
Crop Science

EFFECT OF FOLIAR APPLICATION WITH UREA AND NAPHTHALENE ACETIC ACID ON GROWTH AND YIELD OF MUNG BEAN

H.A.A.S. Kumari[1], H.M.P.T.K. Hettigedara[2], and D.A.U.D. Devasinghe[1]

[1]Department of Plant Sciences, Faculty of Agriculture, Rajarata University of Sri Lanka, Anuradhapura, Sri Lanka.
[2]Field Crops Research and Development Institute, Mahailluppalama, Sri Lanka.

The foliar application of plant growth regulators and nutrients has been practiced in mung bean (*Vigna radiata* L.) for enhancement of growth and yield. However, the effectiveness of foliar sprays on mung bean is not yet studied under Sri Lankan conditions. Hence, a field experiment was conducted at the Field Crop Research and Development Institute, *Mahailluppallama* during November-April (2018/2019 *Maha* cropping season) to investigate the effect of urea and Naphthalene Acetic Acid (NAA) as a foliar application on growth and yield of mung bean. The experiment was arranged in randomized complete block design with eight treatments and three replicates. Foliar sprays; 1% urea [30, 45 days after sowing (DAS) and 20, 30, 40 DAS)], 1% urea [(30, 45 DAS) and (20, 30, 40 DAS) with 40 mgL^{-1} NAA], 40 mg/l NAA alone and spraying of water were tested combined with the recommended N, P, K fertilizers for mung bean. Treatments with NAA were applied at pre-flowering stage and 15 days thereafter. A treatment with zero fertilizers was used as the control. Plant height, canopy width, root length, number of nodules, percentage of dead and live nodules, number of leaves, leaf area, total dry weight, number of pods and seeds per pod were not significant ($p>0.05$) among treatments. Although the SPAD readings were not significantly different among treatments until pod formation, it was significantly higher in treatments with NAA alone and 1% urea (20, 30, 40 DAS and 20, 30, 40 DAS with NAA) at 75 and 85 days after sowing. Highest and the lowest seed yield recorded were 1.93 and 1.25 tha^{-1} respectively, while the seed yield among treatments were remained insignificant ($p>0.05$). In conclusion, the application of urea and NAA as foliar application is not an effective method for improving the mung bean yield under the tested field conditions.

Keywords: Foliar application, Mung bean, Naphthalene acidic acid, Urea

ROLE OF SEED WATER GAP STRUCTURE IN SEED GERMINATION OF *Ficus* SPECIES FROM SOUTH CHINA

V. Silva[1,2], H. Chen[2], N. Geekiyanage[1,2], and U.M. Goodale[2]

[1]Department of Plant Sciences, Faculty of Agriculture, Rajarata University of Sri Lanka, Anuradhapura, Sri Lanka.
[2]Plant Ecophysiology and Evolution Group, Guangxi Key Laboratory for Forest Ecology and Conservation, College of Forestry, Guangxi University, Daxuedonglu 100, Nanning 530005, Guangxi, People's Republic of China.

Investigating the predictive power of seed functional traits to determine regeneration success could improve our understanding of the regeneration process and its response to future global changes. This study, using 16 *Ficus* species evaluated the predictive capacity of seed traits on seed germination success and the role of seed water gap structure during the imbibition phase of seed germination. A dye tracking experiment using seeds submerged in acid fuchsin for 20 min, followed by paraffin embedding, slicing and subsequent measurement of digital images showed that the water gap structure was the main water entry point for all species. The hilum region length and width measured by imbibing seeds for 12 h period at 25°C showed a diversity of changes from increases to decreases in its length. Seed coat thickness in the water gap structure area was different from the rest of the seed coat. Intra-specific differences between seed coat thickness was identified but without a correlation to seed germination or a differentiation between epiphytic versus terrestrial habit. Contrary to expectations, there was no correlation between the hilum length and width after 12 hours imbibition in water and the probability of germination. Correlations between all seed traits (water gap traits such as hilum length and width, and seed coat thickness in the water gap region, seed width, seed length, seed perimeter, seed area, seed coat thickness and seed moisture content) and germination success showed that germination rate was highly correlated with species' seed surface area (p>0.0001) followed by seed length (p>0.01) and seed width (p>0.01), indicating larger seeds has higher germination probability. The seed water gap structure mattered the most for germination along with the thickness of seed coat. This study provides novel insights into the role of the water gap structure and other seed characteristics in determining seed germination.

Keywords: Dye tracking, *Ficus* species, Imbibition phase, Seed water gap structure

IMPACT OF ENVIRONMENTAL TEMPERATURE TO DETERMINE THE CROP DURATION OF SELECTED SRI LANKAN RICE VARIETIES

L.W.D.S. Wijerathna[1], L.D.B. Suriyagoda[2], T. Illangakoon[3], and D.A.U.D. Devasinghe[1]

[1]Department of Plant Science, Faculty of Agriculture, Rajarata University of Sri Lanka, Anuradhapura, Sri Lanka.
[2] Department of Crop Science, Faculty of Agriculture, University of Peradeniya, Sri Lanka.
[3]Rice Research and Development Institute, Bathalagoda, Ibbagamuwa, Sri Lanka.

Despite a large number of agronomic, physiological and modelling studies on rice (*Oryza sativa* L.), the cardinal temperatures and thermal time (TT) requirements for key developmental processes of Sri Lankan rice varieties are not known. Therefore, TT requirements for flowering and maturity of widely cultivated Sri Lankan rice varieties; Bg300, Bg352, Bg358 were studied. National coordinated rice varietal trial data from 14 locations and corresponding weather data were collected. Results showed that average number of days required for maturity of Bg300, Bg352 and Bg358 was 96 ±5, 99 ±7 and 105 ±4, respectively. The optimal temperature for flowering and maturity of all varieties were 27.4^{0}C while the minimal and maximal temperatures obtained from the literature were 14.5 and 35^{0}C, respectively. TT requirements for flowering and maturity during *Yala* season were higher than those estimated for *Maha* season, *i.e*. Bg300, Bg352 and Bg358 required 1593, 1741 and 1831^{0}Cdays for flowering during *Yala;* whereas, 1440, 1457 and 1646°Cdays for the same during *Maha,* respectively. Similarly, TT requirement for the maturity of Bg300, Bg352 and Bg358 during *Yala* were 2345, 2556 and 2588^{0}Cdays while those during *Maha* were 2096, 2153 and 2307^{0}Cdays, respectively. The shortest duration for flowering was observed at *Bombuwela* for Bg300 and Bg358 and *Bathalagoda* for Bg352, and the longest duration for flowering was observed at *Batticaloa*, *Vavuniya* and *Murunkkan* for Bg300, Bg352 and Bg358, respectively during *Yala*. The shortest duration for flowering was observed at *Bombuwela*, *Labuduwa* and *Murunkkan* for Bg300, Bg352 and Bg358 respectively and the longest duration for flowering was observed at *Batticaloa* for Bg300 and *Paranthan* for Bg352 and Bg358 during *Maha*. Higher TT requirement during *Yala* may be due to photoperiod sensitivity of rice. This knowledge of optimal temperature, TT requirements and its seasonal variation is important when designing future physiological and crop modeling studies.

Keywords: Cardinal temperatures, Days to flowering and maturity, Growing season, Rice, Thermal time

RECOVERY OF PHOSPHORUS FROM WASTEWATER BY *Salvinia molesta.*

K.T.S. Nirmani[1], M.C. M. Iqbal[2], and W.C.P. Egodawatta[1]

[1]Department of Plant Sciences, Faculty of Agriculture, Rajarata University of Sri Lanka, Anuradhapura, Sri Lanka.
[2]National Institute of Fundamental Studies, Hantana, Sri Lanka.

One of a major threat to agriculture is the depletion of available phosphorus reserves. Inefficient and irresponsible use of phosphorus fertilizer and other phosphorus based products lead to contamination and qualitative degradation of water bodies. Certain aquatic plants have an ability to sequestrate phosphorus and thereby purify the eutrophic water bodies. Such aquatic plant biomass can be used as a possible source of phosphorous fertilizer for crops. In this study, the ability of an aquatic plant, *Salvinia molesta* to remove phosphorus from wastewater and recover the absorbed phosphorus through preparing a powdered fertilizer from the dried plants were investigated. A fresh weight of 2005 g of *S. molesta* was introduced into 3 L of 10 mgL^{-1} of phosphate solution. After 48 hrs of equilibrium time, *S. molesta* resulted 87% of phosphate removal efficiency. The phosphorus recovery process from plant tissue of dried and powdered *S. molesta* remained at 79% from recovery. A hydroponic experiment was conducted to test the growth and yield attributes of rice cultivar Bg 300, in a greenhouse, using a synthetic phosphorus source and *S. molesta* powder as phosphorus sources. The experiment was laid out in a complete randomized design with three treatments and five replicates. Three treatments were viz; T1-Hoagland solution without phosphorus, T2- Hoagland solution, T3- Hoagland solution without phosphorus + *S. molesta* powder. The results indicated no significant differences (p>0.05) between early growth of rice plants in both Hoagland solution (T2) and Hoagland solution without phosphorus + *S. molesta* powder (T3). Interestingly, the dry biomass at 28 days after transplanting was similar in both treatments. Hoagland solution and Hoagland solution without phosphorus + *S. molesta* powder resulted significantly higher growth with respective to plants treated with Hoagland solution without phosphorus (T1). This research has generated the first set of data to show the dual ability of *S. molesta* to clean P eutrophied water bodies and to use plant sequestrated P as a source of P fertilizer for rice in submerged condition.

Keywords: Phosphorous, Powdered fertilizer, Recovery, Removal efficiency, *Salvinia molesta*

ANTI-MICROBIAL PROPERTIES AND MADE TEA QUALITY OF ORGANIC VS. CONVENTIONAL TEAS OF SRI LANKA

R.W.W.K.A.D. Rajapaksha[1], K.D.K. Wanasinghe[2], W.M.R.S.K. Warnasooriya[1], and D.I.D.S. Benaragama[1]

[1]*Department of Plant Sciences, Faculty of Agriculture, Rajarata University of Sri Lanka, Anuradhapura, Sri Lanka.*
[2]*Amazon Trading (Pvt) ltd, 257, Siri Dhamma Mawatha, Colombo 10, Sri Lanka.*

Ceylon tea with inherently unique characteristics are grown in six major regions in Sri Lanka namely; *Dimbula*, *Nuwara-eliya*, *Udapussellawa*, Southern, *Uva* and Kandy under conventional and organic management systems. Organic tea, produced in absence of synthesized chemicals is hypothesised to have better made tea quality and anti-microbial (anti-fungal and anti-bacterial) properties over conventional tea. Present research assessed the effects of tea production system and their growing region on quality parameters, anti-bacterial and anti-fungal properties of made tea. Two tea estates each for organically certified and conventional were randomly selected from each tea growing regions excluding *Nuwara-eliya*. Freshly harvested leaf samples of each estate were manufactured into CTC black tea using a miniature system. Infused tea and tea liquor characteristics were assessed using a sensory evaluation. Anti-bacterial and anti-fungal properties were assessed against disease causing bacteria and fungi namely; *Escherichia coli* ATCC 25922 and *Aspergillus niger* using disk diffusion technique. Aroma and the colour of the infused tea were significant ($p<0.05$) among growing regions and among the production system, where organic tea showed a greater aroma and a colour. Both production system and growing regions showed a significant difference ($p<0.05$) on colour, aroma and the overall acceptability of tea liquor. Tea growing regions resulted no effect ($p>0.05$) on the flavour profile and the liquor strength. Yet, organic tea showed a better flavour profile and liquor strength than conventional tea. Both anti-bacterial and anti-fungal properties were significantly different ($p<0.05$) among tea production system and the growing region, where organic tea showed higher anti-bacterial and anti-fungal properties than conventional tea. Southern tea had greater anti-bacterial and anti-fungal properties, where it was the lowest in *Uva* region. In conclusion, organic teas have better anti-microbial properties and made tea quality over conventional teas.

Keywords: Anti-bacterial, Anti-fungal, Conventional tea, Organic tea, Tea quality

COMPARISON OF RICE GROWTH AND WEED ABUNDANCE IN ORGANIC, REDUCED AND CONVENTIONAL SYSTEMS: THE FIRST YEAR IN TRANSITION

W.A.D.P. Wickramasinghe, D.I.D.S. Benaragama, and H.C.D. Wijayawardhana

Department of Plant Sciences, Faculty of Agriculture, Rajarata University of Sri Lanka, Anuradhapura, Sri Lanka.

Rice (*Oryza sativa* L.) is grown under a wide range of physical environments such as different soils, elevations, hydrological regimes and management systems in Sri Lanka. Although the conventional production practices are widely used in the dry zone, the demand for alternative crop production systems are rising due to economic, environmental and human health concerns. A field trial was conducted at the Rajarata University of Sri Lanka to compare the growth and weed abundance in rice under three input systems; organic, conventional and reduced, during *Maha* season 2018/2019 as the first season of a long-term cropping systems trial. Department of Agriculture (DOA) fertilizer recommendation and 50% of DOA fertilizer recommendation + compost application were respectively used as conventional and reduced systems. The three input systems were arranged in randomized complete block design with three replicates. Results revealed that at seedling and tillering stages, plant height, and plant dry matter were not different ($p>0.05$) among the systems. However, at 50 % flowering stage, plant dry matter was the highest (1464 kg/ha) in conventional system followed by reduced (1222 kg/ha) and organic (1130 kg/ha). At seedling stage, weed density was high ($p<0.05$) in the organic (77%) compared to the other two systems. At 50% flowering stage, no difference was found in weed density among the systems. Weed biomass at 50% flowering stage were high in conventional (56%) compared to organic and reduced ($p>0.05$). Results concluded that organic system at seedling and tillering stages did not show any difference in plant growth compared to the other two systems, but declined at 50% flowering stage indicating a decline in soil fertility. Weed density is high in organic at early growth stages due to inadequate weed control, but weed competition is high in conventional system due high weed biomass growth.

Keywords: Conventional, Crop growth, Organic, Rice, Weed abundance

EVALUATION OF IMAZETHAPYR AGAINST GRASSY WEEDS IN MUNGBEAN

A.M.G.K.D. Adikari[1], A. Wickramasekara[2], D.M.D. Dissanayake[1], and W.C.P. Egodawatta[1]

[1]Department of Crop Science, Faculty of Agriculture, Rajarata University of Sri Lanka Anuradhapura, Sri Lanka.
[2]BASF Lanka Pvt. Ltd., 186, Vauxhall Street, Colombo 02, Sri Lanka.

Weeds are the major biological threat for crop production and due to limited options in controlling, weed emergence simultaneously with crop growth has become a critical in Sri Lanka. Especially in legumes, fast growing weeds suppress the early growth of legume seedlings resulting non-compensatory yield loss. Current regulatory control of glyphosate had opened up avenues for contemporary herbicides. The Imazethapyr 10% Solution (SL) is a newly introduced herbicide for Mungbean in Sri Lanka. This field study evaluated the bio-efficacy and phytotoxicity of Imazethapyr 10% SL against grassy weeds in mungbean. The experiment was conducted during *Maha* cropping season 2018/19 at Research Unit of Faculty of Agriculture, Rajarata University of Sri Lanka. The experiment was laid out on a split plot design with fourteen treatment combinations replicated thrice. Main plot factor was the time of application and sub plot factor was the herbicide concentration. Time of application had two levels aspre-emergence and post-emergence (14 Days After Sowing (DAS)). Herbicide concentrations were Imazethapyr at 50 gha^{-1}, 62.5 gha^{-1}, 75 gha^{-1}, 100 gha^{-1}, 125 gha^{-1} along with a weed free treatment and an un-weeded treatment. Weed biomass at 20 days after sowing was significantly low in Imazethapyr @ 125 gha^{-1}, however the chemical control always resulted a lower weed biomass than un-weeded control. No significant weed biomass differences ($p>0.05$) were observed between pre-emergence and post-emergence in 20 DAS. Plant biomass at flowering (45 DAS) was significantly ($p<0.05$) high with higher concentration of the Imazethapyr 10% SL. Post-emergence application showed significantly ($p<0.05$) higher plant biomass than pre-emergence application. Grassy weeds were less abundant; however, even with the chemical at higher concentration *Cleome viscose* and *Cyprus rotundus* were abundant, probably showing their resistant to Imazethapyr 10% SL. Post emergence application of Imazethapyr @ 125 gha^{-1}, 14 (DAS) of Mungbean was found to be effective in controlling most of the grasses and broadleaves.

Key words: Biomass, Herbicide, Imazethapyr 10% SL, Mungbean, Weeds

IMPROVING SOIL CARBON RETENTION USING BENTONITE NANO-CLAY INCLUDED ORGANIC AMENDMENT IN REDDISH BROWN EARTH SOIL IN SRI LANKA

A.V.G. Hansika[1], G.I. Senevirathna[2], J.A.S. Chathurika[2], N. Kottegoda[2], and W.C.P. Egodawatta[1]

[1]Department of Plant Sciences, Faculty of Agriculture, Rajarata University of Sri Lanka, Anuradhapura, Sri Lanka.
[2]Sri Lanka Institute of Nanotechnology, Nanotechnology and Science Park, Mahenwatta, Pitipana, Homagama 10206, Sri Lanka.

Soil organic matter plays a key role in soil health through biological, physical and chemical properties. The retention time of soil organic matter is brief in tropics due to rapid mineralisation. General aim of this study was to improve the soil carbon retention by altering the mineralisation rate of common organic amendment; specifically, was to investigate the changes of soil chemical properties and crop performances with the presences of such treated amendment. Reddish brown earth soil was treated with *Gliricidia sepium* leaf and bark to equalise the organic matter content of the soil. Four types of treatments were used viz. organic amendment without additives (T_1), 1% Bentonite (W/W) + Humic acid (100 $mgkg^{-1}$) organic amendment (T_2) and 2% Bentonite (W/W) + Humic acid (100 $mgkg^{-1}$) organic amendment (T_3), and anun-amended control (T_0). Maize was the tēst crop and experiment was laid out on a completely randomized design. The mode of action between Bentonite nano-clay and Humic acid was observed using X-ray Powder Diffraction (XRD), Fourier-Transform Infrared Spectroscopy and Thermal Gravimetric Analysis (TGA). XRD analysis confirmed binding of Humic acid on the surface of Bentonite without intercalation. Differences in the peaks of the TGA graphs were clearly visible due to the modifications of Bentonite by adding Humic acid. The growth and yield parameters of the test crop was significantly ($p<0.05$) superior on organic amendment with 2% bentonite and Humic acid treated soils compared to the rest. Relative greenness (SPAD values) and plant height were early indicators that showed the efficacy of organic amendment with 2% bentonite and Humic acid in retaining and releasing nutrients for a better crop growth. Bentonite and Humic acid on organic amendments showed promising results in altering the natural mineralization of organic matter under tropical climate.

Keywords: Bentonite, Humic acid, Nano-clay, Organic amendment, Soil organic matter

SCREENING OF MAIZE VARIETIES FOR WATERLOGGING TOLERANCE AT V9 GROWTH STAGE ON MODERATELY DRAINED SOILS

R.P.M.U. Ranawaka[1], M.A.P.W.K. Malaviarachchi[2], and W. C. P. Egodawatta[1]

[1]Department of Plant Sciences, Faculty of Agriculture, Rajarata University of Sri Lanka, Anuradhapura, Sri Lanka.
[2]Field Crops Research and Development Institute, Mahailluppallama, Sri Lanka.

Cultivation of maize in moderately drained soils during *yala* season in the dry zone is popular among Sri Lankan farmers. However, unexpected heavy rains due to climate change can trigger water logging conditions in these fields at any growth stage of the crop. As maize is less tolerant to water logging, the yield can be severely affected. Therefore, studying the impact of water logging durations on maize growth and yield related attributes is timely relevant. A field experiment was carried out at the Field Crops Research and Development Institute, *Mahailluppallama* during *Maha 2018*/2019 cropping season to assess yield response and physiological changes of maize accessions (locally available 30 lines) for water logging conditions at V9 vegetative period (28 days after planting). The experiment was laid out on a split plot design with two replicates. Simulated water logging condition (soil submergence at minimum saturation) was maintained at V9 stage of the crop for 5 days. Initial soil fertility, SPAD reading, leaf length and width, number of leaves per plant, plant height, days to 50% tasseling, days to 50% silking, total biomass and seed yield were recorded. Maize lines, CLYQ 220, CLYQ 203, CLYQ 215, CLRCYQ 49, CLRCYQ 59 and CML 194 were stunted, yellowed and low yielding. Anthesis - Silking Interval (ASI) of selected lines ranged from 1 to 9 days while, ASI of CLYQ 220 and CLYQ 203 extended beyond 10 days. For all maize lines, number of days to tasseling ranged from 55-60 days while silking ranged from 56-65 days. Relative greenness (SPAD values) was depleted after soil submergence in most of maize lines. Multiple cobs were observed in more than 50% maize lines. Elite lines for water logging tolerance are available in locally available maize genome which needs to be explored further.

Keywords: ASI, Maize, Multiple cobs, Soil submergence, Water logging duration

THERMAL RESPONSE OF LEAF PHOTOSYNTHESIS IN EVERGREEN TREE SPECIES IN A SECONDARY TROPICAL DRY FOREST IN CENTRAL SRI LANKA

W.G.I.P. Wijayaraja[1], D.P. Kumarathunge[2], S. Wijesundara[3], M.C.M. Iqbal[3], and N. Geekiyanage[1]

[1]Department of Plant Sciences, Faculty of Agriculture, Rajarata University of Sri Lanka, Anuradhapura, Sri Lanka.
[2]Plant Physiology Division, Coconut Research Institute of Sri Lanka, Lunuwila, Sri Lanka
[3]National Institute of Fundamental Studies, Hantana Road, Kandy, Sri Lanka.

Global temperature has increased by 0.6°C over the past century and is predicted to increase by 1.4–5.8°C by the end of this century. The optimum temperature for leaf photosynthesis ranges between 25°C and 35°C, but predicted increase in temperature may affect light saturated net photosynthetic rate (A_{sat}) and rates of carboxylation capacity (V_{cmax}) and electron transport (J_{max}). Estimation of these rates–largely known for temperate species–enable to model the future changes in net primary productivity of tropical forests. The aim of this study was to compare the optimum temperature of leaf photosynthesis in evergreen tree species against leaf structural traits and shade conditions in a secondary tropical dry forest in central Sri Lanka. The study was conducted in Sam Popham Forest Arboretum, *Dambulla*. Ten leaf structural traits of 10 tree species representing the vertical stratification of the forest were measured from a minimum of three mature tree species. The *in-situ* thermal response of photosynthesis was measured for a range of 20-40°C using a portable infrared gas analyzer by climbing metal towers constructed for canopy access. Contrary to the expectations, leaf shade levels, and structural diversity did not affect the optimum temperature for leaf photosynthesis. The optimum temperature for A_{sat} ranged between 31.05±8.59°C suggesting strong biochemical control over thermal response photosynthesis than the leaf traits measured. Collection and analysis of photosynthetic data from more tropical dry forest tree species is recommended before drawing a solid conclusion.

Keywords: Carboxylation capacity, Leaf structural traits, Optimum temperature for photosynthesis, Rate of electron transport chain