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Standardization of banana peel based sauce

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Abstract
Banana peel is a major by product of banana processing industry and a throw away waste after consumtion as a table fruit. This peel is reported to be rich in fibre and various nutrients like poly unsaturated fatty acids, amino acids, micro nutrients and starch. This product is used by certain sections of our population as a vegetable. However, it has not been exploited commercially. This study utilized this raw material to standardize to a sauce with table applications. The product was evaluated for its sensory qualities, shelf life, nutrient and chemical composition. The product was rated as highly acceptable and profitable.

Keywords: banana peel, sauce, sensory qualities, shelf life, nutrient composition

Introduction
Banana, whether eaten raw or cooked, is a popular fruit consumed by all sections of people worldwide. The annual production of bananas was reported to be over 145 MT in 2011. The fruit is protected by its peel which is discarded as waste after the inner fleshy portion is eaten the main by-product of the banana processing industry is the peel, which represents approximately 40 per cent of the fruit. After consumption and processing, a significant amount of banana peel is being generated as waste. This by-product constitutes an environmental problem, because it contains large quantities of nitrogen and phosphorous. Besides its high water content makes it susceptible to attack by microorganisms.

Banana peels have significant nutritional qualities. They are rich sources of starch (3%), crude protein (6%), crude fat (3.8-11%) and dietary fibre (43.2-49.7%). It is a rich source of polyunsaturated fatty acids particularly linoleic acids and alpha linolenic acid. It contains essential amino acids such as leucine, valine, phenyl alanine and threonine and also the micronutrients like K, P, Ca, Mg, Fe and Zn. In the case of Zn and Fe, they are found in higher concentration in peels compared to pulp. Banana peels are also good sources of lignin (6-12%), pectin (10-21%), cellulose (7.6-9.6%), hemicelluloses (6.4-9.4%) and galactouronic acid. Pectin extracted from banana peel also contains glucose, galactose, arabinose, rhamnose and xylose (Emaga *et al*., 2007).

The total amount of phenolic compounds in banana peel ranges from 0.90 to 3.0g/100 (gDW). Phenolic compounds are the secondary metabolites produced by the plants. It has multiple biological effects. Gallocatechin is identified at a concentration of 160mg/100 g DW. Ripebanana peel also contains other compounds, such as bsitosterol, sigmasterol, campesterol, cycloeucalenol, cycloartenol and 24-methylene cycloartanol. Potassium content is found to be high in banana peel (78.10 mg/g).This mineral helps in the regulation of body fluids and maintain normal blood pressure. It also helps to control kidney failure, heart diseases and respiratory flaws (Nguyan *et al*. 2003) [2].

Despite the nutritional, economic and medicinal importance of banana peel, they still remain neglected. Not much work has been done to develop banana peel based processed foods. In this context, the present investigation on 'Development of value added products from banana peel' was selected with the objective of developing value added products from banana peel and to evaluate their organoleptic, functional, nutritional and shelf life qualities.

Materials and Methods
Selection of raw material
Ripe banana peel of *cv nendran* was utilized for the study. Nendran is a popular variety in Kerala. It is not only relished as a fruit but has also got wide applications in the processing industry, thus it ranks first in commercial value among all varieties. Banana chips is a flourishing cottage industry in Kerala. The characteristic flavor of banana chips fried in coconut oil is an exotic identity among the commercial food products of Kerala. Surplus amount of the peel of nendran is generated as waste from the banana chips industry which is found to have application only as cattle feed. Fresh peels of nendran were collected from chips making unit at East fort, Trivandrum.

The banana peel slices were blanched for 5mins and immersed in 0.4% citric acid.

Formulation for evaluation
The adjuncts in sauce namely coriander leaves, vinegar, garlic, chilli and sugar were mixed in different combinations and proportions. A spice bag was used to extract the flavor of spices. It comprised of 10g of crushed clove, cardamom, pepper, fennel seeds and cinnamon. All the ingredients were blended and processed to sauce consistency and subjected to organoleptic evaluation. The cooked volume of sauce obtained was noted.

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DEVELOPMENT OF VALUE ADDED PRODUCTS FROM BANANA PEEL

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ABSTRACT

By products of fruits and vegetables are causing great concern to food processors and the humans residing in that locale. Moreover the nutrition and heaqlth potential of these products have not been recognized. Banana peel is a huge waste generated in the Chip making industries. It is being utilized by a small section of the population as a vegetable .But mostly they are discarded or given to cattle. An attempt was made to standardize three value added products namely, Ready to cook curry mix, instant soup mix and sauce. Various formulations of ingredients were tried out and evaluated by a sensory panel. The ratings were highky acceptable and adviced for scaling up.

KEYWORDS: Banana Peel, Sauce, Ready To Cook Curry Mix, Instant Soup Mix, Sensory Evaluation

Fruit wastes, which are highly perishable, is a problem to the processing industries and pollution monitoring agencies. Suitable methods to utilize them for the conversion into value-added products would be useful for developing healthy foods. By-products recovery from fruit wastes can also improve the overall economics of processing units. Besides this, the problem of environmental pollution also can be reduced considerably.

Despite the nutritional, economic and medicinal importance of banana peel, they still remain neglected. Not much work has been done to develop banana peel based processed foods. In this context, the present investigation on 'Development of value added products from banana peel was selected with the objective of developing value added products from banana peel and to evaluate their organoleptic, functional, nutritional and shelf life qualities.

METHODOLOGY

The methodology of the study is discussed herewith

Selection and Collection of Raw Material

Banana peel of *cv* nendran was utilized for the study. Nendran is a popular variety in Kerala. It is not only relished as a fruit but also has got wide applications in the processing industry, thus it ranks first in commercial value among all varieties. Banana chips is a flourishing cottage industry in Kerala. The characteristic flavor of banana chips fried in coconut oil is an exotic identity among the commercial food products of Kerala. Surplus amount of the peel of nendran is generated as waste from the banana chips industry which is found to have application only as cattle feed. Fresh peels of nendran were collected from a chips making unit at East fort, Trivandrum.

Standardization and Product Development

Three banana peel based dishes were identified for standardization namely, Instant soup mix(ISM), Ready to cook (RTC) curry mix and sauce.

In the recipe verification the selected recipes were reviewed for ingredients and quantity. The selected recipes were standardized to ensure consistency in the quality and quantity of product. Each recipe was prepared three times. Each time the yield and acceptability of the products were noted for bringing about any changes.

Standardization of Instant Soup Mix

Fresh peels were subjected to various preliminary processing to standardize blanching time, pre treatment media, immersion time and formulation. 5 formulations were dehydrated at 65 degree Celsius and powdered. They were then mixed thoroughly to form instant soup mix.

Soup was prepared by boiling 200ml of water and adding the soup mix as a paste and simmering for 1 min.The 5 treatments were prepared and subjected to sensory evaluation. The cooked weight of products were noted.

Standardization of Ready to Cook Curry Mix

Dimensions of vegetable slices and proportion of adjuncts of the curry mixes standardized after evaluation by a sensory panel. Similarly the reconstitution time cooking time were also standardized by sensory evaluation.

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Socio-Economic Profile of Kisan Credit Card holders in Thiruvananthapuram District

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Abstract: ***Kisan Credit Card (KCC) scheme came into being in the financial year 1998-99 with an aim of providing not only the production needs but also meeting the contingent needs of farmers. The study was conducted to analyse the socio-economic profile of holders and to determine the factors affecting the adoption of the scheme. The overall average age of respondents was found to be 55.05 years. The net sown area was found to be 17.29 ha and the cropping intensity was found to be 143.26 per cent. cropping pattern and education were found to be significant at 5 per cent level of significance and positively influencing the respondents in joining the scheme. The result showed that the average amount applied for loan was ₹60,666.66 and in case of beneficiaries of SBI it was found to be ₹69,333.33 and in case on beneficiaries of co-operative banks it was ₹52,000.***
Keywords: KCC, cropping pattern, binary logit regression, amount applied for loan

I. INTRODUCTION

The Narasimhan committee report (1998) stressed on narrow banking system to reduce the Non-Performing Assets (NPA's), which reduced the capacity of the public sector banks lending to the primary sector leading to shortage in the flow of credit. Farmers found it difficult to obtain credit under multi-credit multi-agency approach. Hence NABARD took up the challenge and came up with an idea of providing credit under single-window system. As a result of which Kisan Credit Card (KCC) scheme came into being in the financial year 1998-99 with an aim of providing not only the production needs but also meeting the contingent needs of farmers. The study was conducted to analyse the socio-economic profile of holders and to determine the factors affecting the adoption of the scheme. The micro level study was conducted in Parassala panchayat of Neyyattinkara taluk in Thiruvananthapuram district. From this panchayat one major commercial bank and co-operative bank serving the locality was selected. From these banks 15 beneficiaries and 15 non-beneficiaries were selected at random. Thus the total sample size was 60.

II. REVIEW

A study by Rajnikant (2011) showed, majority of the respondents having KCC were old aged and education plays a major role in the perception of the scheme and among KCC holders about 69.44 per cent were found to be literates. Another study by Sajane (2010) also reported that average age of borrowers under KCC was 46.73 years while it was found to be 44.88 years under non-KCC borrowers and in case of education beneficiaries were cent per cent literates and less than 10 per cent of non-beneficiaries were illiterates and the average size of family for KCC borrowers was 5.6 and for the non-KCC borrowers was 5.15. The study carried by Sirisha (2014) highlighted that the average size of the land holding was found to be slightly more for beneficiaries when compared to non-beneficiaries. A study by Prakash (2013) found that the cropping intensity was 223.11 per cent among the beneficiaries of KCC and 206.6 per cent among the non-beneficiaries and the tendency of farmers in taking the KCC loans a number of times over a period of ten years was found, 45 per cent of the KCC holders availing credit 4-8 times and only 35 per cent of the holders availing credit more than 8 times from the commercial banks. A study by Barik (2011) and Kumar *et al* (2011) reported a positive relationship with KCC and land holding of the respondents. A similar study by Nargaven (2010) and Dhanbhakyam and Malarvizhi (2012) were in conformity with the present study stating agricultural offices as a main source of information.

III. METHODOLOGY

A. Percentages and Averages

In order to examine the socio-economic characteristics of the respondents viz., age, education, income, gender, size of family, land holding and cropping pattern percentages and averages were used. Binary logit regression was used when the dependent variable

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Resource use efficiency in pepper cultivation under changing climate in Kerala

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Phenotypic plasticity of roots in mixed tree species agroforestry systems: review with examples from peninsular India

B. Mohan Kumar · Shibu Jose

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Abstract Agroforestry entails different life forms including mixtures of trees that occupy different soil strata and exhibit a certain degree of spatial complementarity in resource use. However, rigorous experimental studies characterising root interactions in tree–tree systems are notoriously few. We present here the available empirical evidence to support the hypothesis that occurrence of two or more tree species close to one another may favour diminished lateral spread and/or deeper root penetration of the woody components and closer the tree components are located greater will be the subsoil root activity. These evidences are based on either root excavation studies in coconut-based multistorey production systems, or ^{32}P soil injection experiments involving binary mixtures of coconut+interplanted dicot multipurpose trees (*Vateria indica*, *Ailanthus triphysa* or *Grevillea robusta*), and bamboo (*Bambusa bambos*)+teak (*Tectona grandis*) or Malabar white pine (*V. indica*). The excavation study denotes a spatially segregated root distribution pattern of the component species. Furthermore, in the coconut + dicot tree system, interplanted dicot trees absorbed considerable quantities of the radio-label applied to the palm, which declined log-linearly with distance from the palms, signifying a substantial potential for "capturing" the lower leaching nutrients, at proximal distances. Likewise, lower teak/*Vateria* root activity in the surface horizons and higher activity in the deeper layers, when bamboo clumps were nearby and vice versa when they were farther apart, implied that proximity of species/individuals favoured competitive downward displacement of roots. Nutrient pumping and/or current transfer of nutrients between the rhizospheres of the two associated crops are also possible. In designing sustainable agroforestry systems, it is, therefore, advantageous to mix trees with divergent root growth habits.

Keywords Belowground architecture · Nutrient pumping · Root system plasticity · Safety net role of trees · Tree+tree systems

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Introduction

The central hypothesis of agroforestry and other multistrata systems is resource complementarity. Cannell et al. (1996) postulated that the tree components included in the multi-species systems endeavour to access nutrients from the lower layers of the soil profile, and horizontally from non-cropped areas, or

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DISSIPATION KINETICS AND RISK ASSESSMENT OF NOVALURON IN FRESH AND DRY CHILLI PEPPER UNDER HUMID CLIMATIC CONDITIONS

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ABSTRACT: Dissipation of novaluron applied as commercial formulation Rimon 10% EC to fresh and dry chilli pepper was studied using ultra performance liquid chromatography tandem mass spectrometer. The initial deposits of novaluron in fresh chilli peppers after second spraying at 37.5 and 75 gram active ingredient per hectare were 0.11 and 0.20 mg kg^{-1} which declined to below quantitation level within 10 days and in dry chilli peppers initial residues of 0.31 and 0.59 mg kg^{-1} reached below the level of quantitation within 15 days. The half-life of novaluron at the lower and higher doses in fresh chilli pepper was 2.1 and 2.3 days where as in dry chilli pepper was 2.4 and 2.3 days and the corresponding waiting periods; that is the minimum time must* wait *after applying the* pesticide, *calculated were 8.4 and 9.4 days in fresh and 11.3 and 13.0 days in dry chilli peppers. Processing of the chilli peppers by sun drying further reduced the contents of novaluron by a factor of about 3. Theoretical maximum residue contribution values were calculated from the residue data generated and were found to be below maximum permissible intake even on 0 day. Risk assessment studies indicated that the use of the insecticide at both doses did not pose any hazard to humans.

Keywords: novaluron, chilli pepper, dissipation, risk assessment, LC-MS/MS, residues.

INTRODUCTION

Chilli (*Capsicum annuum* L.) is one of the most important spice crops used due to its high nutritional and medicinal values. It is a rich source of capsaicin, dihydrocapsaicin, capsanthin, capsorubin, β-carotene, vitamin C and other compounds[1]. A major threat to chilli cultivation is its proneness to infestation at different stages of growth by sucking pests, especially mites, thrips, and fruit borers. Novaluron, N-[[3-chloro-4-[1,1,2-trifluoro-2-(trifluoromethoxy)ethoxy]phenyl]carbamoyl]-2,6-difluorobenzamide (Fig 1), an insect growth regulator[2] developed by Makhteshim-Agan Industries[3] is registered as insecticide[4] disrupting of normal growth and development of insects. It is used e.g., for protection of chilli pepper against fruit borers and tobacco caterpillar and deemed to be an eco-friendly pest controlling agent[5]. Dissipation studies of novaluron in agricultural crops are limited, and no investigation has been carried out on the risk assessment analysis of novaluron in chilli pepper. Therefore, such a study under humid conditions was conducted.

MATERIALS AND METHODS

Chemicals and reagents

Rimon 10 EC, a formulation of novaluron, was procured from Indofil Industries (Mumbai, India). As reference material, Novaluron (purity 99.9 %) was purchased from Sigma-Aldrich (St. Louis, MO, USA). Analytical grade sodium chloride, sodium sulphate, anhydrous magnesium sulphate, formic acid (Emparta ACS grade) and acetonitrile (Gradient Grade) were obtained from Merck (Mumbai, India). Methanol (LiChrosolv) and ammonium acetate (Emsure ACS grade) were purchased from Merck (Darmstadt, Germany). The solid reagents such as sodium chloride, sodium sulphate were activated at 450 ^{o}C for 4 hours before use. Ultrapure (18.2 MΩ) water was prepared by Elga Purelab water purifier (High Wycombe, UK). The sorbents primary secondary amine (PSA), graphitized carbon black (GCB) and octadecylsilane endcapped silica (C18) were obtained from Agilent (Santa Clara, CA, USA. Polyvinylidene fluoride (PVDF) syringe filters (17mm, 0.2 µm) (Thermo Scientific, Bartlesville, USA) were used to filter the final extracts. The suitability of solvents and chemicals was confirmed by running reagent blank samples.

Preparation of standard solution

A standard stock solution of novaluron (400 mg L^{-1}) was prepared in CH_3OH and serially diluted (1, 0.5, 0.25, 0.1, 0.05, 0.025, 0.01, 0.005 mg L^{-1}) for studying the linear dynamic range of the analytical method, for preparation of matrix matched calibration standards, and for spiking for recovery studies. The calibration solutions were stored at 4 ^{o}C. Matrix-matched calibration standards prepared with extracts of blank samples were in the range of 0.01–1 mg L^{-1}. The analytical method was validated through recovery studies as per EU guidelines[6]. The concentration with a S/N ratio 10:1 was considered as limit of quantification, with linearity from 0.005 to 1 mg L^{-1}. The recovery study of the untreated chilli peppers was carried out at 0.01, 0.05 and 0.1 mg kg^{-1} levels.

Instrumentation

Analysis was conducted on a UPLC system (ACQUITY, Waters. Milford, MA, USA) equipped with reversed phase column (2.1 mm x 100 mm, 5 µm particle size) (Waters Atlantis dC18). The auto sampler temperature was 5 °C, column temperature 40 ^{o}C. The mobile phase consisted of [A] 0.1 vol- % formic acid + 5 mmol L^{-1} ammonium acetate in 10 vol- % methanol in water and [B] 0.1 vol- % formic acid + 5 mmol L^{-1} ammonium acetate in 10 vol-% water in methanol. The gradient elution program was as follows: 20 % B (0.0 - 0.5 min), increased to 50 % B (0.5 - 1.0 min), increased to 70 % B (1.0 - 2.0 min), raised to 90 % B (2.0 - 4.0 min), increased to 100 % B (4.0 - 6.0

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Biomass production, carbon sequestration and nutrient characteristics of 22-year-old support trees in black pepper (*Piper nigrum*. L) production systems in Kerala, India

T. K. Kunhamu · S. Aneesh · B. Mohan Kumar · V. Jamaludheen · A. K. Raj · P. Niyas

Received: 9 August 2016 / Accepted: 7 December 2016

Abstract Diverse kinds of fast growing multipurpose trees are traditionally grown as support trees (standards) for trailing black pepper vines in the humid tropics of India. Apart from differential black pepper yields, such trees exhibit considerable variability to accumulate biomass, carbon and nutrients. An attempt was made to assess the biomass production, carbon sequestration potential (tree + soil) and nutrient stocks of six multipurpose tree species (age: 22 years) used for trailing black pepper vines (*Acacia auriculiformis, Artocarpus heterophyllus, Grevillea robusta, Macaranga peltata, Ailanthus triphysa* and *Casuarina equisetifolia*). Results indicate that *G. robusta* showed the highest total biomass production (365.72 Mg ha^{-1}), with *A. triphysa* having the least value (155.13 Mg ha^{-1}). Biomass allocation among tissue types followed the order stemwood > roots > branchwood > twigs > leaves. Total C stocks were also highest for *G. robusta* (169 Mg C ha^{-1}), followed by *A. auriculiformis* (155 Mg C ha^{-1}). Mean annual carbon increment also followed a similar trend. Among the various tissue fractions, stemwood accounted for the highest N, P and K stocks, implying the potential for nutrient export from the site through wood harvest. All the support trees showed significantly higher soil carbon content compared to the treeless control. Soil N, P and K contents were higher under *A. auriculiformis* than other species. Nitrogen fixation potential, successional stage of the species, stand age and tree management practices such as lopping may modify the biomass allocation patterns and system productivity.

Keywords Pepper standards · Site fertility · Carbon sequestration · Nutrient export · Tree allometry · Biomass partitioning

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Introduction

Black pepper (*Piper nigrum* L.), the king of spice, is an important foreign-exchange earning commercial crop of India. The crop is grown extensively in peninsular India, especially in the state of Kerala, which accounts for 69% of Indian area of 1,17,760 ha. Production is about 37,000 tonnes, which is 54% of the gross Indian production (Spices Board India 2015). Other pepper growing regions in the country include Tamil Nadu, Karnataka and the north-eastern states. The cultural

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Physiological and biochemical responses of harvested rambutan (*Nephelium lappaceum* L.) fruits to postharvest dip treatments during storage.

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Abstract : The effect of pretreatments on rambutan fruit (*Nephelium lappaceum* L.) browning properties during storage or shelf-life was determined. Water loss in rambutan fruits induces degradation of nutritional value and imposes stress that increases respiration and ethylene production. In the present investigation, Good quality rambutan fruits of uniform size and maturity with red skin colour were used. The fruits were dipped in paraffin wax emulsions, ozonated and sulphited water, were air dried and stored under room temperature (30±2°C; RH 80-85%) for standardizing the best pretreatment. Weight loss, TSS, pH, acidity, vitamin C, sugars, and antioxidant activity were measured till the end of shelf life. The application of ozone reduced browning of rambutan fruit. The inhibition of browning was associated with increased consumer acceptance. Thus, ozone treatment can be an effective means to extend the shelf life of rambutan fruit.

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Standardization of banana peel based sauce

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Abstract
Banana peel is a major by product of banana processing industry and a throw away waste after consumtion as a table fruit. This peel is reported to be rich in fibre and various nutrients like poly unsaturated fatty acids, amino acids, micro nutrients and starch. This product is used by certain sections of our population as a vegetable. However, it has not been exploited commercially. This study utilized this raw material to standardize to a sauce with table applications. The product was evaluated for its sensory qualities, shelf life, nutrient and chemical composition. The product was rated as highly acceptable and profitable.

Keywords: banana peel, sauce, sensory qualities, shelf life, nutrient composition

Introduction
Banana, whether eaten raw or cooked, is a popular fruit consumed by all sections of people worldwide. The annual production of bananas was reported to be over 145 MT in 2011. The fruit is protected by its peel which is discarded as waste after the inner fleshy portion is eaten the main by-product of the banana processing industry is the peel, which represents approximately 40 per cent of the fruit. After consumption and processing, a significant amount of banana peel is being generated as waste. This by-product constitutes an environmental problem, because it contains large quantities of nitrogen and phosphorous. Besides its high water content makes it susceptible to attack by microorganisms.

Banana peels have significant nutritional qualities. They are rich sources of starch (3%), crude protein (6%), crude fat (3.8-11%) and dietary fibre (43.2-49.7%). It is a rich source of polyunsaturated fatty acids particularly linoleic acids and alpha linolenic acid. It contains essential amino acids such as leucine, valine, phenyl alanine and threonine and also the micronutrients like K, P, Ca, Mg, Fe and Zn. In the case of Zn and Fe, they are found in higher concentration in peels compared to pulp. Banana peels are also good sources of lignin (6-12%), pectin (10-21%), cellulose (7.6-9.6%), hemicelluloses (6.4-9.4%) and galactouronic acid. Pectin extracted from banana peel also contains glucose, galactose, arabinose, rhamnose and xylose (Emaga *et al*., 2007).

The total amount of phenolic compounds in banana peel ranges from 0.90 to 3.0g/100 (gDW). Phenolic compounds are the secondary metabolites produced by the plants. It has multiple biological effects. Gallocatechin is identified at a concentration of 160mg/100 g DW. Ripebanana peel also contains other compounds, such as bsitosterol, sigmasterol, campesterol, cycloeucalenol, cycloartenol and 24-methylene cycloartanol. Potassium content is found to be high in banana peel (78.10 mg/g).This mineral helps in the regulation of body fluids and maintain normal blood pressure. It also helps to control kidney failure, heart diseases and respiratory flaws (Nguyan *et al*. 2003) [2].

Despite the nutritional, economic and medicinal importance of banana peel, they still remain neglected. Not much work has been done to develop banana peel based processed foods. In this context, the present investigation on 'Development of value added products from banana peel' was selected with the objective of developing value added products from banana peel and to evaluate their organoleptic, functional, nutritional and shelf life qualities.

Materials and Methods
Selection of raw material
Ripe banana peel of *cv nendran* was utilized for the study. Nendran is a popular variety in Kerala. It is not only relished as a fruit but has also got wide applications in the processing industry, thus it ranks first in commercial value among all varieties. Banana chips is a flourishing cottage industry in Kerala. The characteristic flavor of banana chips fried in coconut oil is an exotic identity among the commercial food products of Kerala. Surplus amount of the peel of nendran is generated as waste from the banana chips industry which is found to have application only as cattle feed. Fresh peels of nendran were collected from chips making unit at East fort, Trivandrum.

The banana peel slices were blanched for 5mins and immersed in 0.4% citric acid.

Formulation for evaluation
The adjuncts in sauce namely coriander leaves, vinegar, garlic, chilli and sugar were mixed in different combinations and proportions. A spice bag was used to extract the flavor of spices. It comprised of 10g of crushed clove, cardamom, pepper, fennel seeds and cinnamon. All the ingredients were blended and processed to sauce consistency and subjected to organoleptic evaluation. The cooked volume of sauce obtained was noted.

EASTERN BENT-WING BAT

A new record of *Miniopterus fuliginosus* (Hodgson, 1835) from Wayanad Wildlife Sanctuary, Western Ghats, India

Eastern Bent-wing Bat *Miniopterus fuliginosus* from Wayanad Wildlife Sanctuary, Western Ghats, India

IUCN Red List:
Least Concern
(Chiozza, 2008)

Mammalia
[Class of Mammals]

Chiroptera
[Order of Bats]

Miniopteridae
[Family of Bent-winged Bats]

Miniopterus fuliginosus
[Eastern Bent-wing Bat]

Species described by Hodgson in 1835

The genus *Miniopterus* (Bonaparte 1837) which has a range distributed throughout most of Africa, the Paleartic (from Iberia to Japan) and Australasia (Simmons 2005) has a complex evolutionary history with several cases of morphologically similar species that have at least partially overlapping geographic distributions (Stoffberg et al. 2004). There are 20 species in the *Miniopterus* genus (Simmons 2005; Goodman et al. 2007) which belong to the family Miniopteridae (Hoofer & van den Bussche 2003; Miller-Butterworth et al. 2007).

The presence of unique features such as the long third finger and presence of extra premolar allow the separation of the family Miniopteridae from other members of the family

RESEARCH ARTICLE

CROP PRODUCTION PROFILE OF GARLIC IN THE RAIN SHADOW REGION OF IDUKKI DISTRICT, KERALA

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Abstract: Commercial garlic cultivation in Kerala is confined to Kanthalloor and Vattavada panchayaths of Devikulam block, Idukki. A unique system of production, curing and storage of garlic exists in this high range, having an annual temperature of 23.7^{0}C and rainfall 1276mm. The study revealed that the extent and experience in garlic cultivation was more in Vattavada though two cropping seasons were practiced in Kanthalloor. "Mettupalayam", "Singapore" and land race "Malapoondu" are the major ecotypes grown in this area. Storability is more in "Singapore" and "Malapoondu" but farmers prefer "Metupalayam" because of its short duration. Yield contributing parameters like equatorial diameter(4.3cm), polar diameter(4.2cm) and bulb weight(21.8g) were significantly high in Singapore. The skin thickness(1.58mm) and average number of cloves per bulb(18.3) were more in "Malapoondu". The major constraints in garlic production as perceived by farmers were small size of garlic cloves, high incidence of pest and disease and attack by wild animals.

Keywords: Bulb characters, Constraints in production, Ecotypes, Garlic, Kerala

INTRODUCTION

Kerala, with its varied agro- ecological conditions encourage the cultivation of an array of spice crops. Idukki being the spice hub of Kerala accounts for maximum area and production in almost all spices. The unique climatic condition and the varied agro ecological situations prevailing in the district, favours cultivation of both tropical, subtropical and temperate spices.

The commercial cultivation of Garlic is confined to Kanthalloor and Vattavada panchayaths of Devikulam Block of Idukki district (Miniraj *et al*., 2005). The area represents low rainfall region having tropical sub humid monsoon climate with an annual temperature 23.7^{0}C and rainfall 1276mm. The area comes under the Marayur Dry Hills Agro Ecological Unit number 17. Here garlic is cultivated in an area of about 80ha with production 630 T (2015-16) as per the Spice statistics of Directorate of Arecanut and Spice Development, Calicut, Kerala. However, there has been a drastic reduction in the area and production of garlic as indicated by the published statistics (DASD, 2016). It indicated that an area of 170 ha with 1510T production of garlic during 2010-11 has been reduced to 80 ha with a production of 630T during 2014-15. It was in this back drop the present study was conducted in Vattavada and Kanthaloor panchayath to assess the crop production profile and the major constraints perceived by farmers in garlic production.

METHODOLOGY

The total sample size for the study was 100. Random sampling was followed in the selection of 50 farmers each from Vattavada and Kanthalloor panchayats. Rapid survey was conducted among the selected farmers through structured pretested interview schedule. Focused group discussions and key informant interviews were also carried out to generate adequate qualitative and quantitative data to assess the crop production profile in this region.

The informations collected from farmers of the two panchayaths and other stakeholders were analysed using descriptive statistics like frequencies and percentages. Separate questionnaires, based on the peculiarities of the region were used among the farmers of the two panchayaths to analyse the constraints in production of garlic. The data were analysed using Garrett ranking method.

Garrett's formula for converting ranks into percent is: Percent position = 100 * (Rij – 0.5)/Nj

Where,

Rij = rank given for ith constraint by jth individual

Nj = number of constraint ranked by jth individual

The per cent position of each rank will be converted into scores referring to the table given by Garrett and Woodworth (1969). For each factors, the scores of individual respondents will be added together and divided by the total number of the respondents for whom scores will be added. These mean scores for all the constraints will be arranged in descending order, the constraints will be accordingly ranked.

The bulbs of the three prevailing genotypes of garlic were collected randomly from farmers' fields and were characterized morphologically as per IBPGR descriptors and analysed statically in the experimental design CRD and compared by DMRT.

RESULT AND DISCUSSION

The crop production profile

Experience in garlic cultivation: The survey revealed that there exist a unique system of crop production, curing and storage of garlic in both the

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Micro greens:

nutritious leafy vegetables

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Research Article

Generation mean analysis for quality characters in yard long bean (*Vigna unguiculata subsp. sesquipedalis* (L.) Verdcourt)

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Abstract
Generation mean analysis in yard long bean was undertaken to estimate the gene action operating in the inheritance of quality characters pod protein (%) and keeping quality (% weight loss). Six basic generations *viz.*, P_1, P_2, F_1, F_2, BC_1 and BC_2 of two crosses, namely Kakkamoola Local x Githika (cross 1) and Kakkamoola Local x Vellayani Jyothika (cross 2) were studied. Significance of scaling test revealed the presence of epistasis for characters under investigation. The predominance of dominance component for the characters under study indicates the improvement of the traits through heterosis breeding.

Keywords
Yard long bean, Gene action, Generation mean analysis, Pod protein, Keeping quality

Introduction

Yard long bean (*Vigna unguiculata* subsp. *sesquipedalis* (L.) Verdcourt) vernacularly known as 'Achingapayar', 'Kurutholapayar', 'Vallipayar', etc., is one of the most popular and remunerative vegetable crop traditionally grown in Kerala. It is widely grown in China, South and South East Asia. It is cultivated mainly for crisp and tender pods that are consumed both fresh and cooked. It is called as 'vegetable meat', being a rich and inexpensive source of vegetable protein. Pod protein content in vegetable cowpea is a complex trait governed by polygenic inheritance, affected by environment Singh and Dabas(1992). The study was conducted to understand the mode of inheritance of the quality components and choice of breeding methodology for developing elite varieties in yard long bean

Materials and Method

The present investigation was carried out at Department of vegetable science, College of Agriculture,Vellayani,Kerala from 2017 to 2018. The experiment was carried out in three parts. The six generaations from two cross combinations Kakkamoola Local x Githika (cross1) and Kakkamoola Local x Vellayani Jyothika were raised in Randomized Block Design with spacing 1m x 1m. Five plants from each treatment for the in P_1, P_2, F_1 generations were randomly selected and tagged and ten no plants from F_2, BC_1 and BC_2 generations for the two characters under study was selected and subjected to generation mean analysis Hayman(1958) followed by scaling test (Mather, 1949). Pod Protein (%)Pod Protein was estimated by Lowry method, developed by Lowry *et al*. (1951). The method is sensitive enough to give a moderately constant value and hence largely followed.

Keeping Quality (% weight loss)

Keeping quality was determined to study the shelf life and number of days the pods remained fresh for consumption, without loss of colour and glossiness. It is estimated in terms of physiological loss of weight *i.e.,* loss of weight that occur every day was calculated and average was taken. Weight of harvested pods of all treatments kept under ordinary room condition was taken every day at a fixed time for five consecutive days.

$$\text{Physiological loss of weight} = \frac{\text{Initial weight} - \text{Final weight}}{\text{nitial weight}} \times 100$$

Results and Discussion

Yard long bean is a rich and inexpensive source of vegetable protein and hence pod protein (%) is an important quality parameter. The effect of 'm' was positively significant in both the crosses, hence there was significant difference among the generations (Table 1 and Fig. 1). Pod protein content was maximum in BC_1 generation (6.23 % and 6.27 % respectively) for the cross 1 (VS 50 X VS 34) and 2 (VS 50 X VS 26), but minimum in P_2 in cross 1(VS 50 X VS 34) and 2 (VS 50 X VS 26) (4.55 % and 4.43 % respectively). Significance was observed for

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Research Article

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Spatial variability of soil fertility in a coconut based agro ecological unit in the sandy plains of Kerala, India

■ V. Mini **and** Usha Mathew

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Summary

The sandy plain region of Kerala comprises a unique agro ecological unit designated as Onattukara sandy plain (AEU 3). The main cropping system prevailing in this region is coconut based cropping system in the upland. In the existing perennial plantations like coconut, soil fertility evaluation will help to identify the existing crop nutrition related constraints for formulating suitable nutrient management strategies. Therefore, this study was conducted with the objectives of identifying and mapping the spatial distribution of soil nutrient deficiencies for site specific nutrient management. Soil samples from 200 geo referenced sites were analyzed for available macro and micro nutrients. The nutrient deficiency maps developed can be used for macro and micronutrient management to address steady decline in the yield of coconut in the region through balanced nutrition. Yield gap of coconut in Onattukara region is 207.69 per cent. Thematic maps showed low organic carbon status in 74.2 per cent, P in 0.6 per cent and K in 82.6 per cent area. Ca and Mg deficiency were observed in 96.8 per cent area and S deficiency in 8.6 per cent area. Fe and Mn were observed to be sufficient. Zinc was found to be deficient in 90.3 per cent, Cu in 73.5 per cent and B in 93.1 per cent area of this sandy tract.

Key words : Coconut, Constraints, GIS, Mapping, Sandy tract, Soil nutrient status

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Research Article

PHENOTYPING OF VASCULAR STREAK DIEBACK DISEASE (VSD) RESISTANT COCOA HYBRIDS AND ENDORSEMENT OF RESISTANT GENE IN AUSPICIOUS GENOTYPE BY EMPLOYING MOLECULAR MARKER SYSTEMS

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Abstract- Cocoa (*Theobroma cacao* L.) is native to humid tropical region of Central America and considered as important agro forestry tree species. Vascular streak dieback (VSD), a devastating disease with distinct symptoms of dieback, is one of the major threats for cocoa cultivation. The confounding part of this disease is that chemicals have little effect on disease control. The most tenable and economic technique to tackle this disease is by evolving resistant materials. When this disease began to assume unmanageable magnitudes in India, Kerala Agricultural University had initiated VSD resistant breeding since 1995. Initially, 566 hybrids which expressed tolerance in the nursery for two years were field established. After fifteen years of field screening, 46 hybrids which manifested field resistance were selected for further study. Examination on self-incompatibility position exhibited that majority of them (37) were self incompatible. When yield contributing characters were accessed VSD I 31.8 was found to be superior and out rated the checks, most popular varieties available. Disease resistance was further confirmed by budding and molecular markers.VSD I 31.8 (CCRP 15) can be consider as a novel hybrid released in the world with VSD resistance and considerable yield.

Keywords- *Ceratobasidium theobromae,* resistance breeding, *Theobroma cacao* L., VSD, hybrid.

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DOI: http://dx.doi.org/10.9735/0975-5276.10.4.1126-1131

Introduction

Cocoa (*Theobroma cacao* L.) is native to humid tropical region of Central America and considered as important agro forestry tree species [1,2]. Vascular streak dieback (VSD), a devastating disease with distinct symptoms of dieback, is one of the major threats for cocoa cultivation. The disease was first delineated in Papua New Guinea, engendered by the fungus *Oncobasidium theobromae* [3]. Contemporary studies led to reclassification of the causal organism to another basidiomycete fungus, *Ceratobasidium theobromae* [4]. In India, the disease was first promulgated by Abraham, (1981) [5] and then by Chandramohan and Kaveriappa, (1982) [6]. The confounding part of this disease is that chemicals have little effect on disease control [7-10] and the only control method recommended is frequent pruning of infected branches below the visible symptoms [8,11,12]. However, incessant pruning will result in inhibition of cocoa growth and moreover it is labour - intensive and exorbitant [13].

The most tenable and economic technique to tackle this disease is by evolving resistant materials [14-16]. When this disease began to assume unmanageable magnitudes in India, Kerala Agricultural University had initiated VSD resistant breeding since 1995 [17,18] and this paper reveals the variability prevailing among identified resistant hybrids and endeavour to tag VSD resistant gene in most auspicious genotype of this breeding programme.

Materials and Methods

The hybridization programme to address VSD was initiated in KAU during 1995-96, deploying thirty-one females and four male parents [19]. Since the causal organism is obligate parasite, artificial inoculation of pathogen was not possible. Hence, inoculum was dispensed by keeping already infected seedlings around the experimental materials [20]. After nursery screening for two years, 566 seedlings which manifested resistance were planted in a separate block as VSD set I [16]. These plants were perpetuated under uniform level of management and scored for disease incidence as per the score developed by Abraham, *et al*., (2000) [8] [Table-1] for fifteen years during the peak period of infestation.

Table-1 *Score chart for vascular streak dieback infestation in cocoa*

Disease scale	Intensity of Infection
0	No infection
1	< 25 per cent of twig infected
3	25-50 percent infection
5	50- 75 percent infection
7	> 75 per cent infection
9	Mortality of the plant

Fifty hybrids were deduced with score 0 indicating no infestation during the entire period of investigation [19]. At present only forty-six hybrids are retained in the field and four were defunct due to natural calamities and details are given in [Table-2]. Incompatibility positions of these hybrids were figured out by selfing 100 flowers per tree, as per the procedure advised by Mallika, *et al*., (2002) [21].

Article

Evaluation of tomato cultivars for field tolerance to American serpentine leaf miner, Liriomyza trifolii (Burgess)

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DOI: 10.5958/0974-4576.2018.00027.0

Mithra Mohan · N. Anitha

Abstract

Among the cultivars evaluated against L. trifolii Arka Abha recorded the least leaf damage (10.12 per cent), number of mines plant-1 (6.56) and number of larvae plant-1 (0.11). Arka Abha, Arka Meghali, Arka Vikas, Pusa Ruby, Anagha, Akshaya and LE 20 were recorded as tolerant cultivars whereas Manulekshmi, Arka Alok and Hissar Lalith were in the category of moderately tolerant and hybrids, Arka Rakshak, Arka Samrat and variety Vellayani Vijai were classified as susceptible ones. Hybrid Swaraksha and NS-538 were included under highly susceptible group.

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Antixenosis effect of tomato cultivars to American serpentine leaf miner *Liriomyza trifolii* (Burgess)

Mithra Mohan and N Anitha

Abstract
Antixenosis effect of tomato cultivars against American serpentine leaf miner *Liriomyza trifolii* was evaluated at College of Agriculture, Vellayani, Kerala during 2016-2017. A total of fifteen tomato cultivars were tested for the incidence of *L. trifolii* and their correlation with biophysical parameters. Leaf area exhibited a significant positive correlation with mean leaf damage (percentage), mean number of mines plant^{-1} and mean number of larvae plant^{-1} with correlation coefficients of 0.837, 0.822 and 0.833 respectively. It indicated that with increase in leaf area among the different cultivars, incidence of leaf miner was also increased. Length width ratio of leaves revealed a significant negative correlation with mean leaf damage (percentage) and mean number of mines plant^{-1} with correlation coefficients of -0.547 and -0.547 respectively whereas mean number of larvae plant^{-1} exhibited a non-significant negative relation.

Keywords: American serpentine leaf miner, *Liriomyza trifolii*, tomato, antixenosis

Introduction
Tomato, *Solanum lycopersicum* (L.), is one of the most important and demanding vegetable crops in the world that belongs to the family solanaceae. In India, it is cultivated in 8.82 lakh ha with an annual production of 18.74 lakh tonnes and productivity of 21.2 t ha^{-1} [1]. Even though, the area under tomato cultivation is supplementary, productivity is comparatively low in India due to various factors, in which pest infestation accounts for a significant portion. Out of the numerous pests, American serpentine leaf miner *L. trifolii*, an invasive pest, is considered as an important one which has established at various agro ecosystems in India after its introduction in 1991 [2].

The genus *Liriomyza* is composed of more than 300 species, out of which 23 are economically important which instigate severe damage in crop plants. Among the *Liriomyza* spp., *L. trifolii* is an important polyphagous pest, believed to be originated in United States of America and initially described as *Oscinis trifolii* (Burgess) observed from white clover [3]. Wide host range along with short life span, high reproductive potential, concealed larval stages and resistant populations made the management of *L. trifolii*, a strenuous task [4].

Indiscriminate use of highly toxic insecticides for the management of *L. trifolii* gives rise to pesticide resistance problems, reduction in natural enemy population, pest resurgence, secondary pest outbreak and pesticide residue problems which questions the uniqueness of conventional insecticides. Being a cultural control tactic, host plant resistance is considered as a safe alternative which enhance the effects of biological control strategies and upgrade the performance of pesticide applications for the management of major pests of crops [5].

Material and Methods
Fifteen tomato cultivars were screened for their field tolerance to *L. trifolii* at Instructional Farm, Vellayani, Thiruvananthapuram during 2016-2017. The trial was conducted in grow bags in completely randomized design with three replications. Observations on percentage leaf damage, number of mines plant^{-1}, number of living larva plant^{-1}, leaf area and length width ratio of leaves were recorded from five randomly selected plants of each cultivar starting from one month after transplanting. Leaf area was calculated by multiplying the total length and width of leaves with a constant 0.9 [6]. Length width ratio is calculated by dividing the length of a leaf with its width at the broadest point.

The obtained data were analyzed statistically using WASP software. The mean percentage leaf damage, mean number of mines plant^{-1}, mean number of living larva plant^{-1} were calculated

Elite selections of rambutan (*Nephelium lappaceum* L.) for different economic attributes from Kerala, India

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Abstract

From a large population of natural variability of rambutan (*Nephelium lappaceum* L.), growing in the homesteads of entire Kerala state (India), a preliminary selection for desirable economic traits was done. Ten elite types from the selection were characterized to serve as a basis for specific locations and thereby promote cultivation of this exotic fruit in Kerala. Fruits were harvested from the different growing tracts from May to September 2015, coinciding with the ripening stage, and they were assessed for all morphological and biochemical characters in addition to sensory evaluation. Elite types were characterized on the basis of size, aril thickness and weight, attachment of aril to seed, juiciness, sweetness and texture of aril. Among the ten collections, six belonged to the shape oblong (Col.016, Col.020, Col.052, Col.053, Col.061 and Col.096), three to the shape globose (Col.015, Col.023, Col.042) and one to the shape ovoid (Col.021). Five collections (Col.020, Col.021, Col.023, Col.052 and Col.053) were weighed above 40 g. The attachment of aril to seed was very weak in four collections (Col.021, Col.023, Col.042, and Col.052), medium in two collections (Col. 061 and Col.096) and strong in four collections (Col.015, Col.016, Col.020 and Col.053). Juicy types were also identified in Col.015, Col.020 and Col.061. TSS of seven collections were ranged above 20 °Brix (Col.015, Col.016, Col.021, Col.023, Col.042, Col.053 and Col.061). Total sugar ranged from 13 to 18.4%, ascorbic acid from 26.2 to 45.45 mg 100 g^{-1} and acidity ranged from 0.51 to 1.4%. Fruits from Col.021 and Col.023 were more accepted by panellists because of their better fruit weight, TSS and easy detachment of aril from the seed. This study has immense practical relevance in terms of identifying very promising elite selections which can be turned into promising cultivars in near future.

Keywords: variability, rambutan, *Sapindaceae*, quality attributes, physicochemical characteristics, sensory evaluation.

INTRODUCTION

Rambutan (*Nephelium lappaceum* L.), native to Indonesia and Malaysia, is a medium-sized tree, grown in warm humid tropical and sub-tropical regions and belonging to the family *Sapindaceae*. It bears ovoid fruits, having dark red to yellow coloured pericarp, and covered with soft spinterns on its exterior. The colour of those spinterns vary from green to yellow and red. The fruit weight varies from 20 to 60 g, with 40-60% pericarp, 30-58% fleshy aril and 4-9% seed. The edible aril is white or translucent, sweet and juicy and clings to the testa of seed (Nakasone and Paull, 1998; Smith et al., 1992; Wall, 2006; Sacramento et al., 2013).

For export, the fruits of rambutan should contain the following quality specifications: uniform red colour, free from lesions, pests and diseases, clean, weight above 30 g, spines not longer than 1 cm, thick firm aril with very poor adherence to seed, and total soluble solid content of 16-18 °Brix (Landrigan et al., 1996; Kader, 2001). The fundamental attributes of fruit quality from the consumer point of view are its visual aspects such as appearance, size, colour, texture, firmness and absence of defects, flavour, juiciness, poor attachment of aril to seed and nutrient content (Kader, 2001). According to Codex Standard (Codex Stan 246-

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New reports of pests and diseases in rambutan (*Nephelium lappaceum* L.) from Kerala, India

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Abstract

Rambutan (*Nephelium lappaceum* L.) is a crop of the warm humid tropics that can grow in a wide range of soils – from low land-heavy soil to upland-hilly soil. In India, particularly in the state of Kerala, rambutan is mostly confined to two districts, namely Pathanamthitta and Kottayam. Here, rambutan became one of the most treasured fruits, particularly as a courtyard crop or on its fringes in the home garden. Although there are no reports of severe pest and disease attacks in rambutan, several pests are being monitored, which may point to a significant threat in the near future. Two new pests of economic importance (fruit borer: *Conogethes punctiferalis* and fruit webber: *Eublemma anguilifera*) have been identified from the rambutan growing tracts of Kerala during last year (2015) from fruit set to fruit ripening stage. Their nature of damage and symptoms of infestation have been clearly studied and being reported for the first time in rambutan. Other pests like mealy bug (*Planococcus citri*) from fruit set to fruit ripening stage, fruit fly (*Bactrocera dorsalis*) at fruit ripening stage, and leaf folder (*Thalassodes quadraria)* damage on young foliages have also been observed. The major disease observed was fruit rot caused by *Colletotrichum gloeosporioides*. Hence, there is an urgent need to standardize the management strategies for controlling pests and diseases of this newly emerging crop as they have invaded the major rambutan growing tracts of Kerala.

Keywords: *Sapindaceae*, South India, fruit splitting, fruit rot, fruit borer, fruit webber

INTRODUCTION

Rambutan (*Nephelium lappaceum* L.), native to Indonesia and Malysia, is a crop of warm humid tropical and sub-tropical regions and has been widely cultivated throughout South East Asia. The area under rambutan is rapidly increasing in the western coast of India particularly in Pathanamthitta, Kottayam and Trichur districts of Kerala and Dakshina Kannada, Udupi and Kodagu districts of Karnataka. During the last 2-3 years there has been an increase of almost 500 acres area of rambutan in India. The incidence of pests like mealy bug (*Planococcus citri*), red borer (*Zeuzera* sp.), bostrichid beetle (*Sinoxylon* sp.) and fruit fly (*Bactrocera dorsalis* and *B. caryeaea*) have been reported from different rambutan growing tracts of South India (Mala et al., 2015).

Osman and Chettanchitara (1987) have listed out seven insect pests of economic importance in other Asian countries, namely leaf minor (*Acrocercops cramerella*), armoured scale (*Phenacaspis* sp.), citrus mealy bug (*Planococcus citri*), yellow peach moth (*Conogethes punctiferalis*), oriental fruit fly (*Bactrocera dorsalis*) and dried fruit beetles (*Carpophilus dimidiatus*). Watson (1988) has reported banana spotting bug (*Amblypelia lutescens*), mealy bugs and mites as contributing to skin deterioration and discolouration in rambutan in Australia.

Fungal pathogens of rambutan also affect both quality and quantity of the produce. The major diseases of rambutan are powdery mildew (*Oidium nephelii*) on young growth, pink disease (*Erythricium salmonicolor*) and sooty mould (*Meliola nephelii* var. *singalensis*). Apart from these, the predominant postharvest disease of rambutan is fruit rot, caused by

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Phenophases of rambutan (*Nephelium lappaceum* L.) based on extended BBCH- scale for Kerala, India

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ABSTRACT

This study describes the different phenological growth stages of rambutan (*Nephelium lappaceum* L.) tree grown in India particularly in the state of Kerala where it has become one of the most treasured fruit particularly as a courtyard crop or on its fringes in the homegardens. A total of seven principal growth stages are described for bud, leaf, and shoot development, inflorescence emergence, flowering, fruit development, and fruit maturity according to the extended BBCH-scale. Within them fourty one secondary growth stages are also described. This detailed study on different phenophases of rambutan in relation to the prevailing environmental conditions can certainly serve as a basis for the standardization of agronomic and ecophysiological aspects of rambutan and thereby to promote the cultivation of this exotic fruit crop.

1. Introduction

Rambutan (*Nephelium lappaceum* L.) is commonly referred to as 'hairy litchi' and is a medium-sized evergreen tropical tree belonging to the family Sapindaceae, that also includes other fruit crops such as litchi (*Litchi chinensis* Sonn.), longan (*Dimocarpus longan* Lour) and pulasan (*Nephelium mutabile* Blume). Native to Indonesia and Malaysia, rambutan is now commonly grown throughout South East Asia. This crop has also established itself as a crop of the warm humid tropics that adapts to various kinds of soil from low land-heavy soils to upland-hilly soil. Currently, Thailand is the world's leading producer of rambutan. However, Indonesia, Malaysia, Australia, China, Philippines and some other countries in the western hemisphere are also centres of commercial production.

Naturally occurring rambutan trees are fairly large, grow up to a height of 20 m whereas clonal cultivars are small, 4–7 m tall with spreading habit. Leaves are alternate, paripinnate, ovate to obovate leaflets with a dimension of 5–28 cm × 2–10.5 cm, usually glabrous above, sometimes hairy beneath [1]. Flushing normally start soon after harvest on shoots which have already borne fruits. Lateral buds seen below the desiccated panicles give rise to flushes. About fifty seven per cent of the shoots produce flowers and fruits on previously non-bearing twigs, but only twenty two per cent produce flowers on twigs which have borne fruits previously [2]. Vegetative flushing is stimulated by external environmental conditions like rainfall, heavy irrigation and practices such as pruning and harvest. Flushing will be reduced by cool weather in the presence of heavy rainfall. Hawaii experiences steady rainfall and warm temperatures, which allows rambutan trees to grow and flush year- round as a consequence of which terminal maturation is non-synchronous within the tree and hence it is very difficult to acquire synchrony in flowering, fruit set, and harvest in orchard [3] .

Rambutan flowering is stimulated by water stress, and symptoms of water stress in trees can be observed when leaves curl inward along the margins. In Hawaii rambutan flowers twice a year during the months of March-May and July-August in response to two short periods of dry weather followed by occasional showers [3]. Two flowering periods can also occur in Malaysia from March-May and August-October depending on the prevailing climatic condition. The flowering and fruiting are observed to be a function of weather conditions and the status of the stored food reserves within the trees [4].

The inflorescences of rambutan are erect and widely branched with many flowers, and are produced mainly on shoot tips [4]. Rambutan is androdioecious with separate male and hermaphrodite trees. According to the flower characteristics rambutan trees are classified into three groups [5]: a) trees producing only staminate flowers (male trees), 40–60 per cent of any seedling population b) trees producing hermaphroditic flowers functioning as female (HF) and c) trees producing both hermaphroditic female (HF) and hermaphroditic male (HM) flowers, the most common type in cultivar selections.

Cultivars have been selected for their high percentage of HF flowers and low percentage of HM flowers. The percentage of HM flowers is as low as 0.05–0.90per cent of the total flowers [6,7,1,8]. On panicles

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Possibility of staggered fruit production of rambutan (*Nephelium lappaceum* L.) in Kerala, India

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Abstract

The study was conducted at Kerala Agricultural University, Kerala, India with the main aim of categorizing cultivars with respect to their flowering and fruiting period. The study was conducted from January to October, 2015 in the entire rambutan growing tracts of Kerala state including Pathanamthitta, Kottayam and Trichur districts besides a minor area in the hilly Wayanad district. Flowering and fruiting were greatly influenced by the prevailing climatic conditions of the particular location. Flowering was earliest in Trichur (end of January to mid of March) followed by Kottayam (end of February to end of March), Pathanamthitta (mid of March to end of April) and Wayanad (June to July). Within Pathanamthitta, two distinct flowering periods were observed, one typical of the plain (end of March to end of April) and the other on the hilly region (May). Fruiting and harvesting were a reflection of the flowering period. Plants came to harvest in May in Trichur, in June in Kottayam, in June-July in plain of Pathanamthitta; however, under the hilly conditions of Pathanamthitta and Wayanad district, it came to harvesting stage in August-September and in October, respectively. The study opens out a new area on the availability of fresh fruits from May (if cultivated in humid tropical plains as in Trichur, Kottayam and Pathanamtitta), to August-September (if cultivated in hill tracts of Pathanamthitta) to October (if cultivated in humid sub-tropical belts as in the high ranges of Wayanad). Therefore, in the near future, the fresh rambutan fruit will be made available for a half-span period of a calendar year.

Keywords: *Sapindaceae*, flushing, flowering, fruit set, fruit maturity, phenology

INTRODUCTION

Rambutan (*Nephelium lappaceum* L.) belongs to the family *Sapindaceae* and is an evergreen fruit tree indigenous to Indonesia and Malaysia and is grown in warm humid tropical and sub-tropical regions up to 1,625 feet elevation. It grows well within 18° of the equator with an annual rainfall of 200-500 cm (Tindall, 1994) and diurnal temperature fluctuation between 22 and 32°C (Lim and Diczbalis, 1998).

Flowering in rambutan is mainly stimulated by water stress, and symptoms of water stress in trees can be observed when leaves curl inward along the margins. In Hawaii, rambutan flowers twice a year during the months of March-May and July-August in response to two short periods of dry weather followed by occasional showers (Kawabata et al., 2005). Two flowering periods also occur in Malaysia from March-May and August-October depending on the climatic condition. The phenomena of flowering and fruiting in rambutan depends on the weather conditions and the status of the stored food reserves within the trees (Shaari et al., 1983).

New vegetative flushes develop soon after harvest from shoots that had previously fruited. The percentage of new shoot formation in non-bearing and previously bearing twigs were 57 and 22%, respectively (Lim, 1984).

Pathanamthitta and Kottayam districts of Kerala are the most important rambutan growing areas of India and this fruit crop has also become one of the most treasured fruits, particularly as a courtyard crop or on its fringes in the home gardens. The various developmental stages of rambutan in relation to the location have not yet been studied in India. This study on developmental stages of rambutan sets a platform for carrying out

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RESEARCH ARTICLE

CONSTRAINTS IN BLACK PEPPER (*piper nigrum* L.) PRODUCTION USING MICROBIAL INOCULANTS IN IDUKKI DISTRICT OF KERALA

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ABSTRACT

Farmers in Kerala extensively used bio inoculants for the management of diseases and for promotion of growth in black pepper, vanilla, cardamom, betel vine, ginger, rice and vegetables. The study entitled "Constraints in black pepper (*Piper nigrum* L.) production using microbial inoculants in Idukki district of Kerala" is worth due to the role of microbial inoculants in sustainable agriculture presumes special significance. The present study which is an attempt to understand the challenges of MI application in black pepper production in Idukki district. The major constraints in the adoption of MI are lack of awareness about practical utility and lack of technical expertise on MI. Farmers in the study area are incognizant about all types of MI. The narrow knowledge about this technology was the major challenge which has led to the adoption of only few types of bio inoculants.

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INTRODUCTION

Spices have played a conspicuous role in all the civilization of antiquity in ancient India and China and have promoted international relations amongst the various countries all over the world. Aroma and flavour have been a part of the sorcerous rites and have been put into use for various purification ceremonies. Black pepper renowned as the 'King of Spices' and also termed as 'Black gold' is one of the most important spices contributing to commerce and trade in India since pre-historic period. Kerala accounts for 80-90% of the total black pepper production in the country. Idukki and Wayanad are the two major pepper producing districts in Kerala. Karimunda is the most appealing cultivar of Kerala. The other major cultivars include Kottanadan, Narayakodi. Aimperian, Neelamundi, Kuthiravally, Balankotta, Kalluvally and Panniyur -1 to 8, Sreekara, Subhakara, Panchami, Pournami, PLD-2, Sakthi, Thevam, Girimunda and Malabar are the improved varieties released for cultivation. The continued and indiscriminate use of chemical fertilizers and pesticides for enhanced soil fertility and crop productivity resulted in unexpected harmful environmental effects. In order to maintain agricultural productivity along with sustainable ecosystem, integrated management for nutrients, diseases and pests can be advocated.

The advent of intensive farming and its prevalence in Kerala for the past 50 years have resulted in the decline of beneficial micro-organism, loss of soil fertility and vitality, collapse of the sustainable agricultural system, soaring of cost of cultivation, health hazards and challenged food security and food safety (GOK, 2008). Recently the farmers of Idukki district are switching in favour of organic pepper production. This intensified the need of microbial inoculants (MI) as a substitute of chemical plant protectants. Microbial inoculants(MI) such as *Trichoderma viridae*, *Pseudomonas flourescens, Rhizobium* sp., *Beauveria bassiana, Lecanicilliumlecanii, Azetobacter, Azospirillum,* VAM, Phosphorous solubilizing bacteria, *Paecilomyces lilacinus*, PGPRs etc. in terms of soil, plant and human health. The importance of organic farming and residue free commodities would certainly warrant increased adoption of the microbial inoculants. Under these circumstances, this study pointing finger to the constraints and threats experienced by the microbial inoculants using pepper farmers. The study was conducted in Idukki district which is the major producer of black pepper. Two development blocks in the district Kattappana and Nedumkandam with maximum area under pepper cultivation were selected for the study.

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Nutrient Availability from an Organic Fertilizer Produced by Chemical Decomposition of Solid Wastes in Relation to Dry Matter Production in Banana

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Authors' contributions

This work was carried out in collaboration between all the authors. Author CRS designed and supervised the research, assisted in manuscript preparation and data interpretation. Author PBM helped in designing the methodology and field study. Author NL planned the research work, carried out the field experiment, recorded observations and performed statistical analysis. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

An investigation was carried out at the College of Agriculture, Trivandrum, Kerala, India to evaluate the suitability of an organic fertilizer produced by rapid chemical decomposition of organic waste as a substitute for farmyard manure for banana cultivation with reference to its effects on soil properties, nutrient availability and dry matter production. A field experiment for 11 months duration was conducted in banana (*Musa* spp. variety Nendran) in Randomized Block Design with eight treatments with three replications. The treatments were selected to compare conventional farmyard manure based and soil test based fertilizer recommendations with those of the newly produced rapid organic fertilizer. Treatments to study the combined effect were also included. Fertilizers were applied basally and in six split doses in accordance with the recommended package of practices. The fresh weight of the pseudostem, leaves, fruits and rhizome were recorded at harvest and dry

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Yield and yield attributes in ginger (*Zingiber officinale Rosc.*) somaclones for quality seed production

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Abstract— *The experiment was taken up to elicit the information on the performance of different ginger (Zingiber officinale Rosc.) somaclones for yield and quality for quality seed production. Ten somaclones of ginger were evaluated in RBD with three replications during 2015-18 at College of Horticulture, Kerala Agricultural University, Thrissur district, Kerala. The growth performance of ten somaclones indicated significant variation at all the stages of crop growth. Among the somaclones, SE 86102 (16.00 days) and SE 8626 (16.33 days) registered least number of days for sprouting. Among the vegetative characters studied, the maximum plant height (107.38 cm) was recorded by the somaclone SE 86102 which was significantly superior to other somaclones and check varieties. Somaclone CHP 118 recorded maximum number of tillers (20.33), number of leaves per shoot (28.67) and total number of leaves per shoot (117.33). The highest leaf area was recorded by C 8632 with a value of 62.12 cm^2. Among the rhizome characters recorded, the somaclone CHP 118 gave highest number of primary rhizomes (4.83) which was on par with SE 8626 (4.33) and C 8632 (4.08). The highest number of secondary rhizome was recorded by CHP 118 (10.33) which was on par with SE 8626 (10.06) and C 8632 (10.01). Weight of mother rhizome was the highest in the somaclone SE 8642 (11.00 g) and CHP 118 (10.67 g). Similarly, weight of primary rhizome was highest in SE 8642 (15.73 g), SE 8626 (15.07 g) and CHP 118 (14.80 g). Weight of secondary rhizome was highest in SE 8626 (13.20 g) and SE 8642 (12.33 g). The highest fresh rhizome yield per plant was recorded by somaclone CHP 118 (274.13 g), SE 8626 (266.67 g), C 8632 (259.67 g) and SE 8642 (251.67 g) at full maturity. The highest yield per plot was recorded by somaclone CHP 118 (8.77 kg), SE 86 26 (8.54 kg), C 8632 (8.31 kg) and SE 8642 (8.06 kg). The fresh rhizome yield per hectare was was maximum in CHP 118 (35.08 t), SE 86 26 (34.16 t), C 8632 (33.24 t) and SE 8642 (32.24 t). It is concluded that somaclones were highly variable in their performance, yield and yield attributes. Four somaclones viz., CHP 118, SE 8626, C 8632 and SE 8642 were identified as high yielders from their outstanding performance throughout their growth period with highest yield in CHP 118. This can be due to more number of tillers, leaves per shoot and rhizomes and also weight of primary, secondary and mother rhizomes.*

Keywords— Ginger, Somaclones, Yield and Horticulture.

I. INTRODUCTION

Ginger is an important commercial spice crop grown in India for its culinary and wide range of medicinal uses and is considered as an essential component of the kitchen pharmacy. It belongs to the family *Zingiberaceae,* native of South East Asia. It is a tropical and sub-tropical perennial herb 'generally recognized as safe' by the Food and Drug Administration (FDA) of the United States and has gained considerable attention as a botanical dietary supplement in developed countries, opening ample export potential. Somaclonal variations act as a major source of variability for crop improvement in ginger (Shylaja *et al*., 2010 and Dev, 2013). Evaluation of somaclones derived from two polyploids (Z-0-78 and Z-0-86) and a triploid cultivar Himachal Pradesh (generated through indirect organogenesis and embryogenesis) indicated that somaclones are superior to conventionally propagated plants for various growth and yield parameters (Kurian, 2010) .The present investigation was carried out with the objective of evaluating somaclones in ginger for variability in performance, yield and yield attributes for quality seed production.

II. MATERIALS AND METHODS

Somaclones developed through indirect methods of regeneration from two induced polyploids of ginger (Z-0-78 from 'Himachal Pradesh' treated with 0.25% colchicine by injection method and Z-0-86 from Rio-de-Janeiro treated with 0.1% colchicine by hole method) and diploid cultivar 'Himachal Pradesh' formed the base material for the study (Table 1). Ten such somaclones of ginger viz., SE 86 26, SE 86 83, C 86 26, CHP 118, C 78 284, SE 86 102, SE 86 42, C 86 32, CHP 99 and CHP 282 were selected for the study along with three check varieties (Rio- de –Janeiro, Himachal and Aswathy). The experimental site was located in the farm of Department of Plantation Crops and Spices, College of Horticulture, Thrissur, Kerala. The experiment was laid out in a Randomized Block Design with three replications in plot size 2.0 × 1.0 m^2 at the spacing of 25.0 cm × 25.0 cm. The field was prepared and planting was done in the last week of May and maintained as per

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Characterization and Optimization of Microwave Assisted Process for Extraction of Nutmeg (*Myristica fragrans* Houtt.) Mace Essential Oil

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Abstract: Microwave-assisted extraction could be considered as an extraction technique that results in the production of a higher quantity of oil in less time with minimum energy consumption. This study envisages development and optimization of a microwave assisted extraction system for extracting nutmeg mace essential oil. In order to evaluate the developed system for extraction of nutmeg mace essential oil, the process parameters such as solid: water ratios of 1:14, 1:10 and 1:6, power densities of 9.6, 14.4 and 19.2 $W.g^{-1}$ and soaking time of 2, 3 and 4 h which would influence the essential oil yield, extraction time and energy consumption were chosen as independent variables. The optimized conditions of solid: water ratio, power density and soaking time for extracting nutmeg mace essential oil in the microwave-assisted process were found to be 1:14, 14.4 $W.g^{-1}$ and 4 h, respectively. Under optimized conditions, the microwave-assisted process resulted in an oil yield of 8-12 %, with an extraction time of 3 h and energy consumption of 1.09 kWh.

Key words: Nutmeg mace; essential oil; hydro distillation; microwave-assisted extraction; power density.

Introduction

Spices which are obtained from plant or vegetable products or mixtures of both are used in whole or ground form for cooking, mainly for providing flavour, aroma and pungency to food. The oil of the plant known as "Essential oil" consists of fragrances which are oily in nature and represent the active constituents of plants. Nutmeg (*Myristica fragrans* Houtt.) is an important spice crop of India, and its cultivation is showing an increasing trend. The area and production of nutmeg in India during 2015-16 is 22,360 hectares and 15,170 tonnes, respectively, out of which Kerala accounts for 96.95 % of the area and 98.22 % of total production [1].

Essential oils are generally extracted by distillation which includes hydro distillation, steam distillation, solvent extraction, expression and cold pressing. It has been found that the use of microwaves for extraction of active components could result in enhanced performance in terms of quality and quantity including high extraction efficiency, less extraction time, and increased yield with superior quality of oil compared to conven-

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Identification of differentially expressed MRNA in black pepper (*Piper nigrum* L.) genotype for drought tolerance

Pallavi V and Abida PS

Abstract
The aim of the present study was to identify the differentially expressed, up regulated and down regulated genes by transcriptome analysis for drought tolerance. The genotypes PRS-64 (Angamali) was selected for molecular characterization among the ten genotypes through physiological characterization. The technique used to analyze the transcriptome was differentially display reverse transcriptase polymerase chain reaction (DD-RTPCR) which allows extensive analysis of gene expression among several cell populations (sturtevant 2000) [8]. The first stand cDNA was synthesized from the RNA samples using HT11G. Each first strand cDNA was used for the second amplification with eight different arbitrary primers. The PCR product was resolved in Urea polyacrylamide gels. The upregulated, down regulated and differentially expressed cDNA fragments were retrieved from the gel and reamplified with the same set of primers. The agarose gel electrophoresis showed that the (TDFs) transcript derived fragments obtained were relatively short (400-900 bp). TDFs were cloned using pGEMT vector and the clones were sequenced. The sequence from differentially expressed TDFs showed homology to copper containing amine oxidases which have a broader range of functions including cell signaling which contributes to terminal polyamines oxidation in peroxisomes. Polyamines are involved in growth development and response to abiotic stress.

Keywords: black pepper (*Piper nigrum* L.), drought resistance, DDRT-PCR, gene expression

Introduction
The black pepper has a great export potential and the contributory factor is the presence of chemical piperine in it. In India, black pepper is generally grown as a rainfed crop. Though the average rainfall in pepper growing areas is well above 2000 mm, the distribution is not uniform. The rainfall received during December to May is very negligible. Hence, the crop suffers due to severe soil moisture shortage during these months. Ninety per cent of the area under black pepper is rainfed. These areas frequently experience severe water deficit due to uncertain and uneven rainfall distribution patterns. As India is the primary centre of diversity of black pepper, the indigenous genetic resources are reservoirs of useful genes for plant improvement programmes. Black pepper is grown mainly in Kerala, where water deficit during off season *viz.*, December-May is a common feature. To avoid reduction in yield during water stress condition, cultivation of drought tolerant varieties is essential (Rajagopal and Balasimha, 1994) [5].

Differential display reverse transcription polymerase chain reaction (DDRT-PCR) or differential display of eukaryotic mRNA was first introduced by Liang and parde in 1992 [2]. It is used to identify and compare the differentially expressed genes. The DD technique was developed with the aim of overcoming limitations of methodologies previously used for identifying differentially expressed genes. DD has advantages over these techniques because it is based on simple and established methods, it is reproducible and sensitive, it does not require biochemical information about proteins, more than two samples can be compared simultaneously, and only a small amount of starting material is needed (Yamazaki and Saito, 2000). To generate cDNA fragments, anchored and arbitrary primers are used by reverse transcription, followed by PCR (RT-PCR). In sequencing gel the cDNA fragments are resolved and compared which reflects differences in the mRNA composition. Further, it can be eluted, cloned and sequenced. To obtain intact, DNA free RNA with DD residues then converting the mRNAs from cells into cDNAs, that differs at the last 3' non-T base using 3 individual anchored oligo-dT primers. The beginning of the poly (A) tail for any given mRNA enables the homogeneous initiation of cDNA synthesis. In the presence of a set of second primers by PCR, cDNAs are further labeled with isotopes that are short and arbitrary sequence. To maximize the number of amplified mRNA, the annealing temperature of the PCR is low

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Efficiency of LEADS Project Among The Farmers of Kerala State

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Abstract: LEADS is a project entitled as the Lead Farmer Centred Extension Advisory and Delivery Services which is based on the concept of field level extension work within a district.LEADS primarily aims at farmer to farmer extension.An attempt was made to assess the efficiency of LEADS among the farmers of Kerala state.Any project implemented should undergo an assesmnet in terms of its relevance and efficiency it created among the intented people.Efficiency is definedas the all possible outcome achieved from the all available income combinations.Hence the study shows that, the efficiency created by LEADS was appreciably high among the farmer groups.

Key words: LEADS, Efficiency, MAPP Technology, life curve, trend analysis, influence matrix, impact profile.Transfer of technology

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I.INTRODUCTION

Agricultural extension in the Kerala state was in a collapsed stage. Transfer of Technology aiming at possible productivity increase as well diversification of income sources in a farming systems perspective for homesteads in Kerala assumes great importance. The risks and uncertainties in agriculture were increasing due to increased incidence of natural calamities as well as due to trade policies of Government of India. There is a need to generate location specific technologies for realising the objective. Kerala Agricultural University has established in 1980s five Regional Agricultural Research Stations for generating location specific technologies through a World Bank aided project from ICAR. The funding for the scheme subsequently dried up from ICAR. Strengthening of Zonal Research stations and generation of location specific technologies have to be supported additionally, to supplement agricultural extension. In this context a project named LEADS (Lead Farmer Centred Extension Advisory and Delivery Services) was implemented as part of the Annual Plan 2011-12 scheme on "Strengthening of Agricultural Extension" in few districts of Kerala. Based on the 'Farmers – to-Farmers' extension approach, the LEADS project was being implemented in Kollam, Palakkad and Kannur districts since 2010-11 and the project was implemented in Wayanad district from 2012-13 onwards. The project was sanctioned for implementation in the state wide *G.O (MS): 198/10/ AD Dated. 6.8.2010.* (Government of Kerala, 2013).In LEADS, the extension activity is focused around the lead farmers and the satellite farmer groups.LEADS primarily aims at farmer to farmer extension. Shrestha, (2005) stated that the farmer to farmer extension is a cost-effective service delivery mechanism in order to extend the basic and innovative technologies particularly to the rural farmers especially in remote areas. In LEADS, Field assistants and technology managers are the key players at the grass root level in transfer of technology. (Sreedaya, 2016). Under LEADS, the crops selected are rice, banana, coconut and vegetables. An attempt was made to assess the efficiency created by LEADS among the farmers of Kerala in the past years. According to Casley and Lury (1982) efficiency is definedas the rates by which the recommended advance agricultural practices are adopted by the farmer

II.METHODOLOGY

Efficiency created by LEADS was assessed by a technology named MAPP (Method for Impact Assessment of Programmes) developed by Neubert (1998). Efficiency of LEADS from 2010 to 2016 was analysed by this methodology. MAPP technology has five steps which includes a life curve development using the productivity details of important crops, namely Rice, Banana, coconut and vegetables under LEADS project, trend analysis of the situations, enumeration of the various LEADS activities and interventionsand their relevance, influence matrix in consideration with the influence created by interventions/ activities upon the farmers and finally an efficiency profile of the LEADS. For the Technology construction focus group discussion was conducted and the alterations were recorded.

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Engineering properties of five varieties of coconuts (*Cocos nucifera* L.) for efficient husk separation

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ABSTRACT

Coconut husk is used as a natural fiber, and it is constantly gaining economic importance including in organic farming. Yet, there are major knowledge gaps regarding the engineering properties of coconut to design efficient coconut dehusking and coir manufacturing process. A sample of 40 coconuts of each variety, namely Malayan Yellow Dwarf, Malayan Orange Dwarf, Kera Shankara, Chowghat Orange Dwarf, and Chowghat Green Dwarf, were divided into two groups (20 dry and 20 green coconuts), and different engineering properties were measured. It was observed that coconuts show an extensive diversity in size, density, husk thickness, husk weight, shell thickness, shell weight, and kernel thickness, depending on variety and maturity. The present investigation provides necessary information and the need for classifying the coconut fruits based on size/variety rather than weight to design superior coconut dehusking machine.

摘要

椰子壳被用作天然纤维，它在有机农业中不断获得经济上的重要性。然而，关于椰子的工程性质，设计有效的椰子脱壳和椰壳制造工艺存在重大的知识空白。将40个椰子品种Malayan Yellow Darf MYD）、MalayanOrange Dwarf（MOD）、KeraShankara（KS）、Chowghat Orange Dwarf（COD）和 Chowghat-Green-Dwarf (CGD) 的样品分为两组（20干和20绿椰子），并测定不同的工程性质。据观察，椰子在大小、密度、壳厚度、壳重、壳厚度、壳重和核厚度上表现出广泛的多样性，这取决于遗传多样性和成熟度。本次调查提供了必要的信息和需要分类的椰子果实的大小/品种，而不是重量设计优良椰子去壳机。

KEYWORDS

Coconut; bulk density; true density; husk thickness; shell thickness

关键词

椰子; 体积密度; 真密度; 果壳厚度; 壳体厚度

Introduction

Coconut palm (*Cocos nucifera* L.) is referred to as the "tree of life" because of its multitude of uses including food, fuel, and fiber. Its husk or, botanically, mesocarp is composed of fibers called coir. Endocarp (shell) is the hardest part of the nut enclosing a brown layer (testa) and kernel. The husk and shell become harder with maturity (Mizera, Hrabe, and Herák 2017). Coconut coir fiber is being used as ropes and binderless board production (van Dam et al. 2006), as shell for buttons, as charcoal, and in decorative carving. Activated carbon derived from the coconut husk is characterized

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OPEN ACCESS

NON-INVERSE J - SHAPED POPULATION DISTRIBUTION: PECULIARITY OF RED SANDERS FORESTS

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The article in JoTT (Ankalaiah et al. 2017) was a well-framed study, with regards to the current status of Red Sanders. The authors had the geographical advantage of studying the population in its native range, i.e., Andhra Pradesh.

The study has once again pointed out the significance of protected areas (PA). Even though, the Sri Lankamalleswara Wildlife Sanctuary was not mainly intended to the conservation of the Red Sanders, the sanctuary has helped in the good regeneration of the species. The credit has to be given to the authors for proving that PAs are a significant concept in conservation efforts; the book written by Joppa et al. (2016) provides a similar conclusion. The book portrays a large number of case studies to support the conclusion. This study has indirectly provided the evidence as stated in the book but in an Indian context. Including this aspect in the conclusion will add a jewel to the article.

Red Sanders belong to Family Leguminosae and sub-family Faboideae (CAMP Workshops on Medicinal Plants, India (January, 1998). It has unique wood properties, which made the mature trees a target for poachers. The data in the article reports the same phenomenon, where trees with relatively bigger dimensions are few. There are, however, few statements in the paper that need better explanation. For instance, the statement "linear regression between gbh midpoint $\ln(m_i)$ and density of individuals in each gbh class $\ln(N_i+1)$ was done to determine the recruitment status by analyzing the slope and regression coefficient". How did the regression aid in the assessment of recruitment status? A small explanation, as well as graphical representation, would make it easier to comprehend. Similarly, the statement "Horizontal spread of canopy (D1) and vertical spread from the first joint of the target tree (D2) were added (D1+D2) and a relation with respect to tree height was analysed". Here, the authors have to explain the necessity of measuring the vertical spread and the usage of the term 'vertical spread from the first joint of the target tree' - a very uncommon usage in the forest mensuration. Based on the measurement of canopy parameters, a well-established fact has again been highlighted .i.e. multiple stem trees produce a more horizontal spread. Is that so significant which has to be restated.

Furthermore, in the result section, the authors have stated that Figure 1 indicates that 30–50 cm is the most representative gbh class in NPK1 and NPK2, while in LKM1 and LKM2 the 51–70 cm gbh class has a high number of trees". But as given in figure 1: LMK2 and NPK1 do have a high number of trees in 51–70 cm gbh. This necessitates relooking the result section.

In the discussion section, the findings of the study was linked to the inverse 'j' shaped concept. It is a very relevant and significant way to interpret the result. The paper published by Gonzalez-Rivas et al. (2006), however, does conclude that there was inverse j shaped curve in the species abundance pattern. On the contrary, in the present study, the size population did not go in agreement with the trend (inverse j-shaped). Hence, there is a need for detailed explanation. It is stressed here because there is a study in the disturbed tropical forests of Assam where the population follows inverse j-shaped (Dutta & Devi 2013). This cited study was also subjected to heavy exploitation as similar to that of the present study. This brings greater contradictions to the article.

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Detection and identification of four 16Sr subgroups of phytoplasmas associated with different legume crops in India

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Abstract Phytoplasma suspected symptoms of little leaf, flat stem, witches' broom and leaf yellowing were recorded on the four legume species, cowpea (*Vigna unguiculata* (L.) Walp.), pigeon pea (*Cajanus cajan* (L.) Millsp.), lentil (*Lens culinaris* Medikus) and mung bean (*Vigna radiata* (L.) Wilczek) in the states of Delhi, Uttar Pradesh (UP) and Kerala from 2014 to 2016. DNA specific fragments of approximately 1.3 kb were amplified from symptomatic samples of cowpea, pigeon pea, lentil and mung bean in nested PCR assays by using two sets of universal phytoplasma nested specific primers P1/P7 followed by 3Far/3Rev. No DNA amplifications were observed in any of the non-symptomatic legume samples with same primer pairs. Pair wise sequence comparison, phylogeny and virtual RFLP analysis of 16S rDNA sequences of the four legume species confirmed the association of four different groups and subgroups of phytoplasmas in the present study. The mung bean witches' broom at Delhi was identified to be associated with strain related to '*Ca.* P. aurantifolia' (16SrII-D), pigeon pea little leaf at Faizabad, UP with strain related to '*Ca.* P. phoenicium' (16SrIX-C), lentil witches' broom at Faizabad, UP with '*Ca. P. trifolii*' (16SrVI-D) and cow pea flat stem disease at Kerala with '*Ca.* P. cynodontis' (16SrXIV-A). Association of '*Ca.* P. cynodontis' (16SrXIV-A) infecting cowpea, '*Ca. P. trifolii*' (16SrVI-D) in lentil and phytoplasmas strain related to '*Ca.* P. phoenicium' (16SrIX-C) infecting pigeon pea are the new reports to the world.

Keywords Phytoplasma · Identification · Cowpea · Pigeon pea · Lentil · Mung bean

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Legumes are a significant source of protein dietary fiber, carbohydrates and dietary mineral, grown agriculturally, primarily for their seed, for livestock and silage, and as soil-enhancing green manure. Cowpea is one of the most important legumes across the semiarid tropics valued for its pods and dried seeds (Kumar et al. 2012). In India, cowpea is grown in an area of 3.9 million hectares with a production of 2.21 million tonnes with the national productivity of 683 kg per ha (Singh et al. 2012). Mung bean is an important edible legume grown in Asia, particularly in the Indian subcontinent, where it is used for human and animal consumption. India is the world's largest producer as well as consumer of green gram (*Vigna radiata*). It produces about 1.5 to 2.0 million tons of mung bean annually from about 3 to 4 million hectares of area, with an average productivity of 500 kg per hectare. Lentil (*Lens culinaris*) is one of the oldest known protein-

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Inbreeding and *in vitro* seed germination in *Spathoglottis albida* Kraenzl.

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Abstract: *Development of inbreds, for selecting as parents for hybridisation, in vitro seed germination and its establishment in Spathoglottis albida Kraenzl. was achieved. The pods obtained through selfing were harvested after 30 days and cultured in different media supplemented with individual and combinations of 6-benzylamino purine (BAP) and 1-naphthalene acetic acid (NAA) Seed germination was higher in MS medium (93%) and lower in Mitra medium (87%). The seedlings were grown well in the MS medium supplemented with 1.5 ppm BAP and 0.5 ppm NAA. The plantlets obtained in this medium were healthy and vigorous with 16.8 cm height at the time of deflasking for hardening. The matured rooted plantlets were acclimatized by using potting mixture at 1:1:1 proportion for hardening. The survived plantlets were transferred to field establishment and its growth was successful.*

Keywords: *Orchid, Inbreeding, Spathoglottis albida, Seed culture, Pollen, Protocorm*

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I. Introduction

Spathoglottis albida Kraenzl. is one of the important wild terrestrial species belonging to the family Orchidaceae and it is widely distributed in Northern India, Southern Japan and China [1]. The plant is a native of Thailand. In Kerala it is gaining popularity as an ornamental plant because of its large attractive white beautiful flowers, nature of continuous flowering throughout the year and also due to the long duration of inflorescence with large number of flowers which are opening continuously from base to top. Moreover, it is a good perennial herb for landscaping also. *Spathoglottis* species can be differentiated by their morphological characteristics based on their flower colour and shape of the lip. It produces flowers with varying colours ranging from white to mauve and in shades ranging from yellow to golden yellow. Based on the mode of pollination, orchids are grouped under highly cross pollinated plant species. So naturally this will lead to considerable genetic variability in the seedling progenies. Hence, it is very difficult to get true to type plants through natural seed propagation. Moreover, it is very difficult to get plants through seed germination in the natural condition.

Spathoglottis species are reported to be freely inter-fertile. These are cross pollinated orchids but to induce new variation through cross breeding is difficult [2]. Most hybrids, either it is self or cross pollinated with parent or other species, are nearly sterile [3, 4]. Selfing is done to confirm whether the desired traits are present in double dose or not. So the population may have desirable and undesirable types. If they are well separated geographically the two populations may respectively be homozygous but if there has been interbreeding between populations they may be heterozygous. The only way to tell whether an individual plant will breed true for desirable type is to self the plant and if the progeny are all similar the plant is homozygous or uniform. Selfing is a way of proving that the plant is a suitable parent for whatever desirable trait the hybridizer is pursuing.

It is widely cultivated and have been successfully used for hybridization [5, 6,7] and therefore preservation of its germplasm is worthy for breeding. An attempt was made to utilize it as one of the parents in a distant hybridization programme. In this context, it is essential to develop inbred line to avoid segregation due to cross pollination. *S. albida* is conventionally propagated through separation of pseudobulbs but the proliferation rate is very low [8]. *In vitro* seed culture technique is an efficient approach for its regeneration [9,10]. Seed culture is not preferred particularly in cross pollinated species because true to type plants cannot be obtained. In vitro seed germination is the best option for the rapid development of inbreds. But reports on the *in vitro* culture of *S. albida* are limited [11,12, 13]. Most of the orchids flowered regularly but fail to set pods due to the lack of particular pollinating insects. Hence hand pollination technique should be employed for fruit setting. With this objective, the present investigation was carried out at JNTBGRI, Puthenthope, Thiruvananthapuram during the period 2015-2016.

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Proficiency of Post-harvest Treatments in Maintaining Sensory and Organoleptic Quality Attributes of Rambutan (*Nephelium lappaceum* L.) during Ambient Storage

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Keywords

Rambutan, Browning, spinterns, Sulphitation, Scores, Ozonization, Paraffin

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A B S T R A C T

Water loss is the major problem in rambutan which induces the browning of spinterns and ultimately reduces the consumer acceptance. Techniques which slow down respiration and dehydration rate were found to be more effective in increasing overall acceptability of rambutans. The efficacy of several pre-treatments in up regulating consumer acceptance of rambutan (*Nephelium lappaceum* L.) fruit was examined. Dipping fruits for 5 min in 2 ppm ozonized water comparably reduced the browning of the fruit stored under room temperature (30±2^{o}C; 80-85% RH). On the other hand, waxing treatments did not reduce browning but retained excellent internal fruit quality. Sulphitation (350ppm) solution was not effective in reducing browning and enhancing marketable value. It was concluded that ozonization (2ppm) treatment recorded lowest browning score (4.10) and superior in general appearance (4.83), taste and flavour with minimum pulp browning at the end of shelf life.

Introduction

Rambutan (*Nephelium lappaceum* L.) is an important exotic fruit, indigenous to Southeast Asia, including Thailand, Malaysia, and Indonesia (Lam *et al.*, 1987). It is a good source of vitamin C, calcium and provides fairly a good amount of niacin, iron, phosphorus, carbohydrate, protein, and fibre. As a non-climacteric fruit, rambutan must be harvested at the peak of maturity as further ripening does not continue after harvest (O'Hare, 1995; Wall *et al.*, 2011). The most attractive and distinctive feature of rambutan fruit is its bright red or yellow peel and spinterns (Landrigan *et al.*, 1996). The flavour of the juicy aril is a blend of sweet and sour taste (Lam *et al.*, 1987). Farmers in many parts of Kottayam and Pathanamthitta in Central Travancore have taken rambutan cultivation to cater the demand of fruits from traders in Tamil Nadu and Karnataka (Kuttoor, 2009). However, the presence of the hair like spinterns makes the fruit very

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RESEARCH PAPER

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Effect of pre-treatments and drying methods on nutrient composition and sensory quality of milk yam (*Ipomoea digitata* L.) tuber powder

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SUMMARY :

Milk yam (*Ipomoea digitata* L.) (Family-Covolvulaceae) or Ksheervidari is a potential medicinal cum nutraceutical agent. It is a perennial climber having tuberous roots which are medicinal. Dried and powdered tubers are used in several nutraceutical preparations. The present study focussed on different pre-treatments and drying techniques that can be adopted for improving the flour whiteness and quality of milk yam tuber powder. Peeled as well as non-peeled tubers were shredded and washed (three times, two times, single time and no washing), de-watered by keeping in bamboo basket. These tuber shreds were dried under sun and in a hot-air oven (60^0C, 70^0C and 80^0C). The samples were evaluated for micronutrients, non-nutrient but beneficial components as well as sensory quality attributes.Milk yam tuber powder prepared by three times washed peeled tuber shreds dewatered by keeping in bamboo basket and dried in hot-air oven at 60^0C recorded optimum micronutrients, non-nutrient but beneficial components and sensory (overall visual quality – OVQ) quality attributes. Micronutrients composition include, calcium-3.40 mg/100g, iron-2.47 mg/100g, sodium-2.53 mg/100g, high vitamin A (613.33µg/100g) and vitamin C (7.43 mg/100g). Non-nutritional but beneficial components *viz.*, crude fibre-7.13 g/100g and total ash-3.56 g/100g. Mean rank value for the overall visual quality (OVQ) is 288.55.

KEY WORDS : Beneficial components, Ksheervidari, Micronutrients, Nutraceutical, Overall visual quality

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Seed priming for improving the weed competitiveness in sesame

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ABSTRACT

A field study was conducted at Onattukara Regional Agricultural Research Station, Kayamkulam to understand the effect of seed priming on improving weed competitiveness in sesame variety Thilak. Seed priming treatments selected were plant growth regulator, GA (gibberellic acid), micronutrients ($MnSO_4$, borax), mixture of $MnSO_4$ and borax with GA (tank mix), and water. Species wise weed count and weed dry matter production were calculated at 10 DAS and at harvest. The results revealed that the highest weed control efficiency of 38 per cent was recorded in seed priming with $MnSO_4$ followed by tank mix and borax. The improvement in weed competitiveness of sesame may be due to the enhancement in the early seedling vigour of the primed seeds. This was evident from the improved Crop growth rate (CGR), Net assimilation rate (NAR) and Leaf area index (LAI). The reduced weed density along with improvement in early growth parameters contributed to higher yield of sesame.

Keywords **:** $MnSO_4$, seed priming, tank mix, weed competitiveness, weed control efficiency

Sesame is one of the oldest oil seed crops cultivated in India. Globally, India is the largest producer, consumer and exporter of sesame. As per the Solvent Extractors Association of India (SEAI), the area under sesame crop was 19.81 lakh hectares with a production of 8.87 lakh tonnes during 2015-16. However, its production in the country is declining due to several reasons. Weeds are a major biotic stress in sesame cultivation. This is due to slow growth of sesame seedlings during early stages of first four weeks, making it a poor competitor at the early stages of crop growth (Nazir, 1994; Bennett *et al*., 2003). Yield loss as high as 81 per cent was reported in the crop due to weed infestation (Shaalan *et al*., 2014). Insufficient weed control at early crop periods mainly at the critical period of crop weed competition, leads to yield reduction (Weaver *et al*., 1992). Upadhyay (1985) suggested that suppression of weed growth at crop establishment stage is important as early growth of sesame is slow.

One approach to weed management in sesame could be seed priming (Vafaei *et al*., 2013). Seed priming is a pre-sowing strategy for improving seedling establishment by modulating pre-germination metabolic activity prior to emergence of the radicle. This technique generally enhances germination rate and plant performance (Bradford, 1986). Proper seed priming treatments with micronutrients, plant growth regulators can improve early seedling vigour and establishment.

Wortmann (1993) reported that in bean (*Phaseolus vulgaris* L.) the ability to suppress weeds was found to be related to leaf size, leaf area index, and plant growth rate. Dias *et al*. (2011) reported that soybean plants which developed from seeds with high and intermediate vigour showed the best results for competition against weeds by reducing weed dry mass accumulation. Plants which developed from high vigour seeds gave the best results for grain yield for both weeded and unweeded treatments.

Experiment conducted by Vafaei *et al*. (2013) showed that a proper combination of pre- and post-emergence herbicides along with seed priming could be used to control the weeds in sesame and to obtain a seed yield comparable with weed-free conditions.

MATERIALS AND METHODS

A field experiment was conducted at Onattukara Regional Agricultural Research Station (ORARS), Kayamkulam, Kerala during summer season of 2016-17. Sesame variety used for the field study was Thilak (ACV3) released from Kerala Agricultural University (1993). Thilak is a pure line selection from Malappuram local suited for summer rice fallows of Onattukara. The experiment was laid out in spilt plot design with three replications. The main plots comprised of hand weeded and unweeded plots. The subplots comprised of five seed priming treatments along with unprimed seeds *viz*., control (unprimed seeds), water, gibberellic acid (GA-100 ppm), borax (0.1%), manganese sulphate ($MnSO_4$-0.3%) and tank mixture of 0.1 % borax, 0.3% $MnSO_4$ and 100ppm GA (tank mix). . Application rate in a hector for 5 kg seeds for GA, borax, $MnSO_4$, is 0.5g $GAha^{-1}$, 5g borax ha^{-1}, 15g $MnSO_4$ ha^{-1} respectively. Tank mix can be prepared by sequentially mixing the respective concentration of GA, borax and $MnSO_4$ in water. Seeds were soaked for 8 hrs in the priming solutions and after shade drying, the seeds were sown in the field. The experimental area was ploughed twice to a fine tilth. The

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An Economic Analysis of Nendran Banana of Insured and Uninsured Banana Farmers in Thiruvananthapuram District, Kerala

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Abstract: Risk is a major component in farm business, which makes a wide fluctuation in income. Crop insurance is tool which helps the farmers to mitigate the risk factor by transferring the risk component to insuring authority. Cost of cultivation of insured and uninsured farmers were calculated separately and it was found out that insured farmers were more investing more on inputs than uninsured farmers. It was revealed that farmers adopting crop insurance had incurred higher cost of cultivation, obtained better yield and higher BC ratio from Nendran banana cultivation
Keywords: Nendran banana, crop insurance, Benefit-cost ratio.

I. INTRODUCTION

India is a developing country in which 70 per cent of Its population directly or indirectly depend on agricultural sector for their livelihood. Risks are inherent in farming business. There are different types of risks in agriculture such as production risk, price risk, credit risk, human risk and institutional risk. Agricultural risks exist with regard to weather parameters, price fluctuation, government policies, global markets, credit and several other factors and it can cause a wide swing in the farm income. Agricultural risk cannot be avoided but can be reduced by adoption of proper mitigation measures. Risk mitigation includes a host of techniques that can reduce the negative impact of risk. Banana is a nine-month duration crop and needs more investment for its cultivation and it can be easily affected by strong winds, floods and several diseases. So the farmers should adopt risk mitigation strategies for reducing such excess burdens. Crop insurance is an effective risk mitigation tool that helps producers in case of uncertainties of crop production due to natural factors which are beyond the farmers' control. Kerala state crop insurance scheme provides support to banana farmers to overcome production risk when crop loss occurs. In this context the study is focused on compare the profitability of Nendran banana cultivation.

Manojkumar *et al.* (2003) conducted a case study of crop insurance on banana in Wayanad district and reported that due to the labour shortage, and high labour cost in Padinarathara panchayat compared to Ambalavayal and Panamaram which led to high cost of cultivation in Padinarathara (₹ 71.31 per plant) than Ambalavayal (₹ 57.96 per plant) and Panamaram (₹ 52.62 per plant).

Varalakshmi (2014) studied the impact of weather based crop insurance scheme among chilli farmers in Guntur district of Andhra Pradesh and found that net returns obtained by the insured farmers (₹ 202978.9 ha^{-1}) were higher than uninsured farmers (₹ 178951.67 ha^{-1}).

Kathirvel (2007) revealed that cost of production of banana was high. Among the cost, the cost of labour and fertilizer was more. The output of banana much depended upon maintenance of plants, timely application of fertilizers, manures, pesticides and water availability.

II. MATERIALS AND METHODS

The study is based on primary data. Data was collected from 80 banana farmers from four panchayats in Neyyatinkara taluk of Thiruvananthapuram district, having maximum area under banana cultivation. The farmers were classified into two groups, insured and uninsured, based on the adoption of crop insurance as a mitigation tool. Cost of cultivation was worked out separately for insured and uninsured farmers.

ABC cost concept was used for working out cost of cultivation of Nendran banana.

The Cost A_1 includes

A. Cost of sucker
B. Cost of hired labour

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A Comparison of Engineering Properties of Soils in Two *Kolepadavus* of the *Kole* Lands of Kerala

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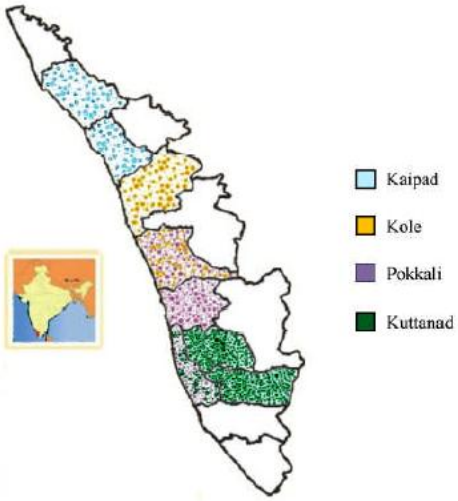
Abstract:
The kole lands lying in the Thrissur and Malappuram districts of Kerala are vast contiguous fertile lands lying below MSL. They remain submerged for about six months every year. After the monsoons these lands are dewatered and rice is cultivated. The yield from these lands is almost double the yield from other paddy growing areas of the State and hence these areas are major contributors to rice production in Kerala. The engineering properties soil of these areas is found to vary widely. The study attempted to classify the engineering properties of soils such as the moisture content, bulk density, soil texture, organic matter, liquid limit, plastic limit, shrinkage limit, penetration resistance and shear strength in two kolepadavus of the kole lands of Kerala.

Key words: Kole lands, bulk density, consistency limit, soil texture, cone index, shear strength

INTRODUCTION

Paddy wetlands are "the lands transitional betweenterrestrial and aquatic systems where the water table is usually at or near thesurface, or the land is covered by shallow water" (Cowardin*et al.*, 1979). As cited in the Article 2.1 of the Ramsar Convention, 1971, "wetlands may incorporate riparian and coastal zones adjacent to the wetlands, and islandsor bodies of marine water deeper than six metres at low tide lying within thewetlands".

Kerala is home to several special areas put under rice cultivation; *viz.*, the *kuttanad*, *kole*, *kaipad*, *pokkali* etc., each of which have unique and intrinsic characteristics, with the common factor being that all of them are located below mean sea level (MSL). Figure 1 shows the extent of such special, waterlogged areas which were traditionally under paddy cultivation.



(Source: Jayan and Sathyanathan, 2010)

The *kole* lands in Thrissur and Malappuram district of the state come under such a special zone. The *kole* lands were shallow lagoons a very long time back and these gradually got silted up. These lands lie 0.5 m to 1.0 m below the MSL and remain submerged under water for around six months every year, from May-June to October - November. The Karuvannurriver and the Kechery rivers bring their flood waters into the *kole* lands, and then move on to empty into the Arabian sea. Along with the flood water come the rich alluvium, which are deposited in the area, resulting in a very fertile and highly specific soil. The term "*kole*" in Malayalam means a bumper yield of the rice crop that is cultivated here, once in a year. Hence the name of the area indicates the richness and fertility of the land which gives the farmers a bumper yield of paddy.

The *kole* lands lie between the Chalakkudy river in the Thrissur district upto the southern banks of the Bharathapuzha river in the north and between 10° 20' and 10°40' N latitudes and 75° 58' and 76°11'E longitudes (Sivaperuman and Jayson, 2000). The entire *kole* lands are distributed in Thrissur and Malappuram districts with 10187 ha of land lying in the Thrissur *kole*. The Mukundapuram and Chavakkadtaluks constitute a major share of the Thrissur *kole*. The *kole* lands lying in the Malappuaram district are termed as the Ponnani *kole* with an area of 3445 ha and are located in the Thalappillytaluk and parts of Chavalkkadtaluk of the Thrissur district and the Ponnani taluk of the Malappuram district. Thus, these cover a vast land area of 13632 ha, which is cultivated with rice. Canals and channels are provide throughout this area for irrigation and drainage. These also divide the *kole* lands into *kolepadavus*, i.e., blocks of land, often having area of 200 ha or more, to ensure easy water and crop management (Johnkutty and Venugopal, 1993; Leema, 2015). The *kole* lands are notified Ramsar Heritage sites and have a rich biodiversity of flora and fauna and aquatic life.

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Effect of nutrient levels and nutrient schedules on physiological parameters and grain yield of upland rice intercropped in coconut garden

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Abstract
The experiment was conducted at Coconut Research Station, Balaramapuram with an objective to study the effect of nutrient levels and nutrient schedules on physiological parameters and grain yield of upland rice (MO 21- Prathyasa rice variety) intercropped in coconut. Field experiment was conducted in factorial randomized block design with nutrient levels as first factor and nutrient schedules as second factor in three replications. Nutrient levels had significant effect on the physiological parameters. Among the nutrient levels rested, NPK applied @ 120:30:60 recorded higher total chlorophyll (2.803 mg g^{-1}) and chlorophyll b content (1.508 mg g^{-1}), crop growth rate (CGR) (11.23 g m^{-2} day^{-1}) and relative growth rate (RGR) (0.056 g g^{-1} day^{-1}) as compared to lower nutrient level tested, NPK @ 60:30:30 kg ha^{-1}. Nutrient schedules also had significant effect (P=0.05) on the physiological parameters *viz*., total chlorophyll, chlorophyll a, chlorophyll b, CGR and RGR and the treatment receiving 0.2 per cent zinc sulphate and 0.04 per cent sodium borate spray at 45 DAS recorded higher chlorophyll content, RGR and CGR. Though the higher nutrient level, NPK @ 120:30:45 kg ha^{-1} recorded higher values for physiological parameters, it recorded the lowest grain yield. Application of NPK @ 90:30:45 kg ha^{-1} recorded the highest grain yield and it was followed by NPK applied @ 70:30:35 kg ha^{-1}. Among the nutrient schedules, N applied as three equal splits, P as basal and K in two equal splits along with foliar spray of zinc sulphate 0.2 per cent and sodium borate 0.04 per cent at 45 DAS recorded the highest grain yield (3.25 t ha^{-1}). The study clearly revealed that excessive vegetative growth is not a desirable parameter for higher grain yield.

Keywords: Chlorophyll content, Crop growth rate, Grain yield, Relative growth rate, Upland rice

INTRODUCTION

Rice provides food for more than 65 per cent of the people living in India and is cultivated in an area of 433.88 lakh ha with an annual production of 104.32 m t and productivity of 2404 kg ha^{-1} (GOI, 2017). In the recent years the rice production shows a declining trend. Recent research findings revealed that, the production potential of rice can be enhanced by enhancing the area under upland rice rather than enhancing the area under transplanted rice (Alagesan and Babu, 2011). Upland rice comes up well under the partial shade in coconut garden. Nearly 60-75 per cent of the land area and 40 per cent of the solar energy in 7.5 m x 7.5 m spaced coconut are left unutilized which provides amble scope for growing compatible intercrops (Nelliat, 1979; Dhanpal, 2010).
Nitrogen, the primary nutrient element plays a pivotal role in rice production. The rice growth and