. Pots were filled with 50% sterilized soil and 50% compost. Seeds (Variety- Agra local, Experimental design- Randomized block design) were treated with Mancozeb 63% + Carbendazim 12% (SAAF), Azoxystrobin 23% (Amistar) and Tebuconazole 2 DS (Raxil) @ 2.5 gm/kg seed whereas three bio-control agents *Pseudomonas fluorescens, Trichoderma viride* and *Trichoderma harzianum* @ of 10 gm/kg of seed. For seed treatment slurry method was used. 30 days after sowing all the plants were challenged inoculated with the conidial solution of *Bipolaris sorokiniana*, and further Disease incidence % and Double digit score was calculated.

Table 1: *Rating scale (0-9)*

Score	Percentage leaf area covered
0	No blight
1	Up to 10% leaf area blighted
2	11-20% leaf area blighted
3	21-30% leaf area blighted
4	31-40% leaf area blighted
5	41-50% leaf area blighted
6	51-60% leaf area blighted
7	61-70% leaf area blighted
8	71-80% leaf area blighted
9	>80% leaf area blighted

(DWR, 2001)

Results and Discussions

Disease incidence percent was recorded at GS 55 ie. 25 days after inoculation. Lowest DI (%) was observed from *Trichoderma viride* (20.00%) followed by *Trichoderma harzianum* and Mancozeb 63% + Carbendazim 12% WP that was 34.29 and 40 respectively as compared to control (100%) as represented in the Table 2. Among all the treatments *Trichoderma* sp. have given best result. Even the bio-control agent has given better result as compared to the chemical treatment. Incase of disease severity, the least double digit score was recorded from *Trichoderma viride* at all the three stages GS 55 (Flowering stage), GS 75 (Milky dough) and GS 87 (Hard dough stage) that was 00, 01 and 12 respectively followed by *Trichoderma harzianum* (00, 12 and 13) and Mancozeb 63% + Carbendazim 12% WP (11, 12 and 23) as compared to control (57, 68 and 89) as shown in the Table 3. The finding of the result was supported by the experiment conducted by Hossain *et al.* (2015) according to his finding he reported that Trochoderma based bio-fungicide was very effective in reducing the mycelial growth of *Bipolaris sorokiniana* by 67.36%.

Table 2: *Effect of fungicide and Bio-control agents on Disease incidence percent (55 days after sowing)*

S. No.	Treatment	DI (%)
1	Mancozeb 63% + Carbendazim 12% WP	40.00
2	Azoxystrobin 23% SC	65.71
3	Tebuconazole 2 DS	71.43
4	*Pseudomonas fluorescens*	42.86
5	*Trichoderma viride*	20.00
6	*Trichoderma harzianum*	34.29
7	Control	100.0
C. D (at 1 %)		7.695
C. V %		10.908
*Mean of five replications		

Table 3: *Effect of fungicide and Bio-control agents on Disease severity (Double digit score)*

Disease severity (Double digit score)				
S. No.	Treatment	*G 55	*G 75	*G 87
1	Mancozeb 63% + Carbendazim 12% WP	11	12	23
2	Azoxystrobin 23% SC	23	35	48
3	Tebuconazole 2 DS	24	36	49
4	*Pseudomonas fluorescens*	12	13	24
5	*Trichoderma viride*	00	01	12
6	*Trichoderma harzianum*	00	12	13
7	Control	57	68	89
*Mean of five replications				

Conclusions

In current scenario, it is very important to work on sustainable eco-friendly agricultural practices for food security and conservation of environment. Use of bio-control agent is best method for the eco-friendly management of diseases. Bio-control agents play important role in activating the ISR (Induced systemic resistance) defense mechanism and protecting the plant from the pathogen. However, regular incorporation of bio-control agents in the soil is very important for their establishment in the soil. Seed treatment with bio-control agents is always a best method for protecting the crop from any seed and soil borne disease because the fungus got proper time and space for its successful establishment and protect all the stages of plant from the spot blotch pathogen. Regular and intensive use of chemical fungicides may result into development of resistance in the pathogen, so only optimum recommended dose of chemical fungicides should be allowed for use at proper stage.

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Track 04
Containing Covid-19 Impact on Rural Economy; Challenges & Opportunities

An Appraisal of Anomaliesin Tea (*Camellia sinensis*) Value Chain During COVID-19 Crisis

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Extended Abstract

Introduction

World Health Organisation (WHO) on 11-03-2020 declared the Novel Coronavirus (COVID-19) as pandemic due its huge coverage throughout the globe. According to WHO the Novel Coronavirus spreads through human to human by physical contact, so Governments of all over the world took strict action to prevent the spread this Novel Coronavirus by imposing lockdown. Indian government also took part in this movement and imposed nationwide "*Janta Curfew*" followed by lockdown from 24-03-2020.

There have been a huge disruption in food supply chain due to potential labour shortages and restricted transportation and logistics services along with changing buying preferences of the consumers (Hobbs, 2020). In many ways, the impact of Novel Coronavirus on both demand and supply side of tea value chain is noticeable.

The value chain is a concept, which can be simply describe as the entire range of activities required to bring a product from the initial input-supply stage, through various phases of production, to its final market destination. Value is any activity that increases the market form or function of the product or service; and in today's business climate, there is a need to maximise the value of every process in a business (Jacoby, 2005). According to Hill & Jones (2001) the term "value chain" refers to the concept that a company's chain of activities for transforming inputs into outputs with purpose to deliver value to the customers.

In the recent past the popularity of green tea leaf production from small tea farms increased manifold. More and more youths were attracted towards production of green tea leaves.

Materials and Methods

Selection of state

The state of Assam covers 55.55 per cent area under tea cultivation in India and produces 51.90 per cent of country's total production of tea. Hence, we chose Assam purposively for the study.

Selection of stakeholders

The major identified stakeholders were green leaf collector, processors, wholesalers and retailers. From each group of these intermediaries, 20 green leaf collectors, 15 processors, 20 wholesalers, 20 retailers were randomly selected for detailed study.

Constraints perceived by the stakeholders were priotized by using Garrett's ranking technique by using the following formula:

$$\text{Percent position} = \frac{\mathbf{100\ (Rij - 0.5)}}{\boldsymbol{Nj}}$$

Where

R_{ij} = Rank given for the i^{th}variable by j^{th} stakeholder

N_j = Number of variable ranked by j^{th} stakeholder

With the help of Garrett's Table, the percent position estimated will be convert into scores.

The percentage position of each rank converted into score using Garrett's table. For each constraint, score of individual respondents were added together and were then divided by the total number of respondents for whom the scores were added. Thus, the ranking was done on the basis of the mean score after arranging it in descending order.

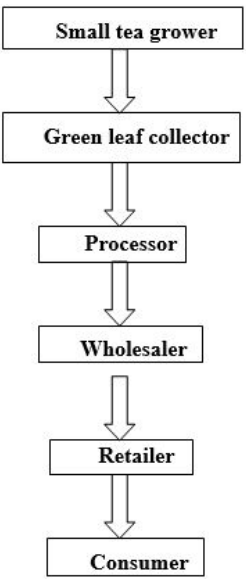

Fig.1: *Supply chain of tea*

Results and Discussion

Tea value chain was associated with the role of various players who controlled and added value along the chain. The players were green leaf collector, processors, wholesalers and retailers. There was no role of producers in tea value chain, they only related with cultivation of green tea leaves and the value addition starts from green leaf collector (Kakati,2011). Consumers were termed as supporters in the value chain as they made decision whether to purchase or not. The details of different actors and their roles in supply chain have been mentioned below:

Different stakeholders and their role in value chain

1. **Small tea grower:** Cultivation
2. **Green leaf collector:** Collection and transportation of green leaves from small tea growers and delivering to processing unit Sorting and quality control
3. **Processor:** Payment for the collected leaves and processing into different types of tea, Processing quality control, Packing and labelling of final product
4. **Wholesaler:** Purchases bulk made tea (processed tea) from different processors, Blending of bulk tea into convenient packing and value addition
5. **Retailer:** Customer relationship, sorting and advertisements of the product. Quality control and monitoring
6. **Consumer:** Making decision to purchase tea

From the supply side, the major players are Small tea grower, Green leaf collector, Processor, wholesaler and retailer; when considered to demand side they are consumer and teashop, hotel & restaurant. The visible impacts of Novel Coronavirus on actors of tea sector has been described below –

1. **Small tea grower:** They have faced tremendous problem due to unavailability of farm inputs on regular basis. The tea gardens which are located in rural area are suffering from this problem the most (Jhajhria *et al.*, 2020), which is responsible for disruption in tea leaf yield, and unsuitable quality of tea leaf, which are not preferred by leaf collector and ultimately it results low profit to the small tea grower (Bhandari & Lal, 2020).
2. **Green leaf collector:** They are not getting good tea leaf from the small tea growers, in such situation they are not able to maintain the standards of their quality leaves, resulting less sell and low profit (Reddy *et al.*, 2016). Due to restriction in transportation, they are not able to transfer the collected leaves to processors in regular basis, which leads to huge loss.
3. **Processors:** They are facing multiple problems during this pandemic; unavailability of work force is one of them. Due to this scarcity they are facing difficulties in running the firm smoothly which creates interruptions in value addition process (Shashidhar, 2020). Restriction in transportation is also another major issue for the tea industry; due to this, they are not able to transfer their final products to distant market.
4. **Wholesaler:** They are not able to maintain the stock of product, as they are receiving less amount from industries due to restricted transportation. Which causes vast price fluctuations (Hobbs, 2020).
5. **Retailer:** They are also facing problem regarding maintaining the appropriate stock of the product.
6. **Consumer, teashop, hotel & restaurant:** Shutting down of restaurants, hotel, teashops, etc. due to nationwide lockdown caused a great impact on the tea sector, as demand for tea reduced drastically.

Novel Coronavirus have also affected international trade throughout the globe in all sectors of commodities.

The ranking of constraints faced by small tea growers have been presented on Table 1. The table revealed that, unavailability of inputs on peak plucking time was considered as the major problem faced by small tea growers with 75.39 average score in garret ranking, followed by less demand from tea leaf collector, labour unavailability and restricted transportation with average score of 62.30, 45.72, 40.84 respectively (Goowalla, 2015)

Table 2 showed that, restricted transportation was the major constraint faced by the tea leaf collector during lockdown with 81.66 average score in garret ranking, followed by getting unsuitable quality of tea leaf from small tea growers, less demand from industry and labour unavailability with average score of 75.37, 72.11 and 62.95 respectively.

In case of processors, the main constraint was unavailability of quality tea leaves (Table 3) with 77.43 average score in garret ranking, followed by scarcity of labour, unavailability inputs to run the industry, restriction in transportation with average score of 73.78, 70.22 and 65.20 respectively (Luttel, 2017)

Table 1: *Constraints faced by sample small tea growers*

Constraints	Garrett Mean Score	Rank
Unavailability of inputs on peak plucking time	75.39	I
Less demand from tea leaf collector	62.30	II
Labour unavailability	45.72	III
Restricted transportation	40.84	IV

Table 2: *Constraints faced by sample tealeaf collectors*

Constraints	Garrett Mean Score	Rank
Restricted transportation	81.66	I
Unsuitable quality of tea leaf from small tea growers	75.37	II
Less demand from industry	72.11	III
Labour unavailability	62.95	IV

Table 3: *Constraints faced by sample processors*

Constraints	Garrett Mean Score	Rank
Unavailability of quality tea leaves	77.43	I
Scarcity of labour	73.78	II
Unavailability inputs to run the industry	70.22	III
Restricted transportation	65.20	IV

Table 4: *Constraints faced by sample wholesalers/retailers*

Constraints	Garrett Mean Score	Rank
Price instability	85.34	I
Llimited stock of product on shop	72.01	II
Restricted transportation	60.44	III

The problems faced by wholesalers and retailers were kind of same, so we have put their constraint ranking on a single table (Table 4). From the table it revealed that, price instability was the major constraint, followed by limited stock of product on shop and restriction in transportation with average score of 85.34, 72.01 and 60.44 respectively.

Conclusions

Though, However, growth rate of Indian agricultural sector is in positive trend during this pandemic, but the effect of Novel Coronavirus on both supply and demand side of agrarian value chain is non ignorable. It is clear from the study that, all the stakeholders of the tea value chain is suffering due to lockdown caused by COVID-19 pandemic. Among them small tea growers stuffed the most, as there is huge pressure on them to produce the sufficient quantity of green tea leaves but due to unavailability of suitable inputs they are not able to produce sufficient quantity of leaves, which caused total disruption the complete value chain. Therefore, government should look forward in the tea sector so that problems can be minimise.

Acknowledgement

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Resource Use Efficiency of Cabbage Cultivation in North East Hill Region of India: A Spatial Analysis

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Extended Abstract

Introduction

The efficiency of vegetable production is an important factor in determining the returns on investment. Based on specific region, crops and access to various other inputs the economic inefficiencies of farmers differ accordingly. Several factors like hilly terrain, rainfall, climate, soil conditions, subsidized inputs and also growing demand for food of different people influenced the cropping pattern in the study area. These results in over utilization or underutilization of resources, which in-turn is adversely affecting long term food production prospects of the region. Efficiency studies help in understanding the existing performance and prospects to improve the production performance of the crop. So, the study was conducted to examined the resource use efficiency in the North East Hill Region of India.

Methodology

The study was carried out in two states of the North East Hill Region during 2018-2019 adopting multistage sampling technique. Cabbage was selected as it is one of the major producing vegetable crops in the region. Sikkim was selected purposively as the control state. Meghalaya was selected randomly to compare the control state. For the control district, East Sikkim district was selected randomly and East Khasi hill district of Meghalaya was selected purposively based on the highest production of cabbage. Martam block from the control district and Mylliem from East Khasi hill were selected randomly.From each block, two villages were selected at randomly and at the last stage 120 cabbage cultivators were selected from a cluster of villages using random proportionate sampling. Cobb-Douglas production function was employed to estimate the resource productivity.

Results and Discussions

For Sikkim, inputs like human labour and seeds can contribute in increasing the returns. The regression coefficients revealed that that with one per cent increase in the inputs,

keeping other variables constant would result to an increase in the total value of production by 0.75 and 0. 23 per cent respectively.

In case of Meghalaya it was found that seeds, fertilizers and farm yard manures can contribute to increase the returns in Meghalaya. The results of the regression coefficients revealed that seeds, fertilizers and farm yard manure were statistically significant at 1 per cent level which indicates that with one per cent increase in the value of seed, keeping other variables constant would result to an increase in the total value of production by 0.43 per cent. Similarly, fertilizers and farm yard manure were also statistically significant at one per cent level with the coefficient of 0.184 and 0.206 indicating that with one per cent increase in the value of fertilizers and farm yard manure the total value of production will increase by 0.18 and 0.21 per cent respectively. Human labour and capital cost were found to be non-significant. The coefficient of multiple determinations (R^2) was 0.88 indicating that 88 per cent of the total variation in the return from cabbage cultivation was explained by the factors taken into consideration.

Allocative efficiency

The results of the allocative efficiency indicate that all the resources used for cabbage cultivation in the region need to be increase so as to achieve the maximum potential yield and henceforth increase the returns. For the Sikkim, inputs like human labour and seeds shows a significant potential to use further as the efficiency ratios are more than one, asserting that every additional rupee spent on these inputs would yield a return of ₹31.854 and ₹15.241. In case of Meghalaya, seed, fertilizer and farm yard manures show significant potential to use further as the efficiency ratios are greater than one, asserting that every additional rupee spent on these inputs would yield a return of ₹15.23, ₹5.018 and ₹4.475. Similar finding was reported by Mathew *et al.* (2017) where seed, fertilizer and manures show significant potential for their further use.

Conclusions

The resource-use efficiency of cabbage cultivation has been estimated using Cobb-Douglas production function. The study concluded that there is still scope for increasing the usage of various inputs so as utilize optimally. So, efforts should be made from the respective state governments in providing awareness or educating the farmers regarding efficient use of resources.

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Borewells and Sustainability of Agricultural Lands

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Extended Abstract

Introduction

Human prosperity and ecological manageability are the key components for economic improvement which are legitimately reliant on the wellspring of water. Water resources of the state keep on assuming a pivotal function in the manageable advancement of the state in the years to come. Groundwater is another significant hotspot for meeting almost 50% of the interest for irrigation, industrial production, and metropolitan water requirements for both rural and urban territories. The surface water source won't be accessible longer than groundwater so that, farmers rely more upon groundwater. Because of enormous yield and profitability these days, farmers have been digging more borewells in a land than the required and simultaneously burning-through more power to lift water. These situations destroying the nature of the agrarian place that is known for soil by over lifting the water, there may be land sliding, misuse of groundwater, loss of fossil water, and so forth.

Materials and Method

The current investigation depends on primary information. The information will be gathered by the farmers and geologists to assess the abuse of borewell on groundwater. The examining strategy has outlined randomly by picking a couple of farmers from various regions of the Davanagere district of Karnataka. Secondary information will be used for the investigation of the effect of unscientific burrowing borewells on next-generation farmers. The further investigation of the examination depends on the significant tools and techniques of statistics, for example, to be specific chai-square test, t-test, ANOVA, and regression to draw the inference about the performance of groundwater for the group of farmers yet to come.

Results and Discussions

Under developed countries rely upon the primary sector more for their job and groundwater asset is the significant hotspot for their agronomic practices. Since, 1/3rd of the agricultural land relies upon rainfall in India, the remainder of the other have been doing development

with surface water and groundwater assets. Because of less accessibility of surface water sources farmers digging more bore wells and devouring more without thought of the farmers to come.

Most of the nations which have adequate irrigated land will likewise one fine day face the shortage of irrigation. For this investigation utilized the all-encompassing way to deal with dissect the function of irrigation in agricultural nations. At last it proposed the part of certain foundations which give help, and of the worldwide financing and specialized help organizations.

The description of the investigation relates to the Davanagere area of Karnataka state especially and that has wanted to take a couple of farmers and their territories which have borewells to break down the effect on supportability. The examination expects to dissect the impact of abuse of groundwater through borewells on the manageability of agricultural terrains. Since as of now the rural reliance has been declining and what are the serious issues for the next-generation yet to come if abuse situation will be proceeded? A large number of the examinations proposed as of now that the issues with respect to groundwater assets. So, the current investigation has been gathering the information with respect to and sustainability of agricultural lands. It needs to appraise yet and still it is running towards examination.

Conclusions

The use of groundwater through borewells is more than the industrial production and metropolitan organization. Its use is huge where it is availing more for the farmer's exercises yet, they don't have the foggiest idea how proficiently to use the groundwater. As of foreseen discoveries, farmers don't have an idea and awareness about the structure of groundwater sources, for example, specifically Static and Dynamic nature of groundwater and furthermore saw that there is a logical premise to that individual who calls attention to the water point on our land through his capacity of resistance. In light of this they can utilize the sources well and associate the force gracefully which is actually required.

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Income and Employment of Age-old Landless in Jalpaiguri District of West Bengal

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Extended Abstract

Introduction

With the help of technology, the human being acting on natural resources are able to produce different types of goods & commodity for daily uses. In rural areas, landless people purely depend on either in wage employment in agricultural & allied activities or in non-farm sectors like construction works, engagement in value added forest/ base products, etc. Due to lack of assets, mainly the elder people are purely dependent on selective agricultural operations in the form of wage employment. On the other, most of the time farmers are not able to harvest premium prices of their products in the output markets despite higher input prices. They are losing their confidence to stay in agriculture as because of lower surpluses from agriculture. Thereby, the investments in agriculture are still under the grip of subsistence, which ultimately affects wage earners in rural areas, and marginal farmers as new entrance as wage earner.

Materials and Methods

The Maynaguri&Dhupguriblock of Jalpaiguridistrict has selected purposefully for the study and the households having at least one age-old person in a wage-earning family have surveyed for the analytical purposes. Total Fifty landless households have been selected randomly from two blocks forming a cluster of two villages in each block with the help of simple random sampling with replacement (SRSWR) during the crop year 2017-18 by the pre tested schedule and questionnaire. The earner dependency ratios in the selected regions are 0.62 and exploring all surrounding possibilities both in farm & nonfarm sectors for their survival.

Results and Discussion

In farm sector, 58 per cent of wage earners are been engaged solely and nearly 33 per cent are in both farm & nonfarm sectors. One remarkable observation here is that, the female member engagements in nonfarm sector are very negligible and only 2 per cent. The duration of time in different activities has also worked out, where the females engaged

over 13.75 hours in a day whereas the males are 12.34 hours in a day. On an average, the males get a scope of 230-237 days but opportunity of females have estimated 152-170 days in a crop year. The female labour participations are higher in all cases. Except in unorganised non-farm activities, average household income has estimated as ₹ 93,000/ whereas the contribution of non-farm sector is highest and it leads about to 63 percent of total income; on the other hand, agriculture & allied sectors' contribution are only 30 percent in totality. In this region, the households get ₹ 6400/ (6.88 per cent) from the participation in MGNREGA activities.

Majority of the labours are engaged in agricultural sector (nearly 80%). Very few got opportunities to earn their livelihood from non-farm activities though its scope was very meagre. Their incomes were directly proportional to the adult equivalency of the household, whereas, incomes per adult are been observed to be inversely proportional with the adult equivalency of that household.

The share of farm sector in total household income was 30.4 per cent and remaining services to MGNREGA and other nonfarm activities. Two-third of the farming communities' annual income was below ₹ 77000/ which was not adequate to maintain a quality life. It is a pity that females received lower wage rate as compare to male counterpart.

Conclusions

The study concludes that work in agriculture is the main source of livelihood in the rural areas. Scopes of Employment opportunities in non-farm sector are very limited. The economic status agricultural labourers have almost of "zero" opportunities cost and, accordingly, they are compelled to work at lower wage rate wherein women and elderly wage earners have to face discrimination in this regard. Hence, the study invites a holistic approach for overall rural development with a view to improve the quality of life of elders eradicating all possible discrimination within farming communities raising the demand for similar work with same wages.

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Behaviour of Market Arrival and Price of Orchid: A Study of Kolkata and Guwahati Market

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Extended Abstract

Introduction

Horticulture sector in north east India is growing in the last decades with the importance for its organic produce. Commercial floriculture has higher potential per unit area than the field crops and is therefore developing as a profitable business all over the world (Misra and Sudip, 2016). The country has exported 19726.57 MT of floriculture products to the world for the worth of 81.94 USD Millions in 2018-19 (APEDA, 2020).Orchid is widely available in the north eastern region of the country in wild environment as well as can be cultivated for commercial production as it fetches a high price in the market. Lack of information on potential market as well as arrival and price behaviour of crops are major bottlenecks for stakeholders. Therefore, market intelligence on potential market and quantum of arrival and price of commodities is necessary for farmers as well as other stakeholders involved.

Methodology

The secondary time series data on market arrivals and wholesale prices of orchid in Kolkata and Guwahati market for the period of 2010-2019 was collected from the database of National Horticultural Board. The pattern of market arrivals and price behaviour of orchid over the period 2010- 2019 was analyzed in terms of mean value for each month and the coefficient of variation. The Karl Pearson correlation coefficient was computed to find the degree of relationship between market arrivals and prices.

Results and Discussion

The result shows that there was significant increase in mean arrival and mean price of orchid in the Kolkata market over the study period with a CAGR of 24.64 per cent and 15.88 per cent respectively. On the other hand there was negative growth found in the Guwahati market during the study period which may be due to tough competition from

other nearby markets like Kolkata which is the largest flower market in Asia. The mean arrival was highest in the month of June (163820 numbers) and lowest in the month of October with only 118484 numbers in Guwahati market. On the other hand the mean arrival was highest in the month of December (446369 numbers) in Kolkata which was much higher than the Guwahati market. The finding also indicated that the mean market price was highest in June (₹3357.82/bunch) in Kolkata and November (₹3220.00/bunch) in Guwahati and the lowest price was in the month of September and February for the two markets respectively. The seasonal indices of arrivals and prices of orchid during the study period shows that arrival was low during May to August and was increased from September to February in Guwahati while in Kolkata market, it was low during August to December and was increased from March to July. Minimum arrival was in December with the arrival index of 84.72 in Kolkata and in June with an arrival index of 83.80 in Guwahati market. The correlation between the arrival and price was found to be positive for both the markets during the study period which depicts that the arrival has positive effect on price of the orchid flower.

Conclusions

The price per bunch of orchid was higher in the Kolkata market which supplies in the global market compared to Guwahati market. Although production is high in the north eastern region the market arrival was observed to be negative. Therefore, it is very important to focus on development of the flower marketing sector of the north eastern region. Proper market information and price behaviour will also help to take decision and minimize the marketing risk of farmers. Seasonal production of flowers has direct influence in their marketing. Therefore, proper policy measures need to be taken up to increase the production of flower around the year so as to reduce the problem of price increase due to less supply. Training should be given to the farmers regarding advanced technology use in flower production so as to compete with other markets in supply by producing higher amount within the north eastern region.

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SocioEconomic Evaluation of Shrimp Farming InBalasore District of Odisha

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Extended Abstract

Introduction

Shrimp aquaculture is now gaining as an important source of quality food for our population and one of a better aspect of income generating activity in coastal areas. It has become a major sector of fish farming which undergone vast scale transformation from low to high incoming agriculture. Odisha is a maritime state of India with seven costal districts and a long coastline of 480 kms. The economy of the state was primarily dependent upon basic economic activities like agriculture & fishing. Brackish shrimp culture is contributing 77 percent of the total fish exports with 92 percent in value terms (FAO yearbook, 2002). Therefore, the small & marginal farmers with low agricultural surplus due to their marginalized land in the coastal areas are gradually switching into shrimp farming instead of high volume low value traditional paddy cultivation. The present study aims to analyze the transformational power of Shrimp farming in coastal areas.

Materials and Methods

The data have been collected from selected farmers based on objective of relative profitability, identification of yield determining factors through stepwise regression analysis, comparative employment potentiality and value addition shrimp farming. Balasore district were selected purposively because; it holds a good share of the production with market infrastructure for both the producers & consumers. The survey covered two blocks viz. the Balasore & Bahanaga. Twenty numbers of shrimp farmers were randomly selected from each block. Both primary and secondary data were collected for the study during 2018-19 agricultural year with the help of specially designed pre tested schedule and questionnaire.

Results and Discussions

The economic feasibility of the shrimp farming has been examined by project appraisal technique are used find out the return at both undiscounted & discounted prices considering the 8 years of life time. The summation of discounted net returns at 10% opportunity cost of capital, the net present worth (NPW) and which is estimated as ₹ 205631/- which shows that this project is worth investing. The ratio of discounted present worth of gross benefit stream & present worth of the gross cost stream, that is the benefit cost ratio (B/C ratio) is estimated 1.02, at 10% opportunity cost of capital and use value of land at 30 percent of the produce, which is sufficiently higher in our country. The financial rate of return (FRR) from the investment is52.15% per annum, means a potential investor may earn 52% per year from shrimp cultivation.

The labor & feeding cost (0.97) is highly correlated to each other & the correlation between the location and the cost of pond management showed negative correlation between them, that cost of management has a positive relations with the Balasore block that means the cost of pond management is high for the shrimp farmers of Balasore block.

The productivity largely depends on feeding cost, age of pond, labor cost, cost of pond management, cost of disease prevention. Except the age of pond, other coefficients show positive value, which means increase in cost of different independent variables will increase the productivity and vice versa.

Shrimp farming is providing employment almost 3 times than the employment provided by traditional paddy cultivation (130-150 man days), if cultivated twice in a year. If we consider only seasonal paddy cultivation in a crop year, then the employment in shrimp farming 5 times than the paddy cultivation (65-75) per acre of land.

Conclusions

The shrimp farming is highly profitable in coastal belts and it provides five times more employment per unit of land than traditional cultivation. The number of man-days employed in one acre of land is around 350 on average per year in that study area. The B/c ratio, NPW and FRR (52%) are also sufficiently higher than any other traditional enterprises. Therefore, it can safely concluded that there is a chance for the local residents (farmers) of this belt to get financial sustainability ensuring the poverty alleviation as there is huge potential of employment generation and profitability in shrimp farming.

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Measuring the Gap between Information Needs Perceived and Fulfilled by the Communication Sources in Bihar

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Extended Abstract

Introduction

Different authors have classified sources of information differently. For example, Beatty and Smith (1987) classified the sources as interpersonal, neutral, retail, and media. The preference and selectivity of information sources varies among the farmers depending upon several conditions such as cosmopolitan/local, richness/poverty, liking/disliking, sources of availability and credibility of source (Balasubramanian and Charles 1996).

A recent Situation Assessment Survey of Farmers by the National Sample Survey Organization (NSSO, 2005) on Access to Modern Technology for Farming indicates that about 40% of households access information on agricultural practices in India. In India, most farmers use information on production-related activities such as improved seed, fertilizer application, and crop protection, while information on harvesting and marketing is being used by only 8% of households.

Rao (2004) concluded that many ICT-based initiatives in India lack a comprehensive plan for addressing the target population due to insufficient infrastructure and a lack of appropriate technologies.

Methodology

The gap between perceived needs related to each aspect and their availability was calculated through the help of an index as mentioned below.

Information / Communication Gap = [(Mean perceived need score – Mean fulfilled need score)/ Mean perceived need score] x100

Results and Discussions

The farmers of Muzaffarpur and Madhubani districts were having varied perceptions on information and communication needs for most of the aspects in agriculture as depicted in Fig. 1. However, farmers of both the districts perceived maximum information and communication needs for their capacity building/ training on different aspects of their farming. The farmers in Muzaffarpur district attached importation to information needs in a decreasing order with agricultural inputs, agricultural production technologies, agricultural finance, livelihood diversification options, agricultural marketing and post-harvest management. While farmers of Madhubani district felt comparatively higher information and communication needs for agricultural finance followed by agricultural production technologies, agricultural inputs, livelihood diversification options, agricultural marketing and post-harvest management. It is a concern that farmers of both districts perceived the information needs related to agricultural marketing and post-harvest management at less than average level. Farmers of Madhubani district have perceived five out of seven broad aspects of agriculture considered in present study at a less than average level on a 4-point continuum scale. That may be attributed to the facts of poor socio-demographic situation, agricultural backwardness as well as lack of adequate information and communication infrastructure in Madhubani district.

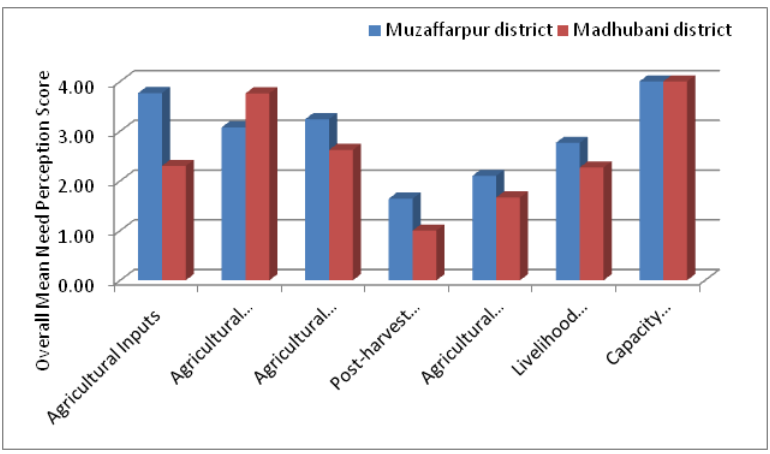

Fig. 1: *Differential perceptions of farmers on information and communication needs with respect to various aspects of agriculture in Muzaffarpur and Madhubani districts of Bihar*

Communication profile of the farmers in Muzaffarpur and Madhubani districts are presented in Table 1 and 2, respectively. Farmers of Muzaffarpur district are found to be more cosmopolite as on an average they have used 5 sources each under personal cosmopolite and impersonal cosmopolite (mass media) type of information sources mean frequency of use score 1.97 and 2.06, respectively. They also availed on an average 4 personal localite sources of information with mean frequency of use score 1.92. While the farmers of Madhubani district have used on an average 4 sources of personal cosmopolite

type, 3 types of personal localite sources and 2 types of mass media sources with mean frequency of use score 1.74, 1.96 and 1.37, respectively.

Table 1: *Communication Profile of the farmers in Muzaffarpur district of Bihar*

Communication source	Mean score (SD)	
	Number of sources used	Frequency of use
Personal localite	4 (1)	1.92 (0.28)
Personal cosmopolite	5 (2)	1.97 (0.21)
Mass media	5 (2)	2.06 (0.37)

Table 2: *Communication Profile of the farmers in Madhubani district of Bihar*

Communication source	Mean score (SD)	
	Number of sources used	Frequency of use
Personal localite	3 (1)	1.96 (1.07)
Personal cosmopolite	4 (0)	1.74 (0.16)
Mass media	2 (2)	1.37 (0.44)

Note: SD stands for Standard Deviation value; minimum and maximum possible scores are 1 and 4, respectively

The farmers have varied information needs related to different agricultural aspects for which they use a number of information sources. Also, a number of information sources are used because a particular source often fails to fulfil the needs of the farmer completely. The remaining, which is left unfulfilled is assumed as a gap. The information gap for various aspects of agriculture was revealed and presented in the Table 3 for two selected districts in present study.

Table 3: *Information / communication gap of the farmers in Muzaffarpur and Madhubani districts of Bihar*

Sl. No.	Information needs	Information / communication gap (%)	
		Muzaffarpur (n=60)	Madhubani (n=60)
1.	Agricultural loan	25.28	49.17
2.	Crop insurance	63.06	75.00
3.	Subsidies of crop produce	36.39	75.00
4.	Soil testing	72.78	75.00
5.	Weather and climate	2.50	-
6.	Entrepreneurship development	46.53	8.75
7.	Income Development activities	66.25	75.00
8.	Capacity building / Training	75.00	75.00

There was no information gap in both the districts for various agricultural inputs as perceived needs were completely fulfilled. However, the extent of perceived needs and their fulfilment is much higher in Muzaffarpur district compared to Madhubani district. The reason being that more number of sources with higher efficiency were available to the farmers of Muzaffarpur. The similar findings can be seen for various aspects under

post-harvest management and marketing of agricultural produce where extent of need perception was low and the same was fulfilled leaving no information gap.

Perceived needs for several agricultural production aspects like land preparation, sowing and transplantation, weed Management, nutrient management, pest & disease management and harvesting were completely fulfilled thus leaving no information gap, which can be attributed to the aforesaid reasons.

The information gap related to entrepreneurship development and income generation activities as livelihood diversification options was found to be 46.53 per cent and 66.25 per cent in case of farmers in Muzaffarpur district; while in case of the farmers in Madhubani district the gap was 8.75 per cent and 75 per cent respectively.

The gap with respect to information on capacity building/ training was equal and to the extent of 75 percent in case of the farmers of both selected districts in Bihar.

Summary and conclusion

Information gap was highest in case of capacity building (75%) followed by soil testing, income generating activities, crop insurance, subsidies for crop produce, entrepreneurship development, agricultural loans, weather information. There was no information gap with respect to other aspect of agriculture. However, the extent of perceived needs and their fulfilment is much higher in Muzaffarpur district compared to Madhubani district.

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Agricultural Sustainability in India using SLSI Approach

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Extended Abstract

Introduction

Sustainable agriculture may be regarded as the successful management of resources for agriculture to satisfy the changing human needs while maintaining or enhancing the quality of environment and conserving natural resources (FAO, 1991). Sustainable Livelihood Security Index was proposed by Swaminathan (1991) to serve as an educational as well as policymaking tool to evaluate the potential of Sustainable development. So, the present investigation was carried out to evaluate the state wise agricultural sustainability in India, then based on the index value ranking of states has been computed and strategies offered to improve it are lying below.

Materials and Methods

Based on literature survey state wise secondary data related to population density, livestock density, forest cover, cropping intensity, food grain yield, fertilizer consumption, per capita milk availability, per capita income, infant mortality rate, female literacy rate, road availability per 1000 square kilo meters and percentage of population below poverty line was taken from various published sources were taken to calculate the simple SLSI and weighted SLSI. Then the states were ranked depending upon their SLSI values.

Results and Discussion

Under the ecological security index better performing states are Mizoram, Tripura, Manipur, Goa, Uttarakhand, Kerala, Himachal Pradesh and worst performing states are Bihar, Uttar Pradesh, Gujarat. Under the economic efficiency index the better performing states were found as Punjab, Haryana, Tamilnadu, Andhra Pradesh, Gujarat, Uttarakhand and the worst performing states were found to be Manipur, Jharkhand, Tripura, Mizoram, Odisha, assam, J&K, Madhya Pradesh. In the social equity index the better performing states were Kerala, goa, Mizoram, Himachal Pradesh, Tamilnadu, Tripura, Punjab, Maharashtra and worst performing states were Madhya Pradesh, Bihar, Jharkhand, Odisha, Uttar Pradesh, assam, Rajasthan, Manipur. Punjab was ranked 1st in the SLSI and weighted SLSI with an index value of 0.61 and 0.58 respectively were as Bihar was ranked in the last position with

an index value of 0.23 in SLSI and Jharkhand was ranked last with an index value of 0.16 in weighted SLSI. The state wise SLSI values are given below in table 1.

Table 1: *State wise SLSI and weighted SLSI*

Name of state	Ecological index	Social index	Economic index	SLSI	rank SLSI	SLSI*	Rank
Andhra Pradesh	0.47	0.43	0.48	0.46	10	0.46	6
Assam	0.53	0.31	0.14	0.33	18	0.25	17
Bihar	0.14	0.18	0.38	0.23	23	0.19	22
Goa	0.63	0.83	0.35	0.60	2	0.53	2
Gujarat	0.37	0.42	0.42	0.40	15	0.40	10
Haryana	0.46	0.42	0.78	0.56	4	0.52	3
Himachal Pradesh	0.70	0.57	0.30	0.52	7	0.46	7
Jammu and Kashmir	0.62	0.39	0.21	0.41	14	0.34	13
Jharkhand	0.47	0.13	0.11	0.24	22	0.16	23
Karnataka	0.48	0.43	0.37	0.43	11	0.42	8
Kerala	0.51	0.97	0.24	0.57	3	0.42	9
Madhya Pradesh	0.59	0.11	0.26	0.32	19	0.21	21
Maharashtra	0.50	0.50	0.25	0.42	12	0.38	12
Manipur	0.70	0.36	0.10	0.39	16	0.22	20
Mizoram	0.83	0.62	0.13	0.53	6	0.28	15
Odisha	0.53	0.22	0.15	0.30	20	0.23	19
Punjab	0.47	0.54	0.81	0.61	1	0.58	1
Rajasthan	0.49	0.26	0.27	0.34	17	0.32	14
Tamilnadu	0.42	0.59	0.47	0.49	9	0.48	5
Tripura	0.83	0.64	0.12	0.53	5	0.27	16
Uttar Pradesh	0.26	0.18	0.38	0.27	21	0.25	18
Uttarakhand	0.70	0.45	0.40	0.51	8	0.49	4
West Bengal	0.38	0.51	0.34	0.41	13	0.40	11

Conclusions

SLSI not only identifies the states requiring immediate attention but also the specific component in which to be focused. So, the policy implications should be directed towards the development of those states and components where the SLSI value is less than or equal to 0.40. Thus, SLSI helps to focus on the conflicts and the potential synergy between ecology, economics and equity dimensions of sustainable development of agriculture.

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Enhancing Rural Livelihood Security through Group Approach

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Extended Abstract

Keywords: Agricultural extension, Integrated Watershed Management Programme, agribusiness, poverty alleviation, cropping culture, User groups, Self Help Groups.

Introduction

We know that development ofagriculture is essential for the socio-economic upliftment of an agrarian country like India. The role of agricultural extension is very important for economic outcome from farming. Role of agricultural extension for diffusion of agricultural technology among rural people is undeniable. The present study has shown how the financial development of agriculture has been made possible among the various beneficiary groups under the Integrated Watershed Management Programme (IWMP). In this context, those Beneficiary Groups are under IWMP, in Darjeeling and Coochbehar Districts of West Bengal. Study was conducted on User groups and Self Help Groups in both districts. Five success stories or case studies have been flaunted here to depict the programme outcome and its impact on farmers. These groups were specially trained in agriculture and allied field through this programme implemented by Office of Assistant Director of Agriculture and Office of Divisional Forest Officer.

Materials and Methods

The study was conducted on five groups in Darjeeling district and ten groups in Cooch Behar district out of which five success stories are presented here. Those are Beneficiary Groups of Integrated Watershed Management Programme, and case studieshave been extracted from them. A purposive random sample survey was conductedwith relevant questionnaire. Two success stories from IWMP-3 in Darjeeling district and three success stories were collected from Cooch Behar district consequently from IWMP-1, IWMP-9, IWMP-4. Secondary data were collected from ADA Office. Not only the beneficiaries but also 100 non beneficiary farmers were interviewed to reveal the programme impact.

Results and Discussion

One thing emerges from this study is that each of the group members somehow has been benefited economically. Female and male farmers have been trained and assisted by this venture which has helped them to be used to with some profitable farming methods by modernising the traditional cultivation. Surveys have shown that the economic impact they have had through this extension has played a significant role in improving their daily living status too. So through this extension process it is possible to include all the backward farmers in new advanced farming methods. Group approach is more successful where there was funding of group loan and marketing linkage too. Extension trainings have helped them to adopt more agril and agri-allied farming options those are much more essentials in this economically down strain situation too. By extensive group training, learning and supervision, farmers feel confident to go to new arena of possibilities which may enrich whole agribusiness process.

Through this group extension education, it has been observed specially in cases of women, who were not directly engaged with farming are now actively involved. This study shows how woman SHG group members are coming forward to be established not only as farmers but as agri-preneurs too. Definitely it will enhance female participation in our national income i.e. a crucial requirement for a developing country. Various cropping culture from paddy to mushroom and profit maximization through agri-allied sectors likewise fish farming, piggery management etc. are most viable prospects found from this study. Present economic situation of an agro-based country needs such extensive group practice which can involve more people that can facilitate rural poverty alleviation.

Conclusions

In such a densely populated country like India, there is no way of mass poverty eradication without self-employing every person. So in this pandemic condition, if we can make farmers financially more self-sufficient through agribusiness, it will be much easier to deal with this economic down strain situation. It is not easy for the Government of a populous country like India to provide thorough training to each and every person. But by this group extension, it is revealed that most of non-beneficiary farmers became motivated and started the same ventures like as beneficiary groups of IWMP. This dissemination indicates an increasingly proportionate future scope of social extensional learning and method implementation. Today's beneficiary farmers are tomorrow's trainers. Agri-prepreneurship development could be a change maker in this aspect. Rural India would glorify whole economy.

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Impact of PMKISAN Scheme on Farm Economy of Karnataka

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Extended Abstract

Introduction

PMKISAN scheme was implemented on 1st Dec 2018 as a cash transfer scheme. It ensures to disburse ₹6000/- per annum in three installments of ₹2000/- each in the begining of crop seasons. The scheme was meant to be used by the beneficiaries for meeting the agricultural input requirements as also the consumption needs. Therefore, the study was taken to evaluate the impact of PMKISAN on input use and income from crop husbandry.

Materials and Methods

Primary data was collected from 120 farmers from two blocks of Tumkur district of Karnataka. The secondary data was compiled on fertilizer sale in the states of Bihar, Jharkhand, Orissa, Assam and West Bengal. The study has used Difference in Difference approach for assessment of impact of PMKISAN on fertilizer consumption in the states of Bihar, Orissa, Jharkhand and Assam. West Bengal was taken as control state as it had not implemented the PMKISAN scheme. The farm business analysis was performed to study the implication of PMKISAN scheme on input use and returns. The primary data was collected from 120 farmers from two blocks of Tumkur district of Karnataka.

Results and Discussion

The performance of the scheme has been assessed through the ratio of beneficiares to potential beneficiaries of PMKISAN scheme. The ratio is 57.5 per cent for Karnataka as against the countries average of 62.7 per cent. It reveals that lot of effort need to be placed by the states and various districts of Karnataka to encourage farmers to participate in the scheme.

The evaluation of fertilizer consumption in the neighbouring states of West Bengal was undertaken by taking the data on sales of fertilizers in these states before the implementation of the programme (2014-15 and 2015-16) and during the programme period of 2018-19. It is observed that the nitrogenous fertilizer increased in all the study states showing increase of 10.74% by Bihar, 38.06 % by Jharkhand, 5.72 % by Odisha and 8.90 % by Assam (Table 1). The increase in nitrogenous fertilizer consumption is primarily attributed to PMKISAN scheme which has increased the purchasing capacity of the farmers.

Table 1: *Impact of PMKISAN scheme on nitrogenous fertilizer consumption of Eastern states*

States	Amount of Nitrogen consumed (Kg/ha)		Change in N consumed		% change in N consumption	
	Av 2015-16	2018-19	Absolute	DID	Using traditional method	Using DID method
West Bengal	80.30	80.88	0.58	-	-	-
Bihar	140.25	155.89	15.65	15.06	11.16	10.74
Jharkhand	29.93	41.90	11.98	11.39	40.02	38.06
Orissa	39.93	42.80	2.87	2.29	7.19	5.72
Assam	44.56	49.11	4.55	3.97	10.21	8.90

The impact of PMKISAN was also assessed on the ragi crop of Tumkur district of Karnataka. It is observed that the beneficiary farmers are using more of inputs like fertilizer, FYM, pesticides and irrigation which is having an implication on yield of ragi (Table 2). The beneficiary farmers are realising higher income (₹11,293) from ragi enterprise as compared to non-beneficiary farmers (₹9964/-).

Table 2: *Cost and returns in ragi cultivation by beneficiaries and non-beneficiaries of PM-KISAN (₹ /acre)*

Particulars	Beneficiary	Non-beneficiary
Yield (quintal/acre)	6.8	6.1
Price (Rs/quintal)	2250	2250
Byproduct	4993	4788
Gross returns	20334	18513
Input costs	9683	9132
Farm Business Income	11293	9964
B-C ratio	2.09	2.02

The farmers are facing constraints in participating in the scheme due to lack of land title in their own name, lack of clarity about the eligibility for the scheme and lack of awareness. The farmers revealed that the scheme is beneficial to them and should continue.

Conclusions

The performance of the scheme has been varied across different states as also across disctricts of Karnataka. The use of Difference in Difference approach reveals that use of nitrogenous fertilizer consumption has increased in the states of Bihar, Jharkhand, Orissa and Assam to the tune of 10.74 %, 38.06 %, 5.72% and 8.90% during 2018-19 over that during the period 2015-16. The primary data analysis of the ragi farmers of Tumkur revealed that PMKISAN has lead to use of higher amount of inputs by beneficiaries (₹11,293/-) over non-beneficiaries (₹9964/-) resulting in increase in yield to 6.8 q/acre by beneficiaries over 6.1 q by non beneficiaries. It is suggested that the scheme is beneficial to the farmers and the states and regions lagging behind in implementation of the scheme need to be promoted. This is essential so that the benefit of the scheme is reaped by all the eligible farmers.

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Behavioural Economics may be the Option for Growth Strategy: Myths and Reality Check on Indian Economy

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Abstract

Lacking the monetary, fiscal and administrative capacity to respond to this crisis, the consequences of a combined health pandemic and a global recession will be catastrophic for many developing countries and halt their progress towards the Sustainable Development Goals. In line with the government's stated policy of Atmanirbhar Bharat or self reliance, Indian will integrate its rich economic and spiritual heritage with modern economic ideas for ethical wealth creation through a marriage of the invisible hand of the market with the hand of trust. We must recognise that wealth creation is a collective process and that market outcomes are the product of how these various "*wealth creators*" interact. We must drop the false dichotomy of governments versus markets and begin to think more clearly about the market outcomes we want. Public investments should be the mission oriented, instead of focused on "*facilitating*" or "*incentivising*" business. Policy should actively shape and create markets, not just fix them when they go wrong. Money creation, through quantitative easing, will not fuel the economy if the new money ends up in banks that do not lend. And when businesses do not see opportunities, interest rates stop affecting investment. Until the 1980s, productivity increases were accompanied by wage increases and rising living standards. This link was broken by a drop in labour's negotiating power and companies' increased financial orientation. The farm sector is likely to register positive growth even as the rest of the economy (barring the government sector) contracts. By generating a virtuous cycle where private investment, wage and employment growth as well as consumption feed into each other. The rise in agricultural activity, coupled with higher allocations to the MGNREGA also appears to have led to a sharp drop in rural unemployment as observed in the CMIE data. However, healthy growth of the farm sector, even if it continues, is unlikely to offset the economic losses suffered by other parts of the economy. It is possible that heightened risk aversion, self imposed restrictions, and localised lockdowns continue to be a drag on activities in urban areas, impinging upon rural economic activity as well. The behavioural economics is playing the crucial role in major economic domain may be drive towards Atamnibhar Bharat in the near future.

Microfinance as a Tool to Fight COVID 19: Performance Evaluation Across States

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Extended Summary

Introduction

In developing countries like India, availability of reliable and affordable financial services to poor and vulnerable section of the society is recognized as a necessity for inclusive socio-economic development (Singh and Padhi, 2019). Microfinance has proven to be an important tool for financial inclusion of the low-income households. But micro-finance activities seem to happen only in certain pockets of the country, and the growth of SHGs has been uneven (Kumar *et al.*, 2013). So, we tried to study the progress of SHG-BLP and analysed the performance of this programme across states and also identified the factors having a foothold on SHG's performance of the states

Materials and Methods

The study is based upon both primary and secondary data. Secondary data was collected from different reports of NABARD. Primary data was collected from 5 SHGs of Cooch Behar district of West Bengal. Principal Component analysis was used to determine the minimum number of factors that will account for maximum variance in the data and Discriminant function analysis is used to identify factors that differentiate poor performing states and good performing states.

Results and Discussion

The objective of principle component is to reduce the number of independent variables into few components. There are around 54 variables related the different aspects of microfinance which are reduced to seven components.

The first seven principal components explained 79.92 per cent of variation. The variable which has higher weights are considered dominant in the component.

After identifying the important components (based on the weights assigned to each variable), the composite principle component score was calculated for the purpose of ranking the states based on the performance of SHG's

Table 1: *Principal Components*

Name of Principal Components	% of variation explained
Credit Support	19.97
Quality of credit support	19.02
Thrift Behaviour	16.47
Performance of RRB	8.16
SHG-Bank Linkage	6.08
Performance of SGSY Scheme	5.16
Implication of SHGs on NPA	5.06

We found that Haryana is the best performing state followed by Bihar and Mizoram and Himachal Pradesh is the worst performing state in terms of microfinance.

After dividing the states into two categories based on their performance, Discriminant Function Analysis was used to identify factors that differentiate poor performing states and good performing states

Factors which are responsible for discriminating the states into two categories are given in the table below.

Table 2: *Factors responsible for differentiation*

Sl. No.	Variables	Coefficients of Discriminant function	Strength of the variable (%)
1	Savings of SHGs with PSBs (No.)	-0.07	0.17
2	Savings of SHGs with PSBs (Amt)	-8.74	20.65
3	Savings of SHGs with RRBs (Amt)	-2.27	5.36
4	Savings of SHGs with Bank (Total Amt)	-0.29	0.70
5	Savings of Women and SGSY SHGs with PSBs (Amt)	16.69	39.40
6	Loan disbursed to SHGs by PSBs (No.)	0.95	2.25
7	Loan disbursed to SHGs by PSBs (Amt)	-6.78	16.02
8	Savings of SHGs with RRBs (No.)	-0.09	0.23
9	Loan disbursed to SHGs by Cooperative Banks (Amt)	1.90	4.49
10	Loan O/s against SHGs in Coops (No.)	0.33	0.79
11	NPA as % to loan O/s against SHGs	0.12	0.30
12	Loan O/s against SHGs in CBs (Amt/SHG)	1.26	2.97
13	NPA as % to loan O/s against SHGs in PSBs	-0.40	0.95
14	Loan O/s against Women SHGs in PSBs (Amt/ SHG)	-2.12	5.01
15	NPA as % to loan O/s against SGSY SHGs in RRB's	-0.29	0.70

Primary data was collected to see the overall performance of SHGs and also how the lockdown has impacted their activities. We found that these 5 SHGs continued their commercial activities during lockdown also. They were less impacted and families associated with these SHGs were able to earn fair income.

Conclusions:

Seven principal components were identified which was responsible for 79.92% of variation, and the composite principle component score was calculated to rank the states based on the performance of SHG's. Haryana is the best performing state and Himachal Pradesh is the worst performing state.

15 factors were identified from discriminant function analysis which were majorly responsible for classifying the states into good performing and poor performing states. The poor performing states need to emphasize on these variables in order to transform their status from poor performing to good performing state.

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Innovations in Marketing during Lockdown: A Case Study of Mango

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Extended Abstract

Introduction

Mango (*Mangiferaindica* L.) is national fruit of our country and is also called as King of fruits because of its unique taste, delicacy and nutritive values. India is the leading producer of mango with production of 21.82 million tonnes constituting around 50 % of the total world production. Increased demand as a result of increased disposable income of the consumers led to the expansion of area under mango cultivation which intern led to the increased production over the years. The mango harvest season varies from variety to variety however it usually starts in the months of March-April. The coincidence of mango harvesting season and COVID-19 lockdown has left the mango farmers as well as the consumers in shock as mango mandis were virtually shut. Karnataka is one of the leading producers of mango in India producing many varieties leading to total production of 1760.60 thousand tonnes from an area of 183.23 thousand hectares. The major varieties grown in Karnataka are Alphonso, Mallika, Amrapali, Totapuri, Badami, Rasapuri, Banganpalli, Sendhura etc. This study aims at identifying the innovative mango marketing channels during lockdown.

Results and Discussion

There exists a large number of institutions promoting quality mango production and efficient marketing of mango in Karnataka. The major traditional marketing channels for mango are producer-preharvest contractor-wholesaler-retailer-consumer where 70-80 % of the produce moves and other traditional marketing channels includes; producer-commission agent-wholesaler - retailer-consumer, producer-preharvest contractor- retailer-consumer, producer-commission agent-retailer-consumer, producer-retailer-consumer etc. Producer share in consumer rupee in these channels is only 50-60 % as these marketing channels involves large number of stakeholders and there is also a loss/damage of fruit during multiple transportation. As mango mandis were shut and consumers were in fear of stepping out from homes which has led to the emergence of many innovative marketing channels viz. Producer-Karnataka State Mango Development and Marketing Corporation (KSMD & MC)- Consumers involving post office has deliver agent, Producer-Resident Welfare Associations-Consumer, Producer-Flipkart (KSMD & MC)- Consumer, Producer-

Consumer with various Agricultural university as facilitating agency and Indian Institute of Horticultural Research also promoted direct marketing of Mango through their business incubation centre. KSMD & MC also signed a MoU with flipkart to ensure the mango growers about the availability of marketing facilities and facilitating consumers to place orders for different mango varieties like Alphonso, Badami, Banganpalli, Kesar, Neelam, Sendur and Mallika etc. with a minimum quantity of 3 kgs on flipkart platform. The major differences between traditional and innovative marketing channels are the time required to reach the consumer is more in case of traditional marketing channels where as it is very less compared in case of innovative marketing channels leading to higher fruit damage/ loss in case of traditional marketing channels where there is no/minimal fruit loss in case of innovative marketing channels as packaging and movement of mango is closely monitored by the KSMD & MC, all the mangoes produced by the farmers can be sold through traditional marketing channels but the mangoes produced following Good Agricultural Practices only sold through the innovative marketing channels. There are restrictions on minimum order quantities in case of innovative marketing channels like minimum 3 kgs should be ordered through flipkart and in case of Resident welfare Associations minimum order quantity is 250 Kgs where as there are no such minimum order requirements in case of traditional mango marketing channels. The mangoes should be natural ripened and free from ripening agents like calcium carbide in case of innovative marketing channels which is not necessarily followed in traditional marketing channels. The most important thing in innovative marketing channels is both producers and consumers must register their names with KSMD and MC which is a difficult task of illiterate farmers. These are some of the difficulties in innovative mango marketing channels however these can be solved by giving proper training to farmers.

Conclusions

These innovative marketing channels not only led to higher producer share in consumer rupee but also led to the higher consumer satisfaction by making available quality mangoes at reasonable price at their door steps in a very short period of time. These marketing channels were the innovations to overcome COVID-19 crisis, however these should be promoted as an important marketing channels in future with complementary government policy support in terms of marketing reforms for farmers and farmers should also be trained to practice good agricultural practices, ripen mangoes without ripening agents, grading and branding etc. So, these innovative marketing channels should replace the existing traditional marketing channels to make Indian farmers more progressive and enthusiastic towards farming in future.

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Risk Perception and Management Strategies of Coconut Farmers of Kerala

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Extended Abstract

Introduction

Coconut is an important plantation crop with multiple of uses apart from being an oilseed crop. On the basis of area under cultivation and share of contribution to state economy, it has a prominent place in Kerala. Compared to many other plantation crops, coconut have a unique position as a smallholder's crop as it is an important component in any small farm area of a small or marginal farmer in the state. Though the state is a leading coconut producer for decades, coconut farmers in the state are facing lot of issues arising out of various risks in farming. Present study looks into perceptions of farmers regarding various risky situations, management strategies being adopted by them to tackle these risks, and the efficacy of major management strategies adopted.

Materials and Methods

The study is based on primary data collected from farmers using pre-tested structured interview schedules. Two major coconut producing districts from the state – Calicut and Malappuram were selected based on higher area under coconut, and also based on presence of coconut producer companies. 3 villages from each district were selected and a total of 273 farmers comprised the total sample. Percentage analysis, binary logistic regression and ordered logistic regression were used for the analysis.

Results and Discussion

Lack of financial capital, high temperature and drought were the most frequently occurring production risks in farmers' opinion. When looked into price risk, input price risk and over-supply in the market were the major issues. Among the various factors that affect income risk, subsidy policies by the government, volatility in input prices, price policy by the government and fluctuations in production were the major factors as perceived by the farmers.

From the results of binary logistic regression on adoption of particular risk management strategy (Joining in producer company, diversification, value addition) by the farmers, among the various factors considered, irrigation status and number of trees were found to have significant positive influence on farmers' decision to join in farmer collective like Producer Company (PC) in order to manage various risks. Another important risk management strategy being adopted by farmers were farm diversification. Factors like irrigation status and number of trees were found to have positive effect, whereas level of education was found to have negative effect on adoption of farm diversification. More educated people were doing other jobs and farming was their minor activity only. This might be the reason for negative effect found from the results. Mass media exposure, irrigation status and number of trees were the major factors motivated farmers for value addition. All the three selected management strategies were found effective in helping farmers in risk management. Apart from these three, mass media exposure was found as effectively helping farmers in managing risks.

Conclusions

Lack of capital, input price hike, product price volatility, high temperature and drought, etc. were the major risk factors as felt by the farmers. Three major risk management strategies being adopted by farmers – joining in farmer collectives like producer companies, farm diversification and production of value-added products from coconut, were found effective in helping them to manage risk. Apart from these, knowledge acquired with the help of mass media exposure was also found effective. Factors like irrigation status and number of trees were found motivating farmers to adopt these risk management strategies. More farmers should be convinced and motivated to adopt these strategies so that it will be helpful for them to get steady income from farming.

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Growth of Agro Processing Enterprises in India: A Reflection of NSSO Unit Level Data

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Extended Abstract

Introduction

Agriculture is the largest unorganised segment of India. It is often criticised that Indian farming is not remunerative for most of the farmers. The existence of small and marginal farmers is one of the reasons behind the low productivity. However, the agro based enterprises have played an important role in generating employment and output. They are located in both rural and urban India. These enterprises use the agriculture outputs as inputs and further process it. In one hand they create demand for the agricultural outputs and on the other side create non-farm employment in that region.

Materials and Methods

The present study is based on NSSO unit level data of 56th (2000-01), 62nd (2005-06), 67th (2010-11) and 73rd (2015-16) rounds. To get data related to agriculture based enterprises we have taken NIC (2008) two digit level enterprises namely food processing, beverages and cotton ginning, baling & cleaning enterprises only. The objectives of the paper are as follows: (i) to determine the growth of employment and output of agr-based enterprises in rural India during 2000-01 to 2015-16 and (ii) to analyse the factors affecting the growth of employment.

Results and Discussion

The study reveals that in India there were 30,17,000 agro-based enterprises in 2000-01 which reduced to 24,62,000 in 2015-16. The employment also reduced from 66,55,000 in 2000-01 to 51,10,000 in 2015-16. Only food processing enterprises had shown a positive growth of employment during 2010-11 to 2015-16. The growth of employment of the food processing enterprises was around 2 per cent per annum during this period. The percentage share of male workers was 64 per cent for food processing enterprise, 53 per cent for beverage enterprise and 61 per cent for cotton ginning, baling & cleaning. The growth of part time male workers was positive for all three enterprises during 2000-01 to 2005-06 and 2010-11 to 2015-16. The growth of output (GVA) of food processing enterprises always remained positive during 2000-01 to 2015-16. Other enterprises had

shown negative growth of output during 2005-06 to 2010-11. Around 85 per cent food processing and beverages enterprises were own account agri-based enterprises (OAAEs). OAAEs are those enterprises which do not hire workers from outside on a regular basis. Although, around 95 per cent cotton ginning, baling & cleaning enterprise were OAAEs. The polled regression analysis confirms the Kaldor hypothesis reflecting the significant relation between growth of employment and growth of output of these enterprises.

Conclusions

Many workers depend on these agro-based enterprises. But the growth of employment was negative in most of the enterprises during 2000-01 to 2015-16. However, the growth of output was positive for all enterprises during 2000-01 to 2015-16. There is a significant relationship between growth of employment and growth of output of these enterprises. This study indicates that the number and employment of such enterprises had been decreased during the study period. This is not optimistic in context of India. The low demand from agro-based enterprises makes farming less remunerative. Therefore, government should focus on these enterprises as they have direct linkage between agricultural outputs and unorganised agro-based enterprises. The study finds that the finance from formal organisations is one of the hindrances of development of these enterprises.

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Marketing Efficiency of Maize: A Case Study of West Khasi Hills District of Meghalaya

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Extended Abstract

Introduction

Agriculture is the mainstay of the economy of the state of Meghalaya, one of the seven northeastern states of India. Although 81% of the state's population is directly or indirectly dependant on agriculture for maintaining their livelihood, the net cropped area is only about 11 per cent of the total geographical area of the State. Maize occupies 18152 ha (7 percent of the net cropped area) in Meghalaya.

Maize is the second most important cereal crop in the state. However, the production and productivity of maize has remained stagnant for the past few years and competes with other crops in area allocation. The present study had been undertaken to determine the marketing efficiency of different maize marketing channels in West Khasi Hills district of Meghalaya occupying a significant area under the crop.

Materials and Methods

Multistage sampling was adopted for selection of districts, blocks and villages on the basis of maize growing area. In the first stage West Khasi hills district was selected, followed by Nongstoin and Mawthadraishan blocks and three villages from each block (Mawkynbat, Mawduh, Nonglwai, Markasa, Nongshillong and Pariong) in the subsequent stages. The primary data on details of marketing were collected by personal interview method from 60 maize growing farmers and 10 retailers based on the population proportional to the size of the village following Simple Random Sampling without Replacement technique. Marketing efficiency was determined by Shepherd's approach.

$$MEI = \frac{\text{Consumer' sprice}}{\text{Marketing cost + Marketing margin}} - 1$$

Results and Discussions

The net return from maize not only depends on the production but also its marketing. The following two channels have been identified in the marketing of maize in the study area.

Channel I: Producer- Local market (consumer)

Channel II: Producer-Retailer - Consumer

The table 1 showed the marketable surplus of maize among the respondents in the study area and it revealed that majority (45 percent) of the population had a marketable surplus of 50 to 75 percent and only around 3 per cent of the population had a marketable surplus of more than 75 per cent.

Table 1: *Marketable surplus of maize*

Sl. No.	Marketable surplus (%)	Percentage of population
1	75-100	3.33
2	50-75	45.00
3	25-50	36.67
4	0-25	15.00

The price spread in the marketing of maize has been delineated in the table 2 which indicated that the highest net receipt of the farmer is found in Channel-I with 50 percent share in the consumer's price. Marketing cost was observed to be higher in Channel-II whereas the middlemen's profit was more in Channel-I which increased his share in the consumer's rupee. In the study area it had been observed that the farmers take up the role of a seller and may choose to follow both the channels.

Table 2: *Price spread in marketing of maize*

Sl. no.	Particulars	Channel-I (%)	Channel-II (%)
1	Net receipts of the farmer	50.00	39.67
2	Marketing cost	19.73	40.84
3	Middlemen's profit	30.27	19.49
4	Price paid by the consumer	100.00	100.00

The table 3 clearly showed that both the marketing channels were efficient but the index of marketing efficiency was higher in Channel-I indicating that it was more efficient. The lower efficiency in Channel-II can be attributed to higher marketing cost and profit of the retailer as they were absent in channel-I.

Table 3: *Marketing efficiency of maize*

Sl. no.	Channel	Marketing efficiency
1	Producer -consumer	1.00
2	Producer-retailer-consumer	0.66

Conclusions

The results showed that the farmers retained a considerable quantity of the produce for self consumption, animal feed and for seeds due to lower production. Increase in price of the produce may results in higher marketable surplus augmenting the farm income and give way to commercialization of the crop. Two main marketing channels were identified in the study area, Channel I: Producer- Local market (consumer) and Channel II: Producer-Retailer- Consumer. The marketing channels were not well developed and primarily involved the farmers and the retailers. The prospects of marketing can be enhanced if the intermediaries take active role in assembling the produce from the producers and making it available to the market. Out of the two channels, Channel-I was found to be more efficient which can be attributed to lower marketing cost. Strengthening the network of market information by the local bodies as well as the concerned department must be taken up for dissemination of timely information.

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Impact of e-NAM on Arrivals and Prices of Paddy: A Case Study of Nawapara APMC, Raipur District of Chhattisgarh

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Abstract

The paper analysed the impact of Electronic National Agriculture Marketing (e-NAM) in Nawapara APMC, Raipur district of Chhattisgarh with the objective of knowing and comparing the average monthly arrivals and prices of paddy before e-NAM and post e-NAM scheme integration with this APMC. For comparison and to know the changes of the arrivals and prices of paddy, percentage change has been evaluated. The results indicated that post integration of e-NAM, the monthly arrivals and prices of paddy increased. The arrivals was found to be maximum during the month of May in both pre and post e-NAM integration and the percentage change in the arrivals was found highest in the month of April with 185.03 % change. The result also indicated that the introduction of e-NAM scheme in this APMC shows positive impact on the price of paddy and the percentage change was highest during the month of June with 33.37% Change. The results of our study shows that there is a positive impact on the prices received by the farmers and an increase in market arrivals post e-NAM Integration compared to pre e-NAM implementation. Even though there is a positive impact of e-NAM platform, where the farmers are benefitted from the higher price and the traders and commission agents are benefited from the higher market arrivals still there is a need to increase its efficiency by eliminating the bottlenecks that this platform is facing.

Keywords: Electronic National Agriculture Market, efficiency and integration.

Effect of COVID-19 Pandemic on Onion Prices: An Application of Machine Learning Technique

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Extended Abstract

Introduction

Support Vector Machine (SVM) has recently been in use by researchers in the field of time series modelling very much. It is an Unsupervised learning technique where input variables are provided with very few information about the results. The "Vapnik-insensitive Loss Function" was introduced by Vapnik *et. al* (1992) which clarifies the use of Support Vector Regression technique in the domain of regression and time-series problems. Non-linear dynamics present in the agricultural products' price structure allow SVR to be implemented for prediction of the prices. We have seen price fluctuation in the price of onion in the Delhi market in the year 2020, the year of Corona pandemic. Due to lockdown condition in our country for around 2 months rural people could not transport their agricultural products to nearby markets which may be a reason for price change and their deteriorating economic condition (Imai *et. al, 2020*). In this situation we have tried an efficient AI tool, SVR to predict the daily data change in the price figure of onion and how the pandemic affects the price figures of agricultural products on a daily basis.

Materials and Methods

Onion daily price (Y) data has been collected from the NHRDF website for the year of 2020 from 1st of January to 27th of October. Dataset is divided into two parts then. One is the data of lockdown period (25th Mar-31st May) and another is of Unlock period (1st Jun-27th oct). Dataset of Covid-19 pandemic effect on human life is also collected for this time period on a daily basis from the website https://www.kaggle.com/sudalairajkumar/covid19-in-india. In this data set three variables are mentioned which are no. of cured (CU), deaths (D) and confirmed cases (CO). Firstly, it is seen that if there is significant correlation between these variables and the onion price (Y). Multiple Linear Regression (MLR) and SVR model have been fitted to these datasets taking onion price as dependent variable and others as predictor variables to predict onion price for the whole year, lockdown and unlock condition.

Results and Discussions

Full knowledge of the variables may be obtained from the below mentioned table and graph. Variability of all the variables are very high may be noticed from the table.

Table 1: *Descriptive statistics of the full data set*

Y	CU	D	CO	
n	301	301	301	301
Min	567	0	0	0
1st Q	916	0	0	1
Median	1310	13	375	674
Mean	1650	20	1088	1194
3rd Q	2000	34	1973	2089
Max	4550	437	7725	4473
Range	3983	437	7725	4473
SD	964	33	1357	1334
CV	58.4	165	125	112
Skewness	1.34	6.82	1.18	0.86
Kurtosis	1.29	78.22	0.98	-0.53

Figure 1: *Line charts describing the pattern of different variables*

Significant correlation coefficients between the predictor variables and the predictandis found for all the three data sets by carrying out t-tests.

Table 2: *Correlation coefficients of different predictor variables with onion market arrival price (Rs/Q)*

Predictors	Correlation coefficient		t-value and df			p -value			
Full	Lockdown	Unlock	Full	Lockdown	Unlock	Full	Lockdown	Unlock	
CU	0.14	-0.66	0.52	2.41, 299	-7.11, 66	7.35, 147	0.02	<0.0001	<0.0001
D	- 0.17	-0.48	-0.13	- 2.93, 299	-4.44, 66	-1.56, 147	0.004	<0.0001	0.12
CO	0.11	-0.76	0.57	1.86, 299	-9.50, 66	8.49, 147	0.06	<0.0001	<0.0001

We can see that correlation coefficients are higher in case of lockdown data. In unlock situation no. of deaths of due to Corona does not affect much to onion prices but other two predictors are affecting significantly to the onion price data. When we observe correlation coefficients for the full dataset, we see less effect of the predictor variables on the price variable. Three different datasets are fitted to the traditional regression model and to the AI tool and prediction results are obtained.

It is clear from the table above mentioned considering the result of AI technology that in the nationwide lockdown condition pandemic indicator variables are having more than 70% influence on the onion price variability. The effect is reduced to near about 60% in unlock condition and if considering the whole year data this effect is near about 45%. The results also tell us that AI algorithm is more efficient to capture the variability than the traditional model.

Table 3: *Comparative performance of prediction models on different datasets*

Comparative measures	Full	Lockdown	Unlock			
MLR	SVR	MLR	SVR	MLR	SVR	
R2 (%)	8.31	45.21	62.78	74.90	38.18	59.94
RMSE	922	756	143.5	118.23	752	643
MAD	707	445	114	84	502	313
RMAPE (%)	52	25	13	9	35	17

Conclusions

Price of perishable agricultural food products is fully dependent on every day transport and supply facility. In the lockdown condition rural people could not able to market their agricultural products to nearby markets properly due to unavailability of transportation. Due to less supply, price of food products might have increased in a normal condition but effect of corona virus is so severe that a different price scenario has been observed due to less demand during the lockdown condition. This price trend has effectively been captured by the SVR and outperformance of the AI tool is noticed over the traditional MLR tool. People assumed the near future. So, they stored essential commodities before the lockdown and for this reason at that time price hike might be noticed due to higher demand. Rural farmers had to go for distress sell. This trend may be observed on other daily food essentials like potato, egg etc. which are marketed by rural people on a daily basis but hampered due to the pandemic and they has been suffered for this.

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Asymmetric Volatility in Onion Priceat Delhi: Impact of Lockdown Due to COVID

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Extended Abstract

Introduction

Price volatility is the variation in the rate of change of price. Price volatility forecasting of agricultural commodities is crucial for both the farmers and policy makers. Asymmetric volatility raises when positive and negative shock of same magnitude lead to different responses to the volatility in some practical time series data. To take into account the asymmetry in the price volatility, asymmetric GARCH type models such as EGARCH, APARCH and GJRGARCH are generally used (Korkpoe and Junior, 2018) incollaboration with ARIMA methodology (Box *et al.*, 2007). Due to the COVID-19 pandemic, a nationwide lockdown was imposed from 25th March to 31st May, 2020 to contain its spread. A study has been conducted to know the asymmetric price volatility of onion for pre-lockdown, lock down and post-lockdown periods for Delhi market.

Materials and Methods

To conduct the study, daily time series data for modal spot prices of onion for Delhi market for the period 1st January, 2019 to 10th November, 2020, are collected from National Horticulture Research and Development Foundation (NHRDF) (http://nhrdf.org/en-us/) website. For both the year, the total time period are divided into pre-lockdown, lockdown and post-lockdown phases. As a holdoutset, 10% data are used. The bestfitted asymmetric GARCH model isobtained for each phases.The extent of asymmetry due to positive and negative information is visualized using News Impact Curve (NIC).

Results and Discussion

At first the data for the year 2019 and 2020 are divided into pre-lockdown, lockdown and post-lockdown phases. The descriptive statistics of these phases are given in Table 1.

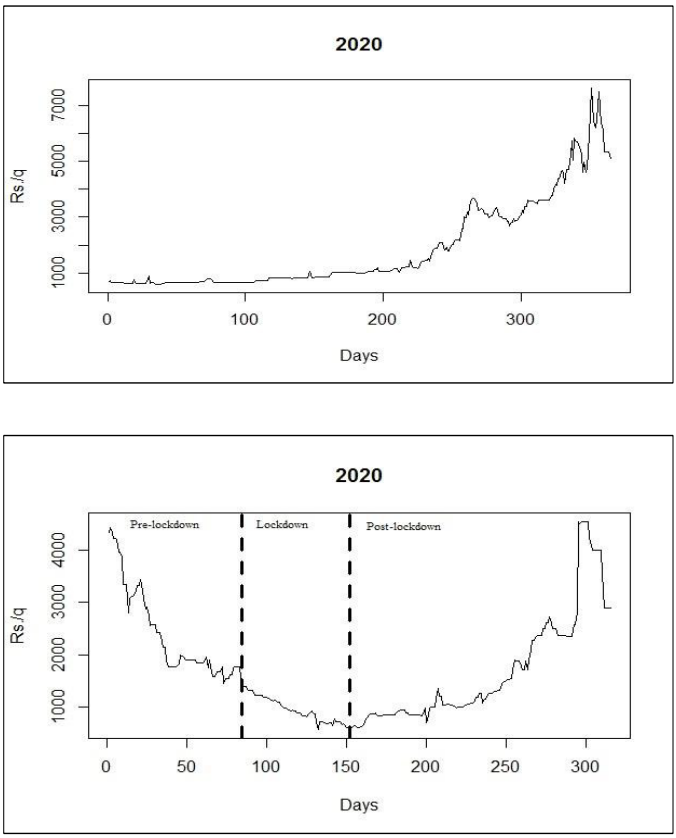


Figure 1: *Timeplot of onion price data for 2019 and 2020*

Table 1: *Descriptive statistics of onion price data for Delhi market, 2019 and 2020*

Statistics	2019 Pre-lockdown period	Lockdown period	Post-lockdown period	2020 Pre-lockdown period	Lockdown period	Post-lockdown period
Observations	83	68	214	84	68	163
Mean (₹/quintal)	659.05	749.92	2704.40	2380.05	945.10	1695.59
Median	655.00	794.00	2638.50	1897.00	916.00	1197.00
Minimum	585.00	640.00	861.00	1400.00	567.00	600.00
Maximum	875.00	1050.00	7650.00	4438.00	1400.00	4550.00
Standard deviation	47.65	90.70	1677.78	843.22	236.92	1062.54
Coefficient of variation (%)	7.00	12.00	62.00	35.00	25.00	63.00
Skewness	1.66	0.32	0.77	0.99	0.25	1.28
Kurtosis	4.45	-0.15	-0.24	-0.27	-1.18	0.74

From the above table it is noticeable that coefficient of variation during the lockdown period for the year 2020 is more than twice than the previous year. It is also seen that during the lockdown period there was a sharp decline of price.

Based on the information criteria, such as Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), Shibata Information Criterion and Hannan-Quinn Information Criterion, appropriate ARMA-asymmetric GARCH-in-mean models are obtained for each of the three periods of both the years. Among these asymmetric models, model with best forecasting performance are obtained using RMSE, MAE and MAPE. The best fitted models areas follows:

Table 2: *Best fitted models of onion price data for Delhi market, 2019 and 2020*

	2019	**2020**
Pre-lockdown	ARMA (0, 0) –APARCH-M (1, 1)	ARMA (0, 1)–APARCH-M (1, 1)
Lockdown	ARMA (1, 0) –APARCH-M (1, 1)	ARMA (0, 2)–APARCH-M (1, 1)
Post-lockdown	ARMA (0, 1) –GJRGARCH-M (1, 1)	ARMA (0, 0)–EGARCH-M (1, 1)

Using these models, News Impact Curve (NIC) is obtained for visualization of asymmetric volatility.

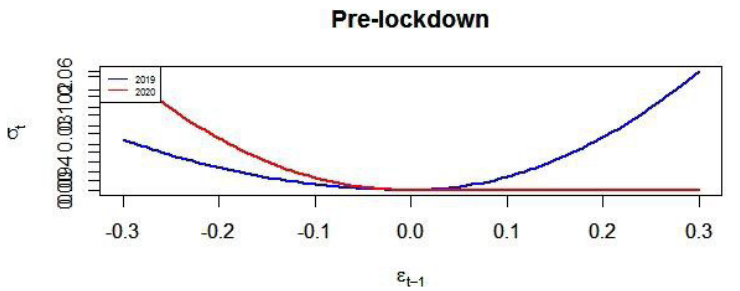
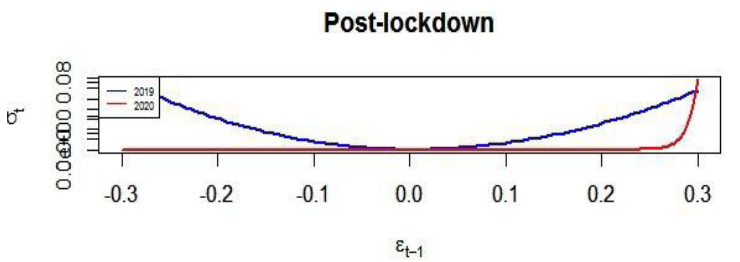
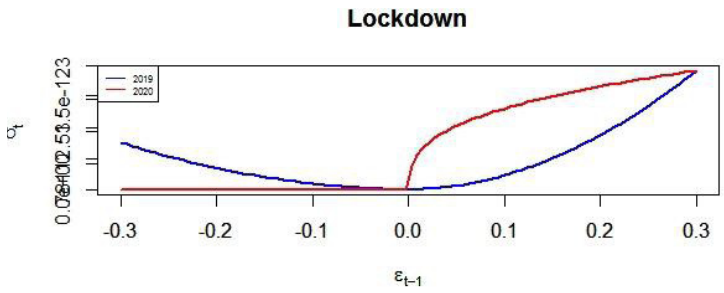


Figure 2: News Impact Curve (NIC) of onion price data for pre-lockdown, lockdown and post-lockdown phases





It can be inferred that during 2019, all the three phases show almost same kind of asymmetry of price volatility. But in 2020, during pre-lockdown phase positive news does not have influence on volatility and negative news has. In contrary to it, during lockdown phase even a lower degree positive news leads to a very high degree of volatility on onion price. Again, during post-lockdown, only a high degree of positive news has a large impact on volatility, otherwise it is invariant.

Conclusions

In this study, impact of news on price volatility is investigated for pre-lockdown, lockdown and post-lockdown phases and also compared with the previous year. Different asymmetric effects of information are seen during these three phases. During the pre-lockdown period, as everyone was aware of COVID-19 pandemic, price volatility was impacted by negative information only. Positive information did not play any role on volatility. During the lockdown period uncertainty was there in the market. This leads to rapid fall in price and also increases price volatility in large extend. A very high degree of impact on price volatility of positive shock is seen during this period. Again, during post-lockdown phase as market regain sits confidence only a high degree of positive news has a large impact on volatility.

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Group Dynamics Effectiveness among the Members of Farmer Producer Organizations in West Bengal

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Extended Abstract

Introduction

In the recent past, Government of India is giving thrust on group approach in agricultural extension to implement development schemes and facilitate transfer of agricultural technology among the farmers. Group extension approaches offer several advantages over individual approach like reaching large number of clients, improving the flow of information to farmers, better access to resources, time and cost saving etc. In this background, the Government of India amended the Companies Act, 1956 during 2002 that paved the way for incorporation of '*Farmer Producer Organisation* (FPO)'.

The state of West Bengal represents among highest number of FPOs (SFAC, January, 2020 and NABARD Portal on FPOs, 2020) but very few researches have been reported on the performance of the FPOs. Group dynamics of FPOs is a critical factor contributing to its' effectiveness. In this context, present study was conducted to explore group dynamics of selected FPOs and to identify the associated factors.

Materials and Methods

Ten FPOs which were functioning for more than five years in West Bengal were selected. From each FPOs 2 office bearers and 10 general members were selected randomly. Total sample size were 120. The data were collected through personal interview method.

The scale developed by Vipinkumar (1998) was used for measurement of group dynamics effectiveness with necessary modification. Five dimensions i.e. *Participation and decision making*, *Norms for operation, maintenance and management function*, *Group atmosphere and interpersonal trust*, *Feelings of social inclusion* and *Empathy* were selected as indicators for analyzing group dynamics. Correlation and regression analysis were done to ascertain the correlates and factors affecting group dynamics.

Results and Discussions

Group Dynamics Effectiveness Index (GDEI) score of high and low performing FPOs

The high and low performing FPOs had a mean GDEI score of 87.37 and 73.29, respectively. Since coordination and higher group interaction is necessary for successfully performing activities in groups, it is normal only that high performing FPOs would have higher GDEI.

Level of different dimensions of group dynamics of members in high and low performing FPOs

Participation and decision making and *Norms for operation, maintenance and management function* were medium in case of both high and low performing FPOs. *Group atmosphere and interpersonal trust, Feelings of social inclusion* and *empathy* were medium to high in case of high performing FPOs, while it was medium to low in low performing FPOs.

Relationship between characteristics of members FPOs and GDEI

Variables such as education, extension personnel and cosmopolite channel contact, personal localite channel contact, social interaction with people, attitude towards FPO, attitude towards group, accommodation and assimilation had positive association with GDEI of members in high performing FPOs. Occupation, Competition and conflict were negatively associated with GDEI of members in high performing FPOs.

In low performing FPOs, extension personnel and cosmopolite channel contact, social interaction with people, attitude towards group and assimilation had positive association with GDEI of members. Competition and conflict were negatively associated with GDEI of members in low performing FPOs.

Contribution of characteristics of members of FPOs on GDEI

Forward Regression analysis showed that extension personnel and cosmopolite channel contact, conflict, attitude towards FPO and competition can explain 68.2 per cent of the variation in GDEI in high performing FPOs. In low performing FPOs, Forward Regression analysis showed that attitude towards groups, extension personnel and cosmopolite channel contact, age, farming experience and social interaction with people can explain 60.6 per cent of the variation in GDEI.

Conclusions

The respondents of both samples were similar on *norms of operation, maintenance and management functions* and *participation and decision making*. But the two samples of respondents were different from each other on *feelings of social inclusion, empathy* and *Group atmosphere*. Contact with extension personnel and other cosmopolite channels was a significant contributor in developing better group dynamics within high performing

FPOs. As the contact with cosmopolite channels opens up one's world view, group members could see that there is worth in maintaining better group dynamics within the FPO. Attitude towards group of the members, especially of low performing FPOs assumes great importance as positive attitude of some members would provide for better group dynamics and a negative attitude of some members would pull down the group dynamics of the group. Age of the members in low performing FPOs is negatively affecting GDEI suggesting that young members had higher GDEI scores.

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Impact of COVID-19 Pandemic on Livelihood Security and Changing Dynamics with Poverty- A Review

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Abstract

Today, the whole world is in dark due to unpredictable pandemic disease COVID-19. It has led to a great loss of human life all over the world and it affects so badly on public health, food systems and the work of whole world. Nobody imagine about the economic and social disruptive caused by the pandemic. Majority of workforce is facing problems of extreme poverty as tens of millions of people are at risk of following into it while the number of people estimated at nearly 690 million, could increase by up to 132 million by the end of this 2020. Due to the pandemic, more than 60 per cent jobs are decimated and millions of livelihoods are at risk.

Several type of abuses are experienced by agricultural workers waged and self-employed while feeding the world , regularly facing high levels of working poverty, malnutrition and poor health and suffering from a lack of safety and labour protection. Therefore, the disordering happened in livelihood security and showing far-reaching impact on almost whole world specially on developing countries. Owing to the importance of these sectors, this paper performs a comprehensive assessment of the effect of COVID-19 on livelihood security and changing dynamics with poverty. The research suggests coping and mitigation mechanisms that can be adopted to sustain livelihoods.

Impact of COVID-19 on Forest Dwelling Tribes in Chhattisgarh

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Abstract

The Covid-19 pandemic and the Government actions, including restrictions to movements, suspension of non essential economic activities has proved devastating to the vulnerable tribal population and the impoverished communities. Restrictions of movements and non-existence of market led to severe forms of food security and wide spread hunger. The Study conducted in Achanakmar Wild life sanctuary in Chhattisgarh. Chhattisgarh with its 42 percent forest cover and an almost similar percentage of tribal population (32 %), of whom almost 90 percent are forest dependent, fared relatively well in comparison with many other Indian states in battling the impacts of the pandemic and lockdown. Chhattisgarh has above 50 percent of its population below poverty line as these are the forest dependent communities. Chhattisgarh also has 5 officially recognized 'primitive' tribe groups comprising mostly landless peasants with no or negligible amounts of land and therefore entirely forest dependent. Almost 90 percent of populations having less than 1.25 USD per day live in the protected forests and they have withstood the challenge and are surviving. It is important to understand here why forests are important and sustain such a large population. It also raises a valid point that there is an urgent need to redefine the prevalent notions of poverty. The study shows that the Baiga population and the forest dependent communities have been subjected to multiple deprivations owing to not only their economic status, but also their social status. On one hand the population deep inside the core area has been historically deprived and discriminated, which multiplied due to further restrictions in this crisis situation as well as shortage of food supply in the remote areas, while in the buffer areas the population has withstand the challenge. The forest ecosystems that support the indigenous societies and their knowledge have survived the sudden and prolonged Covid 19 lockdown. The forest communities could sustain themselves even when markets for forest produce were non-existent.

Migration has increased over the last few years from the protected areas. Migration can be seen among the new generation which has rapidly increased due to natural disaster like drought and erratic rainfall as well as to many other reasons. The new generation are disinterested in farming and forest based livelihood and wants regular wage employment to fulfill their aspiration. The share of total employment in agriculture sector in the area has fallen well below 50 percent. The area being rainfed, has only paddy cultivation and diversification of agriculture has not been focused. Collection of Non timber forest produce has been refrained from collection. Migration is response to aspiration and climate vagaries and studying it from a sustainable perspective where environmental push factor interact with other social economic and political variable.

Keywords: Achanakmar, Baiga, Non Timber Forest Produce, Migration

Online Teaching Learning- vs. -Classroom Teaching Learning

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Abstract

The situation in general education has changing through out the world as a result of growing technology generation at large scale. The birth of online learning in 1986 had given a new direction of the education. Many educational institutes were providing education through online mode since then. In addition to this growth of smart phone worldwide faster the pace of learning via online medium. The genesis of novel corona virus led to lock down of all the educational institutions nationwide. But due to the opportunity of learning via online mode had given a new shape to the education as it was the only way in the present situation by which students are attending their classes, giving their exams and their year is not wasted. Online learning is the use of internet as medium through which education takes place. It has a good scope as it is expected that by the next year online learning market will be 1964 million only in India. In addition to this Government is also focusing on integration of online learning in traditional classroom learning and teachers training for online classes. So it can be said that online learning has a good scope and it is a good option for traditional class room learning.

Keywords: Online learning, Coronavirus, education

Reflection on the Trends on People's Participation and Sustainable Livelihood Approach

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Abstract

During the time of independence of India, community development and community participation were perceived as synonymous but with the time the scenario had been changed. The main focus of community development was shifted from needs-based to an alternative assets-based approachin the recent developmental frontier, globally. People's participation in forming a policy and creating ownership over the available assets has played a significant role in community development. This study attempts to review the existing literature with the main focus to define the relationship between the participation of people, the assets creation, and the resilience against the vulnerability of the livelihood approach. The main attention is drawn to the sustainable livelihood framework of Department for International Development, to build an indulgent over the integrated approach of livelihood system, livelihood strategies, and livelihood assets, including social, physical, natural, financial, and human assets with the people participation and the vulnerabilities of livelihood system. There is a positive relationship between the livelihood assets and peoples' participation in the community development and also shows an inverse relationship between livelihood vulnerabilities and participation and creates resilience against the shocks and redefined the households strategies for sustaining the livelihood at grassroot level.

Keywords: Sustainable livelihood framework, Asset creation, People's participation, Resilience against vulnerability

Factors Affecting Groundwater Depletion in India

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Abstract

Water is one of the critical inputs for agricultural production that leads to food security. Over the years, farmers have identified groundwater as more dependable irrigation source compared to canal. With an annual groundwater draft of 253 BCM, irrigation alone consumes nearly 89 per cent of total groundwater extraction irrigating 62% of country's gross irrigated area. Government incentives to install water extraction mechanisms at farmers' field and electricity subsidies for agriculture have escalated tube wells/ borwells numbers, which led to over- exploitation of groundwater. Groundwater development has been more intense in North-Western region of the country where extraction exceeds its availability. Analysis of groundwater table in 499 districts across Indian states for TE2002 and TE2016 reveals that depletion of water table occurred in 67 % districts. Depletion of water table has been more intense (> 4 meters depletion) in about 10 % of the districts during this period. These districts fall in states which have high dependency on groundwater for irrigation coupled with free/subsidised electricity supply for agriculture. Therefore, this study is as attempt to ascertain factors affecting over-exploitation of groundwater in selected districts where rapid depletion of water level observed. In the panel regression analysis, fixed effect model yielded better result and indicates that rainfall has improved water table, whereas increase in groundwater irrigated area, area under paddy, sugarcane and horticulture crops led to depletion of water table.

With rise in water scarcity in most part of country, sustainability of agricultural production system will largely depend on resource based crop plan and efficient water use at farm level in coming years. So, the region specific crop plan and mushrooming of efficient irrigation technology such as micro-irrigation are indispensable to diminish irrigation water demand. Further, government can play pivotal role in efficient technology adoption and supporting farmers' income.

Keywords: Irrigation, Groundwater, Depletion, Fixed effect, India

Opportunities for Enhancing Livelihood Security of Jute Farmers in Post COVID-19 Period

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Abstract

COVID-19 had created a huge void in farmers' economy especially the weaker section consisting of small and marginal farmers. In West Bengal state of India, 96 per cent of the farmers belong to small and marginal farmers' category and majority of them follow jute based cropping system. The average production of jute in west Bengal was reported as 28 q/ha during 2019 whereas the potential jute yield range from 35 to 4 q/ha. Due to high cost of cultivation in general and lack of proper market system, jute cultivation had become less profitable. It is very important to revive these farmers with suitable technologies, packages and technical assistance for improved production, value addition and marketing so that they can overcome the burden of loan and involve in more production and value addition oriented sustainable agriculture system. ICAR CRIJAF had developed a cafeteria of improved jute production technologies that can be very well adopted by farmers following jute based farming system. Women friendly production and post-harvest technological interventions can further enhance the farm women's participation in agriculture.

A Survey on the livelihood of tribal farmers of Makaltala and Farmania villages revealed that there are various economic activities that can profitably be carried out by the tribal families and Keeping this in mind under Tribal Sub Plan, various activities for enhancing the livelihood security was introduced by ICAR-Central Research Institute for Jute and allied Fibres from 2014-15 to 2017-18. The major interventions were Improved jute varities, line sowing, jute intercrop with mung, nail weeder, retting with CRIJAF Sona, improved package of practices of mustard, coriander, nigella, kharif and boro rice etc, entrepreneurship development through various training programmes, duckery, poultry etc. Special emphasis was given on women empowerment and nutrition security. Several trainings were given to women Self Help Groups (SHG) on preparation of jute bag and other handicraft. Trainings were also organised for the farm women on rearing of improved

breeds of poultry (Vanaraja) and duck (Khaki Campbell). A study was done on the perceived impact of the TSP programme by farmers and the results are presented in the following table. The maximum possible score (Cumulative) was 160 and minimum score was 0. The results indicate that the TSP interventions in the village helped to enhance the livelihood security of the farmers, the highest score was given for the component gain in confidence in farming (140) followed by gain in skill (135) and knowledge (131). The farmers also reported increased income, optimum use of resources and reduced migration. There was an increase in area and production of all the major crops in the study area like jute, rice and mustard. Value addition in jute through jute fibre based handicrafts and jute bags had also proved to be an additional source of income to the farm family. The unprecedented demand of jute fibre based products in both domestic and international market is a ray of hope for jute farmers and entrepreneurs. Empowering the farmers through potent technologies, value addition and value chain establishment would definitely help to enhance the income, rebuild their confidence in farming and achieve sustainable farm income in post COVID 19 period.

Total Factor Productivity and Supply- Demand Gap Analysis of Rice in Sub-tropics of Jammu Region of Jammu and Kashmir

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Abstract

An investigation entitled, Total Factor Productivity and Supply Demand Gap Analysis of Rice in Subtropics of Jammu Region was conducted in Jammu and Kathua districts of J&K UT during the agricultural year 2018-19. The results related to cost and returns revealed that per hectare cost of cultivation for rice was worked out to be ₹55642.45, ₹51729.92, ₹59543.40 and ₹57446.37 for Bishnah, Marh, Mahreen and Nagri with an overall average of ₹56090.40. The per hectare gross returns of rice cultivation of Bishnah, Marh, Mahreen and Nagri were ₹114782.60, ₹114904.60, ₹120820 and ₹120809.90 with an average return of ₹117829.28 respectively. The cost of cultivation of rice was found to be highest (₹59543.40/ha) in Mahreen block of Kathua district with an overall average of ₹56090.40. The cost- benefit ratio was found to be highest (1:2.22) for Marh block with an overall ratio of 1:2.10. The results regarding trends in productivity growth of the rice showed that efficiency change was one for the overall period whereas technical change and TFP change were more than one for 2016-2017 which is 1.044 with a mean of 0.953 for overall period. After calculating the demand and supply in sampled rice farms, both districts were found to be in surplus stage which was highest in Jammu district (282033kg). On the basis of secondary data, it was also found that Jammu, Samba and Kathua district had surplus production of rice, i.e., 1006559.94 kg, 15029.80 kg and 21208.40 kg, respectively while all other districts of Jammu are deficit. Jammu region as a whole was also found to be deficit in rice with requirement of 183329.33 tonnes.

Key words: CACP, DEAP 2.1, total factor productivity, schedule, surplus, deficit.

Cost and Return Analysis of Organic Basmati and Pulse Crops for Sustainable Livelihood Security of Small & Marginal Farmers

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Abstract

Organic farming has the potential to provide benefits in terms of environmental protection, conservation of non-renewable resources and improved food quality The present investigation Cost and Return Analysis of Organic Basmati and Organic Pulse Crops was carried out in the field experiments conducted Organic Farming Research Centre, Chatha. Per hectare gross returns and net returns for Basmati 370 was found to be ₹ 79200.00 and ₹ 52556.75, respectively whereas for moong, mash and toria, gross returns was found to be ₹ 60750.00, ₹ 45840.00 and ₹ 28200.00, respectively and net returns of ₹ 38003.85, ₹ 22484.85 and ₹ 16720.85, respectively. The benefit cost ratio was found to be 1:2.97 which shows that Organic Basmati 370 is more responsive towards the inputs use and under good management and it can give even higher returns. The benefit cost ratio for Moong SML-668 was found to be 1:2.67 whereas for Mash 1008 and Toria, it was found to be 1:2.04 and 1:2.46, respectively.

A Study to Analyze the Impact of Packaging on the Consumer Overall Purchase Decision

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Extended Abstract

Introduction

In today's society, packaging is pervasive and essential. It surrounds, enhances and protects the goods we buy, from processing and manufacturing, through handling and storage, to the final consumer. Without packaging, materials handling would be a messy, inefficient and costly exercise and modem consumer marketing would be virtually impossible The Packaging Institute International (PII) defines packaging as the enclosure of products, items or packages in a wrapped pouch, bag, box, cup, tray, can, tube, bottle or other container form to perform one or more of the following functions: containment, protection, preservation, communication, utility and performance. Package attracts consumer's attention to particular brand, enhances its image, and influences consumer's perceptions about product (Rundh, 2005). Also package imparts unique value to products (Underwood *et al.*, 2001; Silayoi and Speece, 2004), works as a tool for differentiation, i.e. helps consumers to choose the product from wide range of similar products, stimulates customers buying behavior (Wells *et al.*, 2007). Thus package performs an important role in marketing communications and could be treated as one of the most important factors influencing consumer's purchase decision. In this context, seeking to maximize the effectiveness of package in a buying place, the researches of package, its elements and their impact on consumer's buying behavior became a relevant issue.

Materials and Methods

The present study was carried out by taking an appropriate sample from urban area, Sainik Colony, Channi Himmat, and Gandhi Nagar, of Jammu city of Jammu and Kashmir The primary data from respondents was collected by survey method, using well defined

schedule The sample size for the study was taken as 150. As the present study used the sample consists of 150 respondents showing the impact of packaging on consumer buying behavior in Jammu urban To collect the information among the respondents that was taken into consideration was the three main areas of Jammu i.e. Sainik Colony, Channi Himmat and Gandhi Nagar. Therefore, 150 sample size (50 from each area) seem to be enough for conducting study.

Results and Discussion

To analyze the determinants that influence the consumer buying behaviour towards packed food items, the present study uses regression analysis technique.

Regression analysis is far the most widely used and versatile dependence technique applicable in every facet of business decision making. Its uses range from the most specific in each instance relating factor (or factors) to a specific outcome. Multiple regression analysis is a general statistical technique used to analysis the relationship between single dependent variables and several independent variables .its basic formulation is

$$\text{(metric) } Y_1 = X_1 + X_2 \text{----------} + X_n \text{ (metric)}$$

To understand this approach it becomes mandatory to understand certain key terms as under:

Key terms:

Coefficient of determination (R^2): Measure of the proportion of the variance of the dependent variable about its mean is explained by the independent, or predictor, variables. the coefficient can vary between 0 and 1

Correlation coefficient (r).: Coefficient that indicates the strength of the association between any two metric variables. The sign (+ or -) indicates the direction of the relationship. The value can range from +1 to -1, with +1 indicating a perfect positive relationship. 0 indicating no relationship.

Beta coefficient: Standard regression coefficient (see standardization) that allows for direct comparison between coefficient as to their explanatory power of the dependent variable.

Adjusted coefficient to determination (adjusted R^2): Modified measure of the coefficient of determination that takes into account the number of independent variables included in the regression equation and the sample size.

A regression analysis is done to explain the variation in one variable (dependent variable), based on variation in one or more other variables (independent variables). In case there is one independent variable to explain the variation in one dependent variable, it is known as simple regression. If there are multiple independent variables to explain the variation in single -dependent variables, it is known as a multiple regression model.

The value of correlation coefficient from Table 3.1 appears to be 0.746 indicating that the independent variables show a high level of correlation with the dependent variable. The measure of strength of association in the regression analysis is given by the coefficient of determination denoted by R^2. This coefficient varies between 0 and 1 and represents the proportion of total variation in the dependent variable that is accounted for by the variation in the factors. From Table 3.1, the R^2 value is 0.557 which shows that 55.7 per cent of the variation in CBB can be explained by the eight factors or independent variables in the given analysis.

To test the validity of the model, the study incorporated the ANOVA or F test as shown in Table 3.2 It can be depicted from the statistics that the corresponding F-value appears to be 21.97, which further appears to be statistically significant at 1% level of significance. Thus the test statistics conclude the overall goodness of fit of the model.

The equation can be written as

CBB =	0.136 (PM) +	0.127 (DS) +	0.145 (INFO) +	0.186 (LABEL) +	0.028 (SBI) +	0.145 (BRAND)+	0.437 (PIC) +	0.037 (TOP)
Std. Error	(0.63)	(0.070)	(0.056)	(0.045)	(0.041)	(0.051)	(0.068)	(0.061)

The regression model of regression has been used to give the interpret result. From the table 3.3, it can be inferred that all the elements of packaging are statistically significant at 10 per cent level of significance. With exception to shape and type of packaging element, it can be overlooked from the table 3.3 that, if there is 1 unit of change in packaging material (PM), The consumer buying behaviour will change by 0.136 units or in other terms 1 per cent of change in packaging material (PM) will bring 13.6 per cent of change in consumer buying behaviour (CBB) of packed food items in Jammu urban. In consonance with this 1 per cent change in design, information, label, brand, and picture will bring 12.7 per cent, 14.5 per cent, 18.6 per cent, 14.5 per cent, and 43.7 per cent respective change in the consumer buying behaviour for packed food items.More on while looking summary statistics of the model, it can be elaborated that the picture, label, brand appears to be the most influential factors in determining the consumer buying behavior (CBB) for packed food items in jammu urban. mean while looking into the significance of the estimated factors the “T” test

has been applied and it can be concluded that values associated with respective elements are > = to 0.10, thus qualifying the statistical significance of the variable.

Table 1: *Descriptive Statistics of Regression Analysis*

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.746[a]	.557	.531	.43727

a. Predictors: (Constant), TOP, SBI, PM, BRAND, LABEL, INF, DS, PIC

Table 2: *Analysis of Variance for Model Fitness*

ANOVA[b]						
Model		**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
1	Regression	33.619	8	4.202	21.979*	.000[a]
	Residual	26.769	140	.191		
	Total	60.388	148			

a. Predictors: (Constant), TOP, SBI, PM, BRAND, LABEL, INF, DS, PIC

b. Dependent Variable: CBB

Note: *Represents statistically significant at 1 per cent level of significance.

Summary Statistics of the Model

Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**T**	**Sig.**
B		*Std. Error*	*Beta*			
1	(Constant)	.209	.208		1.01	.317
	PM	.136	.063**	.142	2.14	.034
	DS	.127	.070***	.129	1.81	.073
	INF	.145	.056*	.167	2.61	.010
	LABEL	.186	.045*	.270	4.16	.000
	SBI	.028	.041	.042	0.69	.493
	BRAND	.145	.050*	.184	2.92	.004
	PIC	.437	.068*	.463	6.45	.000
	TOP	.037	.061	.040	.60	.552

a. Dependent Variable: CBB

Note: *, ** and *** Represents statistically significant at 1,5,10 per cent level of significance

A Supply Chain Analysis of Cherry in Kashmir

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Abstract

The present investigation entitled "A Supply Chain Analysis of Cherry in Kashmir" was carried out during 2014-15. Both primary and secondary data were analyzed for this investigation. The primary data was collected from District Srinagar of Hazratbal block in which sample respondents of 6 villages were selected purposively. The secondary data was collected from official website of, Directorate of Horticulture Planning and Marketing (GOI). Hundreds cherry producers, twenty-three wholesalers, thirty-seven retailers and two processors were interviewed. The study was focused to identify the agencies involved, channels used in the marketing of cherry, value additions and gross and returns from cold storage and also to calculate the gross marketing margins and price spread of all the intermediaries involved in various marketing channels. Three marketing channels were identified

(i) Producers - pre-harvest contractors-wholesalers-retailers-consumer
(ii) producers-commission agent-wholesalers-retailer-consumer and
(iii) Producers-retailer-consumer was identified. Channel II was the major route for cherry's trade as more than 40% of the farmers sell their produce through this channel. Similarly, 35% farmers followed channel I for selling their produce whereas 19% producers, followed channel III respectively.

The estimates of regression function have revealed that the fertilizer, labour and education level are the significant and positive determinants on yield, while chemical spray have shown negative contribution. The price spread of cherry with respect to various marketing channels has indicated that the producers' share has an inverse relationship with the number of intermediaries. The net price received by the producers is relatively higher in the channels in which the produce is directly sold to the consumers or retailers. Across different varieties, producers receive higher absolute net returns in Mishri followed by Double and Makhmali. The study has highlighted effective measures to reduce marketing losses at various stages. Study has emphasized on the strengthening of institutions, establishment of processing units, cold storages and development of market infrastructure in the area.

Keywords: Marketing channels, marketing efficiency, cherry

Artificial Intelligence in Agriculture

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Extended Abstract

Introduction

In agriculture there is a speedy variation to AI in its different cultivating methods. The idea of artificial intelligence is the one which impersonates human point of view as a model in PC. This outcome as tempestuous innovation in AI fueled agriculture, delivering its administration in deciphering, getting and responding to various circumstances (in view of the learning gained) to upgrade productivity. The agriculture industry is turning to AI for solving the double trouble of the food crisis and food wastage in the wake of locust swarms, climate change, droughts and floods. The contribution of artificial intelligence in agriculture is only set to increase with agri-tech startups cropping up in many states of India. The cloud computing infrastructures with the use of, data ecosystems, Internet of Things (IoT) and AI enables the development of digital agriculture and strengthen the farmers in practicing smart farming, smart irrigation, smart fertilizer application, and disease/ pest diagnosis/ detection, smart spraying, and harvesting.

Material and Methods

The current paper is aimed to find out the role of Artificial Intelligence in the development of agriculture sector. In this paper, an extensive level of qualitative analysis is done. More than 100 research papers were selected based on area of research, and content analysis is done. Content analysis is technique in which the transcript is generated first followed by generation of themes and codes.

Result and Discussion

By analysis n extensive level of research papers, we have identified the most utilized artificial Intelligence platforms and techniques in India.

The Internet of things (IoT) driven development: There are massive volumes of data getting generated each day in structured and unstructured format. These data are regarding weather pattern, soil reports, new research, rainfall, vulnerability to pest attack, imaging through drones and cameras.

Image-based insight generation: In the current world scenario one of the most dissertated areas in farming today is Precision farming. Imaging through drones can assist in rigorous field analysis, in monitoring crops and scanning of fields.

Disease detection: The image sensing and analysis ensure that the plant leaf images are sectioned into surface areas like background, diseased area and non-diseased area of the leaf. The infected or diseased area is then cropped and sent to the laboratory for further diagnosis.

Identify the readiness of the crop: Images of various crops captured under white light and UVA light are to check how ripe the green fruits are. From this analysis the farmers could create different levels on the readiness of the fruit or crop category.

Crop health monitoring: Remote sensing (RS) techniques along with hyper spectral imaging and 3D laser scanning are crucial to construct crop metrics over thousands of acres of cultivable land.

Conclusions

In conclusion the future of farming in the times to come is largely reliant on adapting cognitive solutions. Though a vast research is still on and many applications are already available, the farming industry is still not having sufficient service, remains to be underserved. While it comes down in dealing with realistic challenges and demands faced by the farmers, using AI decision making systems and predictive solutions in solving them, farming with AI is only in a nascent stage. The other crucial aspect is the extortionate cost of the various cognitive solutions for farming readily available in the market. The AI solutions have to become more viable to assure that this technology reaches the farming community. If the AI cognitive solutions are offered in an open source platform that would make the solutions more affordable, which eventually will result in faster adoption and greater insight among the farmers.

Track 05
Institutional Education in New Normal COVID-19

Online Assessment Tools for E- Teaching and Learning: Making ICT more Handy

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Abstract

The COVID-19 induced global lockdown has affected every sphere of life, the educational sector being not an exception. The sudden shut down of all educational organizations starting from kindergarten schools to universities has affected more than 1.2 billion students across the globe. This new normal situation changed the educational sector dramatically, with the sudden rise of e-teaching and learning. Several online educational platforms *viz*., Google classrooms, Microsoft teams, WebEx cisco *etc*. have emerged for this purpose. In such online classes, monitoring and ensuring students' attention and active participation is often problematic for the instructors. Therefore, it raises questions on the actual learning of the students *via* online platforms. Proper assessment of students in online platform is another roadblock faced by teachers worldwide, as students are capable of cheating easily in the online mode, without being noticed, defeating the very purpose of assessment-based learning. Hence, the present situation demands an online form of assessment that can effectively replace the pen and paper mode of assessments/exams. Examples of such commonly used assessment tools are Kahoot!, Quizizz, Socrative, Near Pod, Educanon, Google forms, MS Team based quiz *etc*. Inclusion of scenarios supported by games and competition along with insertion of smart technologies in the classroom enhances the active partaking of students. Game-based online assessment tools *i.e.* Kahoot! and Quizizz can easily be collaborated with digital classrooms. Unique features of Kahoot! and Quizizz is includes real time interaction, instantaneous marking and allotment of finite time period for every question. These online assessment tools is capable of prevention/detection of cheating on the parts of students, in turn leading to proper assessment of learning. Specifically in agricultural sector, by using Kahoot! and Quizizzis, instructors can easily conduct practical examinations like identification of plant species, diseases, weeds, seeds, insects *etc*. within a specified time period and a playful manner. Therefore, the e-learning and assessment techniques needs to be blended with traditional chalk-board and pen-paper mode of learning and assessment, as technology in the hands of great teachers can be transformational.

Online Agricultural Education during Covid-19 pandemic: Reflections Based on Students' Perception

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Extended Abstract

Introduction

With Covid-19 induced mandatory social distancing measures, universities across the globe had to close the campuses. The educational institutes and students have turned to virtual classrooms to cope up with the syllabi. The sudden transition from offline to online mode of education made it much more challenging for the teachers and students across the globe. Understanding the perceptions and feedback of the students is important to improve the effectiveness of online education. The present study aims to examine these within agricultural education, where the prior experience of online learning is scanty.

Methods

Questionnaire data were collected from 307 agricultural students of different agricultural universities across India through google form. This paper employs both quantitative and qualitative techniques to get a boarder view of students' perception and preferences for online teaching.

Results and Discussions

Findings from the study indicated that more than 50 percent of the respondents did not have any prior online learning experience which made e-learning challenging for them. Around 70 percent of the respondents felt that online teaching is the best way to cope with the syllabi. Around 45 % of the students wish to attend classes of duration 45 minutes with 10-15 minutes break between each class which is line with the Thompson's (2014) formula of 52 minutes work followed by 17 minutes break. Flexibility and convenience of the online

classes made online education attractive among the students whereas data connectivity and its limit pose serious challenge to online education with more than half of the students using mobile data pack as source of internet. Learners also felt that structure of content, interaction and infrastructural facilities determines the success of online education. Digital competency of the teachers and learners is also a major factor determining the effectiveness of online classes.

Conclusions

Online learning is gradually being seen as a new trend in education across disciplines. The transition from traditional class room to digital classroom during covid-19 lockdown was unplanned. The findings of our study indicate that majority of the students are in favor of online learning because of its flexibility and convenience. However, the technological constraints and technophobia of the instructors make online learning challenging. Our study also indicates the need for developing innovative models and solutions to enhance the interactivity among instructors and students in online platforms.

Reference

Thompson, D (2014) A formula for perfect productivity: work for 52 minutes, break for 17. *The Atlantic*.

Psychological Impacts of Students on Online Learning During the Pandemic COVID-19

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Abstract

The Karnataka Government formally enforces rules of study and work from home during this pandemic. Minimizing and limiting meetings involving physical contact is an effort to reduce the spread of the COVID-19 virus. These conditions have implications for the effectiveness of the learning process in higher education. The purpose of this study was to identify the impact of student psychology on online learning during the COVID-19 pandemic. The research method uses a qualitative research type of phenomenology. The research subjects were 30 students of Bangalore University who were interviewed via telephone. The research findings show that (1) students have started to get bored with online learning after the first two weeks of learning from home, (2) considerable anxiety on research subjects whose parents have low income, because they have to buy quotas to be able to participate in online learning, (3) mood or mood changes occur due to too many assignments and are considered ineffective by students. Suggestions and recommendations from this research are the need for severe efforts in assisting the psychological well-being of students through the involvement of counselors and psychologists.

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