

Evaluation of rice genotypes for acquired thermo-tolerance using Temperature Induction Response (TIR) technique

SL NO 55

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ABSTRACT

Global climate change is leading to asymmetric atmospheric warming with reduced temperature differences between day and night. Increase in temperature alters broad range of physiological processes, such as growth and development, pollination and fertilization and ultimately affecting the yield. Hot summers in many agricultural regions can negatively affect the vegetative and reproductive growth phases of such crops and can result in up to 80% losses in rice yield. However, heat stress has numerous specific effects depending on the genotype. Physiological observations both under field and greenhouse conditions show a variable degree of tolerance between different genotypes. In this study, a screening protocol was developed based on the principle of "acquired tolerance" in which exposure of seedlings to a sub-lethal level of specific stress is used to induce tolerance to a subsequent lethal level of stress. Seedlings were subjected to a gradual temperature increase from 38 to 48 °C for 3 h (induction treatment), immediately followed by challenging at 54°C for 3 h. Among the landraces, Njavara and Chenellu showed a mortality of 18 and 10% respectively, coupled with a less reduction in percent root and shoot growth when subjected to induction treatments. The physiological basis of thermo-tolerance in these lines was further confirmed, as these lines recorded a higher chlorophyll stability index and a strong antioxidant enzyme system with lesser lipid peroxidation in terms of malondialdehyde content values.

Dissipation of Chlorpyrifos and Profenophos in Cabbage (*Brassica oleracea* var. capitata L.)

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SL NO 56

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Abstract

The persistence of organophosphorus insecticides chlorpyrifos and profenophos @ 300 and 500 g a.i. ha⁻¹ in cabbage following two foliar applications at 15 d interval during the head formation stage, is reported. Samples collected at 0 (2h), 1, 3, 5, 7, 10 and 15 d after the last (second) spray were extracted by QuEChERS method and residues estimated by gas liquid chromatography equipped with flame photometric detector (FPD). The mean initial deposits of chlorpyrifos and profenophos were 1.52 and 1.02 µg g⁻¹ respectively which dissipated with time and reached below the quantitation level of 0.05 µg g⁻¹ within 15 d with half-life values of 1.91 and 2.01 d, respectively. The Limit of detection (LOD) and limit of quantitation (LOQ) of the two insecticides in cabbage were 0.01 and 0.05 µg g⁻¹, respectively.

Keywords

Chlorpyrifos, profenophos, cabbage, dissipation, half life.



Management of rice weevil, *Sitophilus oryzae* using essential volatile oils

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ABSTRACT: Effect of four essential volatile oils viz., clove (*Syzygium aromaticum* L.), cinnamon (*Cinnamomum zeylanicum* Blume), lemon grass (*Cymbopogon flexuosus* (Nees ex steud)) and pepper (*Piper nigrum* L.) on mortality of rice weevil, *Sitophilus oryzae* L. in stored rice was studied under laboratory conditions. Preliminary toxicity bioassays (without food and with food) were carried for fixing the concentrations of these oils. Percentage mortality of weevils by volatile essential oils increased with increase in concentration and period of exposure. Pepper oil @ 200 $\mu\text{l}/500\text{ cm}^3$ volume caused cent per cent mortality without any progeny emergence whereas cinnamon oil @ 30 $\mu\text{l}/500\text{ cm}^3$ caused 95.55 per cent mortality of weevils with 98.81 inhibitions on progeny emergence. The highest concentration (30 $\mu\text{l}/500\text{ cm}^3$) of clove oil caused 76.67 percentage mortality of weevils while lemon grass oil (200 $\mu\text{l}/500\text{ cm}^3$) caused 68.89 percentage mortality.


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KEY WORDS: Essential volatile oils, rice weevil, *Sitophilus oryzae*

Stored product insects cause 3 to 18 per cent postharvest loss in rice during storage which is relation to the area and period of storage (Tagola *et al.*, 2013). There were 1,663 insect species are reported as pest of stored food commodities, among which few insects were known for its greater damage ability and well distribution all over the world. Their presence was reported from grain elevators, mills and retailers (Hagstrum and Phillips, 2017). Pest infestation contributes to contamination in food products through the presence of dead and live insects, excretions and body fragments. Both whole and milled rice are severely attacked by insect pests belongs to Coleoptera and Lepidoptera.

Beetles are highly diversified and cause huge destruction of stored grain when compared with that of moth (Upadhyay and Ahmad, 2011). The increased awareness on the deleterious effect of chemical insecticides and the demand for insecticide free food has prompted the development of safer alternative management option. The use of botanicals offers an alternative management strategy against stored grain insect pests. Essential oils from plant parts exhibit contact, fumigant, repellent and antifeedant actions to several coleopteran insect pests infesting stored products. Fumigant action of volatile oils are due to the presence of monoterpenes (Koul *et al.*, 2008). In

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SL NO 59

Variability of paddy straw mushroom collections from southern Kerala

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Abstract

The occurrence of the underutilized as well as highly tasty paddy straw mushroom is reported to be more in Kerala. A survey was conducted to explore the native isolates of *Volvariella* sp. and to study their morphological as well as microscopic characters. Thirteen paddy straw mushroom collections were obtained from two districts of south Kerala. During the survey, habit, habitat, substrate, minimum and maximum temperature of the location, relative humidity and rainfall data were recorded and compared. Morphological and microscopical characteristics of the collections were studied in detail and identified up to species level. *Volvariella volvacea* predominated among the collections. The collections with superior morphological and microscopical characters in this study can be effectively utilized for cultivation purpose.

Keywords

Paddy straw mushroom; Variability

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RESEARCH ARTICLE

Year : 2019 | Volume : 56 | Issue : 2 | Page : 111-121

Isovaleric acid and avicequinone-C are Chikungunya virus resistance principles in *Glycosmis pentaphylla* (Retz.) Correa

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Quality Evaluation of Important Ayurvedic Raw Drug Brahmi (*Bacopa monnieri*)

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Abstract: *Bacopa monnieri* (L.) Pennell, commonly known as brahmi from the family Plantaginaceae is a well known memory enhancer widely used in the indigenous systems of medicine. Brahmi containing formulations are available in the market claiming memory enhancement nerve rejuvenation. The increasing demand for herbal medicines along with less availability of genuine plant materials has led to widespread adulteration in herbal drug industry. In this context, an attempt has been made to assess the extent of adulteration in traded samples of *Bacopa monnieri* available in Kerala markets by checking the presence of marker compound bacoside in them using High Performance Thin Layer Chromatography (HPTLC) technique. The study revealed that out of 30 fresh market samples analyzed, all were genuine samples with presence of bacoside A with the varying levels. Out of five readymade brahmi powders purchased from market, only one contained bacoside A. Granular formulations collected from the market with Brahmi as the said ingredient contained very low levels of bacoside A compared to fresh samples. Mimicking weeds like *Lindernia* species were found in the fresh samples.

Keywords: Adulteration, Brahmi, *Bacopa monnieri*, Bacoside A

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Introduction:

Bacopa monnieri (L.) Pennell, well known as brahmi in Hindi is a very effective memory booster and brain tonic raw drug used in Ayurveda. In addition to this, plant is effective in the treatment for epilepsy, asthma ulcers, tumors, enlarged spleen, inflammations, leprosy, anemia and gastroenteritis. It is a perennial trailing herb which belongs to the family Plantaginaceae. The whole plant is medicinal, containing

saponin backsides as the major active ingredient which can be taken as marker compound for authentication of true brahmi samples. It is the major ingredient in many ayurvedic formulations like Brahmeegritham, Brahmi oil, Saraswatharishtam etc. (Nambiar et al. (2000), Nayar et al.(1990) and Warriar et al. (1994). The increasing demand for herbal medicines along with less availability of genuine plant materials has led to

Social Capital Formation through Farm Women Groups in Vegetable Production in Kollam District of Kerala

Revathy Chandran¹ and G.S. Sreedaya²

ABSTRACT

Social capital refers to the trust, mutual understanding and shared values which facilitate the collective action and social co-ordination. It can create a service which can enhance the output obtainable from other inputs. Trust, co-operation, networks and norms are the important aspects of social capital. Farmer producer organization is the most appropriate institutional form around which to mobilize farmers and build their capacity to collectively leverage their production and marketing strength. Women groups have emerged as a major source of inspiration for women and collective action of women through their groups strengthened women in all spheres of life. This study was conducted among 120 women respondents in six selected panchayats of Kollam district in Kerala with the main objective of assessing the social capital formation through farm women groups. Social Capital was measured using Social Capital Assessment Tool (SOCAT) developed by World Bank. The results showed that there 82% of the respondents had medium level of social capital formation and the continuous efforts of various governmental and non-governmental agencies had tremendously helped in shifting this neutral attitude of people.

Keywords : Social capital, social networks, trust, women groups.

INTRODUCTION

Social capital refers to the trust, mutual understanding and shared values which facilitate the collective action and social co-ordination. Social capital ponders to the characteristics of a society that stimulates co-operation among the individuals. It can create a service which can enhance the output obtainable from other inputs. 'Networks', 'norms' and 'trust' can be considered as the three important attributes of Social capital.

Unlike human and physical capital, social capital lies as a latent (embedded) resource waiting to be mobilised and utilised, growing and developing with use. (Morris et al.,2006) .

Women groups is the new strategy which enables women to achieve their needs through the overall output of the group. This expected collective or economic benefits derived from the preferential treatment and cooperation between individuals and groups is known

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Short Communication

**16S rRNA gene taxonomic profiling of endophytic bacteria
associated with *phalaenopsis* roots**

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ABSTRACT

Orchids are one of the main groups of ornamental plants commercially exploited. In the present study, we analyzed the diversity of bacterial community in *Phalaenopsis* root using metagenomic approach. The diversity of bacterial taxonomic category was assessed at different Operational Taxonomic Unit (OTU) levels using Ribosomal Database Project (RDP) pipeline and MG-RAST. At phylum level, Proteobacteria (61.34%) was the most dominant group followed by unclassified derived from bacteria (24.74%) and Actinobacteria (12.52%). Genus level analysis revealed the abundance of *Rubrobacter*, *Pseudomonas* and *Acinetobacter*. The study revealed that of the total species detected 50.83 per cent were unclassified, stressing the importance of metagenomics to assess the diversity of endophytes associated with orchid roots.

Keywords: Endophyte, orchid, diversity

INTRODUCTION

Orchidaceae is one of the largest plant families, including almost 10% of all flowering plant species. Among these, the monopodial epiphytic *Phalaenopsis* or 'Moth Orchid' is one of the most popular orchids due to its ease of production and blooming year-round. The orchid roots are associated with various fungi and endotrophic bacteria (Teixeira *et al.*, 2015). Apart from mycorrhizal fungi, previous reports revealed the abundance of endophytic bacteria on the roots of the cultivated tropical orchids of genera *Calanthe*, *Acampe* and *Dendrobium* (Tsavkelova *et al.*, 2003). Orchids are characterized by low survival rate in the green house due to the germination under asymbiotic conditions *in vitro*. Generally, endophytes play an important role in promoting plant growth and yield, suppress pathogens, aid in removing heavy metal contaminants, solubilize phosphate or contribute to nitrogen assimilation for plants (Hallmann *et al.*, 2006). Over the past decade, our understanding of microbial diversity and function in complex environments has increased significantly, primarily because of the introduction of next generation sequencing (NGS) (Lozupone and Knight, 2007). The culture-independent, high-throughput sequencing-based community analysis allows us to observe the microbiome associated with

the plants. Since the endophytes have a strong impact on orchids growth, it is very important to study their relationships with plant for developing new strategies for orchid conservation and better exploitation of their medicinal principles. Therefore, in the present study, we employed NGS technology to unveil the culturable and unculturable endophytic bacteria in *Phalaenopsis* root to elucidate the microbial plant colonisation pattern and evaluate its microbial diversity.

The *Phalaenopsis* plants grown in Sphagnum moss under green house conditions were collected from the Department of Pomology and Floriculture, College of Horticulture, Vellanikkara. Samples were immediately transferred and processed for further studies. The roots were detached with sterile knife and washed with sterile distilled water plus a few drops of Tween-20 and left for 10–15 min to drain. These were then cut into 4–5 pieces (2–3 cm in size). Surface sterilization was performed by immersing separately in 90% ethanol (5 min), followed by sodium hypochlorite (3%) solution (2 min), and 75% ethanol (3 min). The disinfected roots were rinsed three times in sterile distilled water. Total genomic DNA was extracted from the surface sterilized root tissues using QIAGEN DNeasy plant kit following the manufacturer's protocol. Extracted DNA was



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Screening of Superior Genotypes of *Ailanthus triphysa* (Dennst.) Alston. (Matti) for Matchwood Quality

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Abstract

Growth parameters viz., height, collar girth, stem volume, survival percentage and bole straightness of the progenies of twenty different Candidate Plus Trees (CPTs) was studied. The experimental trial was located at the Kerala Agricultural University (KAU) main campus near Aremkul, Thrissur, Kerala, India. The field observations were carried out after 18 months of field planting. The variation in bole straightness was found to be significant among the progenies whereas height, collar girth, stem volume did not show any significant variation. Survival percentage of the progenies ranged between 84.61% to 100.00% after 12 months of planting.

Keywords

Progenies, CPTs, *A. triphysa*

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References

- Bulgannawar G.N. and Math S.B.M. (1991). The role of *Aspic aciduliformis* in afforestation in Karnataka, India. In: Proceeding: workshop on Advances in tropical Aspic research, Bangkok, Thailand. ACIAR, Canberra, 110-115 pp.
- Deka J., Yumnam J.Y., Mahanta P. and Tripathi G.P. (2015). Improvement in Estimation of Above Ground Biomass of Albizia lobbek using Fraction Reflectance of Landsat TM Data. Int. J. Plant Environ., 1(1): 99-105.
- Dhiman R.C. and Dhiman D. (2015). Quantification of wood wastage in mechanized match manufacturing. Int. J. Eng. Tech. Res., 3(2): 51-57.
- Hagde R., Srekanthiah G.N. and Kerkil M.R. (2009). Field manual on clonal forestry.
- Indira B.P. (1995). Genetic improvement of *Ailanthus triphysa*. KPRI Research Report No: 100.
- Kinde A.I., Mndolwa N.A., Edward B. and Chamaheba S.A. (2010). Performance of four-year-old Australian and Papua New Guinea *Aspic apocarpae/provenances* at Kongwa, Kibaha, Tanzania. South. For., 71(1): 13-22.
- Mohamed M.N., Perliben K.T., Ravi R. and Kumar P. (2015). Provenance variation in growth and genetic potential of *Aquilaria malaccensis* under nursery condition. Afr. J. Biotechnol., 14(24): 2005-2015.
- Nair C.T.S., Mammen C. and Muhammed S. (1984). Intensive multiple use forest management in the tropics. KPRI Research Report No. 22, 184p.
- Paul S.N. (2017). Screening of *Ailanthus triphysa* (Dennst.) Alston. For Preferred match wood qualities. M.Sc. Thesis, Kerala Agricultural University, Kerala, 89pp.
- Singh N. and Pakhnyal T.C. (2000). Biomass distribution pattern in relation to seed source variation in *Delbergia aspalathos* seedlings. Ann. For., 5(2): 238-249.
- Suhazendi H. (1992). Tree improvement of *Aspic mangium* for industrial forest plantation development in Indonesia. Asasia for Rural, Industrial and Environmental Development. PAD and Winrock International, Bangkok, 324pp.
- Wilmet G.A. (1929). Timbers suitable for matchmaking. Emp. For. J., 5(2): 263-267.

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Research Article

Effect of plant stimulants on shoot proliferation from nodal segments of *Aegle marmelos* L. (Corr.)

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ABSTRACT

Single node segments from *in vitro* raised seedlings of *Aegle marmelos* were used as explants in this study. Among the different combinations of auxins and cytokinins tried for culture establishment and multiplication, Murashige and Skoog (MS) medium supplemented with BA 2 mg L⁻¹ and IBA 0.5 mg L⁻¹ was found to be the most effective, giving 9.33 shoots per explant in six weeks of culture. The plant stimulants viz., chitosan, adenine sulphate and thidiazuron were added to MS medium supplemented with BA 2 mg L⁻¹ and IBA 0.5 mg L⁻¹ and in MS medium devoid of any plant hormones. The maximum shoot proliferation was obtained in MS medium with BA 2 mg L⁻¹, IBA 0.5 mg L⁻¹ and chitosan 10 mg L⁻¹ recording 35.67 shoots per explant followed by that supplemented with thidiazuron 0.02 mg L⁻¹ recording 20.00 shoots per explant.

Keywords: Plant stimulants, adenine sulphate, thidiazuron, chitosan, *Aegle marmelos*

INTRODUCTION

Aegle marmelos, commonly known as bael, is widely used in the indigenous system of Indian medicine, Ayurveda. Bael leaves are useful in treating jaundice, conjunctivitis, typhoid, diabetes etc. (Chakraborty *et al.*, 2012; Kumar *et al.*, 2015). Exploitation by pharmaceutical industries, indiscriminate or unregulated harvesting practices with no concern for the sustainability of the resource and lack of organised cultivation have enlisted the plant as rare, endangered and threatened (RET) species (Kumar *et al.*, 2015; Venudevan and Srimathi, 2014). Macropropagation is slow, difficult and labour intensive. Earlier reports on micropropagation techniques show low shoot proliferation from the shoot nodal segments. The plant stimulants, chitosan, thidiazuron (TDZ) and adenine sulphate (AdS) have found to influence the plant growth and development in various *in vitro* regeneration systems.

The chitosan a deacetylated form of chitin, is an environment friendly biopolymer that enhances growth and development in plants. This effect can be attributed to some signalling pathway to auxin biosynthesis via a tryptophan-independent pathway (Uthairatanakij, 2007). The plant stimulant, thidiazuron promotes intense shoot proliferation, indicative of high cytokinin activity and is recognized as one of the most active cytokinins for *in vitro* manipulation of woody species (Siddique and Anis, 2007). It is an urea derivative and does not contain the purine ring common to adenine type cytokinins. It promotes the conversion of cytokinin ribonucleosides to biologically more active ribonucleotides. It also encourages the synthesis of endogenous purine cytokinins or inhibits their degradation (Ceasar *et al.*, 2013). It might alter endogenous plant growth regulators, either directly or indirectly and produce response in cell or tissue,

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Screening of Superior Genotypes of *Ailanthus triphysa* (Dennst.) Alston. (Matti) for Matchwood Quality

Growth parameters viz., height, collar girth, stem volume, survival percentage and bole straightness of the progenies of twenty different Candidate Plus Trees (CPTs) was studied. The experimental trial was located at the Kerala Agricultural University (KAU) main campus near Aramkal, Thrissur, Kerala, India. The field observations were carried out after 16 months of field planting. The variation in bole straightness was found to be significant among the progenies whereas height, collar girth, stem volume did not show any significant variation. Survival percentage of the progenies ranged between 84.61% to 100.00% after 22 months of planting.

Key words: Progenies, CPTs, *A. triphysa*.

Introduction

Match industry has been playing a significant role in domestic and national economy by value addition to wood, revenue collection through different taxes and employment generation in India. This product has been considered as one of the essential used commodity by common-man (Dhiman and Dhiman, 2015). In Kerala, the match splint industries are mainly dependent on *Ailanthus triphysa*. There are approximately 500 match splint industries (small, medium and large scale) in Kerala, many of which are facing acute shortage of raw materials. Only ten per cent of the total raw material requirement of the industries is fulfilled through the forests of Kerala and hence the demand is very high (Nair *et al.*, 1984). *A. triphysa* produces an aromatic resin called Halmaddi, used for making traditional incense sticks. The presence of natural resin reduces the necessity for dipping the splints in wax, therefore the species has been counted as one of the best matchwood species (Indira, 1996). An effort towards breeding and producing quality planting material has not been taken up widely for *A. triphysa*, which have a high demand in match industries in Kerala. Based on the objective of a workshop "Homestead grown trees and match industry", organized in College of Forestry, Kerala Agricultural University, Vellanikkara a tree improvement programme was started on *A. triphysa*. The objective of the present study was intended to screen the superior genotypes of twenty Candidate Plus Trees (CPTs) based on the growth performance in experimental plot.

Material and Methods

Seeds were collected from twenty Candidate Plus Trees (CPTs) of *A. triphysa*, located at Thrissur and Palakkad districts of Kerala. Five panchayat were selected for each district namely Madakkathara, Nadathara, Kolazhi, Pananchery, Mulakkunathukavu panchayaths of Thrissur and Cherupulashery, Vilayur, Koppam, Pattambi and Ongallur panchayaths of Palakkad. Two CPTs from each panchayats which recorded seed set were included in the study. Selected CPTs were assigned with the accession number as FCV AT (Forestry College Vellanikkara *Ailanthus triphysa*). The experimental site of the present study was located at the Kerala Agricultural University (KAU) main

The variation in growth parameters viz., height, collar girth, stem volume was found to be non-significant among the progenies of different CPTs whereas, bole straightness showed significant variation. The average survival percentage was 94.98%.

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Morphometrics of stingless bee in Southern Kerala

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Online published on 23 October, 2018.

Abstract

Morphometrics variations of stingless bees in southern Kerala when analysed revealed significant variations within locations and between upland and midland physiographic regions. Among the 17 morphometric parameters variations observed in proboscis, forewing, femur, metatarsus and third sternite were more significant and play a prominent role to improve their pollinating and honey collecting ability. Stingless bees have a capacity to adjust their body parameters based on the available flora and physiographic regions.

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Keywords

Stingless bee, morphometrics, proboscis, femur, metatarsus, sternite, tergite, tomentum, pollinating and honey collection ability.

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Soil Test based Fertilizer Recommendations under Integrated Plant Nutrition System for Rice-F Pulse Cropping Sequence

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Received: May, 1997; Accepted: May, 1999.

Abstract

Field experiments were conducted on Typic Ustropept of Lower Bhavani Project area of Tamil Nadu to assess the fertilizer requirements under integrated plant nutrition system (I rice-residual pulse cropping sequence. Following Ramamoorthy's inductive methodology-cum-targetted yield model, fertilizer adjustment equations were formulated for rice both i rabi seasons. From these equations, the efficient and economic rates of fertilizers were calculated. The quantity of fertilizers that could be adjusted to the levels and sources of or was evaluated to be 38 kg N, 13 kg P₂O₅ and 33 kg K₂O ha⁻¹ for fertilizers with GM (*Sesbania rostrata*), 10-12 kg P₂O₅ ha⁻¹ for fertilizers with PB (*Bacillus megaterium* var. *pho* kg N, 26 kg P₂O₅ and 33 kg K₂ ha⁻¹ for fertilizers with GM plus PB.

Key words

Fertilizer adjustment equations, IPNS, Inceptisol.

Growth, nutrient uptake, yield and quality parameters of *Nendran* banana (*Musa* sp.) as influenced by combined application of soil and foliar nutrition

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Abstract

A field experiment was conducted at Coconut Research Station, Balaramapuram Thiruvananthapuram, Kerala Agricultural University during 2016 April to 2017 February to assess the impact of reduced dose of chemical fertilizers supplemented with foliar nutrition of major and micro nutrients on the uptake of major nutrients, growth, yield and quality of *Nendran* banana (*Musa* AAB group). The experiment was laid out in randomised block design with eight treatments and three replications. Growth parameters (pseudostem height, pseudostem girth and leaf area), uptake of major nutrients, yield attributes (index /D finger characters viz., length, girth and weight of finger) and yield were found higher for the treatment which received 100 per cent of the recommended dose of fertilizers (RDF) + foliar spray of micronutrient mixture (1%) at 3 MAP and was comparable with 75 per cent of RDF + foliar spray of 19:19:19 fertilizer mixture (0.5%) at 2 and 4MAP + foliar spray of micronutrient mixture (1%) at 3 MAP. These two treatments also registered higher content of total sugars and longer shelf lives. The treatment which received 100 per cent of RDF + foliar spray of micronutrient mixture (1%) at 3 MAP could register significantly higher TSS (34.67 °B), TSS/Acid ratio (114.92), pulp: peel ratio (2.58) and lower titratable acidity (0.31 per cent). Growth, yield, nutrient uptake and quality parameters were found significantly inferior for the treatment which received only foliar application of 19:19:19 mixture (0.5%) at monthly intervals in addition to the recommended basal dose of organic manures.

Keywords: Acidity, Banana, D finger, Growth, Nutrient uptake, Pulp: Peel ratio, Total sugars, TSS, TSS/Acid ratio, Yield.

Introduction

Banana, the major tropical fruit, is popular globally for its nutritional significance as well as economic importance to small and marginal farmers. *Nendran* banana belonging to *Musa* AAB group is the most sought after banana variety in Kerala, both for domestic and export markets due to its unique taste, nutritive value and varied options for value addition.

by phosphorus (Abdullah et al.1999). Being an exhaustive crop, proper scheduling of plant nutrition is important in banana for realising potential yield and good quality. Hence a study on conjunctive soil and foliar nutrition was formulated with the objective to assess the feasibility of foliar nutrition in reducing the fertilizer dose of *Nendran* banana and to study its impact on the uptake of nutrients, growth, yield and quality.

Banana is a heavy feeder of nutrients and requires large amounts of nitrogen and potassium followed

Foliar nutrition, the application of fertilizer material to foliage, is considered far more efficient compared

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Influence of storage environment and packing materials on seed germination and viability of *Desmodium gangeticum* (L.) DC..P. Gayathri¹ and M. T. Kanakamany^{2*}¹Academy of Climate Change Education and Research, KAU P.O., Kerala Agricultural University, Thrissur 680656, Kerala, India²AICRP on MAP and B, College of Horticulture, KAU P.O., Kerala Agricultural University, Thrissur 680656, Kerala, India*Corresponding author's email: (kanakambalakrishnan@yahoo.co.in)

Abstract: Seed quality characters like thousand seed weight, seed moisture content, germination percentage, seedling root length, shoot length, seedling fresh weight and dry weight of *Desmodium gangeticum* collected from the research fields of AICRP on MAP and B, Thrissur during the year 2016 were evaluated after storing under different environments viz., 8%, 10% and 12% of moisture levels, cloth, polythene and aluminium as packing materials, ambient and refrigerated storage environments. Weather parameters in the storage environment were also recorded during the storage period. The suitable storage method for *Desmodium gangeticum* seeds was found by evaluating the seed quality characters. The result of the investigation showed that it is better to store the seeds at 8% moisture level, pack in polythene bags and kept in refrigerated condition for higher germination. The finding from this study could be used for better storage of *Desmodium gangeticum* seeds without losing its viability and thus the conservation of this valuable medicinal plant.

Keywords: *Desmodium gangeticum*, Seed germination, Long term storage, Storage environment

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Introduction: Medicinal and aromatic plants have been used by mankind from time immemorial and India is one of the world's richest sources of medicinal and aromatic plants. They are rich in secondary metabolites, potential sources of drugs and

essential oil (Wink, 2003; Deshpande and Bhalsing, 2013). Extinction of medicinal plants is a serious concern. Many plants under medicinal and aromatic category are facing extinction due to depletion of habitat, unscientific collection and harvesting



Short Communication

Effect of sources of coconut water and acidulants on physico-chemical properties of *nata-de-coco*

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Abstract

A study was conducted to find out the effect of sources of coconut water and acidulants on the physico-chemical properties of *nata-de-coco* (*nata*). Coconut water from WCT and CDO showed significant effect on the physico-chemical properties of *nata*. Days to *nata* formation (17.25), thickness of *nata* (8.62 mm), weight of *nata* (378.12 g), TSS (8.72° Brix) and total sugars (1.20g 100g⁻¹) were significantly high when coconut water from CDO was used. However, protein (0.12%) was significantly high when nut water from WCT was used. Fibre (%) and moisture (%) were not influenced by sources of coconut water. Acidulants such as acetic acid and bilimbi juice were on par in their effect on physico-chemical properties of *nata*. Sugar content of the substrate, measured as total soluble solids (TSS° Brix) is the most important factor which determines the yield of *nata*.

Key words: Acetic acid, Bilimbi juice, CDO, *Nata-de-coco*, Sucrose, WCT.

Nata-de-coco is the bacterial cellulose produced by the bacteria *Acetobacter xylinum* at the air-liquid inter-phase of coconut water. It is a chewy, translucent, jelly like food product formed by the fermentation of coconut water. It is mostly sweetened as a candy or dessert and can accompany various food stuffs like drinks, ice cream, puddings and fruit mixes. *Nata* is gaining popularity because of its high dietary fibre content and low calorific value. Conventionally nut water collected in the copra production centres is from mature nuts of WCT, which contain less sugar (sucrose) and hence, results in low yield of *nata*. Sugar in the form of sucrose is an important determinant of yield of *nata-de-coco* (Jagannath et al., 2008). Cellulose producing bacteria *Acetobacter xylinum* grow best at a pH of 4.2 and synthetic acetic acid is commonly used for maintaining this favorable pH. It is observed that nut water from CDO contains more sugar than that found in WCT. Bilimbi fruit (*Averrhoa bilimbi*) juice is highly acidic, and can

maintain a pH of 4.2. Therefore, it is important to explore the suitability of nut water from CDO as substrate, and to find out a more common source of acidulant for *nata* production. With this background, the present study was undertaken to find out the effects of sources of nut water and acidulants on the physico-chemical properties of *nata-de-coco*.

There were eight treatments with three replications in a completely randomized design (CRD). Treatments consisted of two sources of nut water (WCT and CDO), with or without added sucrose (10%), and two acidulant sources [acetic acid and bilimbi fruit (*Averrhoa bilimbi*) juice], thus making a total of eight treatments.

T₁: Nut water from WCT added with sucrose, acetic acid

T₂: Nut water from WCT added with sucrose, bilimbi juice

T₃: Nut water from WCT added without sucrose,

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Diversity of weed flora in pineapple plantations of Kerala

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ABSTRACT

Pineapple is an important foreign exchange crop of Kerala. A study was initiated to survey the pineapple growing areas and identify the weed flora, their habitat preferences and growth habits is a pre-requisite for developing an appropriate weed management strategy. A survey was undertaken in five major pineapple producing districts of Kerala and phytosociological parameters were estimated. The results showed the occurrence of a fairly wide diversity of weeds in pineapple plantations (54 species), with species from 25 families present in almost all the areas surveyed. The highest representation of weeds was observed from the family Asteraceae (10), followed by Poaceae (8) and Fabaceae (5). Highest frequency values were obtained for *Mikania micrantha* (63), *Chromolaena odorata* (60), *Merremia umbellata* (53.3), *Mimosa pudica* (50), *Alternanthera bettzickiana* (50), *Cyclea peltata* (46.6), *Centrosema pubescens* (43.3), *Cleome burmanii* (46.6), *Commelina diffusa* (43.3), and *Ichinocarpus frutescens* (43.3). *Mikania micrantha*, *Chromolaena odorata*, *Merremia umbellata*, *Mimosa pudica*, *Alternanthera bettzickiana*, *Cyclea peltata*, *Cleome burmanii*, *Centrosema pubescens*, and *Ichinocarpus frutescens*, had the highest Relative dominance while Abundance value was higher for *Isachne miliacea*, *Cynodon dactylon*, *Digitaria ciliaris*, *Mollugo verticillata*, *Parthenium hysterophorus*, *Melochia corchorifolia*, *Bulbostylis barbata* and *Cyperus iria*.

Keywords : Abundance, frequency, pineapple, relative frequency and weed flora

Pineapple (*Ananas comosus*) is a member of the family Bromeliaceae, which consists chiefly of epiphytic herbs and small shrubs. Popular for its sweet juicy multiple fruit, pineapple is grown throughout the warmer regions of the world. It is an introduced crop in India and is grown exclusively as a managed commercial crop. India is the sixth largest producer of pineapple in the world with a share of about 8 per cent in production (Joy, 2013). Pineapple is cultivated in an area of 10200 ha in Kerala, with a production of 85500 t and a productivity of 8.4 tons per hectare (National Horticulture Board, 2011). In Kerala, pineapple is grown mainly as an intercrop in rubber and coconut, and also as pure crop in garden land and in converted paddy fields. The humid climate is congenial for its growth and the pineapple fruits of Kerala are renowned for their quality, sweetness and flavour and are in great demand in India and foreign countries.

In Kerala, pineapple is an important foreign exchange earning crop and Vazhakulam in Ernakulam district of Kerala produces the best quality table fruits. GI registration is expected for Vazhakulam pineapple (GI) No. 130 under Agricultural-Horticultural product at the GI Registry. This will endorse brand protection under WTO guidelines to the producers (Joy, 2013).

Planting of pineapple is done throughout the year, except in the days of heavy monsoon. Planting is done in trenches of about 90 cm width and 15-30 cm depth, aligned at a distance of 165 cm from centre to centre (KAU, 2016). The bare spaces between trenches and the high rainfall, which is a characteristic of the state,

promote the abundant growth of weeds. Weeds are a major constraint in crop production and also a cause for escalation of cost of production. They also serve as alternate hosts for the pineapple mealy bug (*Dysmicoccus brevipes*) and ants (Sulaiman, 1997; Tachie-Menson, 2014), which transmit pineapple wilt, and hence their control is of prime importance.

Black plastic mulching is a worldwide practice in pineapple cultivation for weed control. In the absence of mulching, pre-emergence herbicides are sprayed in the areas between trenches with subsequent growth managed by spraying post-emergence herbicides. Intercropping with legumes is another common practice for suppressing vegetation in the interspaces of pineapple. Identification of the major weed species, their habitat preferences and growth habits is a pre-requisite for developing an appropriate weed management strategy. With the objective of identifying the dominant weed species, a survey was undertaken in five major pineapple producing districts of Kerala.

The study was undertaken in 30 pineapple plantations from important pineapple growing districts of the state viz., Kottayam, Idukki, Ernakulam, Thrissur and Palakkad. Selected farms were divided into different blocks based on the area and all the weeds present were identified. Their distribution was then presented on the scale of the whole farm. The field tour method was used for the survey. It is a flora survey technique which involves identification of the different species of the field (Chicouene, 2000; Kouame *et al.*, 2011). It consists of going through the field in many directions to find any

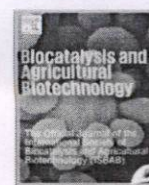
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journal homepage: www.elsevier.com/locate/babVariability of *Pectobacterium carotovorum* causing rhizome rot in bananaG. Geethu Gokul^a, Vimi Louis^{b,*}, P.M. Namitha^b, Deepu Mathew^a, D. Girija^c, M.R. Shylaja^a, P.S. Abida^d^a Centre for Plant Biotechnology and Molecular Biology, Kerala Agricultural University, Thrissur, Kerala 680656, India^b Banana Research Station, Kerala Agricultural University, Kannara, Thrissur, Kerala 680 652, India^c Department of Agricultural Microbiology, College of Horticulture, Kerala Agricultural University, Thrissur, Kerala 680 656, India^d Regional Agricultural Research Station, Kerala Agricultural University, Panambi, Kerala 679 306, India

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ABSTRACT

The rhizome rot or tip over is a major and emerging disease of banana, causing substantial economic losses. Common cultivars such as Grand Naine, Rasthali and Nendran are highly susceptible to this disease caused by different *Pectobacterium* species. Understanding the disease etiology and pathogen variability are essential in management programs. Bacterium *Pectobacterium carotovorum* was isolated from infected rhizomes from 18 locations of Kerala and Tamil Nadu states of India. Pathogenicity of all isolates were confirmed by *in vitro* inoculation in rhizome bits and *in vivo* inoculation in rhizomes of three months old plants and pseudostems of two months old tissue cultured plants of cv. Nendran. Isolates were characterized by cultural, morphological, biochemical, physiological and molecular methods. Cultural characterization was carried out on Nutrient agar (NA), Yeast Extract Glucose Calcium Carbonate (YGC), Logan's medium and Nutrient broth. Morphological characterization was carried out by Gram staining, capsule staining and flagellar staining. Biochemical characterization was done through potato and carrot soft rot test, intrinsic antibiotic resistance, growth of bacteria in three and four per cent NaCl and growth of bacteria in CVP medium. Physiological characterization was carried out by growing the bacterium at different temperatures and pH. Based on these results, 18 isolates were allocated to six groups.

16S rDNA regions of representative isolates of each group have been PCR amplified and the 1.5 kb amplicons were sequenced. Homology and phylogeny analyses had shown that all the groups belong to *Pectobacterium carotovorum*, and two subspecies *carotovorum* and *brasiliense* were identified.

1. Introduction

Banana or plantain (*Musa* sp.) known as 'Apple of Paradise' is one among the ancient fruits known to humankind. Recently, rhizome rot has emerged as a major disease, especially in southern states of India (Usha, 2003; Snehalatharani and Khan, 2010; Nagaraj et al., 2012). Popular banana cultivars Grand Naine, Nendran and Rastali are susceptible to this disease. Symptoms of the disease include massive soft rot accompanied by disagreeable foul smelling rot of the rhizome and internal decay of the pseudostem as the infection spread upward. Infected plants show stunted growth, water soaked appearance on the leaf base, yellowing of leaf and finally toppling over of the plant (Nagaraj et al., 2012).

Different *Erwinia* species (syn. *Pectobacterium*) cause rhizome rot in banana (Kwon et al., 2000). Usha (2003) reported that in Kerala state of India, *Pectobacterium carotovorum* is the pathogen causing rhizome rot

in banana. This study reveals the extent of variability and the subspecies of this pathogen present in humid tropics of India, through cultural, morphological, biochemical, physiological and molecular methods.

2. Materials and methods

2.1. Development of bacterial pure cultures

Infected rhizome samples at the initial stage of rotting (10% rotting) were collected from 18 banana fields from Kerala and Tamil Nadu states of India. Type of soil varied between sandy loam to laterite and the disease was observed mainly under conditions of high soil moisture. Samples were collected in sterile polythene bags and brought to the laboratory for pathogen isolation (Fig. 1).

Rhizomes have been washed, cleaned thoroughly and small rhizome

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Genome, 2019, Vol. 62, No. 9: pp. 571-584

Next-generation sequencing reveals endosymbiont variability in cassava whitefly, *Bemisia tabaci*, across the agro-ecological zones of Kerala, India
E. R. Harish, ManiChellappan, T. MageshKumar, Deepu Mathew, M. T. Ranjith, D. Girija
<https://doi.org/10.1139/gen-2018-0050>

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ABSTRACT

Silverleaf whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae), is one of the most notorious invasive insect pests, infesting more than 900 species of plants and spreading more than 200 viral diseases. This polyphagous agricultural pest harbours diverse bacterial communities in its gut, which perform multiple functions in whiteflies, including nutrient provisioning, amino acid biosynthesis, and virus transmission. The present exploratory study compares the bacterial communities associated with silverleaf whitefly infesting cassava, also known as cassava whitefly, collected from two different zones (zone P: plains; zone H: high ranges), from Kerala, India, using next-generation sequencing of 16S rDNA. The data sets for these two regions consisted of 1 321 906 and 690 661 high-quality paired-end sequences with mean length of 150 bp. Highly diverse bacterial communities were present in the sample, containing approximately 3513 operational taxonomic units (OTUs). Sequence analysis showed a marked difference in the relative abundance of bacteria in the populations. A total of 16 bacterial phyla, 27 classes, 56 orders, 91 families, 236 genera, and 409 species were identified from the P population, against 16, 31, 60, 88, 225, and 355, respectively, in the H population. *Arsenophonus* sp. (Enterobacteriaceae), which is important for virus transmission by whiteflies, was relatively abundant in the P population, whereas in the H population *Bacillus* sp. was the most dominant group. The association of whitefly biotypes and secondary symbionts suggests a possible contribution of these bacteria to host characteristics such as virus transmission, host range, insecticide resistance, and speciation.

Keywords: *Arsenophonus*, cassava mosaic, NGS, 16S rDNA, symbiotic bacteria

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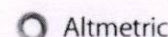
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