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# **Commercial Horticulture**

## Bioactive Compounds and Antioxidant Activities of Selected Tropical Underutilized Fruits

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The antioxidants are capable of scavenging and preventing free radicals and reactive oxygen species resulting from metabolism, which have a positive relationship with chronic non-communicable diseases. Fruits are rich sources of bioactive compounds as majority of them have antioxidant properties. Therefore, the objectives of this study were to screening phytochemicals, to determine the antioxidant properties and compare the potential of activity among selected fruit species, namely *Cynometracauli flora* (Nam nam), *Psidium cattleianum* (Jam pera), *Annona squamosa* (Sugarapple) and *Diospyros discolor* (Velvet apple). Phytochemical screening was done using colourimetric qualitative analysis for screening phenols, flavonoid, tannin, alkaloid and saponin. *Cynometracauli flora* seeds and *Psidium cattleianum* fruit extracts were positive for saponin and tannin while *Cynometracauli flora* pericarp was positive only for flavonoid, tannin and saponin. *Annona squamosa* fruit extract was positive for all the phytochemicals except flavonoid while *Diospyros discolor* was positive for all the phytochemicals except alkaloids. Antioxidant properties of fruit extracts were determined by *in vitro* antioxidant assays using 96 well microplates. Total Phenolic Content (TPC), Total Flavonoid Content (TFC), Ferric Reducing Antioxidant Power (FRAP) and Oxygen Radical Absorbance Capacity (ORAC) were determined by using standard procedures. Softmax Pro 5.2v software was used to calculate antioxidant values. All TPC, TFC, FRAP and ORAC values were significantly different for the tested fruits ( $p < 0.05$ ). The highest TPC value was recorded for *Cynometracauli flora* seed ( $306 \pm 1.64$  mg of Gallic Acid Equivalents/g of extract; GAE/g of extract) while the lowest TPC was recorded for *Annona squamosa* ( $19.17 \pm 4.78$  GAE/g of extract). The highest TFC value was showed by *Psidium cattleianum* ( $4.76 \pm 0.19$  Quercetin Equivalent/g of extract; QE/g of extract) while the lowest TFC was shown by *Diospyros discolor* ( $0.35 \pm 0.02$  QE/g of extract). The highest FRAP value was shown by *Cynometracauli flora* seed ( $685.38 \pm 1.63$  Trolox Equivalent/g of extract; TE/g of extract) while the lowest FRAP was shown by *Cynometracauli flora* pericarp ( $30.74 \pm 1.3$  TE/g of extract). The highest ORAC value was recorded for *Psidium cattleianum* ( $549.79 \pm 6.91$  TE/g of extract) and the lowest ORAC was recorded by *Annona squamosa* ( $33.57 \pm 0.31$  TE/g of extract). Overall results of the study revealed *Cynometracauli flora* seed, *Cynometracauli flora* pericarp, *Psidium cattleianum*, *Annona squamosa* and *Diospyros discolor* fruit extracts have contained marked antioxidant properties and in general *Cynometra cauli flora* seeds and *Psidium cattleianum* had high antioxidant properties respectively. Conclusively, the present study provides scientific basis of using underutilized fruits in preventing non-communicable chronic diseases caused by oxidative stress among humans.

**Key words:** alkaloid, flavonoid, free radicals, phenol, phytochemicals, saponin, tannin

## **The Effect of Phosphorous and Partially Burnt Paddy Husk on Mitigating Iron Toxicity in Rice (*Oryza sativa L.*)**

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Iron toxicity is the most widely distributed nutritional disorder in lowland rice and it affects for plant growth and development. Finally, it affects yield decline by 12–100% and in severe cases, it leads to a complete crop failure. Iron toxicity can easily be identified by leaf bronzing symptoms. There are several methods to mitigate iron toxicity but they are not cost-effective and effects are delayed. Thus, present study was conducted to test the effect of partially burnt paddy husk together with Phosphorous fertilizer, under parachute method of planting to treat iron toxicity in lowland rice cultivation. A field experiment was conducted using Bg 94-1 rice variety (susceptible to iron toxicity) and consist with a control (Department of agriculture recommendation of Triple super phosphate) and four treatments including the partially burnet paddy husk with two different Phosphorous fertilizer (Eppawala rock phosphate and Triple super phosphate). Treatments effect were measured by using plant height, plant density, number of tillers per pant, and soil pH, electrical conductivity, yield and dry matter content as indicators. Severity of the iron toxicity was taken as an indirect measurement, using leaf scoring system. According to the results obtained, no significant differences between the treatments were found related to all those indicators used, except leaf symptom severity. Severity Scale showed significant difference among the treatments in relation to the development of Fe toxicity symptoms. Triple Super Phosphate (100g) with partially burned paddy husk (460g) under parachute method appeared to be the best to reduce Fe toxicity, followed by Eppawala Rock Phosphate (80g, 160g) with partially burnt paddy husk (460g) under parachute method of planting. It can be concluded that the Eppawala Rock Phosphate and Triple Super Phosphate with partially burnt paddy husk reduce iron toxicity severity significantly ( $P < 0.05$ ) but, iron toxicity can vary from year to year, season to season and place to place. Therefore, further research may be needed under different soil, climatic and varietal conditions to decide on recommendations

**Keywords:** Iron toxicity, Rice

## **Effect of Biofilm Biofertilizer on Growth, Yield and Endophytic Bacterial Abundance in Rice (*Oryza sativa* L.) Plant**

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Biofilms are aggregates of multiple microbial communities, attached to each other or onto a surface. Beneficial biofilms can be developed *in vitro* to be used as biofertilizers, which are then called biofilm biofertilizer (BFBF). Pseudo nodules like structures produced by BFBF on rice roots increase available nutrients and hormones for the plant. Thus, BFBF can reduce usage of chemical fertilizers, when combined. Therefore, this study was conducted to evaluate the effect of BFBF on growth, yield and bacterial abundance in rice, when cultivated according the recommended practices of the Department of Agriculture. A field experiment was conducted in a selected field at the Rice Research Institute, Ambalantota. Five different treatments were applied with a control, and the treatments consisted of different levels of chemical fertilizers alone and their combined application with BFBF. The experiment was arranged in randomized complete block design with three replicates to each treatment. Microbial, plant and soil parameters were recorded and analyzed to find out the relationship between grain yield and the measured parameters. The results revealed that root endophytic diazotrophs and total bacterial communities determine tillering and panicle formation of rice plants. There was a significant positive relationship between the count of total bacterial community (x) and tillering (y); ( $Y = 0.004x + 2.180$ ;  $R^2 = 0.70$ ,  $p < 0.05$ ). Further, the count of root endophytic diazotrophs (x) was significantly related to grain filling, as reflected by 100 seed weight (y); ( $Y = -0.000x^2 + 0.015x + 1.89$ ;  $R^2 = 0.68$ ,  $p < 0.05$ ). Similarly, root growth and grain filling showed a positive relationship ( $Y = 0.088x + 1.9$ ;  $R^2 = 0.54$ ,  $p < 0.05$ ). Treatments with the application of BFBF showed increasing trends of tillering, panicle formation and grain filling, because BFBF increases the soil and plant microbial communities and their functions. However, further studies under the same field conditions and the recommended practices are required to confirm the effects of microbial activities in rice plants with the intervention of BFBF.

**Keywords:** Biofilm biofertilizer, rice plant

## **Growth and Yield Performance of Local Accessions of Okra (*Abelmoschus esculentus*) Under High Temperature**

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With the changes experienced in climatic pattern resulted by global warming, it could be expected to have a significant impact on crop production. Hence, the need has been arisen to improve the crops with a potential to withstand higher temperatures. Okra (*Abelmoschus esculentus*) is an annual crop cultivated in hot humid tropics with an inherent ability to tolerate a higher range of temperature, but can be affected by high temperature. A study was carried out for a period of ten weeks to evaluate the growth and yield of fifteen accessions of okra under a controlled environment with a maximum temperature ranging from 37.96°C to 41.56°C. Two other quantitative morphological characters: leaf chlorophyll content and stomatal density of upper and lower epidermis were also recorded. The analysis of variance of both growth and yield parameters and chlorophyll content revealed a significant difference among the accessions. Only the stomatal density of upper epidermis was significant among accessions. The accessions OK2 and ET8 were the best performers in terms of growth parameters. Only fourteen accessions produced pods during the period of study while accessions 9181 and 10247 recorded the highest yield. The accessions that produced pods were divided in to three clusters based on growth and yield parameters to select accessions for breeding. This study concludes that the selected okra accessions could be used as parental lines for breeding for the development of a temperature tolerant variety.

**Keywords:** Global warming, Okra accessions, High temperature, Growth and yield

## Effect of Colored Cellophane Shading on Seed Germination, Plant Growth, Yield and Fruit Quality Characteristics of Tomato (*Solanum lycopersicum L*)

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Tomato (*Solanum lycopersicum.L*) is one of the most important vegetable crops in the world. Due to increase in population, nutritional demand has also increased. The present study was to investigate the effect of different colored cellophane shading on seed germination, plant growth, fruit quality and fruit yield of tomato. Yellow, red, green, blue colored cellophane and transparent cellophane as the control were used for the experiment that was conducted with Complete Randomized Design under greenhouse conditions. The results showed that the colored cellophane shading had (significantly??) different effects on seed germination, growth, fruit quality and yield of tomato. The highest seed germination was found under yellow cellophane cover and the lowest at green color. Early stage of growth at one month after transplanting, highest plant height (24.50 cm) and number of leaves (8) were recorded under yellow cellophane shading and lowest in green (13.68 cm, 7 cm, respectively). The highest leaf area (20.07 cm<sup>2</sup>), hue angle of leaf color (122.92), weight of fresh plant (4.83 g), weight of dry plant (0.47 g), weight of fresh root (0.93 g) and weight of dry root (0.10 g) were recorded in the control whereas the lowest of the same parameters were recorded under green cellophane shading (4.34 cm<sup>2</sup>, 120.99, 0.74 g, 0.05 g, 0.09 g, 0.01 g, respectively). To evaluate quality of fruits two experiments were conducted; (1) whole fruits covered by colored cellophane and the (2) whole plant covered by colored cellophane. The highest fruit weight (35.13 g) and length (3.97 cm) were recorded in the fruits covered by green colored cellophane whereas, the lowest (24.74 g, 3.20 cm) in the blue cellophane in the experiment one. The highest width resulted in control (4.3 cm) and the lowest in blue (3.4cm) cellophane shading. The highest Brix value was found in red (7.8°Bx) and the lowest from yellow cellophane shading (4.5°Bx). Ascorbic acid content (91.25 mg) and hue angle (57.49) of fruit color were highest in yellow but lowest (31.87 mg, 47.97) in green cellophane shading. There were no significant differences on peel thickness and the pH value of fruits among the treatments. In the experiment 2 where whole plant was covered, the highest fruit weight (51.10 g), length (4.04 cm), width (4.92 cm), were recorded in the blue cellophane whereas, lowest in the control (34.93 g, 3.77 cm, 4.32 cm). Brix value was highest in the control (5.05°Bx) and lowest in blue (3.12°Bx) cellophane shading. Fruit peel thickness was highest in red (0.65 cm) and lowest in blue (0.51cm) cellophane shading. Hue angle of fruit color was highest in blue (49.72) and lowest in green (46.02) and pH value was highest in green (4.56) cellophane shading whereas lowest in control (4.32). The highest Ascorbic acid content was recorded in yellow color (121.25 mg) cellophane shading whereas the lowest in blue (57.5mg). Finally, it can be concluded that yellow treatment is the most effective on seed germination and the control treatment is better for vegetative growth of the plant. For tomatoes consumed fresh, the most effective treatment was the whole plant covered with yellow colored cellophane as it gives high ascorbic acid content. However, blue colored cellophane is the best in terms of the yield.

**Key words:** Colored cellophane, Fruit quality, Seed germination, Tomato, Vegetative growth

## Effect of Different Rates of a New Granular Fertilizer (15: 3: 20) on Growth and Yield Components, Using Capsicum (*Capsicum Annuum L.*) as Model Crop

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Plants need macro and micro nutrients for their growth and development. Among different fertilizers, granular fertilizer is becoming popular among farmers. Therefore, objective of the study was to evaluate the effectiveness (efficacy) of different rates of a new granular fertilizer produced in Sri Lanka, using plant growth parameters and yield components. Two pot experiments were conducted by using Capsicum (*Capsicum annuum L.*) as model crop and soil with compost and only soil as media in two experiments. New granular fertilizer in different rates (0.5, 1, 1.5, 2 g), recommended fertilizer by Department of Agriculture, commercial blue granular fertilizer (1000 mg) and control (no added chemical fertilizer) were used as treatments. Plant growth parameters (height of plant, number of leaves) and yield components (weight of pods, pod length, girth of pod, and thickness of pod) used as the measures of response to fertilizer treatments. Further, ascorbic acid content of pods, and plant dry weight were measured. The highest average stem height per plant (19.31 cm  $\pm$  0.74) was observed in recommended fertilizer. The highest average number of leaves per plant (104  $\pm$  7) was recorded in new granular fertilizer 2 g. New granular fertilizer 1 g treatment showed the highest yield per plant (248.178 g  $\pm$  31.24) ( $P < 0.05$ ) and the highest average length per pod (10.73 cm  $\pm$  0.27). The highest ascorbic acid content of pods (15.83 mg /100 g  $\pm$  1.54) was shown by new granular fertilizer 1.5 g treatment. In experiment two (only soil), the highest plant height was shown (19.92 cm  $\pm$  1.44) by new granular fertilizer 1.5 g. The highest yield per plant (38.823 g  $\pm$  6.746) was shown by new granular fertilizer 2 g and highest dry weight of shoots (4.09 g  $\pm$  0.92) was recorded in new granular fertilizer 2 g. However, any of these parameters were not significantly different ( $P > 0.05$ ) with other treatments. Therefore, overall results suggest that the effect of 1 g (1000 mg) of new granular fertilizer on growth and yield potential of capsicum is similar to other tested fertilizers available in the market.

**Key words:** Capsicum, growth parameters, granular fertilizer, yield components

## **Effect of Pulp Water Temperature and Maltodextrin Percentage on Final Weight and Properties of Spray Dried Durian (*Durio zibethinus*) Powder**

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Durian (*Durio zibethinusmurray*) which is commonly known as "king of fruit " in fruit world is highly seasonal, expensive, highly perishable, nutrient rich and alternative bearing thorny fruit with specific odor. Usually the durian is a restricted fruit even in the luggage area of flights, some restaurant, public places, taxis, public transport and hotels. Generally, durian is consumed as a fresh fruit without any preservation and value addition in the growing countries except in Thailand and Malaysia. Durian has great export potential but has practical limitation due to its odor and bulky thorny husk. Therefore, it needs novel methods to preserve durian flesh to be used in food applications through a value addition process. Spray drying is one of the best techniques used to produce a wide range of light weight dry powders and agglomerates by flesh dehydration. Present study focused to produce spray dried durian powder from durian flesh using a commercial scale spray dryer. This study explains the method and investigate on some optimum parameters to dry durian pulp using a commercial scale spray dryer. The raw durian flesh was blended with different water-temperature treatments and filtered and Maltodextrin was incorporated to the filtrate as the microencapsulating agent before the spray drying. In this process three pulp making water temperature (0 °C, 27 °C and 40 °C) and three levels of maltodextrin (10%, 20 % and 30 %) were used to identify the best treatment combination which can produce highest final powder yield with optimum physicochemical properties. Total soluble solids, P<sup>H</sup>, Moisture percentage, Acidity percentage, Ascorbic acid level, Solubility, Rehydration time, Hygroscopicity, Organic matter percentage and Ash percentage were evaluated in spray dried powder samples. When pulp was extracted at 0 °C and the incorporation of 20% maltodextrin resulted in higher powder yield, higher ascorbic acid preservation and low moisture level of the spray dried powder. Six value added products such as Yoghurt, Yoghurt drink, Cake, Ice cream, hot drink with tea and Cool drink with milk were produced by using spray dried Durian powder. The sensory attributes were evaluated in the value-added products with randomly selected 15 members panel. The all six value added products got more than 73% overall acceptability ranks. This study clearly demonstrated that durian pulp can be successfully transformed to high quality powder using spray drying technique and that powder can be applied to enhance the quality of the above tested food products.

**Key words:** Durian, Alternative bearing, Hygroscopicity, Microencapsulating, Maltodextrin, Spray drying

## ***In Vitro* Inhibitory Effect of Selected Plant Extracts Against the Major Causal Agent (*Fusarium Spp*) of Damping Off in Capsicum**

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Damping off caused by *Fusarium spp.* is a major problem in nursery management. As common practice farmers are use synthetic fungicides as a preventing measure of that disease which causes, many health and socio-economic problems throughout the country. Plant extracts based botanical pesticides are one of the eco-friendly approaches due its non-persistency and bio degradability. Therefore, objectives of the study were to investigate antifungal activities of methanol extracts of selected plants species and to find out the most effective plant extract to inhibit the growth of *Fusarium* fungi with the most effective minimum inhibition concentration. Methanol crude extracts of *Azadirachta indica* (Neem), *Tithonia diversifolia* (Wild sunflower), *Senna alata* (Candle bush/ Aththora), *Syzygium cumini* (Damba), and *Mirabilis jalapa* (Hendirikka) were comparatively studied for fungistatic and fungicidal activities against *Fusarium spp.* which is isolated from Capsicum. The causal fungi were identified based on their microscopic and macroscopic features. The experiment was conducted using completely randomized design *in vitro* with the methanol extracts of different plant species, which showed significant inhibitory effect on fungal growth in disks dipped method. Those extracts were assessed for their antifungal activities by growing fungal isolate in Potato Dextrose Agar (PDA) media amended with different concentrations of plant extract (12.5%, 25%, 50%, and 100%). After an incubation period of 10 days, the diameter of growth was measured and the inhibition percentage was calculated. The results showed that the minimal inhibitory concentration for Hendirikka, Wild sunflower, Syzygium and Ath-thora was 12.5% and 50% in Neem. Ath-thora had 64% as highest minimal inhibitory concentration at 100% concentration than others. The present study concludes that, the selected plant extracts exhibit antifungal properties against *Fusarium spp.* and it has a potential to formulate fungicidal products to control *Fusarium spp.*, causing damping off for capsicum.

**Key words:** Antifungal Activity, Damping off, Fungicidal, *Fusarium*, Plant extracts

## **Evaluation of Different Training and Spatial Arrangement Systems on Growth, Yield and Fruit Quality of Salad Cucumber (*Cucumis sativus* L.)**

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Salad cucumber (*Cucumis sativus* L.) hybrid varieties are popularly grown using protected crop technology in Sri Lanka. Fast vegetative growth is a characteristic feature of salad cucumber leading to overcrowding of vines which poses problems in various cultural operations. Damage to the crop, difficulties in harvesting and spraying are common problems in commercial cultivations affecting the yield and profit. Training and pruning techniques are effectively used to minimize these problems. However, some salad-type cucumbers are very sensitive and respond differently to training and pruning methods. The present study was conducted under the controlled environmental conditions to investigate the effect of different training and spatial arrangement systems on growth and yield of salad cucumber. The experimental design was Complete Randomized Design (CRD) with 4 replicates. Five training & pruning systems were applied as treatments by using F1 hybrid variety namely EFDAL F1. Plants were arranged in a double row system with 30 × 45cm spacing. The fourth treatment (double twin system) was significantly superior than other treatments in terms of vine length (183.54 cm), total leaves per plant (37.50), number of fruits per plant (16.50), fruit set percentage (40.93%), average fruit length (17.92cm), average fruit weight (216.06 g) and average fruit yield per plant (2715.59 g). The fourth training system gave highest values in all the vegetative and yield parameters except in the fruit circumference and brix value.

**Key words:** Salad cucumber, Training and spatial arrangement systems, Growth and yield

## Efficacy of Chemical Control of Citrus Mealybug (*Planococcus citri* Risso) in Kalanchoe (*Kalanchoe Blossfeldiana*) Under Tropical Greenhouse Condition

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*Planococcus citri* cause serious problems in *Kalanchoe blossfeldiana* grown in greenhouses for export market. *Planococcus citri* the pest is difficult to be controlled because of its congregation in locations that is hard to spray chemicals. Their rapid proliferation and waxy body cover of adults make it even more difficult to control. Nevertheless, neonicotinoid based chemical insecticides are effective against this pest. Therefore, the present study was conducted to evaluate the efficacy of three selected insecticides on *Planococcus citri*. A pot experiment was carried out under tropical greenhouse condition using Thiamethoxam (2.0 g/l), Acetamiprid (1.2 ml/l), Imidacloprid (1 ml/l) and another three treatments with same chemicals combining with removal of 50% leaves at the base up to 10 cm (cultural practice). Treatments were applied six times with seven-day interval. Total number of instars and adults were counted three days after each application of treatments. All treatments arranged in Randomized Complete Block Design (RCBD) with each treatment replicated five times. Data were analyzed with ANOVA procedure and graphical analysis of data is done by Microsoft excel 2016. Used dosages of all three insecticides were significantly effective while Acetamiprid demonstrated the best performance in controlling *Planococcus citri* in Kalanchoe. Removal of 50% leaves has no significant effect on controlling the insect. Thus, *Planococcus citri* in *Kalanchoe blossfeldiana* cultivation can effectively be controlled by the tested dosages of these neonicotinoid insecticides by Acetamiprid being the best.

**Keywords:** Kalanchoe, Citrus mealybug, Neonicotinoid insecticides, Cultural practice

## Evaluation of Selected Rice Varieties for Growth, Yield and Yield Contributing Characters in Low Country Wet Zone

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The rapid growth of human population and gradual increment of biotic and abiotic stresses have been identified as major challenges of the rice production. High yielding, low input, short duration varieties with high ability of withstand against adverse conditions are vital in this phenomenon. Therefore, the study was carried out to investigate the performances of growth, yield and yield related traits of eight selected rice varieties by the evaluation process. The field experiment was conducted at low country wet zone of Sri Lanka with rice varieties, including Bg 94-1, Bg 360, Bw 367 as standard varieties and Ld 12-6-22-1, Bg 15-520, Ld 11-7-3-1, Bw 14-509, WAS 4-2-3 as varieties to be released. Field experiment was laid out as a Randomized Complete Block Design as included four replicates for each treatment. Growth parameters tested were plant height, number of tillers per hill, and leaf area of third top most leaf. Harvest index, grain yield / m<sup>2</sup>, spikeletes per panicle, weight of 1000 grains were significantly differed and components of effective tillers / m<sup>2</sup> and filled spikeletes percentage were not significant for yield determination. Rice varieties significantly differed with respect to yield contributing characters of leaf area, unproductive tillers per hill, days to 50% flowering and 85% maturity, bio mass of maturity stages, panicle weight and length, seed width and length, respond to Nitrogen at flowering stage, bacterial leaf blight severity, lodging severity and its related morphology of culm height and number of internodes. Biomass of flowering stage and number of rice sheath mite (*Steneotarsonemus spinki* smiley) per hill were not significantly different among rice varieties. The rapid and long vegetative growth performances were recorded by Ld 11-7-3-1, Bw 367 and Bw 14-509. The best yield and yield related characters were recorded by Ld 12-6-22-1 and Bg 94-1. The highest harvest index ( $0.39 \pm 0.03$ ) and grain yield / m<sup>2</sup> ( $89.28g \pm 56.11$ ) were recorded by Ld 12-6-22-1 than its standard of Bg 94-1. The highest panicle weight ( $2.71g \pm 0.20$ ), the lowest bacterial leaf blight severity ( $31.62\% \pm 3.27$ ) and rice sheath mite (*Steneotarsonemus spinki* smiley) population ( $2.15 \pm 0.94$ ) were also obtained by Ld 12-6-22-1. Bg 94-1 reported the highest weight of 1000 grains ( $28.87g \pm 0.49$ ), minimum days to flowering ( $70.5 \pm 0.29$ ) and maturity ( $100.5 \pm 0.28$ ), the lowest demand to Nitrogen at flowering stage, the lowest culm height ( $64.15cm \pm 3.12$ ) and minimum number of internodes ( $4.2 \pm 0.09$ ). Hence, identifying those varieties and varietal characters lead to increase the rice productivity and development of further breeding programs.

**Keywords:** Bacterial leaf blight, Culm height, Lodging, Productivity, Rice sheath mite (*Steneotarsonemus spinki* smiley)

## Effect of Organic Manure and Bio - Fertilizers on Growth and Yield of Gherkin (*Cucumis sativus L.*)

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Gherkin is a short term, high yielding crop with a relatively higher marketing value. However, the cost of production in industrial Gherkin farming is getting higher resulting reduced profits. Therefore, it's necessary to introduce a cost effective efficient and sustainable farming system for Gherkin farmers. This field experiment on Gherkin (*Cucumis sativus. L*) was carried out at Regional Agricultural Research and Development Centre, Makandura, Gonavila during the month of July to September 2017. The study aimed at finding the effect of organic manure and bio fertilizers on the growth of Gherkin, with reference to growth parameters, yield and nutrient uptake, five different bio fertilizers with recommended inorganic fertilizers were used to evaluate the best cost effective and suitable fertilizer for Gherkins. Randomized complete block design were used with 6 treatments and 3 replicates. The results revealed that, soil quality was significantly increased in comparison with the initial state with the application of organic manure and bio fertilizers treatments. Plant mortality for week-one was significant ( $p<0.0476$ ). Recommended inorganic fertilizer treatment exhibited the highest mortality ( $3\pm1.15$ ) compared to the other treatments. Plant survival rate is also significantly ( $P<0.047$ ) differing during the 1 week. Even though, the results were not significant, application of organic fertilizers results the highest yield and pod number per plant. Recommended inorganic fertilizers showed the lowest yield ( $174.58\pm18.32g$ ) and pod number per plant. The highest yield ( $221.52\pm47.22g$ ) and pod number ( $0.6818\pm0.12$ ) per plant was shown in Indonesian bio fertilizer treated compost. However, organic manure and bio fertilizers are identified as the best cost effective and efficient fertilizer option for Gherkin .

**Keywords:** Bio-fertilizers, Cost effective, Growth parameters, Nutrient retention, Organic manure

## Screening of Sri Lankan Tomato Parental Lines for Resistance of Root Knot Nematodes, *Meloidogyne* Spp.

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Nematodes are a diverse group of worm-like organisms and found in virtually every environment, both as parasite and as free-living organisms. About 2000 plants species worldwide are susceptible to infection by root-knot nematodes causing a huge global crop loss. The control measures are mainly considered as Integrated Nematode Management (INM) programme including cultural, physical, chemical and biological methods. The main component of an INM programme is the use of resistant varieties. Therefore, the present study was initiated to screen the resistant tomato parental lines available in the pump line of the tomato germplasm at HORDI. A Pot experiment was conducted to select root knot nematode resistance parental lines of tomato. The experimental design was complete randomized design. Ten parental lines were used and two weeks after germination, inoculation was done with 500 *Meloidogyne incognita* juveniles (J2) for each plant. Four weeks after inoculation tomato plants were uprooted and plant height, fresh shoot and root weight, dry shoot weight, numbers of root galls per root and nematode egg masses per 1 g of root were recorded. Root galling indexes were measured according to standard root galling chart. Selected lines were used for penetration studies. Tomato roots were stained with acid fuschin at 12, 24 and 48 hours. According to the results, three tomato lines, BVC 9758, LOV3 and V8 gave lowest root galling indexes. Therefore, among the three tomato lines, LOV3 can be categories as Immune, and other two lines BVC 9758, and V8 can be categories as highly resistant. According to growth parameters, AVTO 0102 line has shown best growth performances compared to other two lines. Among the tested lines AVTO 1130, AVTO 1009, AVTO 1004 and AVTO 0102 were showed most susceptible for root knot nematodes. Minimum numbers of juvenile penetration were observed in LOV3 line compared to the other two lines and therefore, LOV3 line can be considered as the most resistance line for root knot nematode.

**Keywords:** Root Knot Nematodes, juveniles stage 2 (J2), Resistance, Parental line, Susceptible

## **Field Validation of a Rapid Method for Calculating the Lime Requirement in Soils of the Up Country Intermediate Zone**

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Upcountry Intermediate Zone (UCIZ) soil is considered as moderately acidic ( $\text{pH} < 6$ ). However, soil pH should be maintained around 6.5-7 for optimum nutrient availability for plant growth. In Sri Lanka, lime requirement for acidic soils is estimated based on their pH values and recommended a single rate of lime application as  $2000 \text{ kg ha}^{-1}$  for all acidic soils. An accurate and rapid method for estimating lime requirement for different location in where the existing acidic soil is timely important. Therefore, objective of this study was to validate the suitability of proposed new method for calculating lime requirement for soils of UCIZ under field condition. Twenty five soil samples with different pH levels were collected from Welimada and Bandarawela area in UCIZ. Hydrogen ions in soils were extracted using the prepared extractant solution and required amounts of saturated  $\text{Ca}(\text{OH})_2$  to react with the soil acids were recorded at the colour change of a mixed indicator. The required amount of saturated  $\text{Ca}(\text{OH})_2$  for neutralization was used to calculate the lime requirement. A field experiment was carried out with preparing a plot ( $1\text{m} \times 1\text{m}$ ) in each selected site, where soil was collected previously. Each plot was then cleared and calculated amount of lime, according to the developed method was applied. Two weeks of incubation period was maintained and pH of each sample was measured after two weeks. Result showed that the lime requirement of rapid method was significantly different under field condition ( $P < 0.05$ ). It is evident that proposed new method can effectively use to calculate the site-specific lime requirement in UCIZ soils.

**Keywords:** Field condition, Lime requirement, New method, Soil pH

## **Evaluation of Major Irrigation Schemes at Badulla District by Empirical Tool**

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Water availability is considered as an important limiting factor for crop production and food security in 21<sup>st</sup> century. Demands for irrigation water continue to be increased with the increasing temperature under predicted climate change. In agriculture, paddy cultivation is considered as the highest water consuming practice. Thus, it is important to assess whether the water provided through irrigation is efficiently used in paddy cultivation. Therefore, crop water demand was empirically estimated to assess the water use efficiency in paddy cultivation. Estimated crop water demand, irrigation water usage, and plant growth data were used to estimate the water use efficiency at three paddy grown areas under major irrigation scheme in Badulla district. Accordingly, irrigation water use was greatest at Boliyadda (680.5 cm season<sup>-1</sup>) and that was lowest at Maligathanna (480.1 cm season<sup>-1</sup>). Similarly, crop growth rate was highest at Boliyadda (0.47g/g) and that was lowest at Maligathanna(0.24g/g). However, during the vegetative growth phase, water use efficiency was not significantly different between locations. Contrast to that, during the reproductive phase, Boliyadda (7.88g/m<sup>2</sup>/cm) shows the greatest water use efficiency and that was lowest at Maligathanna (4.98g/m<sup>2</sup>/cm). According to these results during the studied season, it shows that the irrigation water use is positively correlate with crop growth rate. However, greater crop growth is not necessarily indicating the greater water use efficiency in paddy.

**Keywords:** Crop Growth, Efficiency, Irrigation, Modeling

## **A Suitable Substrate to Conserve Soil Moisture by Reducing the Percolation of Water**

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Water is one of the most scarce natural resources in the world. The highest percentage of world's water is utilized by Agriculture. Most of the water used in agriculture is lost through various means (e.g. percolation) so that plants cannot find access to it for their use. Conservation of water by reducing the percolation is one of the appropriate alternatives, which helps to increase the water use efficiency. Therefore, the present study was focused on increasing the water retention within the root zone by treating the soil with natural or artificial absorbents, which can enhance water retention in the soil. The objectives of the study are to identify the possibilities of increasing water holding capacity of the soil by treating the soil with different moisture absorbing substrates and to identify the most suitable material as the absorbing substrate. Three treatments, i.e. sawdust, sponge and biochar and control, were buried at 20cm depth as 5cm layer lined with high gauge polythene into a Complete Randomized Design with three-times replication of each treatment. Six planting holes were established for chili (*Capsicum annum*) plants (variety *KA 2*) in one plot (90 x 180 cm) to establish two plants in a hole. The moisture content of the soil was measured daily and was maintained at 50 % of allowable depletion level throughout the study period by supplying the deficit as necessary. Days to 50% flowering, plant height at 50% flowering and at first harvesting, yield, plant biomass and root biomass were measured. There were no significant differences in plant height, days to 50% flowering, plant biomass or root biomass among treatments. The results indicate that no any moisture stress has been experienced by treatments. However, there was a significant difference among the treatments in water usage by the crop throughout the duration. The water usage was significantly lower in sponge compare to other treatments. It means that the sponge material can conserve water at the rate of 992.59 m<sup>3</sup>/ha without any effect on the yield. Therefore, a substrate can be used to effectively conserve soil moisture by reducing the percolation and sponge was proven to be the best among the treatments. A cost-benefit analysis of farmer field and trails with various crops are needed for a more precise assessment.

**Keywords:** moisture absorbent material, substrate, water holding capacity, sponge

## **Determination of Races and Genetic Confirmation of *Ralstonia solanacearum* Causing Bacterial Wilt of Solanaceae Crops in Kandy and Matale Districts**

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Bacterial wilt caused by *Ralstonia solanacearum* is a major problem in Solanaceae crops in Sri Lanka. This disease is difficult to manage due to variability, adaptability, and diversity of pathogen. The experiment was undertaken to determine the races, genetically confirmation and study the host range of *R. solanacearum* that collected from different locations in Kandy and Matale districts. Ten isolates of *R. solanacearum* (confirmed as biovar 3) from tomato, brinjal and chili plants grown in Kandy and Matale districts were characterized in terms of pathogenicity on four susceptible Solanaceae crops (tomato, brinjal, chili and capsicum). Molecular characterization were performed using 16s rDNA gene to confirm identity of *R. solanacearum*. Each isolate was inoculated to sixteen tomato, brinjal, chili and capsicum plants separately using stem inoculation method under greenhouse condition. Data collection was done at one day intervals up to 14 days. Results showed that the highest wilt incidence (100%) and severity (4.75 mean score value) were recorded in Kandy district isolates that collected from Gannoruwa. A Total of ten isolates (*R. solanacearum*) were produced pink or dark red color with whitish margin on Triphenyl Tetrazolium Chloride (TZC) medium. The races of *R. solanacearum* were identified by pathogenicity tests. The result showed that eight isolates of *R. solanacearum* tested in the experiment was able to cause wilt symptom in tomato, brinjal, chili and capsicum plants indicating a wide host range. Therefore, eight isolates of *R. solanacearum* causing bacterial wilt of Solanaceae crops collected from two different districts belong to race 1, biovar 3. Molecular identification of *R. solanacearum* using RALSF and RALSr specific primers showed positive results for all ten isolates. Based on the results, two higher degree of virulence isolates of *R. solanacearum* were reported in Kandy district (Gannoruwa) and the *R. solanacearum* isolates causing bacterial wilt of solanaceous crops in two districts were belonging to Race 1 and biovar III.

**Key words:** Bacterial wilt, Genetic confirmation, Pathogenicity, Races, *Ralstonia solanacearum*

## **Development of Anther Culture Technology for Bitter Gourd (*Momordica charantia* L.)**

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Bitter gourd is an annual tendril herbage plant belonging to the gourd family. It can be considered as a valuable vegetable and a medicinal plant. Even though, conventional breeding method is the most common method currently being used, it is limited by the high time consumption and resulting highly heterozygous plants. The plant breeding programs can be accelerated through anther culture technique by producing double haploid plants. However, the reports of anther culture in cucurbitaceous vegetables are limited. Therefore, this experiment was carried out to study the callus induction and regeneration from anthers of bitter gourd using F4 breeding lines. The research was conducted in Complete Randomized Design (CRD) and data was analyzed in Statistical Analysis Software (SAS). Anthers from unopened flower buds of three breeding lines were cultured on MS medium containing Auxin and Cytokinin. Two callus induction media were used with different concentrations of 2,4-D (1 mg/L and 2 mg/L) and BA (2 mg/L and 4 mg/L) with Murashige and Skoog medium as basal medium. A combination of 1 mg/L 2,4-D and 2 mg/L BA showed the earliest and highest percentage of callus induction from anthers of the three breeding lines. (88.82%) Plant regeneration was studied using a selected regeneration medium with 0.05 mg/L NAA, 0.1 mg/L BAP, 0.5 mg/L GA3 and 500 mg/L Casein. In representing embryogenesis or organogenesis the maximum greening of bitter gourd callus was recorded in the callus induction medium with 1 mg/L 2,4-D and 2 mg/L BA in all the three breeding lines. The experiment revealed that MS medium supplemented with 1 mg/L 2,4-D and 2 mg/L BA is the most suitable medium for callus initiation. Regeneration ability of the explants have to be studied further with different level of hormones to produce plants. The results revealed that the studies should be continued in order to produce the homozygous lines to be used in the future breeding programs.

**Key words:** BA, Callus induction, 2,4-D, *Momordica charantia* L., Plant regeneration

# **Plantation Management**

## Sustainable Detering Methods for Higher Animal *Muntiacus muntjak malabaricus* on Cinnamon Cultivation

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One of the critical pest problem prevailing in the Sri-Lankan cinnamon (*Cinnamomun zeylanicum* Blume) cultivation is the damage of higher pests (vertebrate animals). Vertebrate pest damage reduces the productivity of the cinnamon cultivation than insect pest damage. According to crop damage assessment results, study was undertaken to evaluate effectiveness of different deterring methods against higher animal “Olu Muwa” (*Muntiacus muntjak malabaricus*) for cinnamon cultivation. The experiment was arranged in a RCBD with three replicates and conducted at Olugantoa, Karadiyamulla, Balangoda. Five treatments were used such as T1 (Odor repellent), T2 (polythene strips), T3 (old CD's), T4 (odor repellent + polythene strips + old CD's) and T5 (no treatment/ control). After application of all treatments, data collection was performed until 35 days. The standardized testing method was performed to determine pH variation in the odor repellent with time to identify a suitable storage time for application. The initial pH value of the odor repellent was 8.1. Then pH value of the repellent was reduced up to 3.6 with the time and pH value of the repellent is 6.7 after 3 -4 days from the preparation. Therefore, the best time for the application of the odor repellent is 3 -4 days from the preparation. Statistically, there is a significant difference ( $p \leq 0.05$ ) in between the Mean values of the damage among the treatments throughout the 35 days and there is a no significant difference ( $p > 0.05$ ) in between the Mean values among the blocks throughout the 35 days. According to results among five treatments; treatment T4 (odor repellent + polythene strips + old CD's) is the best method to deterring Olu Muwa in the cinnamon cultivation with no damage followed by T1 (odor repellent) and T2 (polythene strips). However, further field evaluation of all treatments should be implements all cinnamon growing areas prior to make a recommendation.

**Keywords:** Cinnamon, deterring methods, higher pest, odor repellent, Olumuwa

## Investigation of the Effect of Climate and Soil Properties on Quality of Ceylon Cinnamon (*Cinnamomum zeylanicum* Blume)

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The superior quality of Cinnamon has occupied with the highest demand from the spices within the world market. Climatic conditions and soil properties of cultivating areas of the Cinnamon can have an impact on this superior quality. A study was conducted to evaluate the relationship between soil properties together with climatic conditions and quality parameters of Cinnamon. Five locations were selected for the study (Galle 6°11'00.8"N 80°08'49.9"E, Matara 6°00'26.7"N 80°30'40.3"E, Walasmulla 6°13'34.0"N 80°39'33.5"E, Balangoda 6°39'04.8"N 80°45'16.3"E, Matale 7°27'37.9"N 80°36'05.8"E) to represent five different agro ecological zones in Sri Lanka. Bark samples with similar characteristics were selected from five moderately steep lands. Soil samples were collected from 30cm depth for the analysis of physical and chemical properties. Color of Cinnamon barks was measured with Chroma meter and Munsell color chart. Bark thickness was measured with Vernier caliper. Monthly climatic (Minimum temperature, Maximum temperature and rainfall) data were downloaded through Centre for Environmental Data Analysis (CEDA; [http://data.ceda.ac.uk/badc/cru/data/cru\\_ts/](http://data.ceda.ac.uk/badc/cru/data/cru_ts/)). Standard soil analytical methods were performed to determine the soil bulk density, soil texture, pH, Electrical Conductivity (EC), soil organic matter, total nitrogen (N), available phosphorus (P) and available potassium (K). Sensory evaluation of the Cinnamon bark was performed to determine the quality parameters of Cinnamon. Spearman's Rank Correlation and Linear Regression analysis were used to analyze the relationship between quality parameters and soil properties together with climatic factors. Friedman test was used to analyze the sensory evaluation. The Hue value reported significant positive correlation with EC ( $r_s = 0.53$ ,  $p=0.04$ ). Chroma value ( $r_s = -0.69$ ,  $p=0.005$ ) and Value value ( $r_s = -0.57$ ,  $p=0.03$ ) were negatively correlated with available P. Value reported significant negative correlation with EC ( $r_s = -0.57$ ,  $p=0.03$ ). The rainfall reported significant positive correlation with bark thickness ( $r_s = 0.155$ ,  $p=0.001$ ), Value ( $r_s = 0.118$ ,  $p=0.02$ ) and Chroma ( $r_s = 0.136$ ,  $p=0.01$ ) EC, available P and rainfall are effected on the color of the cinnamon bark and the rainfall has affected the bark thickness. Soil EC and available P has effected the pigmentation of the bark, while rainfall has effected the bark pH. So these three factors have affected the color of Cinnamon bark. Also, when the rainfall is high, the amount of moisture retention will be high. It reduces the shrinkage of the bark cells and that is the main reason for the results obtained by the study.

**Keywords:** Cinnamon, Quality, Soil properties, Climate, Bark thickness, Bark color

## Genetic Variation of Growth and Flowering Characteristics of Physic Nut (*Jatropha curcas*) Progeny Trial at Anapallama (IM<sub>2</sub>), Sri Lanka

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*Jatropha curcas* can be used for biodiesel production as substitute for the fossil fuel. In order to study genetic variability of *J. curcas* progeny trial has been established at Anapallama (IM<sub>2</sub>) by the Forest Department in 2009. Trial composed with 60 families from 13 seed sources were tested in row column design, which consisted 4 replicates and each family represented by 5 trees row plot. Tree base diameter at 10 cm height, tree height, and number of branches, fruits and flowers per tree were assessed at different ages. Analysis of ANOVA, estimate mean values, individual tree heritabilities ( $h_i^2$ ), correlation among traits and selection were performed using the software programs as Dataplus and Genstat 5.3.2. The results indicated that there are significant differences ( $p < 0.05$ ) among seed sources for survival, base diameter, number of branches and fruits. Further, there were significant differences ( $p < 0.05$ ) among families within seed sources for number of branches, flowers and fruits. Promising seed sources for growth traits were resulted in Polonnaruwa, Hambanthota and Badulla. The highest tree base diameter (5.9 cm) was observed in Hambanthota seed source. The highest number of branches (16/tree) and flowers (27/tree) were recorded from the seed source of Badulla and fruiting (9 /tree) for Matara. Maximum survival (100%) was recorded in the seed source Matara and Embilipitiya while the least (80%) in Anuradhapura. Family variability for number of branches, inflorescences, fruits varies from 6-16, 7-27 and 1-9 respectively. Individual tree heritability estimates for number of flowers, fruits branches and tree base diameter was 0.34, 0.8, 0.78, and 0.59 respectively. There is a strong positive favorable correlation between number of branches and fruit production and basal diameter and fruit production. Results of this experiment indicates that genetic variation and heredity of the economical traits are favorable for future improvement of this species. Accordingly, superior genotypes from each seed source can be used for future improvement programmes and for the use in establishment of commercial plantations.

**Key words:** *Jatropha curcas*, genetic variation, heritability, selection, correlation

## Effect of Climate and Soil on Bark Yield Components of Cinnamon (*Cinnamomum zeylanicum* Blume)

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Cinnamon (*Cinnamomum zeylanicum* Blume) is a world famous perennial spice crop. As rated in the world, Sri Lanka provides the best quality cinnamon to the world market. The most valuable part is the bark, which provides quills for the market. Climate and soil factors are important to determine the cinnamon bark yield. The study was conducted to examine the correlation between climate/soil factors and cinnamon yield parameters. Six areas; (Matara; 6°00'26.7"N 80°30'40.3"E, Galle 6°12'15.3"N 80°07'47.1"E, Kegalle; 6°52'30.1"N 80°16'52.1"E, Mathale; 7°27'37.9"N 80°36'05.8"E, Balangoda; 6°39'04.8"N 80°45'16.3"E, Walasmulla; 6°13'34.0"N 80°39'33.5"E) were selected representing six agro-ecological zones in Sri Lanka. Cinnamon trees, which were in same age and same morphological characters were selected. Soil samples from each location were taken at 30 cm depth for the analysis of physical and chemical properties. According to the standard soil analytical methods, soil samples were analyzed for soil bulk density, texture, pH, electrical conductivity (EC), organic matter (OM), total nitrogen (N), available phosphorous (P) and exchangeable potassium (K). The yield parameters; peelable stem length, average stem diameter, fresh weight of the plant, dry bark thickness, dry bark weight was measured at harvest. Monthly climate data (Maximum temperature, Minimum temperature, Rainfall) for above six locations were downloaded from [http://data.ceda.ac.uk/badc/cru/data/cru\\_ts/](http://data.ceda.ac.uk/badc/cru/data/cru_ts/). Regression analysis was used to observe the correlation among yield parameters and climate and soil factors separately. Some of the tested soil parameters correlated with some yield parameters. Average stem diameter ( $r_s = +0.57$ ;  $p = 0.01$ ), dry bark thickness ( $r_s = +0.67$ ;  $p = 0.01$ ), dry bark weight ( $r_s = +0.56$ ;  $p = 0.02$ ) and fresh weight ( $r_s = +0.57$ ;  $p = 0.01$ ) were positively correlated with OM. Dry bark weight positively correlated ( $r_s = +0.56$ ;  $p = 0.02$ ) with total N. Peelable stem length was positively correlated ( $r_s = +0.60$ ;  $p = 0.01$ ) with K. Dry bark weight was negatively correlated ( $r_s = -0.63$ ;  $p = 0.01$ ) with bulk density. Dry bark weight showed positive correlation ( $r_s = +0.54$ ;  $p = 0.02$ ) with silt, but negative correlation ( $r_s = -0.49$ ;  $p = 0.04$ ) with sand. Climate also showed significant correlation with some yield parameters. Average stem diameter was positively correlated ( $r_s = +0.228$ ;  $p = 0.001$ ) with monthly rainfall. Also, dry bark thickness showed positive correlation ( $r_s = +0.177$ ;  $p = 0.001$ ) with rainfall. These significant correlations were used to develop regression equations and significant correlations were found between tested soil parameters and dry bark weight, between rainfall and average dry bark thickness and between rainfall and dry bark thickness. These regression equations are important to predict response of significant dependent variables with variations of soil properties and rainfall. Correlations show how each variable relates to each other. So, a farmer can increase availability of positively correlated soil parameters and decrease negatively correlated soil parameters to achieve higher productivities. It was evident from the results that average stem diameter, fresh weight, dry bark thickness, dry bark weight and peelable stem length are affected by the soil properties prevailing in the area. Also, average stem diameter and dry bark thickness are affected by rainfall received by the area.

**Keywords:** Bulk density, Cinnamon, Correlation, K, N, Organic matter, P, Rainfall, Temperature, Yield parameters

# Effectiveness of the Approach Grafting Over the Other Vegetative Propagation Methods of Nutmeg (*Myristica fragrans* Houtt)

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Nutmeg (*Myristica fragrans* Houtt.) is unique among spice plants as it produces two distinct spices, nutmeg and mace. Nutmeg is the seed kernel inside the fruit and mace is the covering (aril) on the kernel. It is dioecious plant and sexual propagation by seedlings yields 50% male seedlings, which are unproductive. There is no reliable method to determine the sex of the nutmeg plant until flowering, which takes 6-7 years. Even though, the solution for this is vegetative propagation, available techniques take long time and less in success. This experiment was conducted with the objective of testing the effectiveness of approach grafting over the current vegetative propagation methods of nutmeg in local context. Different other methods of vegetative propagation namely cleft grafting, soil layering, air layering and stem cutting were attempted. After three months period, the reported mean successful percentages for cleft grafting, soil layering, air layering, stem cuttings, approach grafting with plagiotropic shoots and approach grafting with orthotropic shoots were 24.81%, 0.00 %, 17.13%, 0.00 %, 75.00% and 87.37% respectively. A significant difference was observed between the mean successful percentages of approach grafting against other vegetative propagation methods ( $P < 0.05$ ). But, there was no significant difference between the mean successful percentages of approach grafting with plagiotropic shoots and approach grafting with orthotropic shoots ( $P > 0.05$ ). Mass propagation through approach grafting with plagiotropic shoots and orthotropic shoots can be recommended to produce female plants. Field testing of approach grafted plants with the cleft grafted and air layered plants could also be proposed.

**Key words;** approach grafting, orthotropic shoots, plagiotropic shoots, propagation

## Comparison of Plant Biodiversity of Oil Palm (*Elaeis guineensis*) Plantation with Rubber (*Hevea brasiliensis*) Plantation in Udugama, Galle

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Oil palm (*Elaeis guineensis*) is one of the world's most rapidly expanding equatorial crop and also in Sri Lanka. Oil palm producers have asserted that natural forest being cleared for cultivation, that makes a huge threat to biodiversity. Rubber (*Hevea brasiliensis*) is already established in Sri Lanka for more than 140 years. Plant biodiversity of oil palm and rubber plantation under four difference age (i.e. 1-5, 6-10, 11-15, 16-20 years) classes were assessed. All individual plants were identified into species level and counted within a 25 m square plot (5 m × 5 m). Plant biodiversity was evaluated in six different locations at Homadola estate of Watawala Plantation in Udugama, Galle (WL1a). Plant biodiversity were calculated using four different diversity indicators as Simpson diversity index, Shannon diversity index, species evenness and species abundance. Oil palm fields showed significantly higher Simpson (0.846) and Shannon (2.000) index than rubber. Species evenness also significantly higher in oil palm (0.567) compared to rubber (0.065). Species abundance does not effect on crop but on age classes, the highest species abundance showed in 3<sup>rd</sup> age class (0.313) but not significant difference with 2<sup>nd</sup> age class (0.294). The maximum mean species availability (11) was observed in the 3<sup>rd</sup> age class of rubber, but not significantly different from oil palm (10). The maximum (Simpson index: -0.846, Shannon index: -2.000) species richness showed in 2<sup>nd</sup> age class of oil palm. There was no significant difference in plant family availability on both oil palm and rubber. Among all study sites, 29 plant species and 17 plant families were identified. Overall results suggested that the oil palm has high biodiversity than rubber. Since best management practices followed in oil palm at the estate and it leads to high biodiversity and sustainable surrounding environment compare to rubber. Increment of biodiversity in oil palm directly influences the Round Table Sustainable Palm Oil (RSPO) certification system.

**Keywords:** Abundance, Biodiversity, Plantation, Plant species

## **Effects of Nano-Fertilizer on Soil Microbial Communities in Coconut (*Cocos nucifera* L.) Plantations**

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Nano fertilizers are becoming increasingly popular in the agricultural sector. The large surface area and small size of the Nano Materials (NM) improves the efficiency of releasing nutrients to the soil dynamic pool. Therefore, enables the uptake of fertilizer by plants in a slow and sustainable manner. The study was conducted to evaluate the effects of Nano fertilizer on soil microbial communities, before it is being recommended to use in coconut plantations as they are important driving forces of soil functioning. The study was conducted in an existing Nano fertilizer experiment established by the Coconut Research Institute of Sri Lanka (CRISL) in Bandirippuwa Estate, Lunuwila in 2015. The CRISL recommended inorganic fertilizer mixture for adult palms as a control was tested against the treatments replacing urea with 50% and 75% of urea base Nano fertilizer (N-Nano); Muriate of Potash (MOP) with 50% and 75% MOP base Nano fertilizer (K-Nano); and both urea and MOP with 50% and 75% N-Nano and K-Nano. Soil samples for the study were collected before and 3 weeks after the second fertilizer application and analyzed for soil pH,  $\text{NH}_4^+$  content, soil bacterial and fungal population, population of nitrifiers and basal respiration. The soil pH, before and after fertilization was not significantly different between treatments and ranged from 6.54 to 6.93 and 6.28 to 6.93 respectively. Results envisaged that the total bacterial population, total fungal population and soil microbial activity were not significantly affected by Nano fertilizer application compared to the recommended fertilizer mixture. A significant increment in  $\text{NH}_4^+$  content was showed in the recommended fertilizer mixture compared to other treatments at three weeks after fertilization, while a significantly high population of ammonium oxidizers was observed in 50% K-Nano fertilizer treatment. Nevertheless, the results have not shown any significant adverse effect caused by the applied Nano fertilizers to coconut plantations on soil microbial activity and soil microbial communities tested in this study.

**Keywords:** bacterial population, fungal population, K-Nano, nitrifiers population, N-Nano, respiration rate

## Determination of Differences in Heat Tolerance of Exotic Coconut (*Cocos nucifera* L.) Cultivars by *In Vitro* Pollen Germination

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Different germplasm accessions available at the Coconut Research Institute of Sri Lanka (CRISL) has been used for developing new crosses with favourable characteristics such as high yielding potential, resistance to abiotic stresses etc. Even though some crosses developed using exotic pollens have been evaluated using some physiological traits, some important flower characteristics have not yet been assessed. There are four such exotic hybrids developed by the CRISL namely, TBGD, TRIT, TTMRD and TTAGT. As nut is the main economically important component of coconut, it is essential to evaluate the reproductive performance of such new hybrids. Successful fruit set in coconut depends on several reproductive processes, including pollen quality, pollen germination and pollen tube growth processes. These processes heavily depend on environmental conditions such as moisture availability and temperature. Along with the phenomenon of global warming, it is imperative to identify the potential of new exotic hybrids which can withstand high temperatures. The pollen germination response and pollen tube growth were quantified in order to determine the differences in heat tolerance and to determine cardinal temperatures ( $T_{min}$ ,  $T_{opt}$ ,  $T_{max}$ ) of four exotic coconut cultivars by *in vitro* pollen germination. Newly developed hybrids planted in experimental blocks in the Middeniya Research Center were used for the study. Pollens were collected from six palms from each hybrid. Pollen germination percentage and pollen tube growth were recorded after incubation for 20 hours and 3 hours respectively in artificial growth media under different temperatures (22°C to 40°C). Quadratic model best described the response of pollen germination to temperature and pollen tube length. All hybrids reached maximum pollen germination (100%) mostly in the range of 26°C – 32°C. The monthly mean cardinal temperatures ( $T_{min}$ ,  $T_{opt}$ ,  $T_{max}$ ) over hybrids ranged from 18.52-23.09°C, 22.08-32.73°C, 36.91-56.42°C for TBGD, 16.92-21.71°C, 22.15-31.80°C, 40.44-43.62°C for TRIT, 8.89-21.53°C, 28.71-31.84°C, 40.36-48.53°C for TTAGT and 18.11-21.54°C, 29.43-32.44°C, 39.99-43.91°C for TTMRD. It is evident from the results that all exotic hybrids have wider temperature adaptability than most of the commercially grown cultivars in Sri Lanka.

**Keywords:** pollen tube growth, cardinal temperatures, coconut, heat stress, exotic hybrids

## Screening the Efficacy of New Bio Herbicides Against Weeds in Tea (*Camellia sinensis*) Lands

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A weed is a plant which grows out of place and interferes with the Agricultural objectives. When controlling weeds, herbicides are convenient, economical and cause lesser disturbance to top soil compare to manual weed controlling. With the banning of most effective herbicides, now most of tea planters face problems in controlling weeds. Current study is to determine the potential of Organic Weed Free Rapid Concentrate (OWRC) 25% W/V of pine oil from *Pinus spp* and 57% W/W of Pelargonic Acid from *Pelargonium spp* in controlling weeds. Six treatments of OWRC (10, 12, 14, 16, 18 and 20 l/ha) were tested at high, mid and low elevations of tea lands with standard chemical herbicides (40% MCPA and Diuron + MCPA) recommended by Tea Research Institute of Sri Lanka and three treatments of Pelargonic acid (16, 20, 24 l/ha) were tested only at high elevation (standards were 40% MCPA and 60% MCPA). Quadrate samples of weeds were taken one week after application (WAA) and three WAA. Then dry weights were measured (85 °C for overnight) in weed samples. Visual observation was carried out to determine the weed injury rate. Soil pH was tested only in high elevations. Data were analysed using one way ANOVA followed by Duncan's multiple range test to compare means of each treatments and Dunnett's multiple comparison to compare means of treatments with a standard treatment. Efficacies of rates of bio herbicide were not consistent in all elevation. In high elevation at 1WAA 18 l/ha and 16 l/ha showed lower mean and both treatments were not significantly different. Also both were efficient than MCPA+ Diuron treatment. In mid elevation at 1WAA, 16 l/ha is effective than MCPA but both treatments were not significantly different. In low elevation MCPA was the most effective herbicide and it is significantly different from rest of treatments. According to visual observations, Getakola (*Spermacoce hispida*), Girapala (*Commelina diffusa*) and *Cyrtococcum trigonum* grass species were highly susceptible for OWRC and rest of weeds showed burnet like patches only. The pH of soil has been increased in all treatments 2WAA but 4WAA, pH has been decreased again. The Pelargonic acid rates of 16 l/ha, 20 l/ha and 40% MCPA were not significantly different but 40% MCPA showed the highest efficacy to control weeds. Pelargonic acid does not show any selective action as in OWRC. In both bio herbicide trials, means of dry weights at 3WAA were increased since bio herbicides are contact weed killers and they cannot suppress the re-growth of weeds as systemic herbicides. Both bio herbicides show good potential in controlling weeds. Particularly, OWRC can be used as selective herbicide for patches of above mentioned weed species in high and mid elevation while Pelargonic acid can be used as non-selective herbicide at high elevation tea lands.

**Keywords:** bio herbicides, weed control, pine oil, pelargonic acid

## Identifying and Classifying Lift Irrigation Potential Sugarcane Lands in Rain-Fed Areas in Sevanagala Using GIS (Geographic Information System)

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The present study was conducted to identify and classify lift irrigation potential sugarcane lands in rain-fed areas in Sevanagala using Geographic Information System. Rain-fed yield is comparatively 21% lower than irrigated yield. Supplementary irrigation greatly improves the rain-fed sugarcane yield; thus, farmers are tending to practice lift irrigation for maximizing the yield of rain-fed sugarcane. There are numbers of water sources in the rain-fed area namely, Kataupila Wawa, Makulu Wawa and Habaralu Wawa, which are currently used for supplementary irrigation by pumping with diesel water pumps. However, most of the farmers unable to get full benefit from supplementary irrigations as their wrong lift irrigation practices and energy wastage at the water pumping stage due to use of inappropriate water pumps. In this study, questioner survey was conducted at Sevanagala ran-fed area to collect information on lift irrigation i.e. sources of water, determination of pump power. Google earth software was used to select farmer fields and to investigate on spatial data such as geographical elevation, distance from nearest water source and the elevation from the nearest water source to each farmer field. According to lift irrigation information, estimated require pump power requirement, fuel cost, and brake-even point for lift irrigation cost. And also, a GIS database was developed for each farmer field indicating information about the actual power requirement, appropriate water pump, convenient water conveying lines and potential economic benefit from supplementary irrigation for each farmer field. Spatial distribution of these parameters then depicted in a map and irrigation potential area was identified. According to the developed irrigation potential area map, the average diesel consumption was  $16.8 \pm 0.5$  liters per ten hours within day. Generally, lift irrigated sugarcane can produce Rs 104,000 extra income per ha. Average irrigation cost within the irrigation potential area was 30,332 Rs/ per ha and it is varied between Rs.1, 944 to Rs.113, 137. The irrigation cost was highly correlated with land distance from the water source ( $r^2= 0.93$ ). The developed GIS data and depicted map which indicates irrigable sugarcane lands and their economic benefits from supplementary irrigation can be used as a guideline to improve land productivity and farmer's profit, particularly farmers who are interesting to start new lift irrigation projects in rain-fed sugarcane areas in Sevanagala. Furthermore, the present study recommends practicing lift irrigation only within the irrigation potential area and farmers who are beyond the irrigation potential area are highly advisable not to invest for supplementary irrigation projects even they are technically feasible as most of them are not economically beneficial respective to their irrigation cost and potential yield enhancement.

**Keyword:** Economic benefits, rain-fed sugarcane, supplementary irrigation, water pumps

## Comparison of Some Key Antioxidant Genes Expression Between Tapping Panel Dryness (TPD) Affected and Healthy Rubber Trees (*Hevea brasiliensis* Muell. Arg.)

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Natural rubber, (*cis*-1,4-polyisoprene) is synthesized in over 2000 plant species, representing about 300 genera from seven families. Among them, *Hevea brasiliensis* Muell. Arg., commonly known as rubber tree, is almost the sole source of natural rubber. Currently, the rubber industry of Sri Lanka contributes about 0.3 % of the GDP being one of the major income sources of the Agriculture sector. Tapping panel dryness (TPD) is a serious physiological disorder which causes 15 % to 20 % yield loss worldwide annually. Currently, yield loss due to TPD is increasing at an alarming rate in rubber plantations in Sri Lanka. Based on studies related to TPD, it has been hypothesized that the production and scavenging of Reactive Oxygen Species (ROS) might play an important role in onset of TPD and it is caused by oxidative stress resulted from ROS generated by abiotic stresses as well as overexploitation (excessive tapping and over-stimulation by ethylene application). Superoxide dismutase (SOD), Glutathione peroxidase (GPX), Peroxiredoxins (PRX), Ascorbate peroxidase (APX) and Catalase (CAT) are key enzymes involved in ROS scavenging in plants. GPX, PRX, APX and CAT reduce hydrogen peroxide, which is a key ROS in TPD, to water. At present, there are no effective measures to prevent or treat TPD. As such, it is of paramount importance to understand the molecular basis underlying this serious physiological disorder to mitigate the yield losses. Therefore, this study was started to analyze the difference of expressions of some key antioxidant genes between TPD affected and healthy rubber tree by using semi-quantitative real time PCR, and to identify which antioxidant genes express differentially under TPD condition. This information is vital for designing a treatment or future remediation to minimize the economic losses caused by TPD to the country's rubber industry. Already synthesized cDNA from both TPD affected and healthy rubber tree were amplified with antioxidant genes specific primers. The amplified products were run on the gel and gene expressions were detected by UV transilluminator. *HbACT* gene expression was used as internal control. The results showed that the *HbMnSOD*, and *HbCAT* genes were down regulated in TPD affected rubber clones compared to those of healthy clones. Based on these results, it was concluded that the down regulation of *HbMnSOD*, and *HbCAT* genes lead to accumulation of ROS which may causes TPD.

**Keywords:** *Hevea brasiliensis*, tapping panel dryness, Reactive Oxygen Species, Semi-quantitative RT-PCR, Superoxide dismutase, Catalase.