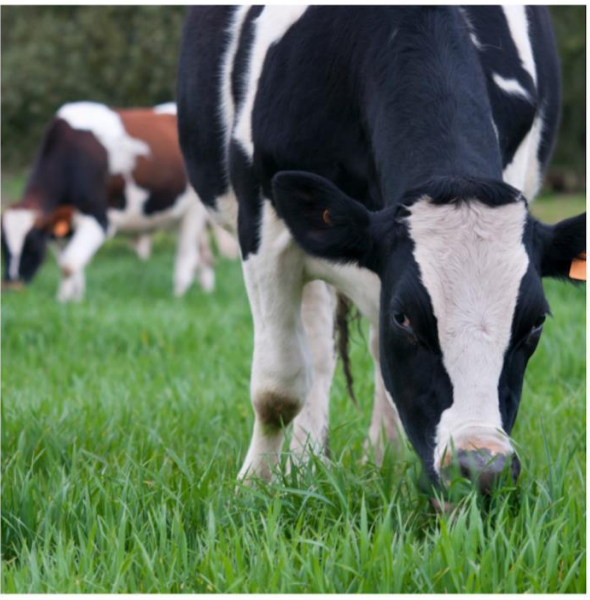
Explore the World Through Research & Innovation



Book of Abstracts

AgSURS|2022

Undergraduate Research Symposium | 2022

Faculty of Agricultural Sciences | Sabaragamuwa University of Sri Lanka

Undergraduate Research Symposium

Faculty of Agricultural Sciences

(AgSURS 2022)

Sabaragamuwa University of Sri Lanka

4th August, 2022

"Explore the World Through Research & Innovation"

Book of Abstracts

AgSURS 2022

Faculty of Agricultural Sciences

Sabaragamuwa University of Sri Lanka

P.O. Box 02, Belihuloya, Sri Lanka, 70140

Abstract book of Undergraduate Research Symposium of Agricultural Sciences 2022

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Undergraduate Research Symposium

Faculty of Agricultural Sciences

4th August, 2022

Explore the World Through Research & Innovation

Thematic Areas

Agricultural Economics and Agribusiness Management

Agri-Environmental Modelling

Agronomy and Soil Sciences

Livestock Production & Food Safety

Plant Breeding and Biotechnology

Plant Protection

Food Processing and Post-harvest Technology

Faculty of Agricultural Sciences,
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Keynote Address
Professor Ranjith Senaratne

Needed: Transformation of conventional agriculture into a tech-savvy, knowledge-based circular agribusiness

Agriculture, which was mainly aimed at feeding the population in the Agrarian Era, has gone through a great deal of transformation to date. The present-day agriculture needs to produce not only food but also feed, fibre, fuel (energy), "cosmeceuticals", nutraceuticals (e.g. dietary supplements, functional food, medicinal food and "farmceuticals"), and biotechnological products such as crops and livestock resistant to pest, diseases and abiotic stresses, vaccines, antibiotics, and enzymes.

However, this sector is beset with a myriad of issues, including stagnant and low yield and quality, poor efficiency in the use of resources, including water and fertilizer, uncoordinated and unregulated production leading to unpredictable gluts and scarcities that cause drastic price fluctuations. Moreover, overuse and abuse of pesticides and fertilizers, heavy post-harvest losses, low-value addition, the predominance of small and scattered holdings, excess labour with low productivity, lack of innovative business models, and poor integration of agriculture into national, regional and global value chains are the other major issues. These issues have been exacerbated by a lack of a rational, coherent, and consistent national policy with a clear sense of direction and depth.

Given the serious economic, social, environmental, nutritional and health issues associated with conventional agriculture, agriculture in the 21st century needs to produce more with less due to limitations in resources such as land, water etc. and harmful effects of inputs such as fertilizer and pesticides and expanding agriculture on landscape, biodiversity and ecosystem services. Therefore, agriculture has to be more productive, eco-friendly, resource-efficient, climate-resilient, knowledge-based, and zero-waste through circular production and integrated into regional and global value chains.

Hence, a step change in agriculture in Sri Lanka is urgently needed to transform it into a tech-savvy export-oriented agri-business through smart farming where the whole process from production, processing, storage, marketing and distribution should be reengineered and remodeled for value chain enhancement. This includes, among other things, advanced provision of weather data, market dynamics and price fluctuation through ICT and early detection of pests and diseases, and determination of water and nutrient needs based on IoT sensors which contribute a great deal to reducing the risk and uncertainty, associated with agriculture and use of input, including fertilizers and pesticides. While applying modern technologies in agriculture, one should not disregard or underestimate the value and relevance of indigenous knowledge (IK) — a precious hitherto untapped national resource — that should be harnessed to enhance agricultural production cost-effectively and sustainably.

With the advent of climate change, there is rising demand for crops and livestock that are resistant to pests, diseases and abiotic stresses. Moreover, owing to the exacerbating land scarcities following the expansion in population and built areas, aquatic agriculture, sea farming, and vertical farming have become increasingly relevant and important. This

demands a suite of technologies to be adopted from among precision agriculture, IT, biotechnology, nanotechnology and remote sensing and GIS along with the 4th Industrial Revolution (4IR), including artificial intelligence, automation, Big Data, drones, Internet of Things, Robotics, 5G technologies etc.

Therefore, it is imperative to rethink not only the way we produce, process, package, store, transport, distribute, market, deliver and consume food, but also the way we dispose of agricultural waste, to create a "zero waste" society. This calls for the transformation of conventional agriculture into knowledge-based circular agriculture through a sea change which will enable increased production based on considerably fewer resources and inputs to achieve sustainability with reduced carbon footprint, water footprint, energy footprint and ecological footprint with greater profit Therefore, a cultural revolution of sorts is the need of the hour paving the way for a new Agri-Culture in Sri Lanka.

Prof. Ranjith Senaratne

Professor Emeritus
Department of Crop Science/ Faculty of Agriculture/ University of Ruhuna
Chairman/ National Science Foundation

Message from the Vice Chancellor
Sabaragamuwa University of Sri Lanka

Senior Professor Udaya Rathnayake

It is an immense pleasure for me to extend my heartfelt appreciation for the 1st Symposium of Agricultural Sciences Undergraduates Research (AgSURS 2022) of the Faculty of Agricultural Sciences, capturing the theme of "Explore the World through Research and Innovation."

Research skills are a prominent part of the curriculum, and our research effort continues to focus on central areas of study, reflecting national and international priorities, while ensuring that we play our role as global citizens. Whether you are a student, academic or potential collaborator, you will find opportunities to achieve research excellence in a meaningful way at the Sabaragamuwa University of Sri Lanka.

Holding the Annual Student Research session in a simple yet graceful manner convinces the stakeholders, the Faculty, and the University to establish an affordable path to continue the event without huge burdens. Including a keynote speech from an eminent scholar as a role model enables the participants and contributors to enhance their wisdom and virtue. I also take this opportunity to appreciate and thank the Dean of the Faculty of Agricultural Sciences and the Symposium committee for their tireless effort to make the Undergraduate Research Symposium a success. I am sure this will motivate our undergraduates to enhance their research capacity while improving their soft skills such as presentation skills and team spirit which are beneficial for them to embark on the world of work.

Snr. Prof. R.M.U.S.K. Rathnayake

Vice-Chancellor/ Sabaragamuwa University of Sri Lanka

Message from the Dean
Faculty of Agricultural Sciences

Prof. P.M. Asha S. Karunaratne

I am delighted to issue this message for the 1st Symposium of Agricultural Sciences Undergraduate Research, Sabaragamuwa University of Sri Lanka - AgSURS 2022. This conference is aimed at bringing together undergraduate researchers, from different agricultural disciplines to a common platform on the theme; "Explore the World through Research and Innovation".

Research and innovation play an essential role in generating smart and sustainable growth by producing new knowledge. The AgSURS provides the opportunity for students to present their research and findings. Presenting at the symposium gives students a valuable presentation experience, as well as a place to network and learn about research in a variety of fields.

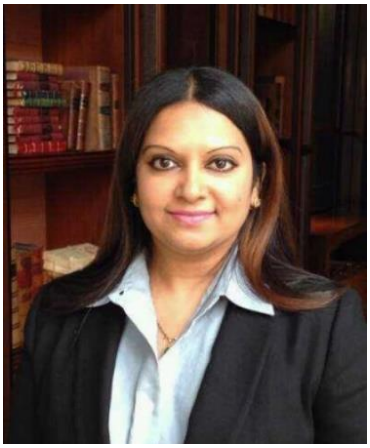
Organizing such a symposium reinforces our objective of developing an environment of exchange of ideas for the progress of the agricultural sector. The hard work and dedication of all the members of the organizing committee during the preparation of this symposium are highly appreciated. Without them, the event would not have been possible.

Finally, I wish all the best to the organizers and participants to make their effort a success.

Prof. P.M. Asha S. Karunaratne

Dean/Faculty of Agricultural Sciences

Message from the Symposium Chair



Dr. R.K.C. Jeewanthi

It is a great privilege to welcome you to the foremost Agricultural Sciences Undergraduate Research Symposium of 2022 held at the Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka. We are delighted to announce that we have successfully organized this event on a virtual platform to gather academics, researchers, and other interested parties amidst the prevailing calamities of the country. This conference aims to publish, educate and make awareness of the young scientists, featuring the theme "Explore the world through research and innovation". We believe that this conference offers a noteworthy opportunity for academics, researchers, and students to present their research findings and discuss their latest research.

The abstracts presented here, have been selected through a strict editorial procedure and we sincerely thank all the researchers who submitted their abstracts for consideration representing seven thematic fields; Agricultural Economics and Agribusiness Management, Agri-Environmental Modeling, Agronomy and Soil Science, Processing and Post-harvest Technology, Agricultural Economics and Agribusiness Management, Livestock Production and Food Safety, Plant Breeding and Biotechnology and Plant Protection. On behalf of the organizing committee of the AgSURS 2022, I would like to extend our thanks to the editorial board and the panel of reviewers for their vigilant work. Also, a special thank goes to the chairmen, for their professional input in the technical forums.

We wish to thank the Vice Chancellor, the Dean of the faculty, and the invaluable comments of all the senior faculty members for their immense support. We are extremely grateful to Professor Ranjith Senaratne, Chairman of the National Science Foundation, for accepting our invitation to be the keynote speaker at the conference. We warmly thank our sponsors for their support in this event, especially during such a challenging period in the country.

Our deepest gratitude is also extended to all the committee members who are actively involved, the entire staff of the Faculty of Agricultural Sciences, and all the administrative staff of the University for their assistance in making this conference a reality. We also wish to thank all the technical support that was given to make this virtual event a success. We wish everyone an unforgettable professional experience at this conference.

Dr. R.K.C. Jeewanthi

Symposium Chair
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Agricultural Economics and Agribusiness Management I

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Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka
4th of August

Study of Factors Affecting the Adoption of Modern Post-harvest Processing Technologies of Pepper in Kegalle District

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Sri Lankan pepper is famous for its inherent pungent quality and is identified as the most widely used spice in the world. Even though the Department of Export Agriculture (DEA), introduced Post-harvest Processing Technologies (PHPTs) to the farmers, they are not much popular among them. The use of those technologies and adoption rates seems to be low. Due to lower-level post-harvest practices, pepper quality is reducing at a rapid pace. As quality is a critical parameter in the global pepper trade, most of the high-end European markets prefer the finest quality pepper and tend to refuse low-quality pepper. The use of appropriate PHPTs is one major way to mitigate production and quality issues related to pepper. Therefore, popularizing PHPTs among the farmers and increasing the technological diffusion rates is crucial. Thus, this study aims to investigate the affecting factors, level of satisfaction, and information-seeking behaviors for the adoption of modern PHPTs. The primary data was obtained from 100 purposively selected pepper farmers in the Kegalle district. Binary logistic regression and Mann-Whitney U Test were employed to analyze the data. The results revealed that internet and credit accessibility, cost of production, and distance to the marketplace have a significant positive impact on technology adoption. As information-seeking behaviors, contacting extension officers and internet searching had a significant positive impact on technology adoption. Only training classes had a significant difference in the satisfaction level for extension services among the adopters and non-adopters and satisfaction was higher in adopters than that of non-adopters. Thus, this study recommends decision-makers formulate necessary strategies to disseminate and popularize new technologies among the farmers by considering the factors affecting technology adoption. Moreover, DEA should take necessary steps to enhance the farmers' knowledge and level of satisfaction with extension services regarding the use of PHPTs.

Keywords: *Farmers' wellbeing, Information-seeking behavior, Post-harvest*

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Consumer Behaviour of Fresh Organic Vegetables to Stimulate a Healthy Lifestyle: With Special Reference to Consumers in the Colombo District

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Consumer awareness and purchasing intention are known to be the most important factors that affect consumer buying behavior towards fresh organic vegetables. Today, consumers' awareness is high about the adverse effects of conventionally produced food, especially vegetables. In the Sri Lankan context, there is a 'niche' market for organic food. However, recent studies show that consumers in urban areas are gradually shifting to organically produced food, especially considering the health and nutritional benefits. This study's objective was to investigate the influence of consumer awareness about organic food, consumer purchasing intention, and consumer awareness about organic food certifications on consumer buying behavior toward fresh organic vegetables. The study was conducted in the Colombo District using a structured questionnaire covering a sample of 110 consumers visiting main fresh food outlets. The data was collected by both physical and online modes. The findings of the study revealed that consumer awareness about fresh organic vegetables, organic food certifications, and consumer purchasing intention towards organic vegetables positively influenced consumer buying behavior. The study suggests that enhanced consumer awareness of organic food and certification along with strengthening factors related to purchasing intention may help to convince consumers to buy fresh organic vegetables. The findings of this research will be useful for stakeholders in the fresh organic food business to develop strategies to promote fresh organic vegetable production and marketing.

Keywords: *Consumer awareness, Consumer behavior, Fresh organic vegetables, Organic food certifications, Purchasing intention*

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4th of August

Implications of Quality Standards on Export Performance of Tea Export Firms in Sri Lanka

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During the past few decades, awareness, and concern regarding food safety among consumers have increased due to the emergence of food safety issues. As a result, the standards, and the regulations on food in many countries have strengthened. The tea industry in Sri Lanka is a key foreign exchange earner. The emergence of stringent standards and regulations in international markets has made a huge challenge for Sri Lankan tea exporters. Thus, this study aims to identify standards for tea in various market destinations and how obtaining certification is important for export performance. This study adopts both qualitative and quantitative approaches with the involvement of 39 tea export firms in the country conducted as an online survey. The case studies involved interviews with four large-scale and four SME {Small and Medium Enterprises} tea exporting companies. This study revealed that the adoption of public voluntary standards by tea export firms is higher (65.7%) than the adoption of private voluntary standards (34.3%). Japan, the EU, and the USA markets are following the most stringent standards for tea. The Japanese market is very strict on the MRLs (Maximum Residue Levels) of pesticides in tea, especially for MCPA (2-methyl-4-chlorophenoxyacetic acid) and Diuron (N-(3,4 dichlorophenyl)- N, N-dimethyl urea). EU market is extremely concerned about social and environmental issues. Secondly, it revealed a high correlation (0.75) between the numbers of certifications adopted by the firms and their export performance measured by the number of market destinations reached. Thirdly, it was revealed that firms with financial and management capabilities are more likely to comply with standards irrespective of the firms' size measured by the number of employees or the firm's experience. Finally, as a strategic response, many tea exporters do their best to comply with emerging standards. The government and responsible institutions of Sri Lanka should provide the necessary support to tea export firms to ensure the position of Ceylon tea in the global market.

Keywords: *Compliance, Export performance, Financial and management capabilities, MRL*

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Reducing Defects in Glass Bottle Handling at a Beverage Production Line to Maintain Production Efficiency: A Case Study at Sunquick Lanka Pvt Ltd.

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Mishandling and accidents that happen during glass bottle handling lead to an increased downtime of the production by reducing the production efficiency. Companies use the six-sigma method to identify the efficiency of production which reduces defects happening in the production. This research intends to reduce the mishandling of glass bottles and accidents in a beverage production line using six- sigma methodology to maintain production efficiency. The research was conducted in a beverage manufacturing company where the production was disturbed by mishandling the glass bottles. The company comprises approximately 60-70 employees. Among them, 45 employees specifically engaged in handling glass bottles. Data were collected using secondary sources. Data were analysed using descriptive analysis. Results revealed that the month of March was the high-risk month to damage glass bottles, followed by February, November, and December. The total loss due to damages during handling was calculated as Rs.3.3 million for 2021 and the number of damages was reported as 8,366 which is a considerable loss for the company. The company's current six-sigma level was identified as 4.2 which is higher than the accepted efficient six-sigma level of 3.4. Thus, the management has to address the issue with production efficiency since there is a considerable amount of glass bottle damage contributing to increased downtime. Therefore, these damages should be more focused on, and the six-sigma value should be minimized to acceptable levels. Employees should be given proper training on the safe handling of glass bottles, especially before the season. Furthermore, supervisors should check whether the employees work under the safety protocols to minimize defects and accidents in handling glass bottles.

Keywords: *Beverage industry, Handling glass bottles, Six-sigma, Supply defects*

Agricultural Economics and Agribusiness Management II

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4th of August

The Impact of Rural Development Projects on Rural Livelihoods: A Case Study of Mushroom Project in Hewadiwela Grama Niladari Division

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Agriculture is an engine of growth and poverty reduction, for rural people of developing nations. Nowadays, many rural communities have the opportunity to improve their livelihoods through mushroom production as a popular medium of self-employment. Saemaul Mushroom Project is a Korean-funded project that operates in the Hewadiwela Grama Niladari (GN) division in the Kegalle district, where the majority of the villagers experience a significantly low economic status. Though this project started a few years back, the project officers were not in a position to provide conclusive evidence for the success or failure of the project. Hence, this study was conducted to find out the true impact of this project on the livelihoods of the Hewadiwela rural community. This study aimed to investigate the impact of the Saemaul mushroom project on the living standard improvement of the Hewadiwela GN division. The study was quantitative and primary data collection tools were structured pre-tested questionnaires and in-depth interviews. The total sample size was 124 respondents and among them, there were selected 65 sample families in the Hewadiwela GN division who were engaged in the Saemaul Mushroom Project and 59 families in the Hewadiwela GN division that were not engaged in the Saemaul Mushroom Project. Propensity Score Analysis, Descriptive Statistics, and Frequency Analysis tools were used to analyse the data by using SPSS 25 version and Stata 17 version. In this study, the independent variable was the mushroom project and the dependent variable was living standard improvement. Among them were, measuring the living standard improvement through income status, saving, food security, education, household property, etc. The propensity score model was estimated using the above dimensions and to estimate the propensity score, the logistic regression model was used. According to the results, the people who participate in the Saemaul Mushroom Project have a higher level of contribution to improving their living standards than those who do not participate in the Saemaul Mushroom Project.

Keywords: M*ushroom production, Rural living standards, Rural development, Saemaul Mushroom Project*

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Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka
4th of August

Study on Implementation of Good Agricultural Practices among Fruit and Vegetable Farmers: A Study in Kegalle District Sri Lanka

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Food safety has been increasingly important in recent years as a result of its relevance to food availability, access, utilization, stability, and nutrition. Consumer interest in safe food while preserving the environment and ensuring worker well-being has increased in recent years. Since 2015, the Government of Sri Lanka has implemented Sri Lanka- Good Agricultural Practices (SL-GAP) certification system as a plan to maintain food safety and quality. However, slow progress in farmers' adaptation to the GAP program and poor tendency for farmers' recertification to the program has been seen. This research aimed to study the factors influencing the successful implementation of the SL-GAP program, level of awareness about good agricultural practices, satisfaction with existing extension programs, and constraints for GAP farmers. 100 fruit and vegetable farmers were interviewed using a pre-tested questionnaire and structured interviews from March to April 2022 and analyzed by descriptive statistics, Mann-Whitney U test, and Binary Logistic Regression. Contact with extension officers, years of farming, government funding, training about good agricultural practices, and having internet access were significant factors for adaptation. Adapted farmers were fully aware of site management, irrigation activities, fertilizer application, storage, and pest & disease control while Non-Adapted farmers didn't aware of the above-mentioned practices of GAP. Lack of premium prices in the local market, unavailability of proper marketing channels, high cost of production, and lack of fertilizers among adopted farmers were the key constraints faced by the SL-GAP certified farmers. Furthermore, satisfaction levels of farm visits, field days, and leaflets showed a significant difference between GAP adapters and Non-GAP adaptors. It can be recommended that government should focus on conducting GAP training including more awareness programs, making available premium prices, and marketing channels. The public and government sector authorities should be more involved and encouraged to provide material support to GAP farmers, especially at the start.

Keywords: *Adapted, Awareness, Non-adapted, Satisfaction*

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The Impact of In-Filling on Sustainable Livelihood Development of Tea Smallholders: A Study in Kalutara District

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Sri Lankan tea industry is strengthened by the tea smallholdings sector as over 75 per cent of national tea production comes from this sector. Lack of productivity in smallholdings is a major problem faced by tea smallholders. Therefore, interventions by the government and other stakeholders are mainly focused on tea in-filling programs to enhance the productivity of smallholder tea lands. Thus, this study attempts to assess the impact of in-filling program commissioned by the Smallholder Agribusiness Partnerships Program (SAPP) for tea smallholders in the Kalutara district. Primary data was collected through a pre-tested questionnaire and direct observations while secondary data was gathered from repositories of SAPP. A stratified random sample of 164 program beneficiaries was selected. Descriptive statistics, principal components analysis, and paired t-tests were used to analyze data. The study revealed that there was a significant impact of the program in terms of tea leaf yield and household income of the beneficiaries. While the average green leaf yield has increased by nine percent, average household income has increased by 12 percent three years after the project. The asset index was 54.10 which was a higher value which reflect a better housing conditions and facilities of beneficiaries. Results revealed that the beneficiaries had a relatively good perception about the program reflected by a high perception index of 778 (out of 820) for the high quality of plantlets supplied by the project for in-filling. High input cost, lack of inputs and problems with floods within the specific area of the district have been identified as the major constraints of tea smallholding sector in the Kalutara district. This study recommends promoting in-filling further, providing subsidies for inputs, restructuring the government policies to increase the availability of inputs for low cost and construction of drainage systems to remove flood water rapidly.

Keywords: I*n-filling, Perception index, Sustainable livelihoods, Tea smallholders, Tea smallholdings sector*

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Identification of Floriculture Export Potential and Barriers with the Supportive Network in the Kurunegala and Kegalle Districts: The case of Mike Flora (Pvt) Ltd.

P.M.G.D. Thilakarathne[1], R.K.C. Jeewanthi[1*], P.A.S.C. Wickramasinghe[2]

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Sri Lanka has enormous botanical diversity and residence of a wide range of floricultural species. The floriculture industry transitioned to a commercial business venture with a high market value and opened as a substantial business opportunity. Especially large-scale export companies work as supportive networks with the collaboration of rural farmers to increase their production and fulfill the required demand. This research was carried attempt to identify floriculture growers' potential to export their products with the help of a supportive network in the Kegalle and Kurunegala area. Primary data were gathered through a pre-tested questionnaire and structured interviews. The researcher used the cluster sampling technique and randomly selected 100 floricultural growers among these clusters to form a sample from Kegalle and Kurunegala areas. Analysis was done using descriptive statistics, Multiple regression, one-way ANOVA, and correlation analysis. First identified the current potential of the selected farmers, 67% were growing a diverse range of plants for local customers. The majority of their customers were local individual farmers who did not enter the export market. They were low engagement in exporting their products due to barriers and connected with the grower society. They had a lack of network with industry expertise and the least trust with the export companies The second objective was to identify those barriers to floriculture export production. The main floriculture entry barrier was a lack of finance and infrastructure facilities. Farmers' perception of participation in training programs and identification of disease conditions of the plant enhanced the income of the grower. This scientific information will be important to recordation the commercialization of agriculture through private sector intervention successfully. The study specifically recommends that more attention should be given to major potentials in areas of finance, infrastructure, and marketing to be strong to be effective support networks with the collaboration of rural farmers.

Keywords: *Export barriers, Floriculture exportation, Floriculture farmers*

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Constraints to Re-cultivation of Abandoned Paddy Lands: A Case of Galle District in Sri Lanka

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The agriculture sector in Sri Lanka is vital to the country's economy. In Sri Lanka, the paddy sector has been playing a significant role in achieving the country's food requirements. Since rice is the staple food of Sri Lanka covering half of the country's daily calorie needs, every government has prioritized the development of paddy cultivation on a national level. The Low Country Wet Zone (LCWZ) of the country has long been considered a zone where paddy farming is less productive and unprofitable. Moreover, paddy yields differ significantly among the districts in LCWZ. Due to various circumstances, The Galle district has a substantial amount of abandoned paddy lands. It has been observed that farmers face various issues during the entire process of re-cultivation of abandoned paddy lands. Therefore, this study aims to identify issues faced by paddy farmers when re-cultivating abandoned paddy lands. Identification of major issues for re-cultivation is beneficial to ensure food security in the area. In this study, a total of 100 paddy farmers with abandoned paddy lands were selected by purposive sampling. Data was collected from a field survey using a questionnaire in the Pahalagamhaya Agrarian Service Division, Bentota. Data analysis was done using Descriptive Statistics and Garrett's Ranking Technique. According to the findings, production difficulties due to flood and salinity problems were identified as the main issues in the re-cultivation of the area. The poor drainage system, lack of access roads to paddy fields, low-profit margin, wild animal damage, shortage of fertilizers, shortage of labour, and lack of capital ranked in the 2nd, 3rd, 4th, 5th, 6th, 7th and 8th ranks among the issues respectively. The findings of this study would be useful to the policymakers in planning the re-cultivation of abandoned paddy lands in Sri Lanka.

Keywords: *Constraints, Paddy cultivation, Paddy land abandonment, Re-cultivation*

Agri-Environmental Modelling

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Assessing Soil Erosion and Carbon Storage in Agricultural Soils: A Case Study in the Farm of the Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka

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Soil erosion is one of the most significant threats which affects the soil health and productivity of agricultural lands. The quality of vegetative cover is an important factor that indicates the healthiness of soil. Thus, the study was aimed to assess soil erosion rate and carbon storage in agricultural soil. The study was conducted on the farm of the Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka. It is located in the Mid Country Intermediate Zone, Sri Lanka. Soil erosion and carbon storage of the study area were estimated using Integrated Valuation of Ecosystem Services and Trade-offs (InVEST 3.9.2), InVEST Sediment Delivery Ratio (SDR) and InVEST Carbon models. The soil erosion assessment was done within three different time periods, baseline (2001-2020) period, mid-century (2040-2069) and end-century (2070-2099) period. According to the obtained results, estimated total soil loss ranges from 0 to 274 t ha^{-1} $year^{-1}$ with an annual average 18 t ha^{-1} $year^{-1}$ for the baseline period. For the mid-century and end-century period, total annual average soil loss was 13 and 14 t ha^{-1} $year^{-1}$ respectively. The predicted mean annual soil loss in the study area is 282, 213 and 220 t ha^{-1} $year^{-1}$ for the baseline, mid-century and end-century periods respectively. In the baseline period of the study area received more rainfall than the mid-century and the end-century. Thus, it may cause for high total soil loss and predicted mean annual soil loss in baseline period than other two periods. According to the developed carbon storage map of the study area, the total carbon storage ranges from 0 to 257 t ha^{-1} with average 166 t ha^{-1}. Further, the study shows that among the major carbon pools, aboveground biomass is the most prominent one. The findings of the study would help in formulating soil conservation practices in agricultural soil, to mitigate the present condition of soil erosion and to enhance soil quality and agricultural productivity.

Keywords: *Soil erosion, Carbon sequestration, InVEST SDR model, InVEST Carbon model, Climate change*

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A Primary Model for Estimating Biomass and Carbon Accumulation in Kithul (*Caryota urens L.*)

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With over 2,600 species and 181 genera, Palms (Arecaceae) are one of the most diversified and widely distributed plant families in tropical and subtropical regions. The *Kithul* palm has the ability in alleviating greenhouse gas emissions through carbon sequestration, in addition to mitigating the global warming. Plant biomass is a significant feature of the global carbon cycle which slows the rate of global warming. The purpose of this research was to study and develop a model predicting the biomass and carbon content of the fishtail palm and in its components. This research was conducted in the Ratnapura district of Sri Lanka. Using destructive procedures, the biomass of the fishtail palm trunk and various fishtail palm components (fronds, leaves, stem, base and stalk in frond) was estimated at different age levels ranging from 1 to 15 years old. Tree total dry weight contributed an average of 45% to total aboveground palm biomass, while moisture content contributed to an average of 55%. Of the total tree dry weight, total carbon amount in a tree accounted for 7%. According to the estimates, the average carbon stock in a 15 years old fishtail palm plantation is 5 tC/ha. Present study investigated the potential to predict tree biomass using data derived from field and laboratory measurements. It is evident from results that the above ground biomass provides a comprehensive view of storing carbon in a *Kithul* plantation and the model generated can be used to interpret the carbon content of a *Kithul* palm. Results envisaged that leaf carbon percentage is a key predictor of *Kithul* carbon content. This approach has the potential to dramatically reduce time-consuming fieldwork. Findings generated from the study are extremely useful to enlighten the decision-makers choices on how to manage the fishtail palm plantations in order to mitigate the climate change.

Keywords: *Above ground biomass, Carbon sequestration, Destructive sampling, Kithul*

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Simulation of Potential Oil Palm Production in Sri Lanka Using Agricultural Production Systems Simulator (APSIM) Model

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Global palm oil production has risen in recent decades and is expected to rise even more in the future. However, oil palm cultivation has been banned in Sri Lanka in 2021 due to potential environmental threats. It is cultivated in the Wet zone of Sri Lanka but the yield potential and environmental sustainability have not been studied. Therefore, the objective of this study was to evaluate the sustainability of oil palm cultivation in Sri Lanka using Agricultural Production Systems Simulator (APSIM) model and to forecast the mid-century (2040-2069) oil palm production and evaluate the potential areas for expansion of the cultivation in Sri Lanka. Yield simulations were done at the selected locations in the Wet (Walpola, Galle, Undugoda, Kaluthara and Watawala) and Intermediate (Moneragala) zones of Sri Lanka for baseline (2015- 2030) and mid-century climates. Mid-century simulations were performed under the two Representative Concentration Pathways (RCP4.5 and 8.5) and five General Circulation Models (BNU_ESM, GFDL_ESM, MPI_ESM_MR, MPI_ESM_IR and CCCMA_CanESM2) which were bias-corrected using AgCFSR data. According to the results, the highest and the lowest average yields for the baseline period were recorded at Kaluthara (14.86 tons/ha) and Walpola (9.94 tons/ha) respectively. In all the stations, the annual rainfall was higher than the annual evaporation in most of the years during the baseline period. The average yield at Moneragala (11.29 tons/ha) during the baseline period was higher than some of the cultivated locations in Wet zone. According to the results, water sustainability is ensured and there is no threat to the environment and underground water by cultivating oil palm in the Wet zone of Sri Lanka. There is an unexploited potential for oil palm cultivation in the Intermediate zone of Sri Lanka which needs to be confirmed by field experiments.

Keywords: *Climate change, General Circular Model, Yield potential*

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Model-Based Assessment of Soil Erosion and Carbon Stock in Agricultural Soils: A Case Study in a Plantation Land in Deraniyagala Area

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Soil erosion is one of the major environmental concerns which directly affect the plantation sector in Sri Lanka. Proper assessment of soil erosion for both the current climate and the future climate is key in implementing soil and water conservation measures to increase the productivity of plantation lands. Climate change is another challenge faced by humans with ever-increasing levels of greenhouse gas emissions. Assessment of carbon stock plays a major role in mitigating climate change through carbon sequestration in agroecosystems. This study assessed soil erosion and carbon stock in plantation land in Deraniyagala area using the Integrated Valuation of Ecosystem Services and Trade-offs Sediment Delivery Ratio model and Carbon Storage and Sequestration model. The estimated mean soil loss rate of the study area for the current climate (2016-2020), mid-century climate (2040-2069), and end of the century climate (2070-2099) were 106 t (ha year)$^{-1}$, 75 t (ha year)$^{-1}$ and 86 t (ha year)$^{-1}$ respectively. The mean soil loss rate under the current climate was comparatively higher than of the mid-century climate and end of the century climate. In contrast, the mean soil loss rate of the mid-century climate was comparatively lower than the mean soil loss rate in the end of the century climate. The estimated mean carbon stock of the study area was 210 t ha^{-1}. The estimated carbon stock was high in the majority of the land extent mainly due to the healthy forest cover and addition of compost to the fields. Results indicated that the plantation management functioned in an environmentally sustainable manner while practicing soil and water conservation measures at their level best. Hence, the findings of the study will be important to make management decisions regarding conservation measures in the future.

Keywords: *Carbon sequestration, Climate change, GIS, InVEST SDR, Modelling*

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Performance Evaluation of a Simple Model by Inter-comparison with Two Detailed Crop Models

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Maize (*Zea mays* L.) is the second essential and second largest cultivated cereal crop in Sri Lanka. Maize is one of important annual upland crops which gained good local demand. Crop models are modern tools in agriculture that support decision-making which simulate crop growth, development, and yield depending on environment. The established crop model requires comprehensive datasets to perform while simple models are developed under local agronomic conditions. This study has been carried out to evaluate the performance of a simple model by inter-comparison with two detailed crop models. CERES-maize model was calibrated and APSIM-Maize model was validated for local maize cultivar (*Ruwan*) by using observed data obtained from an experiment conducted in published literature. APSIM-Maize model had already parameterized in literature. Therefore, only validation was performed. The experimental data were obtained for two seasons in 2013-2014 time period for three different locations. Dodangolla site is in Intermediate Zone while Mahailuppallama and Kilinochchi sites are in Dry Zone. Resulted RMSE values were 3 days, 7 days, and 1575 $kgha^{-1}$ for anthesis date, physiological maturity date, and yield, respectively in CERES-Maize model calibration. For validation in APSIM-Maize resulted 974 $kgha^{-1}$ RMSE value for yield. Calibration analysis revealed that CERES-Maize model is not calibrated to satisfactory level to perform validation. APSIM-Maize model had validated with good model prediction. The model comparison was performed by using only simple and APSIM-Maize models. These models were statistically alike (RMSE = 990 $kgha^{-1}$, nRMSE = 17%) which reveals simple model performs well same as detailed model. However, the study warrants to be continued further to calibrate and validate CERES-Maize model for *Ruwan* cultivar to assess the performance of simple model by comparing simulated output. Also, other established crop models can be calibrated and validated for different locations in Sri Lanka for *Ruwan* cultivar to predict phenology, growth, and yield.

Keywords: *APSIM-Maize, Calibration and validation, CERES-Maize, Maize, Sri Lanka*

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Maturity Determination of Sugarcane (*Saccharum officinarum* L.*)* Using Airborne Multispectral Images

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Maturity determination of sugarcane has been based on crop agronomic conditions, historical crop yield statistics, and visual observations of the crop. However, some sugarcane plants observed complete ripening before reaching their full maturity age. Yet, physical inspection of the plants within the vast fields of sugarcane is also not possible. In recent years, the increased use of Unmanned Aerial Vehicles (UAVs) has opened up new possibilities for remotely measuring crops. This study focuses on identifying well-grown matured sugarcane fields to obtain high sugarcane yield; by the Normalized Difference Vegetation Index (NDVI) received from UAV images. The NDVI value presents the greenness or chlorophyll activity in an area. Recovery Cane Sugar (RCS) was observed from the Pelwatte Lanka Sugar Company (Pvt) Limited and related NDVI indexes were obtained from 8-12 months old sugarcane fields which are having only plant crops in both intermediate and dry zones. According to the results, NDVI is not significantly different from crop age. Intermediate zone RCS (%) shows a strong negative correlation with NDVI values. The coefficient of determination for the relationship between NDVI and RCS (%) is 0.86 and the correlation coefficient value is - 0.93. In the dry zone also RCS (%) shows a strong negative correlation with NDVI values. The coefficient of determination for the relationship between NDVI and RCS (%) is 0.84 and the correlation coefficient value is - 0.91. So these results can be concluded as RCS has an inverse relationship with NDVI values. This study requires more data to identify the maturity stage of sugarcane in both dry and intermediate zones. Also, this study can be further developed by combining more vegetative indices to find out the best fit index to assess sugarcane maturity.

Keywords: *Brix value, Normalized Difference Vegetation Index, Unmanned Aerial Vehicles, Vegetative indices, Yield assessment*

Agronomy and Soil Sciences

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Strengthening the Nation-wide Open 3D Soil Database of Sri Lanka Using Data Mining

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Soil information is important for addressing issues related to the environment, food, energy and water security. In Sri Lanka, soil data are available through semi-detailed soil series maps which are typically outdated and provide details in soil mapping units. The course nature of the mapping unit does not properly capture the wider range of soil property variation. However, the first version of the open digital soil database of Sri Lanka was developed at 1 km spatial resolution for nine soil properties at five standard depth intervals using the data from 122 locations across the country. The objective of this study was to improve the first version of the open digital soil database using new data. To develop this database, data mining was done by using previous literature from the year 2000-2021. The improved database contains ten soil properties taken from 305 locations (bulk density, sand, silt and clay content, pH, organic carbon, cation exchange capacity, electrical conductivity, volumetric moisture content at 0.33 and 15 bars level) at 250 m spatial resolution. Soil properties were harmonized for 0-5, 5-15, and 15-30 cm standard depth intervals using thin equal area quadratic smoothing splines. To validate the results soil property data were compared with the first version of the open digital soil database and the soil grids. For cross-validation, Empirical Bayesian Kriging and Kriging interpolation methods were used. According to the study, both national and global databases did not show a higher agreement with the collected data as most of the soil parameters were significantly (P<0.05) different from each other. However, most of the parameters in the global database showed over-estimated values. Therefore, both national and global soil databases need further improvement. A digital soil database with 10 parameters was developed to provide reliable and accurate gridded soil profile data for Sri Lanka.

Keywords: *Digital soil database, Empirical Bayesian Kriging, Soil properties, Soil mapping*

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Analysis of Soil Physicochemical Properties and Development of a Database for Farm of the Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka

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Understanding the spatial variability of soil physicochemical properties is important in agricultural and environmental research. Traditional soil series maps are outdated due to their limited use in agricultural decision making. Due to the higher resolution and easy comparison of different standardised depths, digital soil databases are widely used in decision support systems. Therefore, the objective of this research is to assess the variability of selected soil physicochemical properties and to map their spatial distribution in the farm of the Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka. A total of 86 composite soil samples were collected from 43 locations at 0-15 and 15-30 cm depths and analysed for 9 soil physicochemical properties; pH, bulk density (g cm^{-3}), electrical conductivity (µs cm^{-1}), soil organic carbon (%), volumetric moisture content (VMC) at 0.33 and 15 bars levels (mm mm^{-1}), sand (%), silt (%) and clay (%) contents. Measured soil data were harmonized for three standard depths (0-5, 5-15 and 15-30 cm) using equal area quadratic smoothing splines. The data set was subjected to exploratory analysis to describe soil properties and Geostatistical analysis was performed to illustrate the soil spatial variability using Empirical Bayesian Kriging and Local Polynomial interpolation methods in the ArcGIS environment. Results showed higher spatial variability of soil properties within the study area in terms of moderate to strong spatial dependencies of soil properties where the relative nugget effect ranged from 0 – 64.77% under semivariogram analysis. A new digital soil database for the faculty farm was developed that contains interpolated soil property maps for all 9 soil physicochemical properties under three standard depth layers (0-5, 5-15 and 15-30 cm) in raster format. These data provide complementary soil information at a finer scale which can be effectively used for proper land use planning, crop simulations and for other agricultural decision making.

Keywords: *Digital soil mapping, Empirical Bayesian Kriging, Local Polynomial interpolation, Soil physicochemical properties, Soil spatial variability,*

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A Study of the Effect of the Different Fertilizer Mixtures on the Early Growth of Betel (*Piper betle* L.)

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Betel (*Piper betle* L.) is extensively cultivated as a cash crop in Sri Lanka. As a consequence of frequent removal of the betel leaves huge amount of soil nutrients withdraw from the soil permanently. Then must supplied all nutrients through fertilizer application. However, farmers complain, recommended rate of fertilizers given by the Department of Export Agriculture (DEA) is insufficient for the growth of betel. The experiment study was conducted at the Intercropping and Betel Research station (IBRS). The treatments were T1- Cow dung; Gliricidia leaves, T2 - Cow dung; Gliricidia leaves; Eppawala rock phosphate; Dolomite, T3- Jeewamurtham(1:100), T4 - DEA Recommendation - Urea 195g; TSP 65g; MOP 100g; kieserite 60g, T5 - Bio carbon and T6 - Jeewamurtham(1:50). Fertilizer mixtures were applied in three weeks interval. The experiment design was Randomized Complete Block Design (RCBD) with three replicates. The plant height, number of leaves (kada leaves and peedunu leaves), number of lateral branches, leaf length and width were measured as early plant growth parameters in two weeks interval. The soil pH, electrical conductivity, total nitrogen like soil data were measured at the beginning and end of the study. According to the results, a significant difference ($p<0.05$) was observed between the vine height and treatments. The highest mean value for vine height, 91.58cm was recorded for Cow dung, Gliricidia leaves, ERP, Dolomite (T2). Other parameters were not significant difference between the treatments and plant growth. Highest mean value for "Kanda kola" and "Peedunu kola" were recorded as 11.6 and 10.25 respectively for Cow dung, Gliricidia leaves mixture (T1). Treatment 1 which consist with Cow dung, Gliricidia leaves recorded the best early growth parameters. These organic manures supply all nutrients required for the growth of betel and farmers can easily find them for low cost. Since the betel is a perennial crop, it is required to continue this study at least 1-2 years to provide an appropriate fertilizer recommendation to the farmers.

Keywords: *Betel, Fertilizer application, Growth parameters, Nutrient requirement*

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Influence of the Crepe Rubber Processing Wastewater on Soil Characteristics

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The rubber industry is the third-largest export earner in Sri Lanka. However, it has been identified as one of the most polluting industries while producing large amounts of effluent which adversely affects soil and water. Almost half of the rubber companies do not treat the effluent before releasing it into the ecosystem due to expensive and less effective methods. This research was conducted to study the impact of rubber effluent on soil characteristics and to identify the least harmful, cost-effective disposal method. A field-level test and an incubation test were conducted. The incubation experiment consists of six different treatments; raw serum, neutralized raw serum, fifty percent diluted raw serum, fifty percent diluted neutralized raw serum, and completely treated serum while water was the control for eight weeks. Soil parameters; pH, electrical conductivity, organic carbon, bulk density, total nitrogen, and nutrient availability, were measured in two-week intervals. Treatments have been arranged in Completely Randomized Design with four replicates and data were analysed by ANOVA in SAS statistical software. Results showed that soil pH was not significantly different among treatments. The mean pH was not changed conspicuously until 6 weeks, however, in the last week it has changed noticeably. Soil electrical conductivity and the bulk density were also increased with time. Soil nutrients such as organic carbon, available nitrogen, available phosphorus, available magnesium, and available potassium were also increased. Therefore, rubber effluent can be considered a soil nutrient enrichment media since it has many available and exchangeable nutrients. Although there is comparatively low nutrient content in the completely treated raw serum water, when it is continuously added to the soil for a long time period, the nutrient content in the soil becomes rich. Though many nutrients are available in the rubber effluent, the major problem is soil becoming acidic which can disturb nutrient uptake. Fifty percent diluted or neutralized serum is the least harmful and cost-effective method for disposing of rubber effluents.

Keywords: *Crepe rubber, Rubber effluent, Soil characteristics*

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Effect of Foliar Application of Aqueous Moringa (*Moringa oleifera* L.) Leaf Extract on Growth and Yield of Cowpea, Mung bean, and Okra

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Natural plant-derived biostimulants have been used worldwide for the last few decades under sustainable agriculture. Moringa is one of the biostimulants enriched with phytohormones, macro, and micronutrients, vitamins, phenolics, and antioxidants. Therefore, it is timely and important to introduce novel and beneficial biostimulants as such. A field experiment was conducted at Grain Legume and Oil Crops Research and Development Centre during the 21/22 *Maha* season, to investigate the effect of Moringa leaf extract on the growth and yield of Cowpea, Mung bean, and Okra. The experiment was laid in Randomized Complete Block Design (RCBD) with four treatments and four replicates. The treatments used were T1 (foliar spray 5% Moringa leaf extract + organic fertilizer), T2 (foliar spray 10% Moringa leaf extract + organic fertilizer), T3 (organic fertilizer), and T4 (recommended synthetic fertilizers). Spraying commenced two weeks after crop establishment and then once in two weeks intervals thereafter. Cowpea and mung bean received 3 applications while okra had 5. The results revealed that the application of T2 significantly increased the plant height (69.17±7.27 cm), canopy width (44.82±1.38 cm), and 100 seed weight of cowpea (17.11±0.33 g) over T3. However, T2 produced the highest yield (1594.33±96.72 kg/ha) over the other treatments. T2 significantly increased the plant height (44.57±3.29 cm), canopy width (39.7±2.59 cm), the number of pods per plant (10.44±0.77), and 100 seed weight (4.93±0.17 g) over T3 in mung bean. T4 on mung bean resulted in the highest yield (1214.04±167.19 kg/ha) over other treatments. In okra, T2 significantly increased the plant height (165.95± 9.23 cm), canopy width (110.42±2.88 cm), number of pods per plant (34.50±2.60), and yield (12521.7±533.2 kg/ha) over T3. However, T4 produced the highest pod yield (13334±1020.05 kg/ha). The results of the present study suggest that 10% aqueous Moringa leaf extract could be used with organic fertilizers to boost the crop growth and yield attributes of cowpea, mung bean, and okra as an eco-friendly and cost-effective alternative.

Keywords: *Biostimulant, Fertilizer, Moringa leaf extract, Yield*

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Selecting an Appropriate Seed Coating to Enhance the Initial Growth of Finger millet *(Elusine corocana* L.)

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Finger millet cultivation in Sri Lanka has been facing numerous constraints due to improper spacing, ants' threats, poor germination, etc. Therefore, a field study was conducted to select an appropriate seed coating to enhance the initial growth of finger millet (*Elusine corocana* L.). This research was conducted in four experiments. The first experiment was carried out to enhance the nutrient availability of the seed coat. The second experiment was conducted to enhance the moisture absorption ability of the seed coat. According to the results derived from experiments one and two, newly formed seed coats were tested to increase the anti-ant effect of the seed coat. The best treatment was selected from the third experiment as the best coating combination for finger millet. The best coat was employed to test the utility of the seed coat with broadcasting, row seedling, and seeder method compared with naked seed. The results of the first experiment revealed that T1 (Talc powder: Diatomaceous earth: CMC: TSP) was the best for germination parameters [vigor index (605.87±212.18), germination percentage (99.5%), germination index (12.66±1.83)] and in second experiment T4 (Talc Powder: Diatomaceous earth: CMC: Biochar: Manioc starch) given the best performance in germination parameters [vigor index (479.79±80.8), germination percentage (96.4%), germination index (21.72±5.68)]. The third experiment revealed that T4 (Talc powder: Diatomaceous earth: CMC: Biochar: Manioc starch: TSP: Nepheline ball) has given the highest germination percentage (32.5±0.5) while indicating a lower ant attack problem. The final experiment revealed that coated seed spend low seed rate but high plant density with proper spacing. Hence, the research concluded that the best seed coating mixture was "Talc powder: Diatomaceous earth: CMC: Biochar: Manioc starch: TSP: Naphthalene balls" for finger millet.

Keywords: *Anti-ant, Biochar, Moisture absorption, Nutrient, Seed coating*

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Impact of Inulin and Guar Gum on the Physicochemical, Probiotic and Sensory Properties of Frozen Yoghurt

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There is a growing consumer demand for frozen yoghurt as a healthy alternative for ice cream. Soluble dietary fibers are added in the processing of frozen yoghurt to enhance the physicochemical, probiotic and sensory priorities. Currently little is known about the impact of mixtures of soluble dietary fibers on the above properties of frozen yoghurt. The objective of this study was to produce a soluble dietary fiber (inulin and guar gum) containing probiotic frozen yoghurt, with acceptable physicochemical and organoleptic attributes. Individual and combined effect of inulin and guar gum were investigated during 21 days at the -18°C storage. The results showed that the addition of guar gum and inulin significantly affected ($p < 0.05$) on titratable acidity, pH, overrun and melting rate. A significant reduction of pH was noticed for all the tested samples during the storage period while the level of acidity was increased. The increment of acidity during storage was higher in the sample treated only with inulin than the rest of the samples and the lowest pH values were also found from the same samples. Both inulin and guar gum significantly enhanced the rate of overrun but guar gum had much higher impact than that of inulin. Results of survival assessment of *Bifidobacterium* (BB-12) and *Lactobacillus acidophilus* (LA-5) showed that there was a significant effect ($p < 0.05$) of the dietary fibers on the survival ability of probiotic bacteria during the frozen storage and this was more pronounced when both dietary fibers are used (treatment 3). There was no significant difference ($p > 0.05$) between the sensory attributes of freshly prepared fiber added frozen yoghurt samples and the control. This study has demonstrated that combining soluble dietary fiber, inulin with guar gum can significantly enhance the physicochemical and probiotic properties of frozen yoghurt with acceptable sensory attributes.

Keywords: *Frozen yoghurt, Guar gum and inulin, Physicochemical properties, Probiotics*

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Effect of Light Emitting Diode (LED) Light Spectrum on Post-harvest Fruit Qualities of Selected Banana (*Musa* spp.) Varieties

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Banana (*Musa* spp.) is one of the most popular fruits in the world trade as well as major staple food crop in many tropical countries. Post-harvest losses of banana are about 20%-30% higher than that of other fruits due to the climacteric and perishable nature of banana. At the commercial level, the chemicals used for artificial ripening of fruits lead to serious health hazards for its consumers and affect the nutritional values in certain extent. Therefore, the present study was to investigate the effect of LED irradiation with different wavelength on the ripening and nutritional quality of mature green bananas for post-harvest storage. Mature "Ambul" and "Kolikuttu" bananas were separately stored under blue, red, yellow, green, white LED lights and in dark condition for 8 days. The experiment was conducted in Complete Randomized Design with six treatments and three replicates. Data were analyzed by one-way analysis of variance (ANOVA). The means were separated by Duncan's multiple range test, and differences at $P < 0.05$, were considered to be significant. On the 8th day of storage fresh weight loss%, Total Soluble Solid (TSS), Ascorbic acid and change of peel color were significantly high in order of red < yellow < blue LED lights compared with the control in both banana varieties. On the 8th day of storage, hardness and pH of "Ambul" and "Kolikuttu" banana significantly low in blue LED light compared with the control. At the 4th day after inoculation, the lowest *in vitro* microbe colony growth was recorded under red LED light in both banana varieties and LED light treatment significantly affected on sensory attributes in "Ambul" banana. Blue light treatment was proven to be the most effective in inducing ripening and nutritional quality of mature green bananas during storage, followed by yellow and red LED light.

Keywords: *Banana, Fresh weight loss, LED light, Microbial growth, Post- harvest storage*

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Comparison of Nitrate Content in Cabbage (*Brassica oleracea var. capitata*) under Organic and Inorganic Fertilizer Application

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The excess nitrate consumption of vegetables can result in various health consequences in humans. Nitrate and nitrite are considered widespread contaminants in leafy vegetables. Therefore, determining the nitrate and nitrite levels in leafy vegetables is important to ensure human health. This study compares the nitrate content in cabbage under five different fertility treatments. During the process, 100% organic (T1), 100% inorganic (T6), 75% organic + 25% inorganic (T3), 50% organic + 50% inorganic (T4), 25% organic + 75% inorganic (T5), and control without fertilizer application were used as treatments for cabbage plants grown under controlled environmental conditions during January to April with 12 replicates and the entire experiment was duplicated. Growth parameters, such as plant height, number of leaves, plant fresh weight, dry weight, and the leaf area index were measured. The level of nitrate accumulation in cabbage plants was determined by the salicylic acid digestion method. Hundred percent inorganically grown cabbage samples contain higher nitrate content (5609 mg/kg) compared to the 100% organically grown cabbage samples (444 mg/kg). However, optimum plant growth was recorded in 50 % organic fertilizer + 50 % inorganic fertilizer combination (T4) with moderate nitrate accumulation (1,485 mg/kg) compared to T3, T5, and T6. In summary, the study concludes fertility treatments have a significant impact on nitrate accumulation in cabbage while 1:1 organic and inorganic fertilizer application is necessary for optimum plant growth with moderate nitrate accumulation.

Keywords: *Accumulation, Cabbage, Nitrate, Spectrophotometer*

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Importance and Major Concerns for Implementation of British Retail Consortium (BRC) Food Quality Management System in Cinnamon Production

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Food safety and quality management are an important part of an organization's system for the protection and assurance of human health. Implementing standards in the food industry enables us to effectively manage the food company by minimizing food safety risks and increasing the food manufacturer's ability. The overall objective of this study was to analyse the process of applying the British Retail Consortium (BRC) Global Standard to cinnamon production for explore the modifications necessary to adopt the BRC Global Standard while refine the quality process as well as to discuss the challenges and opportunities when implementing the certification. By this research it was investigate the current GAPs in the company using a Self-Assessment Tool based on the BRC regulations. It is mainly divided into seven main sections and also, structured interviews were conducted to achieve the objectives of the study. Several findings were identified and those are divided into two major categories based on the affect for final quality of the product. Under the critical findings, lack of proper segregation, inappropriate airflow effects, need for proper sanitary requirements and potential cross-contamination risks were identified. The findings revealed that the main factors for the adoption of the BRC food safety and quality management system were related to achieving better control over the production, boosting the company's morale, and demonstrating the advantages it provided and also certification implementation for mostly to address the European Union and reach the requirements of other major exporting destinations and doors being open for new international markets as a great marketing tool, which led to a long-term stable relationship with current clients. Time management and planning for implementation, along with the highest level of employee commitment and changing attitudes to create a quality culture in the organization, will lead to the successful quality offering of cinnamon products.

Keywords: *British Retail Consortium (BRC), Cinnamon, Food Quality Management*

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Potential Use of the Sri Lankan Indigenous Fruit; *Hal* (*Vateria copallifera*) in Composite Flour for Diabetic Patients

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Unhealthy dietary habits have been linked to metabolic disorders and a higher risk of noncommunicable diseases (NCDs). Consumers increasingly believe that foods have a direct impact on their health. Today, foods are designed not only for key intended functions; satisfy hunger, provide necessary nutrients, and improve physical and mental health, but also to prevent nutrition-related diseases among people. Anti-diabetic properties of *Hal* (*Vateria copallifera*) seed flour have been well established in the literature. This study was conducted to develop a composite flour product for diabetic patients from *Hal* seed flour incorporated with brown rice flour as a substitute for highly refined wheat flour. Three blending ratios of *Hal* seed flour and brown rice flour viz. 1:0, 1:1, and 2:1 were tested in this study. Sensory quality evaluation was done to select the best formulation of human appeal and a one-way ANOVA test was used to determine the acceptability. It was concluded based on the sensory evaluation that, a 2:1 *Hal* seed flour with brown rice flour blending ratio on weight was the best for composite flour production. The nutritional analysis of composite flour confirmed that it contains six percent moisture, six percent ash, six percent fat, 14 percent dietary fiber, and no sugar. A market survey was conducted with diabetic patients in the Mathugama administrative area to investigate consumer opinion towards the newly developed composite flour. Data was gathered from 100 respondents using simple random sampling. The data of the study revealed that 48 percent of respondents were diagnosed with diabetes after 40 years. Most of them (69 percent) generally consume wheat flour, and the majority (69 percent) were aware of the impacts of different types of flour on blood sugar levels. Overall, this study indicated that 75 percent of the respondents were unaware of the anti-diabetic properties and health benefits of *Hal* seed flour and that the majority (59 percent) preferred to purchase this new mixture as an alternative to wheat flour.

Keywords: *Brown rice flour, Composite flour, Food Product Development*

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Consumer Preference and Chemical and Microbial Stability of a Pepper and Mustard Incorporated Concentrated Yoghurt Spread

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The incorporation of spices into concentrated yoghurt is a novel product concept in Sri Lanka. The incorporation of pepper and mustard; which are popular spices in Sri Lanka, is a modern and long-lasting trend in the traditional food spread market that increases consumer preference while also providing health benefits to its consumers. The objectives of the study were to develop a pepper and mustard incorporated concentrated yoghurt spread with higher sensory quality for the local market and to evaluate the chemical and microbiological stability of the product for its long-term quality. Experiments were done with different levels of salt on a weight-by-weight basis to obtain suitable texture. The organoleptic properties for the concentrated yoghurt spread showed that the best ratio of salt was one percent by weight (w/w) according to the mean values. Different treatments of concentrated yoghurt spread prepared by changing the level of pepper and mustard (ratio of 1:1) were tested and the data were analyzed using Friedman non-parametric test. Organoleptic attributes such as appearance, taste, aroma, color, mouth feel, texture, spread-ability, and overall acceptability were analyzed using trained sensory panels. Physiochemical parameters such as pH, titratable acidity, dry matter, moisture; and microbiological parameters such as coliform, yeast, and mold count were measured periodically for up to 20 days to evaluate the shelf life of the product. The sensory analysis, physicochemical analysis, and microbiological analysis confirmed that the 0.75 percent (w/w) pepper and mustard incorporated concentrated yoghurt spread was the best product. It was also substantiated that the shelf life of this product was 15 days at 4 °C. According to the consumer preference survey, respondents preferred this novel product over the other spreads at a similar price. The recommended pack size was 100 g in a glass/ plastic jar as the packaging material for this new product.

Keywords: *Concentrated yoghurt spread, Organoleptic properties, Product development, Shelf life, Spices*

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Impact of the COVID-19 Pandemic on Commercial Mushroom Cultivation in Sri Lanka

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The global COVID-19 pandemic has a significant negative impact on agriculture by disrupting the food supply chain and uncertainty of the agriculture-based business operations. Mushroom packed with nutritional value in the form of low calories, high protein, and fiber contents. This study investigated the impact of the pandemic on commercial mushroom cultivation using direct interviews and structured questionnaires through Google forms to gather data during the period from October to November 2021. A total of 147 farmers participated representing all 25 districts of Sri Lanka. Results showed that 82.9% and 17.1% of respondents started mushroom cultivation before and after the COVID-19 pandemic situation, respectively. More than 95% of growers experienced an increase in the price of raw materials for mushroom cultivation after the pandemic situation. According to the growers, there was a variation in "percentage change in cost of raw materials". Majority of them stated that the price change was about 10-20%. The lockdown situation and travel restrictions caused a great impact on obtaining raw materials for mushroom production, and prices were increased. The majority of respondents (84.1%) were unable to obtain mushroom seeds due to the pandemic situation. The opinions of the majority of respondents (39.2%) were very unsatisfied with the Agriculture Instructors' support for mushroom cultivation during the pandemic situation. Ninety percent of respondents have faced marketing problems with the COVID-19 pandemic such as inability to transport the harvest to the market due to curfew (75.6%), loss of purchasing locations (66.9%), and customers not buying the harvest due to health care problems (24.4%). Sixty five percent of respondents mentioned that the selling price per one mushroom packet did not change during the pandemic situation. The results of this study provide important insights about the impact of COVID-19 pandemic for commercial mushroom cultivation in Sri Lanka.

Keywords: *COVID-19 pandemic, Mushroom cultivation, Raw materials, Respondents*

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Influence of Marination Technique, Holding Temperature and Time on Physicochemical Characteristics and Sensory Attributes of Japanese Quail Breast Meat

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The effects of marination method, holding time and holding temperature on physicochemical and sensory attributes of Japanese quail breast meat were assessed. The experimental design was 4 x 3 x 2 factorial arrangement of treatments evaluating four marination methods (unmarinated control, immersion, injection and tumbling), three holding times (4 hr, 8 hr, and 12 hr) and two holding temperatures (4℃ and 8℃). A total of 96 deboned breast meat samples (10 ± 2 g) obtained from 42 day old unsexed Japanese quails, were subjected for marination and tested for marinade uptake, pH, marinade loss, cooking yield, cooking loss, drip loss, hardness and colour. Injection method resulted the highest marinade uptake ($P<0.05$). Three way interactions ($P<0.05$) were significant ($P<0.05$) for meat pH, cooking yield, cooking loss, hardness and lightness (L*). No marination method x holding time x holding temperature interactions were reported for ($P>0.05$) marinade loss, drip loss, redness (a*), and the yellowness (b*). The highest meat pH was observed ($P<0.05$) when unmarinated meat was held for 8 hr and the resulted pH values were not affected ($P>0.05$) by the holding temperatures. Holding marinated meat tumbled for 12 hr at 8℃ resulted the highest cooking yield (60.3%). Holding meat for 12 hr has resulted the minimum cooking loss in unmarinated control, immersion and tumbling marinated meat. Regardless the holding temperature, holding meat for 4 hr resulted the minimum meat hardness in all four marination methods. Holding meat for 12 hr after tumbling held at 8℃ resulted the minimum cooking loss, the highest cooking yield, minimum hardness and lightness (L*). Holding meat at 4℃ for 4 hr after injection marination reported the highest score for aroma, colour, flavor, marinade penetration and overall acceptability. The present study concluded that, holding quail breast meat at 8℃ for 12 hr after tumbling marination is the best in developing meat quality. Quail breast meat when held at 4℃ for 4 hr after injection marination attracts the panelists most.

Keywords: *Immersion, Injection, Marination, Quail, Tumbling.*

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Effect of Litter Material and Elevated Platform Enrichment on Welfare of Broiler Chickens

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Cooling pads in closed-type poultry houses may result in poor welfare in birds due to high moisture content in the surrounding area. This study assessed the effect of litter materials (paddy husk and sawdust) and elevated platform enrichment in the cooling pad area on welfare (foot pad dermatitis (FPD), hock burns, plumage cleanliness, behaviour) and body weight of broiler chickens. On the 10th day of age, 320 Indian River broiler chicks were randomly allocated to four treatments: paddy husk with an elevated platform, paddy husk with no elevated platform, sawdust with an elevated platform, and sawdust with no elevated platform. Each treatment had four replicates (n=20). Behaviour was assessed by scan sampling method using live observation. Other welfare factors were assessed using a scoring system at the end of the production. The generalized linear mixed model and Kruskal-Wallis tests were used for the analyses. There was no effect of litter material on the prevalence of FPD ($P>0.05$). Elevated platforms reduced the severity of FPD both in paddy husk and sawdust ($P<0.05$). The prevalence of hock burns was higher in sawdust ($P<0.05$). Higher plumage dirtiness was observed in paddy husk with no elevated platform than in sawdust with no elevated platform treatment ($P=0.014$). Litter quality was lower in sawdust than in paddy husk ($P<0.05$). There was no significant effect of elevated platforms on hock burns, plumage cleanliness, and litter quality. Litter material or elevated platform enrichment did not affect the body weight of the birds. The frequency of dust bathing behaviour was higher in paddy husk than in sawdust ($P=0.014$). There was no effect of elevated platforms on behaviour. In conclusion, providing an elevated platform reduced FPD with no effect on body weight. Paddy husk resulted in better welfare in broiler chickens in reducing both hock burns and deterioration of litter quality while resulting in a higher frequency of dust bathing behaviour in the cooling pad area.

Keywords: *Behaviour, Broiler chickens, Elevated platform, Litter material, Welfare*

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In Vitro Antibacterial Effect of Leaf Extract of *Atalantia ceylanica* (*Yakinaran*) on *Salmonella* spp., *E. coli* & *Proteus* spp. Isolated from Broiler Chicken Meat

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Foodborne diseases associated with *Salmonella*, *Camphylobacter*, and pathogenic *Escherichia coli* are one of the globally important public health problems in developed and developing countries. Antibiotics are used to control foodborne diseases, yet due to irresponsible use, an alarming problem of resistant development of microorganisms against antibiotics has emerged. Searching for natural alternatives to antibiotics is among the keen interests of scientists today. This study focused on investigating the *in vitro* antibacterial effect of 250 mg/ml and 125 mg/ml concentration levels of ethanol and aqueous extracts of *Atalantia ceylanica* leaves on isolates of *Salmonella* spp., *E. coli* and *Proteus* spp. from broiler chicken meat by well diffusion assay. Antibiotic sensitivity of the selected bacterial isolates was also determined for three commercially available antibiotics viz. Ceftriaxone 30 µg, Ampicillin 25 µg and Gentamycin 10 µg. It revealed that none of the isolates were inhibited by aqueous extracts, but there was an antibacterial effect of ethanol extracts on all the tested isolates. Ethanol extract showed a significantly higher inhibition in all the isolates than that of Ampicillin and Gentamycin. Effect of Ceftriaxone was significantly higher than two concentrations of extracts and two other antibiotics. The higher the concentration of the ethanol extract, the greater the inhibition zone in majority of isolates. This study concluded that there is an antibacterial effect of ethanol extract of *Atalantia ceylanica* leaves at 250 mg/ml and 125 mg/ml concentrations which is more than that of some commercially available antibiotics. But aqueous extract at same concentrations had no inhibition effect. This study will contribute to developing alternative sources for antibiotics.

Keywords: *Antibacterial, Atalantia ceylanica, E. coli, Proteus spp., Salmonella,*

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Isolation of *Vibro* Species from *Machrobacium rosenbergii* in Mahagalwewa and Weerawilawewa Reservoirs and the Sensitivity of *Vibrios* to Commonly used Antibiotics

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Macrobrachium rosenbergii is an important species in Culture-Based Fishery in Sri Lanka. There is high consumption of *M. rosenbergii* both in the local and export markets. However, there are limited studies on the function of the foodborne pathogens particularly *Vibrio* on *Macrobrachium rosenbergii.* Therefore, this study focused on the enumeration of total Vibrio (on TCBS media), and isolation and identification of *Vibrio* associated with *M. rosenbergii* in Sri Lankan reservoirs (Mahagalwewa and Weerawilawewa). The sensitivity of *Vibrio* isolates to commonly used antibiotics (09) including Chloramphenicol, Ciprofloxacin, Tetracycline, Streptomycin, Amoxicillin, Penicillin, Cefixime, Trimethoprim, and Ampicillin was investigated. The highest total *Vibrio* count from *M. rosenbergii* was 1.9483×10^8 CFU/g and the lowest count was 2.7219×10^2 CFU/g while the highest was above the recommended safe limit for consumption of 1×10^6 CFU/g. A total of 14 isolates were identified as genus *Vibrio*. All the isolates were resistant to Ampicillin, Penicillin, and Amoxicillin while all the isolates were sensitive to Ciprofloxacin and Cefixime. The majority were sensitive to Tetracycline, and Chloramphenicol while showing sensitivity, resistance, and intermediate resistance to Streptomycin and Trimethoprim. All the isolates showed multidrug resistance having resistance to more than two showing the multi-drug resistance development. This study concluded that there is a variation of total *Vibrio* present in *M. rosenbergii* and there is a diversity among identified *Vibrio* clusters. There is a higher *Vibrio* count than the allowable limit for human consumption in *M. rosenbergii* collected from both reservoirs. Detection of resistance development of *Vibrio* to common antibiotics concluded as a potential danger for aquatic species, and consumers, and shows that these resistance determinants might spread further in ecosystems, posing major health hazards to both humans and aquatic animals.

Keywords: *Antibiotics, Biofilm, Enumeration, Macrobrachium rosenbergii, Vibrio*

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Biofilm Forming Ability of *E. coli, Salmonella* and *Proteus* spp. Isolated from Beef and Pork Samples

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Free living bacteria produce biofilms on biotic or abiotic surfaces as complex communities residing within an extracellular polymeric matrix as a survival mechanism thriving the harsh conditions. These biofilm forming bacteria get more attention as they are more virulent and resistant to antibiotics and sanitizers. This study isolated *E. coli*, *Proteus* and *Salmonella* spp. from beef and pork and their biofilm forming ability was investigated. Beef (18) and pork (14) samples were collected from three different meat suppliers. *E. coli*, *Proteus* and *Salmonella* spp. were isolated and identified. Eight *E. coli*, seven *Proteus* and eight *Salmonella* isolates were used for determining the biofilm forming ability by spectrophotometrically (at 600 nm) using the microtiter plate assay. Isolates were grown for 120 hrs period in 96-well microtiter plates (10^5 CFU /mL) and biofilms were quantified at every 24 hrs. This study revealed that majority of the bacteria were forming their maximum biofilms at 24 hrs. *Salmonella* isolates showed maximum biofilm formation at 24 hrs and minimum at 48 hrs. Majority of (five) *Salmonella* isolates showed second peak of higher biofilm at 96 hrs in except in three All *Salmonella* isolates exhibited declining of biofilm at 120 hrs. A similar pattern was observed with *E. coli* where the maximum biofilm was recorded at 24 hr, and a subsequent declining at 48 hrs followed by a second peak at 96 hrs, but there were few exceptions (two isolates out of eight) having different biofilm forming patterns. Majority (five out of seven) of the *Proteus* spp. also showed similar pattern but two of the *Proteus* isolates had second peak at 72 hrs. This study concluded that the presence of *E. coli*, *Proteus* and *Salmonella* in beef and pork samples collected from suppliers and more importantly it shows that these bacteria are capable of forming the biofilms at different degrees. Findings of this study will pave a way in determining the control strategies for the devastating phenomenon of bacterial biofilms.

Keywords: *Biofilm, E. coli, Salmonella, Proteus, Quantification*

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Effect of Egg Shape Index and Age of Broiler Breeders on Incubation and Chick Quality Parameters

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The effect of egg shape index and age of broiler breeders on incubation parameters and chick quality parameters were assessed in commercial Cobb 500 broiler. The experimental design was a 3 x 3 factorial arrangement having breeder age (41, 45, and 49 weeks) and egg shape index (72-76%, 76-80%, and 80-84%) as treatment combinations which were evaluated on incubation and chick quality parameters subjecting a total of 5400 eggs within the weight category of 64-67 g. The main effect of the shape index was not significant ($p>0.05$) with incubation parameters; chick yield, the hatch of fertile, hatchability, moisture loss, shell temperature, and embryonic mortality, and with chick quality parameters; Tona score, chick weight, chick length, chick yolk weight, chick yolk free bio-mass, gut weight, and heart weight. However, the main effect of age was significant ($p<0.05$) with moisture loss, yolk weight of chicks, and embryonic mortality at the early stage of incubation. According to the results, the moisture losses showed an increment when advancing the age of broiler breeders. The highest and lowest moisture losses were found at 49 weeks and 41 weeks, respectively. Nevertheless, the results revealed that yolk weight decreased with the age of broiler breeders showing the highest chick yolk weight at 41 weeks of age and the lowest chick yolk weight at 49 weeks of age. Two-way interaction of breeders' age and shape index ($p<0.05$) was significant for early deaths. When considering the percentage of early deaths in each category, the highest early death was observed at 45 weeks of age with 72-76% shape index, and the minimum early death was found at 41 weeks of age with 72-76% shape index and 49 weeks of age with 76-80% shape index. This research conclude that the shape index (72-76%, 76-80%, and 80-84%) had no effect on incubation and chick quality parameters and further provided basic information that could be useful when making decisions on the shape index and age of broiler breeders for broiler chick production of Cobb 500.

Keywords: *Breeder age, Chick quality, Cobb 500, Incubation parameters, Shape index*

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Impact of Heat Stress on Hemato - Biochemical Profile and Production Variation of Dairy Cattle in Low Country Dry Zone

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Dairy farming is one of Sri Lanka's most important industries. Animals reared in dry regions are subjected to high ambient temperatures (T), relative humidity (RH), wind, and solar radiation. The temperature-humidity index (THI) is a data point that is commonly used to assess stress. This study was carried out to assess the impact of heat stress on the hematological, biochemical, and production variation of dairy cattle in the low country dry zone. The study used 20 dairy cows from the Ridiyagama NLDB dairy farm which had similar physiological conditions. Blood samples of 20 cows from both control and treatment groups were collected from the caudal vein into anti-coagulated (EDTA) coated tubes. A complete evaluation of packed cell volume (PCV), red blood cell (RBC) count, and total white blood cells (WBCs) were analyzed. Under the biochemical parameters, Blood Urea Nitrogen (BUN) and Urea content were measured. Production parameters were collected from the database. The data were statistically analyzed using SAS (version No.9.0-2000). THI was used to evaluate blood samples. There is a significant ($p< 0.05$) difference in the production parameter records of both Jersey and Crossbred animals between the control and treatment groups. Also, there is an association between white blood cells (WBCs) concentration and THI of crossbred ($p=0.0001$) and jersey ($p=0.0001$) animals in both the treatment and control groups. Furthermore, there is an association between Urea content and the THI of crossbred ($p=0.0011$) and jersey ($p=0.0008$) animals in both treatment and control groups. Seasonal fluctuations can influence cattle's hematological and biochemical profiles. Therefore, Urea content and WBC content in the blood can be effectively used as clinical diagnostic tools to identify the stress condition of animals in dry zone dairy farming. Further research is required to verify the findings of the study and apply them to commercial-level dairy farming.

Keywords: *Biochemical profile, Hematological Profile, Low Country Dry Zone, Milk yield*

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Morphological Characterization of *Syzygium zeylanicum* in Belihuloya Region and Assessment of its Suitability as a Landscaping Plant

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Syzygium zeylanicum (*Maran*) grows naturally in India, China, Malaysia, Singapore and Sri Lanka. The plant is classified as an underutilized crop, and no studies on its values, other benefits, or morphological characterization have been reported in Sri Lanka. This study focused on the morphological characterization and suitability as a landscaping plant of S. zeylanicum in the Belihuloya region. Data on the morphological characteristics of leaves, flowers, and fruits were collected from randomly selected trees. Landscaping suitability was evaluated using measurements of shading under the crown cover, the air pollution tolerance index of the plant and a perception survey. Leaf (area, length, maximum width of leaf, petiole length, internodal length, and leaf-veins-angle), flower (length and width of style, filament, and length of pedicel, floral cup, and anther) and fruit (pericarp thickness, seed diameter, width and weight of fruit) morphological parameters were significantly different among plants except for width of anther, floral cup and fruit length. The average shading was measured as 88.7%. Seventy six percent of respondents preferred to grow this species as a landscaping plant. Seventy percent of the respondents indicated that the species can be used as a good shade tree. More than 50% of the responses indicated that the fruit appearance, tiny leaves, and branching patterns are features that would give high landscaping value to the plant. The air pollution tolerance index was low and calculated as 9.72 in the control site and 9.32 in the polluted site. This study concluded that the morphological characteristics among trees in the Belihuloya region are diverse except for the width of anther, floral cup and fruit length and can be used as a landscaping plant, mainly as a shade plant. The index values indicate that the plant is sensitive in a polluted environment and can be used as an air pollution indicator.

Keywords: *Landscaping plant, Landscaping suitability, Morphological diversity*

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Molecular and Leaf Morphological Variation among *Syzygium cumini* Trees from Different Locations of Sri Lanka

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Syzygium cumini (L.) Skeels is an underutilized fruit crop. Most of the *S. cumini* trees in Sri Lanka show enormous variability concerning tree and fruit morphology, quality, maturity, and productivity. A limited number of studies have been conducted in Sri Lanka on the benefits and the genetic variability of *S. cumini*. Genetic variability is the variation in alleles of genes or variation in DNA sequences in the gene pool of a species or population. In this study, the molecular diversity analysis of *S. cumini* populations in two different climatic regions was supported by five Randomly Amplified Polymorphic DNA markers (83SP10G14, 87SP10T18, 77SP10G8, OPA 16, OPC 19). DNA was extracted with the use of the CTAB Extraction procedure. The PCR results showed that selected primers support checking the polymorphism in samples. Through RAPD primer screening, primers 77SP10G8 and OPA16 indicated the best results for Belihuloya and Kalpitiya, respectively. This result obtained in primer screening can be utilized in future molecular diversity analysis programs related to *S. cumini*. This study was further concentrated on the leaf morphological characterization of *S. cumini* trees in two different climatic locations in Sri Lanka (Intermediate, and Arid zones). Data were collected as morphological traits. Leaf morphological attributes such as leaf length, width, area, angle, and internodal length showed significant differences between the two locations ($P<0.05$). The Shannon diversity index indicated high diversity in leaf morphology among locations. The findings of the study concluded that there was a variation in leaf morphology and a variation in molecular basis in *S. cumini* trees in these two different locations of Sri Lanka. The DNA polymorphisms for deriving phylogenetic relationships among *S. cumini* using phenotypic characters and RAPD markers are extremely helpful for germplasm management, crop improvement, and varietal selection for breeding programs and protecting indigenous crop wealth in Sri Lanka.

Keywords: *CTAB DNA extraction, Genetic variation, Leaf morphological traits, RAPD PCR amplification, Syzygium cumini*

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Screening of Rice Varieties and Advanced Breeding Lines for Tolerance to Acid Sulphate Soils

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Paddy (*Oryza sativa* L.) is cultivated most extensively as a monocrop in most parts of the country and is the staple food in Sri Lanka. Urbanization leads to a continuous loss of agricultural lands and food demand which are increased due to population growth. Because of this, marginal lands such as acid sulphate soil lands are cultivated to fulfil the demand. Acidic soils have a pH value of about 3.0 and these soils create toxicities and nutrient deficiencies, such as aluminium toxicity. Therefore, a study was conducted to identify acid sulphate soil tolerant rice varieties and advanced breeding lines from 26 genotypes namely, At17-233, Bg16-2062, At20-360, Bg18-897, At19-204, At18-154, At18-1322, At18-1327, At18-928, Bw16-1567, Ld368, At17-271, At20-541, At19-351, At20-353, At13-1558, Bw18-604, At18-2223, Bg19-3093, Bg360, At18-1306, Bg347, At14-713, At19-1723, At18-1310, At20-507. Under low pH levels of 3.0 growth factors of different rice varieties and advanced breeding lines were studied. Under greenhouse conditions, a pot experiment was conducted which studied the plant height and survival percentage of rice genotypes. The experiment was conducted in Complete Randomized Design with twenty-six treatments and three replicates. Another *in-vitro* experiment was conducted to identify the performance of rice varieties and advanced breeding lines under 4 different aluminium concentrations of 0 ppm, 30 ppm, 60 ppm, and 90 ppm at a pH value of 3.0 Yoshida solution in a Randomized Complete Block Design. The experiment was conducted as a two-factor factorial experiment. The two factors were rice variety and Al^{3+} concentration with three replicates. In lower acidic soils the plant growth in susceptible varieties was reduced. Plants shown a decrease in growth with increasing Al^{3+} concentration. At18-1322, At18-1310, At18-2223, and At14-713 advanced breeding lines showed the best performance in *in-vitro* screening method and actual acid sulphate soil conditions considering the number of roots and root length, and number of leaves and shoot length.

Keywords: *Acid sulphate soil, Advanced breeding lines, Aluminium concentration, In-vitro, Varieties*

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Screening RAPD Primers for Molecular Diversity Analysis in Proso Millet (*Panicum miliaceum* L.) Landraces in Sri Lanka

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Proso millet (*Panicum miliaceum* L.) is an underutilized cereal crop that is rich in proteins, vitamins, minerals and also low on glycemic index. It has the potential to address the global concerns of increased demand for food production, water scarcity and malnutrition. Hence, it is a timely concern to incorporate proso millet germplasm for the crop improvement programs in Sri Lanka. Molecular and morphological diversity details of the crop is essential to contribute to crop improvement programs. Therefore, it is required to perform a diversity analysis for the available proso millet germplasm. DNA markers play a vital role in diversity analysis and facilitate the molecular characterization of available germplasm. Random amplified polymorphic DNA (RAPD) has been extensively used for the molecular diversity analysis of species in populations. In the present study four RAPD markers (OPA 16, 77SP10G8, 83SP10G14 and 87SP10T18) were used for primer screening of proso millet. Genetically purified five proso millet cultivars were subjected to the analysis. DNA extraction was done following two different extraction protocols, Mace 2013 and Doyle 1991 to identify the most convenient and applicable method to obtain higher yield and quality DNA from leaf tissues. Both DNA extraction methods have demonstrated their effectiveness in DNA isolation which is suitable for PCR amplification. Among the two DNA extraction procedures Doyle 1991 method provided a higher DNA yield. Extracted DNA was amplified with the four RAPD markers, by Polymerase Chain Reaction (PCR). A total of three RAPD primers (OPA 16, 83SP10G14 and 87SP10T18), have formed `polymorphic bands for selected DNA samples. Monomorphic bands were formed by 83SP10G14 and 87SP10T18 primers in two samples. The OPA 16 primer produced unclear bands. According to the RAPD output OPA 16, 83SP10G14, and 87SP10T18 RAPD markers indicate banding pattern properly over 77SP10G8 marker. These three RAPD primers can be used to molecular diversity analysis of proso millet landraces in Sri Lanka.

Keywords: *DNA extraction, Panicum milliaceum L., Primer screening, RAPD*

Plant Protection

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Effect of Plant Essential Oils and Commonly Used Synthetic Pesticides on Phytotoxic Responses of Chilli (*Capsicum annum*) Seedlings

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Pesticide application is a widespread method of eradicating insect pests that has significant negative consequences for the environment and excessive use of pesticides can adversely affect the growth of non-target host plants in different ways. Pesticide-induced phytotoxicity can affect non-target plants through elevated levels of reactive oxygen species (ROS) responsible for detrimental effects on cell metabolism and biochemical and other physiological activities. In response to phytotoxicity, plants activate an antioxidant defence system consisting of both enzymatic and non-enzymatic components. Essential oils are the safer alternatives to these xenobiotics. In the present investigation, two commonly used pesticides; Carbosulfan®, Abamectin®, and two plant essential oil; Nutmeg oil and black pepper oil were assessed for causing phytotoxicity in chili seedlings. The phytotoxicity induced by these pesticides and plant essential oils at five different concentrations; ¼X, ½X, ¾X, recommended application dose (1X), and 2X of *Capsicum annum* seedlings which are grown under the controlled environmental conditions with 3 replicates in each treatment were evaluated. Following pesticide exposure for 2 days with 7 days intervals, leaf area, plant height, electrolyte leakage, total chlorophyll content, cell viability, total soluble protein content (TSP), total soluble sugar (TSS), and proline level were measured. Both synthetic pesticide-induced concentration and time-dependent phytotoxic responses on the seedling. According to inhibition concentrations (IC_{50}/EC_{50}) Carbosulfan® is more toxic than Abamectin®. Both nutmeg and pepper oil induced, concentration and time-dependent phytotoxic responses in *C. annum* seedlings. Pepper oil is more phytotoxic than nutmeg oil. Analysis of the data revealed that pesticide application at higher concentrations significantly elevated toxicity. The study concludes excessive use of Carbosulfan® and both plant essential oils adversely affect the *C. annum* seedling growth.

Keywords: *Abamectin®, Black pepper, Carbosulfan®, Nutmeg, Oxidative stress*

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Assessment of Parasitoid Guild on Whitefly Pupae in Mid Country Intermediate Zone in Sri Lanka

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Whitefly (*Bemicia tabac*i) is a worldwide insect pest causing severe yield loss and economic injury in many crops. Chemical control has become a challenge due to high resistance development against recommended insecticides. Exploitation of natural enemies that have potential to use as biocontrol agents is an efficient and sustainable pest controlling method that can incorporate into integrated pest management. The study has been done to identify the parasitoids guild of whitefly pupa and to assess their diversity and relative abundance in brinjal and Chilli fields of Mid-country Intermediate Zone during January to March 2022. Whitefly pupae were collected from selected fields in Kandy and Mathale districts and reared in laboratory conditions. Identification of parasitoid species was done using taxonomic keys and the existing literature. Species diversity, richness and evenness were calculated performing Shannon diversity index (H_0) to the sampled data. Seven parasitoids guild species were collected from both Kandy and Mathale Districts, and which belongs to *Encarsia* spp. and *Eretmocerus* spp. and sent for the further identification and confirmation (Species 1-7). Total intensity of parasitism in Kandy was higher in species 2 (46.8%) in Kandy district and Species 3 showed higher parasitism intensity in Mathale district (42.15%). Whitefly infestation was higher in Brinjal compared to Chilli in both districts. Frequency analysis confirmed that the higher whitefly infested in brinjal than in chilli, in both districts suggesting parasitoids guild and whitefly infestation is varying with the crop type. The study confirmed that the parasitoids guild species was more common in brinjal than in chilly in the Mid-country intermediate zone. Species 3 and species 2 could be used as a potential biological control of whitefly in both crops with further evaluation.

Keywords: *Biological control, Intensity of parasitism, Parasitoids, Whiteflies*

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Identification and Control of the Fungal Contaminants in *In Vitro* Cultures of *Heuchera hybrida* (Coral Bells)

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Heuchera hybrida, also called "coral bells," is a versatile perennial with attractive foliage and bell-shaped flowers. To meet the increasing demand for commercial-scale cultivation, tissue culture protocols have been developed. There is a necessity to suppress the growth of fungal contaminants that were present in the original explant or introduce them as laboratory contaminants without causing an adverse effect on tissue cultured plantlets. The objective of this study was to identify fungal contamination in *in vitro* propagated *H. hybrida* and control those using fungicides. Complete Randomized Design (CRD) was used for the experiment. One-way, two-way (Analysis of Variance) ANOVA, and linear regression analysis methods were used. The contaminated fungi were isolated from tissue culture media and cultured on Potato Dextrose Agar and incubated at 25°C for one week. Macroscopic, microscopic, and molecular studies were used to identify fungi. Six fungicides (Carbendazim®, Topsin M 70®, Chlorothalonil®, Mancozeb®, Antracol®, and Homai®) were tested. The effectiveness of fungicides was evaluated using the inhibition zones produced by fungicides against fungal contaminants. Four different types of fungicides were chosen for *in vitro* screening and incorporated into the MS medium at rates of 75%, 50%, 25%, and 10% of its recommended dosage. Three fungal contaminants were identified; *Penicillium* spp., *Phlebia acerina, and Cladosporium* spp. Topsin M 70® showed strong fungicidal effects on *Penicillium* spp. and *Cladosporium* spp., while having a fungistatic effect on *Phlebia acerina*. All the fungicide-treated samples did not have any fungal contamination during the multiplication period of *H. hybrida*. Topsin M 70® in tissue culture medium stimulated *H. hybrida* growth without causing visual toxicities in plantlets. The results of the experiment revealed that a 100 ppm concentration of Topsin M 70® effectively controls the identified fungal contamination in *H. hybrida*, avoiding annual production losses due to fungal contamination.

Keywords: *Fungal contaminants, Fungicides, Tissue cultured Heuchera hybrida*

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Surveys on Bean Mosaic Virus Diseases in Badulla District and Preliminary Study of Effect of Selected Botanicals Against Viruses

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Bean mosaic virus (BMV) is a highly destructive disease and causes huge yield losses in Sri Lanka as well as worldwide. BMV is frequently observed in all bean cultivated lands in Badulla District. The present study was conducted to study farmer awareness regarding bean mosaic virus disease and to determine the efficacy of botanical extracts against viruses (BMV) on *Phaseolus vulgaris*. A survey was carried out in Bandarawela and Welimada area to identify farmer awareness regarding bean mosaic virus disease. The sample size was about 100, and the questionnaire was carried out through face-to-face interviews. Four bean varieties (Bandarawela Green, Capri, *Kota roll* (local), and *Pokuru Sitti*) were cultivated under insect-proof conditions by using a propagator for a period of about 75 days. Bean seeds were treated with seed extracts of *Azadirachta indica*, flower extracts of *Mirabilis jalapa*, and *Cupressus* sp. leaves extracts and seeds were established in open field plots. All the farmers had experienced with bean mosaic virus, but they are not aware of effective management practices to control bean virus disease. Among four varieties grown under insect proofing conditions only the Bandarawela Green variety showed bean common mosaic virus symptoms at the early vegetative stage confirming its seed-borne nature. Bean mosaic virus symptoms were observed *M. jalapa* flower extract-treated bean plants and no symptoms were developed in bean plants from *A. indica* seed and *Cupressus* sp. leaves treated seeds in an open field experiment. All untreated bean plants were infected with bean common mosaic virus. According to the results, botanical extracts *A. indica* seed and *Cupressus* sp. leaves extracts have potential to use as effective seed treatments for bean mosaic viruses. However, further experiment with quantitative data is required prior to making any recommendation.

Keywords: *Antiviral activity, Bean common mosaic virus, Bean golden mosaic virus, Bean yellow mosaic virus*

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Isolation and Screening of Antagonistic Microbes Against *Xanthomonas campestris* Causal Organism of Cabbage Black Rot Disease

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Black rot disease is a highly destructive disease of cabbage cultivations in Sri Lanka and caused by *Xanthomonas campestris*. Bio controls of pathogens by antagonistic microbes are considered desirable alternatives owing to their friendly profile for human health and the environment. Plants harbour diverse microbial communities in their rhizosphere, phyllosphere and endosphere, which play significant roles in plant health and growth. Isolation and screening of antagonism is an initial step for development of microbial pesticides. Therefore, this study was conducted with the objective of isolation and initial screening of antagonistic microbes against *X. campestrisi*is in both laboratory and field conditions. Soil samples were collected from healthy cabbage fields in three different locations such as Seethaeliya research station, Rahangala and Kappetipola area. Black rot infected leaves were collected from cabbage fields in Seethaeliya research station. Soil samples were diluted and soaked overnight and cultured in three different culture media, Nutrient agar, Potato Dextrose Agar and King's B. Black rot infected leaf samples were cultured in Nutrient Agar media to isolate the pathogen. 110 single microbial isolates were isolated from three different areas and dual cultured with *X. campestris* were carried out to screen the antagonistic effect of each microbe. According to *in-vitro* observation, microbial suspension of seven microbial isolates with competition or inhibition effects against *X. campestris* were sprayed onto the infected cabbage plants. Out of seven isolates, isolate Rc3-1 showed effective control of black rot and the same isolate was frequently recovered from the rhizosphere of treated cabbage plants confirming its ability of colonization on the root zone. Seven isolates have inhibitory activity or competition against *X. campestris* and further study is required to evaluate their efficacy in different locations prior to development as an effective microbial pesticide.

Keywords: *Antagonist, Bacterial isolate, Black rot, Xanthomonas campestris*

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