Abstract Book

9th International Horticulture Conference & Expo-2025

Horticultural Transformation: Sustainable Food Safety & Security

April 15-17, 2025

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Biodiversity in Horticulture: Conservation & Utilization

Dynamics of Horticulture-Associated Microbial Communities to Benefit Cucumber Production

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Abstract

Soil microbial communities are fundamental drivers of ecosystem function, playing a crucial role in maintaining soil health, enhancing crop productivity, and managing soil-borne diseases. In horticultural systems, particularly under intensive cultivation, these microbial assemblages can either suppress or support plant health depending on their composition and functional potential. With rising challenges in sustainable cucumber production such as soil degradation, nutrient imbalances, and increased pathogen pressure understanding and manipulating the soil microbiome has become increasingly essential. This review explores the dynamic interactions between horticulture-associated microbial communities and their role in sustainable cucumber production systems. These integrative roles offer unique opportunities to steer soil microbial communities in favor of plant-beneficial traits. The research highlights how targeted soil management practice such as organic amendments, crop rotation, and microbial inoculant can enrich beneficial microbial taxa and functional groups associated with nutrient cycling, disease suppression, and plant growth promotion. By employing advanced soil microbiome analysis techniques, including high-throughput sequencing and quantitative PCR, we investigate the shifts in microbial diversity, structure, and function under different soil and crop management practices. Our findings reveal that specific microbial consortia are closely linked with improved cucumber yield, enhanced nutrient availability, and reduced incidence of soil-borne diseases. Furthermore, we demonstrate how microbial indicators can serve as early predictors of soil health status and crop performance. The presentation will provide a comprehensive overview of how manipulating microbial communities contributes to sustainable horticulture, particularly in high-value vegetable crops like cucumber. Special attention is given to the application of microbiome-based strategies for biological disease management, where promoting antagonistic microbes and disrupting pathogen niches offer eco-friendly alternatives to chemical controls. Overall, this research contributes to a better understanding of the ecological functions of soil microbial communities in horticultural systems and provides practical insights into microbiome-informed management practices. These findings support the development of resilient, productive, and sustainable cucumber production systems by leveraging the power of beneficial microbes. The integration of soil microbiome science into protected cultivation has the potential to revolutionize how we approach crop management, making it more biologically driven and environmentally sound.

Keywords: Cucumber Production, Microbial Community Dynamics, Biological Disease Management, Sustainable Horticulture.

Flavor Evaluation of Chinese Chive Germplasm Resources via HS-SPME/GC-MS and Electronic Nose Technology

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Abstract

Chinese chive is nutrient-dense, rich in bioactive compounds, and valued for its unique flavor, culinary versatility, and medicinal properties. In China, numerous varieties of Chinese chives exhibit distinct flavors, which draw interest from researchers and consumers alike. This study employed headspace solid-phase microextraction gas chromatography-mass spectrometry (HS-SPME/GC-MS) and electronic nose (E-nose) technology to identify and compare volatile compounds in 39 Chinese chive varieties. Results showed variability in the composition and content of volatile components among samples. The electronic nose effectively captured flavor profiles, and enabled differentiation between Chinese chive varieties. 97 volatile compounds were detected by GC-MS, including sulfur compounds, aldehydes, ketones, esters, alcohols, nitrogen oxides, and other substances. Among all varieties, sulfur compounds exhibited the richest variety (14-24 compounds) and the highest content. Twenty-five characteristic volatile compounds with Odor Activity Value (OAV) were identified, with dimethyl trisulfide and dimethyl disulfide, presenting the highest OAV values, and imparting garlic, onion, and floral aromas. Multivariate and correlation analysis between GC-MS and electronic nose comprehensively and accurately revealed samples differences. This study can offer a reliable, accurate method for identifying volatile components and differentiating the flavors of various Chinese chive varieties. Additionally, it will establish a foundation for evaluating and enhancing the Chinese chive flavor quality.

Keywords: Chinese Chive, Electronic Nose, Flavor, GC-MS, Volatile Compounds.

Effects of Different Garlic Straw Additions on Eggplant Rhizosphere Matrix Microorganisms

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Abstract

Garlic has a broad spectrum of antibacterial activity, and garlic straw returning has different degrees of promoting crop growth and soil conditions. In order to explore the effects of different garlic straw additions on eggplant rhizosphere substrate microorganisms, a pot experiment was carried out in the climatic chamber of the East Campus of Tianjin Agricultural University. Three treatments were set: T_0 = eggplant monoculture (CK), T_1 = 14 cloves of straw in each pot (60.2 g in total), and T_2 = 9 garlic heads and 108 cloves of straw in each pot (463.5 g in total), and each treatment was repeated 3 times. High-throughput sequencing was used to determine the species abundance, community structure diversity and function prediction analysis of microbial species in rhizosphere matrix of eggplant. The results showed that the addition of garlic straw to the substrate could increase the dominant microbial community. Matrix bacteria phyla were mainly Proteobacteria, Chloroflexi and Actinobacteriota, and the matrix fungi were mainly Ascomycota and Basidiomycota. Ascomycota is the dominant phylum. In terms of Alpha diversity, the diversity and richness of bacteria and fungi in the rhizosphere matrix of eggplant were reduced, indicating that garlic straw showed good bacteriostatic properties, inhibited the growth of some pathogenic bacteria, reduced the occurrence of diseases, and improved the microbial environment. In the function prediction analysis of matrix fungi, the main manifestations are pathogen-saprophytic, endophytic-pathogen, etc. Therefore, garlic straw can improve the microbial environment of rhizosphere matrix by increasing the dominant microbial community of matrix microorganisms and inhibiting the growth of pathogenic bacteria, and this study provides a scientific basis and technical reference for the selection of appropriate garlic straw addition methods and the study of eggplant rhizosphere matrix microorganisms.

Keywords: Antibacterial Activity, Garlic Straw, Microbial, Rhizosphere, Sequencing.

Evaluation of Fruit Quality of Tangerine Varieties on Australian Bigarade Rootstock Under Climatic Conditions of Malakand

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Abstract

An experiment was conducted at Sub-Tropical Fruit Germplasm Unit, SherKhana, Malakand during 2020. The experiment was laid out in completely Randomized design with single factor and each treatment had three replications. Four varieties of tangerine (*C. sinensis* × *C. reticulate*) were budded on Australian Bigarade (*C. aurantium* L.) rootstock and data were recorded for their different biochemical traits. The results showed that most of the fruit characters were good in Tarnab Dasiy followed by Fair Child. Maximum fruit volume (138.48 cm^3), fruit weight (130.23 g), Number of segments (11.66) and juice percentage (52.12%) was observed in Tarnab Daisy (138.48 mm). However maximum pH (3.20), total sugars (2.29%), and sugar acid ratio (0.83) and were observed in Fair Child. More percentage of peel was observed in Dancy i.e. 25.88%. Total soluble solids were maximum in all the three varieties except Dancy. Maximum Titrable acidity was recorded in Dancy (5.64%). Vitamin C content was analyzed to be more in Dancy. Regarding shelf life Tarnab Daisy and Fair child had maximum shelf life. Based on the above results it is suggested that Tarnab Daisy of attractive orange rind with red blush, Oblate shape, smooth skin, compact columella structure and orange flesh performed best among various tangerine varieties, similarly Fair Child with orange bright rind, oblate shape, very smooth skin, semi hollow structure of columella and orange flesh is also the top Tangerine variety in term of qualitative and quantitative characteristics.

Keywords: Citrus, Sugar Acid Ratio, Root Stock, Skin, Tangerine.

Germplasm Diversification and Unlocking Genetic Potential of Fruit Crops

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Abstract

The importance of genetic resources in fruit crops has been widely recognized since the 19th century. However, the significance of germplasm collections or development, characterization, documentation, maintenance and conservation are rising with time. With the rapidly changing climate scenario, there is a dire need to work on multiple avenues to screen the local germplasm, develop genetically diverse plant material with novel traits including abiotic stress tolerance, introduce new or exotic fruit crops for crop as well varietal diversification and screening for climate change resilience. We have collected and introduced diverse germplasm in citrus, mango, guava, grapes, lychee, longan, jack fruit, dragon fruit, avocado, berries and other exotic fruit crops. The plant material has been distributed to collaborating institutes including Barani Agriculture Research Institute (BARI) Chakwal, Citrus Research Institute (CRI) Sargodha, Mango Research Institute (MRI) Multan and MNS University of Agriculture, Multan under a funded project by PARB, Lahore for adaptability trials and characterization. The introduced plant material has been planted as germplasm blocks in the experimental fruit gardens for further studies. Moreover, genetically diverse mutant germplasm of citrus and guava has also been developed, characterized and planted in field for further evaluations under different research projects funded by HEC and PARC, Islamabad. Salient findings of these research and technology transfer research ventures will be discussed. Conclusively, it is vital to conserve indigenous genetic resources, develop heterozygous plant populations for selections and introduce exotic plant material of potential fruit crops to enrich the fruit basket of the country, broaden the harvest window and enhance exports of quality products.

Keywords: Genetic Resources, Diversity, Introduction, Selection, Breeding, Mutation.

Current Status and Future Prospects of Certified Fruit Nurseries in Khyber Pakhtoonkhwa

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Abstract

Pakistan is a country where small farming households dominate, and horticulture presents a significant opportunity to boost the income of underprivileged communities. The growth rate of horticultural crops has been remarkable, and the sector holds immense potential for expansion in Khyber Pakhtunkhwa (KP), which ranks third in the province after minerals and hydro power. Although nearly all regions of KP are suitable for various fruit plants, the area under cultivation remains limited. A major challenge in growing high-quality fruit plants is the lack of improved, true-to-type, market-oriented, and certified plants. As farming remains a key livelihood, rural communities have increasingly turned to fruit culture, driving demand for quality fruit plant nurseries. However, the nursery sector struggles with issues such as the availability of disease-free and true-to-type plants, outdated cultivars, and private nurseries selling low-quality plants. To address these challenges, Germplasm Units (GPUs) have been established within the Agriculture Research System to supply registered varieties of budwood, graftwood, and cuttings to nurseries. Unfortunately, the limited number of GPUs cannot meet the growing demand. The Federal Seed Certification & Registration Department (FSC&RD), in collaboration with the Agriculture Research System and Department of Agriculture Extension, works to ensure plant authenticity and health. They are focusing on increasing the number of registered nurseries, currently about 160 out of 350 in KP, to meet market demands. Strengthening this sector can improve human nutrition, reduce poverty, and enhance food security. Registering nurseries and producing certified plants ensures quality, motivates new farmers to enter the industry, and supports sustainable agricultural practices. This effort will strengthen the private nursery sector, enhance foreign exchange through better fruit production, and improve farming communities' income and productivity.

Keywords: Certified, Germplasm, Registration.

Transforming Biodiversity Studies in Agriculture: The Role of DNA Barcoding and Meta-Barcoding

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Abstract

Linnaeus taxonomy has been very important for understanding biodiversity by classifying and naming living organisms based on their shared traits. The global decline in taxonomic expertise and the vast number of undiscovered land and marine species necessitates some alternative methods particularly in context of flora and fauna associated with horticultural crops. DNA barcoding, which enables rapid and accurate species identification using genetic sequences, provides a powerful and cost-effective alternative. Meta barcoding extends this potential by allowing the analysis of complex environmental samples, offering insights into community composition and ecosystem interactions. Pakistan, as a signatory to the Convention on Biological Diversity, faces significant challenges in biodiversity conservation due to its largely unexplored flora and fauna and limited molecular data. Advances in DNA barcoding and meta barcoding present transformative opportunities in agricultural contexts, including pest and disease management, identification of invasive species, and monitoring crop-associated biodiversity. These tools can enhance our ability to assess species roles in ecosystems, develop strategies to mitigate climate change impacts, and strengthen sustainable agricultural practices.

Keywords: Meta Barcoding, Biodiversity, DNA barcoding, Sequence Analysis.

Morphological and Biochemical Characterization of Peach (*Prunus persica* L.) Varieties from Quetta, Balochistan

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Abstract

Peach is an important fruit crop of Rosaceae family after apples and pears. Peach production in Pakistan has increased in recent times due to the introduction of exotic varieties and the establishment of well-mechanized orchards. Characterization and evaluation of Peach has become crucial, especially in different climatic zone due to wide variations in germplasm. The present study assessed the morphological and biochemical variations from Peach genotypes grown at Agriculture Research Institute Quetta, Balochistan. Five Peach varieties (Julie Red, Prem Rosa, Mainley, Elberta and Augustan) were evaluated using descriptors developed by the European Cooperative Program for Plant Genetic Resources (ECPGR) and International Board for Plant Genetic Resources (IBPGR). Significant morphological and biochemical variations were observed among the varieties. Augustan exhibited the longest leaf blade followed by Elberta, Prem Rosa, Julie Red and Mainley. The broad leaf blade was observed in Elberta followed by Augustan, Prem Rosa, Mainley and Juile Red. Julie Red, Elberta and Augustan had dark green-colored leaves whereas, Mainley and Prem Rosa had light green-colored leaves. Anthocyanin coloration was observed around the stone in Augustan and Julie Red, however Prem Rosa and Elberta displayed weak anthocyanin intensity and Mainley displayed higher anthocyanin intensity throughout the flesh. Elberta had highest total soluble solids (15.23%) followed by Julie Red (14.16%), Augustan (12.03%), Mainley (11.56%) and Prem Rosa (11.26%). Elberta displayed highest ascorbic acid contents (0.71 mg 100 mL^{-1}) followed by Julie Red (0.67 mg 100 mL^{-1}), Prem Rosa and Mainley (0.60 mg 100 mL^{-1}). The lowest ascorbic acid content was observed in Augustan (0.50 mg 100 mL^{-1}). These findings highlight significant morphological and biochemical differences among peach varieties, providing valuable insights for cultivar selection and improvement strategies in Balochistan's climatic conditions.

Keywords: Baluchistan, Characterization, Germplasm, Peach.

Morphological and Biochemical Characterization of Apple Varieties from Dhirkot, Azad Jammu and Kashmir

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Abstract

Apple (*Malus domestica* Borkh) is an important fruit in temperate climate. It is a vital source of vitamins and minerals. Azad Jammu and Kashmir has accumulated wide range of variability in apple cultivars. Any crop variability should be evaluated since a large range of variability always increases the likelihood of choosing the desired varieties. This study has been designed to evaluate the morphological and biochemical traits of different apple varieties grown in Dhirkot, Azad Jammu and Kashmir. A total of 25 plants were selected and four branches of each plant was tagged from different directions for data collection. Five replications of the experiment were set up using a Randomized Complete Block Design. Data was collected for various parameters including, field parameters such as tree height (m), trunk girth (cm), shoot length (cm), leaf area (cm^2), average date of first flowering (days), duration of flowering (days), fruit set (%), fruit drop (%), fruit size (cm), yield per tree (Kg) and date of harvesting (days), postharvest quality parameters such as pH, titratable acidity (%), total soluble solids (%), total phenol (mg $FeSO_4$ FW^{-1}), total antioxidant activity (mg of GAE 100 g^{-1}) were determined. Statistical software Statistix 8.1 was used to analysis of variance (ANOVA) and the HSD Tukey test was used to compare the means. Results showed that maximum plant height (5.23 m), trunk girth (53.27 cm), shoot length (31.18 cm), leaf area (30.90 cm^2), average date of first flowering (22.60 days), duration of flowering (12.35 days), fruit set (88.80 %), fruit drop (53.80 %), fruit size (88.80 cm), yield per tree (75.60 Kg) and date of harvesting (27.80 days), postharvest quality parameters such as pH (3.86), titratable acidity (1.83 %), total soluble solids (13.16 %), total phenol (103.04 mg $FeSO_4$ FW^{-1}), total antioxidant activity (74.80 mg of GAE 100 g^{-1}) was observed in Star Crimson while duration of flowering (12.35 days) and fruit set (88.80 %) was found maximum in Starking. This study was helpful in assessing the screening of apple varieties based on morphological and biochemical traits.

Keywords: Apple, Dhirkot, Morpho-Biochemical Traits, Varieties.

Horticultural Biodiversity: Conservation and Utilization

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Abstract

Horticultural biodiversity is an important aspect of permaculture and is key to global food security and ecological balance. Conservation and use of horticultural biodiversity are important to create sustainable and resilient agriculture for the future. Horticultural biodiversity mainly includes fruits, vegetables, ornamentals, and medicinal plants. This study investigates the important role of conservation and sustainable use of biodiversity in changing horticulture to solve the global food crisis. Investigate strategies such as landscape and habitat conservation, agroecological practices, and integration of endangered species to understand their potential to enhance genetic diversity and ecosystem services. Special attention is paid to the role of wild relatives and native horticultural varieties in breeding programs to improve disease, climate adaptation, and yield stability. Through case studies and analysis of successful interventions focusing on biodiversity, this work demonstrates how conservation efforts can reduce the impact of monoculture, prevent genetic erosion, and promote sustainable food production. These findings underscore the urgent need for scientists, policymakers, and farmers to work together to integrate biodiversity conservation into practice in horticulture as a way to ensure the safety of the world.

Keywords: Biodiversity, Conservation, Climate Resilience, Sustainable Agriculture.

Exploration of Genetic Architecture of Common Bean Based on Quantitative and Qualitative Traits

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Abstract

A common bean (*Phaseolus vulgaris* L.) is a dual purpose crop used both vegetable as well as legume. It is grown as a cash crop and used as valuable source of protein, fiber, and essential micronutrients for millions of people worldwide. Local landraces cultivated in traditional farming systems are the sole source of its production. Despite being a vital crop, the farmers have been denied access to superior cultivars, and very little attention has been given to the crop for genetic improvement in Pakistan. Common bean landraces constitute a diverse gene pool with broad genetic variations having immense potential in crop improvement and yield enhancement programs. Morphological characterization is essential for understanding the diversity and identifying desirable traits in bean genotype. The genotypes were collected from Plant Genetic Resource Institute, National Agricultural Research Centre, Islamabad and Azad Jammu & Kashmir. The experiment was conducted using Randomized Complete Block Design at Horticultural Research Institute, Islamabad during 2023-2024. This two year study is pioneer being newly conducted in Pakistan with an objective to document the characteristics of common bean landraces. Morphological diversity in qualitative traits (growth habit, leaf shape, flower color, seed color, and seed shape) and quantitative traits (days to flowering, days to pods formation, number of pods per plant, number of seeds per pod, and 100 seed weight) was studied. The data of preliminary analysis of traits showed wide variation for different morphological traits. Secondly, each accession has its own specific and distinguishing traits like flower color, growth habit, seed color and seed shape was observed based on two years data. The core objective was to evaluate the morphological traits of common beans accessions for the identification of the best performing genotypes for breeding purposes to achieve sustainable crop production. This study emphasizes the importance of conserving and utilizing the morphological diversity of common bean for sustainable agriculture.

Keywords: Common Bean, Germplasm, Landraces, Morphological Diversity, Pods.

Characterization and Post-Harvest Management of Mentha Species Under Various Growing Conditions

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Abstract

Mentha (family - Lamiaceae), known as Mint is a perennial aromatic herb rich in antioxidant phenolic compounds. Understanding plant diversity across species, ecosystems and genetic levels is a prerequisite for conserving and sustainably utilizing native plants. Therefore, the present study was conducted with the objectives (i) Characterization of mint accessions based on various morphological & biochemical attributes (ii) Molecular characterization of Mentha species to investigate genetic diversity (iii) Assessment of suitable growth medium for cultivation of mint accessions (iv) Effect of different packaging material on the shelf life of mint. Morphological traits were assessed to identify species-specific characteristics. Quantitative analysis revealed significant variation in stem length (20-65 cm), leaf area (15-45 cm), and chlorophyll index (25-45 SPAD units). Molecular characterization involved DNA barcoding using the Internal Transcribed Spacer (ITS) region of rDNA. The results revealed significant morphological diversity, classified into three distinct groups using Unweighted Pair Group Method with Arithmetic Mean (UPGMA) analysis. ITS markers proved effective in assessing genetic diversity and phylogeny, confirming the species; identities with 95% to 100% similarity to Gene Bank sequences. The present study was conducted to access ten Mentha accessions under two production systems, soil-based and hydroponics for two consecutive years 2022-23. The results revealed that *M. royleana* performed better in agronomic traits as compared to other accessions when grown under hydroponic conditions for two consecutive years. Whereas, biochemical characteristics were increased in soil-based media. Results of the study revealed that fresh weight loss and percent variation in the chlorophyll index were minimal for Low-Density Polyethylene bags followed by food paper bags. Among mint species, *M. royleana* and *M. canadensis* showed minimum weight loss and most of the Mentha species had longer shelf life when grown hydroponically. The present study will provide an opportunity to design commercial packaging and improve mint plants; shelf life and storage. This will enhance the economic value of mint production in Pakistan and ensure a sustainable supply of high-quality mint to meet market demands.

Keywords: DNA Barcode, Growing System, Mentha, Shelf-Life.

Biodiversity Conservation in Horticulture: Approaches to Protected Cultivation and Utilization

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Abstract

Biodiversity conservation is fundamental to sustainable horticulture, as it reinforces ecosystem resilience, improves genetic resource management, and boosts agricultural productivity. In a period marked by climate change, habitat loss, and resource scarcity, horticulture can play a transformative role in preserving plant diversity through protected cultivation and consumption strategies. This abstract inspects innovative approaches that integrate biodiversity conservation into horticultural practices, focusing on cultivation systems, genetic supply management, and policy support. Protected cultivation systems, such as greenhouses, shade houses, and vertical farming, are gaining prominence as effective implements to enhance resource efficiency and crop yield. These systems provide controlled environments that alleviate adversarial climatic conditions, reduce water usage, and improve pest management. The including sustainable practices in horticulture, such systems not only advance productivity but also minimize environmental impact, creating a balance between human needs and environmental preservation. A critical element in this framework is the utilization of indigenous plant species. Attached with modern propagation techniques, such as tissue culture, indigenous plants foster resilience against environmental stressors and pests while preserving the ecological heritage of agro-climatic regions. Biotechnological advancements have revolutionized biodiversity conservation, providing apparatuses to protection rare and endangered horticultural species. Methods like in vitro conservation, cryopreservation, and molecular breeding are pivotal for the long-term preservation of plant genetic resources. This integrated approach confirms the continuity of genetic resources, essential for sustaining agricultural productivity in the face of global challenges. To overcome these barriers, it is essential to strengthen research and development, invest in capacity building, and encourage partnerships between public and private sectors. Aligning biodiversity conservation with horticultural practices offers a pathway to achieving long-term agricultural sustainability, food security, and ecological balance. By integrating innovative technologies, leveraging traditional knowledge, and fostering community appointment, horticulture can become a cornerstone of global biodiversity conservation efforts, ensuring a strong and productive future for generations to originate.

Keywords: Biodiversity Conservation, Genetic Resources, Protected Cultivation, Sustainable Horticulture.

Botanic Gardens as Communicators of Plant Diversity and Conservation

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Abstract

About a third of the world vascular plant species face the threat of extinction due to a variety of devastating activities, including, over-harvesting and over exploitation, destructive agricultural and forestry practices, urbanization, environmental pollution, land-use changes, exotic invasive species, global climate change, and more. According to the Plant Conservation Report 2020, the IUCN Red Listpresently includes assessments for 40,468 plant species, of which 16,620 (41%) are considered to be threatened with extinction or extinct. Botanic Gardens Conservation International (BGCI), together with partners from the National Red List and the Royal Botanic Gardens, Kew, have assembled all currently available digital conservation assessments, including data from IUCN, into a single list of conservation assessments for plants. To address conservation issue botanical gardens can mitigate up to proximal level. Because, botanical gardens devote their resources to the study and conservation of plants, as well as making the world plant species diversity known to the public. Today, there are about 2500 botanical gardens in the world. Together, these botanical gardens cultivate more than 6 million accessions of living plants, representing around 80,000 taxa, or about one-quarter of the estimated number of vascular plant species in the world. One of the major objectives of botanical gardens is to create and support collections of native taxa, and to build and maintain stocks of plants for ex situ conservation and sustainable utilization of plant resources. Botanical gardens not only serve as taxonomic and systematic research centers, but they also play an important role as valuable sources of plant ecology data collection such as phenological indication of climate change, plant physiology and plant growth tactics, and plant animal interactions. Overall, botanical gardens offer a multitude of benefits, including educational, environmental, economic, and cultural advantages, making them valuable assets to any city. Presently, National Herbarium, National Agricultural Research Centre, Islamabad developed botanical garden that have representation of 43% Floral Families of Pakistan along with five Pteridophytes families, seven Gymnosperm families, eighty five dicots families and thirteen monocots families. Moreover, the National Herbarium at NARC hosts largest collection of plant species reported in flora of Pakistan. There are about >100,000 dried plant specimens preserved in National Herbarium which represent about 225 families and 10,000 species. Specimens are placed according to families, genera and species arranged in alphabetical order. The collection is housed in four halls; two are dedicated to Dicotyledons and the other two to Monocotyledons, Gymnosperms and Pteridophytes

Keywords: Biodiversity, Botanical Garden, RAW.

Effect of Green Synthesized Zinc-Oxide Nanoparticles on Growth and Lead Uptake in Food Crops

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Abstract

Excess of lead (Pb) in arable soils is increasingly disturbing vegetables and food crops worldwide. A pot study was conducted to investigate the effectiveness of foliar applications of zinc oxide nanoparticles (ZnO NPs) at different concentrations on two maize varieties: a Pb-tolerant variety and a Pb-sensitive variety. The maize plants were subjected to three levels of Pb contamination (0, 250, 500 mg Kg^{-1}). Various physiological and biochemical parameters were closely monitored, analyzed, and recorded throughout the study. The results showed that ZnO NPs (300 mg L^{-1}) successfully alleviated Pb induced stress across all treatments and enhanced several growth parameters, including plant height (56.6% in V1 and 88.9% in V2), root and shoot dry biomass, chlorophyll content (79.3% in V1 and 38.2% in V2), and gas exchange characteristics. In addition, ZnO NPs treatments significantly reduced electrolyte leakage and H_2O_2 levels, whereas improved activity of antioxidant enzymes in leaves of maize compared to control and Pb stressed plants. This study opens promising avenues for future research and practical applications. These findings suggested the potential of ZnO NPs to enhance crop resistance and yield under metal stress and it can be suggested the application of NPs to a broader range of crops and contaminants for quality food production.

Keywords: Crop Physiology, Cereal Crops, Environmental Remediation, Green Synthesis.

Assessment of Tomato Genotypes Against Yield and Quality Related Attributes Under Arid Climatic Zone

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Abstract

Tomato is one of the widely cultivated vegetable around the world and recognized as protective food because of its diversity, nutraceutical values and export economy. Present study was conducted at Pakistan Agricultural Research Council, Arid Zone Research Centre, Dera Ismail Khan to check the adaptability of seven different tomato genotypes (Nadir, Naqeeb, Nagina, Rio Grande, NIAB, Roma and Pakit) against various agronomic traits grown under poly tunnel houses. Results exhibited the enormous diversity among all determinate genotypes of tomato. Maximum yield was observed in Nadir genotype (49.12 tons ha^{-1}). Regarding physical attributes, Naqeeb possessed heaviest fruit (46.53 g) while fruit length (56.2 mm) and width (51.21 mm) were higher in Nadir. Naqeeb exhibited the highest fruit shape index (1.23 L:W). Higher fruit firmness was observed in Rio Grande (3.88 Kg cm^2). Among chemical traits, total sugars (66.30 %) and ascorbic acid contents (23.10 mg 100 mL^{-1}) were higher in Naqeeb. Whereas pigmented contents viz. lycopene was higher in Nadir (6.60 mg 100 g^{-1}) while Beta carotene were maximum in Naqeeb 188 (mg 100 g^{-1}). These findings highlight the best performance of tomato genotypes (Naqeeb and Nadir) regarding yield and other quality related attributes under arid zone of KPK province. Furthermore, these potential candidates will be helpful to widen the gene pool of tomato varieties and development of tomato progeny block for germplasm enhancement.

Keywords: Germplasm, Genepool, Qualitative Traits, Yield.

Phenotypic Characterization and Clonal Propagation of Avocado Germplasm

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Abstract

Avocado (*Persea americana* Mill.), family Lauraceae have originated from Latin America. Avocado is a remarkable fruit crop with its unique flavor, creamy texture, exceptionally higher nutrient contents and low sugars. Tree grows to a height of 10-12 meters in its natural subtropical to tropical habitat and produces fruit year-round. Globally leading commercial cultivars include Hass, Lamb Hass and Fuerte etc. In Pakistan, Murree Gola-a local selection is growing in the Northern Punjab while California Long and Ceylon Blue are American varieties is suitable for plain areas with cool environments. Under a PARB funded project, exotic and local germplasm of avocado has been collected and planted in exotic fruit crops germplasm unit (GPU), at the institute. The germplasm has been characterized by phenotypic variability and growth behaviour under local climatic conditions. Avocado is being commercially propagated by both sexual and asexual methods. Seedlings usually take longer to bear whereas asexual methods including budding, grafting and micropropagation are potential tools for mass scale propagation and early bearing in avocado. Seedling germplasm could be used as rootstock, or it may also be clonally propagated. Grafted avocado plants are preferred due to early and better-quality fruit production. In the current study, two scion and two rootstock varieties were used for phenotypic characterization and propagation by cleft grafting with 40-50% success. Phenotypic characterization revealed maximum leaf length (7.3 cm) and width (3.73 cm) in V3, greater leaf area (3.2 cm) in V2, maximum internodal distance (3.9 cm) and shoot length (14.1 cm) in V1. The grafted plant material has been planted in field for further growth and evaluation. The imported germplasm of avocado has also been shared with the Horticulture Department, MNS University of Agriculture, Multan for evaluation under south Punjab conditions and Barani Agriculture Research Institute (BARI), Chakwal. Conclusively, avocado cultivation offers enormous potential and could be highly profitable addition for the farmers and other industrial stakeholders of Punjab.

Keywords: Alligator Fruit, Butter Fruit, Biodiversity, Climate Resilience, Drought Tolerance.

Morpho-Physiological Evaluation of Exotic Chrysanthemum (*Chrysanthemum morifolium* L.) Cultivars in Faisalabad

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Abstract

(*Chrysanthemum morifolium* L.) a member of family Asteraceae, is grown as cut flower as well as potted plant around the world, which may flower throughout the year by adjusting photoperiods. Challenging climatic patterns adversely affect their production and quality, which necessitates to evaluate different varieties for selecting those ones which can withstand intense summer temperatures and can produce best quality marketable stems. A study was conducted during 2023-2024 at Floriculture Research Area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad, on ten exotic chrysanthemum cultivars, viz., 'Altaaj', 'Barca', 'Code Green', 'Pinacolada Yellow', 'Podlask Purple', 'Podlask Yellow', 'Rabelo', 'Ribbon Purple', 'Sound' and 'Zambla Lime' to evaluate best cultivars for commercial cultivation in Faisalabad, Punjab, Pakistan. Results depicted that least production time (60 d) was recorded in 'Podlask Yellow' followed by 'Podlask Purple' (71 d) and 'Rabelo' (73 d). 'Zambla Lime' and 'Code Green' performed almost similar regarding production time (84 and 83 d, respectively). 'Ribbon Purple' exhibited longest production time (112 d) followed by 'Barca' and 'Sound' (110 and 106 d respectively). Tallest plant height (115.0 cm) was recorded in 'Sound' followed by 'Pinacolada Yellow' and 'Rabelo' (102.6 and 101.0 cm, respectively). Greatest flower diameter was recorded in 'Zambla Lime' (94.3 mm) followed by 'Pinacolada Yellow' (92 mm). 'Altaaj' and 'Ribbon Purple' exhibited almost similar flower diameter and were statistically at par. 'Zambla Lime' had longest vase life (17.4 d) with least change in flower quality (2.1). 'Altaj', 'Barca,' 'Code Green' and 'Rabelo' exhibited similar vase life (15.0 d). 'Ribbon Purple' exhibited shortest vase life (8.5 days). It is concluded that 'Altaaj', 'Pinacolada Yellow', 'Barca' and 'Rabelo' performed best regarding morpho-physiological characteristics and may be grown for commercial cultivation in agro-climatic conditions of Faisalabad.

Keywords: Cut flower, Temperature, Photoperiod, New cultivars, Vase life.

Formation and Characterization of Nanosuspensions of *Zingiber Officinale* Rhizome for Enhanced Bioactivities

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Abstract

Plants have been used for health purposes from primitive times. *Zingiber officinale* rich in vitamin C, Mg, Ca, flavonoids and paranol. The extract of ginger rhizome was prepared with the Soxhlet method. Nanosuspensions of ginger was prepared with the help of the nano precipitation technique. Antioxidant potential was checked TPC, TFC, and DPPH quantities. Antidiabetic potential was assessed by anti-glycation and alpha-amylase inhibition assays. Cytotoxicity was checked by performing the hemolytic assay. Microtiter dish assay was carried out to check antibiofilm activity. High-performance liquid chromatography (HPLC) and Fourier-transform infrared spectroscopy (FTIR) was done for structural characterization and identification of a functional group, respectively, present in the sample. According to the results obtained, TPC content was high in ginger extract (311.62 mg GAE $100g^{-1}$) than its nanosuspension (160.15 mg GAE 100 g^{-1}). In TFC assay, 330.66 mg CE 100 g^{-1} of extract and 143.70 mg CE 100 g^{-1} nanosuspension was recorded. While, the percentage of DPPH inhibition was found 49.59% and 33.91% for extract and nanosuspension respectively. The growth inhibition against *E. coli* was revealed by extract 67.78% and 50.42% against *S. aureus* while for nanosuspension 67.78% against *E. coli* and 50.42% against *S. aureus*. Nanosuspension and extract of ginger showed a mean percentage of 58.54 and 34.31 for anti-glycation inhibition and 16.5% and 13.67% for alpha-amylase inhibition respectively. Hemolysis was found to be 48.51% and 18.16% in ginger extract and nanosuspension. The HPLC analysis found phenolic acids such as chlorogenic acid and gallic acid. Whereas FTIR spectrum indicated the presence of alkyne, alkane, alkenes, sulfoxides and tertiary alcohols in powdered *Z. officinale*. The ginger nanosuspension has an effective chances for the medical use as this research indicated that nanosuspension of *Z. officinale* can be potential treatment of diabetes mellitus and in-depth studies are required to further evaluate the marvelous properties and therapeutic potentials of this wonder plant. Data analysis was conducted using ANOVA.

Keywords: Antioxidant Potential, Antidiabetic Potential, Nano-Suspensions, Nano Precipitation.

Understanding the Role of Carotenogenesis in Regulation of ABA Biosynthesis and Tuber Dormancy in Potato

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Abstract

Potato tuber dormancy is a complex physiological phenomenon influenced by abscisic acid (ABA) biosynthesis and carotenoid accumulation. This study aimed to determine the relationship between carotenogenesis and ABA levels in regulating dormancy duration across diverse potato genotypes. High-performance liquid chromatography (HPLC) analysis showed that the genotypes with yellow or orange-colored tubers, such as BD 1310-1, BD 1319-2, BD 1326-1, Yukon Gold and BD 1335-4, exhibited higher levels of lutein (950-1400 µg 100 g^{-1} FW) and zeaxanthin (500-850 µg 100 g^{-1} FW). These genotypes had shorter tuber dormancy (45-70 days). In contrast, genotypes with white-fleshed tubers, such as BD1421-5 and Dark Norland, accumulated significantly higher ABA levels (180-195 µg g^{-1} FW) with prolonged tuber dormancy (150-160 days). Statistical analysis demonstrated a strong negative correlation between lutein/zeaxanthin content and dormancy duration ($r = 0.82$, $p \leq 0.05$), while ABA levels showed a significant positive correlation with dormancy duration ($r = 0.87$, $p \leq 0.05$). These findings suggest that carotenogenesis is upstream of ABA biosynthesis, with lutein and zeaxanthin accumulation resulting in early sprouting while ABA accumulation extending dormancy. Understanding this process can be advantageous for potato breeding aimed at increasing tuber storage through dormancy elongation or multiple cropping via forced sprouting for commercial potato production.

Keywords: ABA, Carotogenesis, Flesh Color, Lutein, Potato Tuber Dormancy, Zeaxanthin.

Prospects of Coffee Cultivation in Pakistan

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Abstract

Coffee, the second most traded commodity globally, had a market value exceeding $466 billion in 2022, with a projected growth rate 4.8% from 2023 to 2030. Pakistan 's coffee consumption has increased by 10-15% annually, yet the country imports 100% of its coffee, incurring a trade deficit of over $ 5 million annually. This analysis evaluates Pakistan's potential for domestic coffee cultivation, focusing on ecological suitability, economic implications, and challenges. Region's like Azad Jammu and Kashmir, Khyber Pakhtunkhwa, and northern Baluchistan offer ideal conditions for Arabic and Robusta cultivation, including temperatures of 15-25°C, altitudes of 800-2,000 meters, and well – drained soil's with pH of 5.5- 6.5. Lessons from Vietnam, which transitioned from an importer to the world's second largest coffee exporter generating $ 3 billion annually, highlight the transformative potential of coffee production. Economically, local cultivation in Pakistan could reduce import expenditure and generate $ 100-200 million annually, while creating over 50, 000 rural jobs. However, challenges such as water scarcity, soil management, and the lack of local expertise in coffee agronomy remain significant barriers. Current import tariffs -53% on finished coffee products and 28% on raw coffee – discourage private sector investment. Rationalizing tariffs, coupled with subsidies for coffee nurseries and water – efficient farming practices, could incentivize domestic production. Targeted interventions, including pilot project, public-private partnership, and farmer training program, are essential to overcome these obstacles. By integrating coffee into its agricultural framework, Pakistan can diversify its economy, reduce import dependency, and tap into $85 billion global coffee market, fostering rural development and economic growth.

Keywords: Coffee Cultivation, Economic Diversification, Import Dependency.

Varietal Screening of Papaya Cultivars Based on Their Performance in Local Climatic Conditions

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Abstract

A field experiment was conducted during 2023-24 to evaluate the performance of papaya cultivars with respect to yield, quality and physicochemical properties of fruits under local climatic conditions. The treatments of three varieties viz., Red King, Yellow King and Red Lady were considered as treatments replicated six times in complete randomized block design. Result of study revealed that maximum plant height, lowest virus infestation percentage and leave area were observed from Yellow King while highest value for stem girth was observed from Red Lady. Maximum fruit weight (1.5 Kg) and fruit size (1219 cm^2) was recorded from Red King with highest TSS (9.80 °Brix). Red Lady bears highest fruit yield (56 Kg) per plant. Thus, it is concluded that most suitable variety for cultivation in local climatic conditions of Faisalabad is Yellow King.

Keywords: Red Lady, Red King, Varietal Performance, Yellow King.

Morphological and Genetic Characterization of Pakistani Jujube Genetic Resources

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Abstract

Exploring the jujube (*Ziziphus* spp.) genetic potential can prove a key for crop diversification programmes, as the specie is drought hardy and has vast potential to combat hidden hunger. In-depth characterization is essential for jujube genetic improvement and to conserve germplasm resources. Objective of this study was to characterize 60 jujube accessions based on morphological and molecular traits. Morphological traits necessarily linked to breeding programmes were estimated with wide variation i.e. thorn length differed 0.40-4.23 cm, fruit weight deviated from 2.12-38.15 g, stone weight diverged from 0.30-2.14 g, total soluble solids ranged from 5.73-24.02 % and vitamin-C contents varied from 61.64-165.05 mg 100 g^{-1}. Applied simple sequence repeat markers proved highly efficient with polymorphic information contents (PIC) ranging from 0.4089-0.5882, whereas Maximum Allele Frequency (MAF) varied from 0.3750-0.8917% for selected accessions. STRUCTURE software showed that at K = 2 germplasm was distributed in two populations whereas at K = 3 higher genetic diversity was gained by grouping the germplasm into three populations. Cluster analysis (CA) partitioned the germplasm into three clusters. This study will set a solid foundation for jujube cultivar authentication and as well as will reveal the reference set of morphologically characterized jujube accessions for future studies.

Keywords: Cluster Analysis, Diversity, Microsatellite Markers, Structure.

Assessment of Morphochemical Diversity in Exotic and Indigenous Potato Germplasm

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Abstract

Potato (*Solanum tubersosum* L.) is an important cash crop grown in Pakistan and round the world. It has significant contribution among horticultural crops in terms of food and revenue. Morphological characterization in potato is important to evaluate varieties for variability and yield and correlate important morphochemical traits. A wide range of exotic and indigenous potato germplasm is available in Pakistan. Forty indigenous and exotic potato varieties were evaluated for their morphological and biochemical attributes under Faisalabad environmental conditions. Data were collected for yield per plant, tuber weight (g), tuber firmness, tuber diameter (mm), tuber length (mm), dry matter content (%), ash content (%), moisture content (%), and total soluble solids. Among exotic varieties tuber weight and diameter was higher in Sumi whereas among indigenous varieties it was higher in SL-28-51 and SH-718, respectively. Yield per plant, dry matter and tuber firmness were higher in Fortus among exotic varieties. Among indigenous varieties these traits were higher in FD-73-44, N-96-25 and SL-28-51, respectively. Total soluble solids (°Brix) were higher in Red Ana and GO-22. Moisture content (%) was higher in Asterix and FD-63-1. Tuber length (mm) was greater in Bohemia and SL-28-51. Such studies and datasets shall be useful to evaluate exotic and indigenous germplasm under diverse climatic conditions and identify candidate accessions and varieties for further crop improvement programs.

Keywords: Diversity, Germplasm, Potato, Quantitative Traits, Yield.

Pomological Characterization of Apple (*Malus Domestica*) Genotypes Grown in Gilgit-Baltistan

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Abstract

Apple (*Malus domestica*) is a deciduous perennial tree that belongs to the family Rosaceae. It is one of the most important and widely cultivated fruits in Gilgit-Baltistan. The agro-climatic conditions of Gilgit-Baltistan are suitable for apple cultivation and it is center of local and acclimatized apple genotypes. This research aims to evaluate elite apple genotypes growing in Gilgit-Baltistan on the base of pomological traits. The apple genotypes selected for pomological characterization were Naga Fu 2, Feista, Mondy Gala, and Tracogala and major fruit attribute parameters such as fruit weight (g), fruit firmness (Kg cm^{-2}), and Fruit Shape, were taken to evaluate these genotypes. This research aims to give a detailed characterization of morphological traits among apple genotypes in different areas of Gilgit-Baltistan. The result revealed that maximum fruit weight was recorded in Naga Fu 2 (101.02 g), Mondy Gala (87.61 g), Feista (76.51 g), and Trocogala (66.88 g) respectively. Fruit firmness was maximum in Naga Fu 2 (6.9 Kg cm^{-2}) followed by Tracogala (6.7 Kg cm^{-2}), Mondy Gala (6.5 Kg cm^{-2}), and Fiesta (3.9 Kg cm^{-2}) respectively. The study genotypes were also varied in fruit shape. The genotypes Naga Fu 2, Feista, Mondy Gala was oblong in shape while Tracogala showed conical fruit shape. The result revealed that the genotype Naga Fu 2 was better among selected genotypes and was highest in fruit weight and firmness.

Keywords: Altitude, Conservation, Fruit Firmness, Germplasm.

Diversity Assessment of Citrus Germplasm Through Morphological and Biochemical Markers

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Abstract

Among the various citrus species, the mandarin (*Citrus reticulata*) and sweet orange (*Citrus sinensis*) emerged as the most significant in terms of production volumes and cultivated areas. They are highly appreciated not only for their delightful taste but also for their impressive nutraceutical benefits, particularly due to their rich antioxidant content. Morpho-biochemical characterization and evaluation is the basic key to better identification of desired varieties based on market demand. Therefore, the present study aimed to investigate the morphological and biochemical profiling of 9 mandarin accessions and 18 sweet oranges accessions. Results showed that the Fall glow (76.65 mm) had the highest fruit diameter, Dency possessed higher segments (13) per fruit, and also exhibited greater total soluble solid (11 °Brix), while seedless Kinnow had higher titratable acidity (1.04%) and a notable phenolic content (80.31 µg mL^{-1}), Kinnow low seeded showed maximum ascorbic acid (1.08 mg 100 mL^{-1}) than other mandarin accessions. In sweet orange accession, fruit diameter was higher in Ruby Blood (74.14 mm), whereas Tracco had the maximum segments (14) per fruit, Salustiana displayed greater total soluble solid (12.6 Brix), Morro Blood was superior in terms of titratable acidity (1.49%), Parson Brown exhibited higher ascorbic acid (218.67 mg 100 mL^{-1}) while Wetson presented maximum total phenolic content (136.75 µg mL^{-1}). These findings reveal significant morphological and biochemical diversity among the mandarin and sweet orange accessions, providing crucial data to enhance breeding programs and support the development of marketable and sustainable citrus varieties in Pakistan.

Keywords: Antioxidants Chemical, Mandarin, Sweet Orange, Physical, Sweet Orange.

Conserving Biodiversity through Horticulture: Investigating Substrate Effects on Spore Propagation in Exotic Ferns

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Abstract

Polypodiopsida are a distinct group of vascular plants that are marked by their special reproductive organs, and distinct leaves. However, Ferns are in high demand in Pakistan horticulture market, but their import is banned, leading to a supply-demand gap, we need to propagate ferns by germinating their spores. This study aims to explore the effects of different substrate media on the spore germination and growth of three exotic fern species (Platycerium, Cyrtomium, and Asplenium). Conducted at the Landscape Designing Lab, Department of Horticulture, PMAS-University of Arid Agriculture Rawalpindi, this study emphasis the challenges of propagating ferns locally in Pakistan. The primary objective is to identify the best substrate conditions that encourage the maximum germination rates and healthy growth of fern spores, thereby contributing to the preservation and sustainable cultivation of these species. The study includes a complete experimental design, where spores of the selected fern species are collected and stored in paper bags. The spores are then sown into three different substrate media (peat moss, potting bark, and peat moss) and monitored under controlled temperature, humidity, and light conditions. Each substrate is prepared and sterilized to guarantee a controlled environment for the spores. The germination rates, growth patterns, and physiological responses of the spores are precisely recorded and analyzed over a specified period. The significance of this study remains in its potential to provide valuable insights into the propagation techniques of exotic ferns, which are often challenging to propagate due to their specific ecological requirements. By finding the most suitable substrate media for spore germination and growth, this study aims to improve the successful propagation and preservation of exotic ferns, contributing to biodiversity and ecosystem stability. The findings could have important suggestions for horticulture, conservation, and ecological restoration practices, contributing practical solutions for the sustainable propagation of ferns in regions with similar climatic conditions. The study also highlights the ecological and aesthetic value of ferns, emphasizing their role in enhancing the biodiversity and visual appeal of landscapes. By encouraging a deeper understanding of fern propagation, this research objects to support the conservation of these exotic and valuable plant species, guaranteeing their continued existence in both natural and cultivated environments.

Keywords: Ecological, Exotic, Ferns, Germination, Spore.

Breeding, Genetics & Genomics: Climate Resilient Horticulture

Development of New Superior Quality Grape Varieties with Embryo Rescue Method

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Abstract

Breeders have been conducting research for many years to develop new table grape varieties using different *Vitis* species. Due to the increasing demand for seedless grape varieties, especially in recent years, using them in cross-breeding studies has become very important. However, both parents must be seedless to increase the number of seedless genotypes in the hybrid population. However, in this case, after pollination and fertilisation, young embryos must be transferred to a nutrient agar medium under in vitro conditions using the embryo rescue technique. However, for various reasons, the desired high success rate in embryo rescue studies has not yet been achieved. In this study, embryos obtained from different crossbreeding combinations were transferred to nutrient agar medium at 6, 7, 8, 9 and 10 weeks for 4 years. The most successful crossbreeding combination and the transfer time to nutrient agar medium were examined. In addition, seedless and large berry grape varieties and some seeded varieties that are resistant/tolerant to fungal diseases were selected as parents because they can provide resistance to disease infections in vitro and thus increase the success rate. The results obtained from the study showed that the selected variety and combination significantly affected the success rate in embryo rescue. Especially in combinations with the 'Yalova Seedless' variety as the female parent, more successful results were obtained compared to combinations of other varieties. When the 'Yalova Seedless' variety was pollinated with pollen of 'Red Globe', 'Muscat Bailey A' and 'Exalta' varieties, more seedlings were obtained with the help of embryo rescue. The results obtained over four years showed that the best sampling time after pollination was the eighth and seventh weeks. According to the results, the selected varieties and the sampling time significantly affect the success rate in embryo rescue studies. Therefore, comprehensive breeding studies can achieve higher success rates in which they will be included as pollinators, especially in different seeded varieties that are resistant to diseases and have larger berry sizes.

Keywords: Cross-Breeding, Disease Resistance, Live Embryo, Pollinator, Seedless.

Current Berry Production in the World: Sustainability, Climate Change, and Trade

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Abstract

Berry production has emerged as a critical component of global agriculture, driven by growing consumer demand and international trade. Berries, such as strawberries, blueberries, and raspberries, contribute significantly to the agricultural economies of producing countries while also serving as key exports in the global food market. New berry species and varieties have also been included in this trade recently. However, the industry faces challenges related to sustainability and the impacts of climate change. Sustainable practices in berry cultivation are essential to mitigate environmental trade-offs and adapt to the long-term effects of climate variability. The effects of climate change, including altered precipitation patterns, increased temperatures, and extreme weather events, have profound implications for berry cultivation. These changes threaten both the yield and quality of berries, particularly in regions where water scarcity or heat stress is already a concern. Research recently emphasised the development of climate-resilient berry cultivars that can withstand such conditions. Advances in genomics and breeding programs are paving the way for more adaptable varieties. To address these challenges, research highlights the need for climate-resilient berry cultivars and innovative trade policies that support sustainable practices. Additionally, integrating nature-based solutions and technological advancements can enhance adaptive capacity and promote environmental and economic sustainability. A collaborative approach among stakeholders, including policymakers, researchers, and growers, is vital for fostering a resilient berry production system capable of withstanding global challenges. This paper investigates the interplay of sustainability, climate resilience, and trade in influencing the future of global berry production, emphasising the necessity for creative solutions and collaborative efforts to enhance the sector durability.

Keywords: Berries, Sustainability, Weather Fluctuations.

Harnessing CRISPR/Cas-Based Genome Editing To Enhance Fruit Quality, Yield, And Stress Resilience In Walnut

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Abstract

Walnuts (*Juglans* spp.) are among the most valuable nut crops globally, prized for their rich nutritional profile, economic importance, and environmental contributions. The emergence of CRISPR/Cas-based genome editing offers a transformative approach to overcoming these challenges by enabling precise modifications to the walnut genome. This research explores the application of CRISPR/Cas systems to enhance critical traits in walnuts, focusing on fruit quality, yield, and stress resilience. Enhancing fruit quality involves editing metabolic and regulatory pathways to improve kernel size, shell thickness, oil composition, and nutritional value. For example, targeting lipid biosynthesis pathways can increase the proportion of healthy unsaturated fats in walnut kernels, boosting their market appeal. Yield improvement focuses on genes influencing flowering time, reproductive efficiency, and tree architecture, such as compact growth forms and enhanced fruit set. These genetic enhancements not only improve the sustainability of walnut farming but also reduce dependency on chemical inputs like pesticides and fertilizers.This research employs a multidisciplinary approach, integrating advanced bioinformatics for guide RNA design, high-throughput phenotyping for accurate trait evaluation, and molecular techniques to validate editing outcomes. To ensure safety and efficacy, off-target effects are rigorously assessed using next-generation sequencing and predictive algorithms. Additionally, ethical and regulatory considerations surrounding the deployment of genome-edited walnuts are addressed, with a focus on compliance with international standards and public acceptance. By leveraging the precision of CRISPR/Cas technology, this study aims to develop next-generation walnut varieties that combine superior fruit quality and yield with enhanced stress tolerance. These innovations hold the potential to transform walnut cultivation, making it more resilient to environmental challenges and better suited to meet the growing global demand for high-quality nuts.

Keywords: Abiotic Stress, Fruit Quality, Genome Editing, Yield Improvement.

Flower Diversity of Butterfly Pea (*Clitoria ternatea*) from Matara District, Sri Lanka, and Breeding Novel Flower Phenotypes

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Abstract

Butterfly Pea Clitoria ternatea, a member of the Fabaceae family, plays an important role in folk medicine, floriculture, as a food colorant, and as a pesticide. However, the limited documentation of its diversity in Sri Lanka restricts its use in floriculture. To address this, seeds from eight accessions were collected from the Matara District, Sri Lanka, and planted for characterization. The days to flowering ranged from 60 to 98 days across accessions. Both single- and multiple-petaled flowers were observed, with single-petaled flowers in blue, white, and purple, and multiple-petaled flowers in blue, purple, purple-blue, and white. Petal dimensions varied as follows: banner petal length (4.2–5.6 cm), banner petal width (3.1–4.5 cm), wing petal length (2.0–5.3 cm), wing petal width (1.0–3.9 cm), keel petal length (1.0–4.9 cm), and keel petal width (0.5–3.7 cm). Principal component analysis and cluster analysis revealed separate clustering of blue-flowered accessions at a height of 6.5, while single- and multiple-petaled accessions (white, purple, and whitish-blue single-petaled; purple, purple-blue, and white multiple-petaled) formed two distinct clusters at a height of 6. The pH of petal extracts ranged from 6.3 in blue flowers to 5.7 in white flowers. A cross between a purple single-petaled accession and a light blue multiple-petaled accession produced a novel phenotype of light blue shaded multiple petals, along with a blue multiple-petaled phenotype. Transformation using a transcription factor gene from the anthocyanin biosynthesis pathway was attempted as an alternative method for phenotype development, but seedling transformation resulted in low survival, and floral dip was unsuccessful. These findings shed light on the phenotypic diversity of butterfly pea flowers and the potential for developing novel varieties.

Keywords: Flower Phenotype Diversity, Hybridization.

VvHY5 and VvBEE1 Antagonistically Control Resveratrol Biosynthesis to Mitigate High Light-Induced Damage in Grapevine

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Abstract

Excessive exposure to high light can lead to photoinhibition, which impairs photosynthetic efficiency and causes oxidative damage in plants, such as sunburn in grapevines. This study investigates the role of resveratrol (Res), a stilbenoid with antioxidant properties, in protecting plants from high light damage. We found that exposure to high light increased reactive oxygen species accumulation and induced photoinhibition in grapevine leaves. In response, Res biosynthesis was upregulated, along with an increase in stilbene synthase (VvSTS) expression. Application of exogenous Res alleviated ROS accumulation and improved photosynthetic efficiency. Further analysis revealed that the VvHY5-VvBEE1 regulatory module plays a pivotal role in regulating VvSTS expression under high light conditions. Specifically, VvHY5 activated VvSTS expression, while VvBEE1 repressed it. Transgenic analysis showed that overexpression of VvHY5 enhanced Res production and photoprotection, whereas overexpression of VvBEE1 reduced Res levels and exacerbated light-induced damage. VvHY5 and VvBEE1 competed for binding to the VvSTS promoter, with brassinosteroids (BRs) modulating their interaction. Our findings reveal the interplay between light signaling and brassinosteroid pathways in regulating Res biosynthesis, providing insights for protecting grapevines from sunburn.

Keywords: Grapevine, High Light, Resveratrol, ROS, Vvhy5, Vvbee1.

Identification and Analysis of Abiotic Stress-Responsive bHLH Gene Family in *Brassica oleracea*

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Abstract

Basic helix-loop-helix (bHLH) transcription factors (TFs) are key to stress response, growth, and development of cabbage, a vegetable crop with considerable economic and nutritional importance globally. The study classified the cabbage bHLH gene family into 23 groups, each containing 244 unevenly distributed *BobHLH* genes across nine chromosomes. These genes encode 84 to 1037 amino acids, most of which are hydrophilic. Moreover, it was not limited to the prediction of functions and structures for these genes. Expression analysis under abiotic stresses was conducted to identify the functional and evolutionary relationships in the cabbage genome. Promoter and Gene ontology analysis showed the presence of several abiotic stress-responsive cis-regulatory elements in the *BobHLH* promoter. Most of the identified BobHLH genes were found to be localized in the nucleus, with the majority exhibiting tissue-specific expression patterns. Different abiotic stresses negatively regulate cabbage plant growth at various parameters, including shoot and root fresh and dry weights. Furthermore, RT-qPCR analysis revealed the stress-induced expression of nine *BobHLH* genes in response to cold, heat, NaCl, and PEG. The study thus deduces that these genes further underscore the enhancement potential of cabbage resistance to abiotic stresses and offer valuable targets for genetic improvement and breeding strategies.

Keywords: Abiotic Stress, Cabbage, Expression Analysis, Gene Family.

Development of Carotenoid Biosynthesis Enhancement in Tomato Through CRISPR-Cas System

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Abstract

This study explores the enhancement of nutritional values in tomatoes that is beneficial for human health. Our aim focused on increasing lycopene and β-carotene levels. Traditional plant breeding methods have been insufficient in producing Malaysian-grown tomato varieties with high levels of these nutrients. Therefore, this research utilized CRISPR-Cas9 genome editing to improve tomato nutritional content. By targeting and knocking out the NCED and DET1 genes, the study successfully increased carotenoid content in the tomatoes. The process involved germinating sterilized tomato seeds, designing specific sgRNAs, and using Agrobacterium tumefaciens-mediated transformation. Results showed effective gene editing with minimal mismatches. For the NCED gene, there is only one mismatch found with a pairwise identity of 99.81%. A substitution of nucleotide base A from wild-type tomato plants into nucleotide base C from T0 tomato plant, which encodes the protein from glutamate to aspartate were found. As for DET1 gene, it has been found the gene has two mismatches with a pairwise identity of 99.80%. The editing involved was a deletion of a nucleotide base and the substitution of nucleotide base A from the wild-type tomato plant into nucleotide base G in the T0 tomato plant, which encodes the protein from phenylalanine to leucine. Additionally, a quantitative real-time PCR analysis was conducted to investigate carotenoid content. As we expected, it is shown that the carotenoid content is increasing with the suppression of NCED and DET1 gene expression in tomatoes. The edited tomatoes demonstrated higher lycopene and β-carotene levels, indicating the potential of CRISPR-Cas9 for enhancing crop nutritional values. These findings could be applied to other important crops, offering a promising approach to improving food quality.

Keywords: Food Quality, DET1, Nutritional Values, NCED, sgRNA.

Recent Advances in Plant Biotechnology for Sustainable and Climate-Resilient Horticulture

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Abstract

The increasing challenges posed by climate change, resource depletion, and population growth necessitate innovative approaches in horticulture to ensure sustainability and resilience. Technologies like CRISPR-Cas9 have revolutionized genetic improvement by allowing the development of climate-resilient crops with minimal off-target effects. Plant tissue culture plays a critical role in the rapid propagation of elite genotypes, ensuring uniformity and quality in horticultural crops. Biotechnological advances also contribute to resource efficiency by developing cultivars that require less water, fertilizers, and pesticides, reducing the environmental footprint of horticulture. Furthermore, synthetic biology has opened new frontiers in designing plants with enhanced photosynthetic efficiency and secondary metabolite production. These innovations not only improve crop performance but also enable the cultivation of nutritionally enriched horticultural products, addressing both food security and malnutrition. Biotechnological interventions also support the conservation of genetic resources through cryopreservation and in vitro storage techniques, safeguarding biodiversity critical for adaptive breeding. Addressing these issues requires interdisciplinary collaboration among scientists, policymakers, and stakeholders to ensure the equitable and sustainable application of biotechnological solutions in horticulture. The convergence of plant biotechnology and horticultural practices offers unparalleled opportunities to develop climate-resilient and sustainable cropping systems. By harnessing the potential of advanced molecular tools and integrative approaches, the horticulture sector can adapt to evolving challenges, ensuring food security, environmental sustainability, and economic growth in a changing world.

Keywords: Crop Productivity, Climate Change, CRISPR-Cas9, Plant Biotechnology.

Engineering Salt-Resilient Cucurbits: Functional Insights from CmoPIP1-4 Knockout Mutants

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Abstract

Plasma Membrane Intrinsic Proteins (PIPs) play a crucial role in plant water transport and stress responses, particularly under salinity conditions. Despite their importance, the PIP gene family in pumpkin (*Cucurbita moschata*) remains largely unexplored. This study presents the first genome-wide identification of 21 CmoPIP genes, categorizing them into two subfamilies (CmoPIP1s and CmoPIP2s) based on phylogenetic and structural analyses. Functional predictions suggest substrate specificity among CmoPIP proteins, highlighting their potential roles in water and ion transport. To assess the functional relevance of CmoPIP1-4, we generated CRISPR/Cas9 knockout mutants using a recently developed hairy root transformation system. Overexpression of CmoPIP1-4 in yeast enhanced salt tolerance, confirming its role in stress adaptation. Conversely, CmoPIP1-4 knockout plants exhibited hypersensitivity to salt stress, characterized by reduced relative water content, lower photosynthetic activity, and increased Na accumulation in shoots. Additionally, mutant plants showed higher levels of ROS (reactive oxygen species), increased lipid peroxidation (MDA levels), and decreased antioxidant enzyme activity (SOD, POD, and CAT) compared to wild-type plants. The expression of salt-responsive genes (CmoSOS1, CmoHKT1;1, and CmoNHX4) was also significantly downregulated in mutants, further confirming the involvement of CmoPIP1-4 in salinity tolerance mechanisms. This study highlights the essential role of CmoPIP1-4 in maintaining osmotic balance, enhancing antioxidant defense, and regulating ion transport under salt stress. The findings provide valuable insights into the molecular mechanisms of stress tolerance in cucurbit crops and open avenues for developing genetically improved, salt-tolerant cultivars. By establishing a robust root transformation system, this research paves the way for future genetic studies on stress-responsive genes in cucurbits.

Keywords: Aquaporins, CRISPR/Cas9, Pumpkin, Salinity Stress.

Genetic Dissection and Ultrastructural Analysis of A Yellow Leaf Mutant in Melon (*Cucumis melo* L.)

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Abstract

Melon is a fruit of significant commercial and nutritional value, playing a vital role in the global fruit industry. The color of melon leaves influences several critical physiological processes, including photosynthesis, organic matter accumulation, and overall plant growth and development. Consequently, leaf color directly impacts both the yield and quality of the fruit. This study aims to investigate the genetic basis underlying leaf color variation in the melon leaf color mutant ZT0091 and to identify the key genes associated with this phenotype. A hybrid cross was performed between ZT0091 (female parent) and ZT0249 (male parent), and DNA pools from yellow-leaved and normal green-leaved plants were established using an F2 segregating population. Bulked Segregant Analysis sequencing (BSA-seq) and parental resequencing were employed for map-based cloning of the gene responsible for the abnormal leaf color in ZT0091. Molecular markers were developed to assist in gene localization, and candidate genes were identified and validated. Chlorophyll content was quantified in both mutant and wild-type leaves, while Transmission Electron Microscopy (TEM) was used to observe the cellular structures of leaves from both genotypes. Through BSA-seq and resequencing, the target gene was mapped to a 643 kb region on chromosome 11. Within this interval, 31 candidate genes were identified. Further sequencing revealed a 6,631 base pair deletion from positions 23,933,935 to 23,940,564 on chromosome 11, which coincides with the gene encoding MAIN-like2. Chlorophyll content analysis showed a significant reduction in the true leaves of the ZT0091 mutant compared to the normal green-leaved wild-type plants. This study suggests that the abnormal leaf color observed in the melon mutant ZT0091 is primarily caused by alterations in chloroplast structure, leading to reduced chlorophyll content and yellowing of the leaves. The deletion of the MAIN-like2 gene in this mutant is likely the key factor responsible for the yellow leaf phenotype. These findings contribute to a deeper understanding of the genetic mechanisms controlling leaf pigmentation and may provide potential targets for genetic improvement in melon.

Keywords: BSA-seq, Candidate Gene, Melon, Transmission Electron Microscope.

Characterization of CsPHYB Mutation and its Role in Regulating Leaf Senescence in Cucumber (*Cucumis Sativus* L.)

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Abstract

Cucumber is an economically vital crop, with leaf growth and development playing a pivotal role in biomass accumulation. Impairments in leaf function and reductions in photosynthetic capacity have pronounced negative effects on yield and quality. Despite their importance, the molecular mechanisms governing these traits remain poorly understood.In this study, we identified and characterized a natural cucumber mutant, NW079, which exhibits pale green leaves and early leaf senescence. Through bulked segregant analysis sequencing (BSA-seq), we discovered an insertion of a long terminal repeat retrotransposon (LTR-RT) within the CsPHYB gene. This insertion introduces a 261-bp sequence into the first exon, containing multiple stop codons that disrupt CsPHYB function, leading to abnormal leaf development and premature senescence.RNA sequencing (RNA-seq) further elucidated the role of CsPHYB, revealing reduced expression levels of the gene and evidence of alternative splicing. The insertion of the LTR-RT transposon was found to directly disrupt splice sites, thereby altering splicing patterns and efficiency, which significantly contribute to the observed early senescence phenotype.The CsPHYB mutation carries important implications for cucumber adaptation to varying light environments, revealing novel functions of CsPHYB in regulating leaf development and senescence. This study not only provides valuable molecular markers based on the insertion for breeding programs but also offers critical insights into the interplay of light signaling pathways in plant development. By elucidating the genetic basis of CsPHYB and its role in leaf senescence, this research advances our understanding of cucumber growth regulation. The findings establish a robust theoretical foundation for genetic improvement and molecular breeding, with practical applications for enhancing cucumber yield and quality under diverse environmental conditions.

Keywords: BSA-Seq, Cucumber, Hytochrome B, LTR-RT, RNA-Seq.

Identification and Functional Characterization of *CsPRL*: A Key Gene Regulating Short-Fruit Phenotype in Cucumber (*Cucumis Sativus* L.)

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Abstract

Fruit shape is a critical phenotypic trait in cucumber that profoundly influences consumer preferences and market positioning. Despite its significance, progress in elucidating the genetic basis of cucumber fruit shape remains limited, with only three regulatory genes having been positionally cloned to date. This knowledge gap poses a substantial challenge to the advancement of cucumber breeding for desired fruit shapes. In this study, we identified a novel spherical fruit shape mutant, NW003, through space-induced mutagenesis. Genetic analysis using segregation population derived from a cross with wild-type cucumber revealed that the spherical fruit shape is governed by a single recessive gene and exhibits stable inheritance across successive generations of self-pollination. To investigate the genetic mechanism underlying this phenotype, we employed Bulked Segregant Analysis-sequencing (BSA-seq) on extreme phenotypes from the population. This approach localized the mutation to chromosome 6, leading to the identification of a candidate gene, CsPRL, implicated in brassinosteroid biosynthesis. Subsequent analyses identified a single-nucleotide polymorphism (SNP) in the promoter region of CsPRL, which may serve as a key regulatory element responsible for the shortened fruit shape. Functional validation using CRISPR/Cas9 genome editing confirmed the involvement of CsPRL in determining fruit morphology. Crossbreeding the NW003 mutant with multiple cucumber varieties from diverse ecotypes further demonstrated that the short-fruit trait was prominently expressed in three hybrid progenies, underscoring its utility as a valuable germplasm for breeding efforts. This study provides significant insights into the genetic control of cucumber fruit shape by identifying and functionally characterizing the CsPRL gene. Additionally, molecular markers linked to the short-fruit phenotype were developed, offering robust tools and theoretical foundations for molecular breeding. The NW003 mutant represents a critical resource for the development of cucumber cultivars with desirable short-fruit traits, advancing both basic research and breeding applications.

Keywords: Cucumber Fruit Shape, CsPRL Gene, Molecular Breeding, Short-Fruit Mutant.

Acclimation of Fruit Crops to Climate Change-Induced Stresses: A Comprehensive Review

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Abstract

Climate change is posing significant challenges to global agriculture with fruit crops particularly vulnerable to its detrimental effects. The increasing frequency and severity of abiotic stresses, such as flooding, drought, heat, cold, and salinity, are threatening the survival and yields of many economically important fruit crops. These stresses have been reported to negatively affect the biomass and yield of fruit crops up to 70%. To ensure food security and sustainable fruit production, it is crucial to understand the mechanisms by which fruit crops acclimate and adapt to these climate change-induced stresses. In this review, we examine the physiological, biochemical, and molecular responses of fruit crops to various climate change-related stresses and also discuss the key adaptive strategies employed by fruit trees, including modifications in stomatal regulation, osmolyte accumulation, antioxidant defense systems, and alterations in gene expression patterns. Furthermore, this review explores the role of integrated management practices, including the use of cover crops, mulching, irrigation scheduling, and the application of plant growth regulators, in mitigating the adverse effects of climate change on fruit production. By providing a brief overview of this issue emails discuss the challenges and future research directions in acclimating fruit crops to climate-change-induced stresses, paving the way for more resilient and sustainable fruit production in the future.

Keywords: Abiotic Stress, Adaptive Strategies, Climate Resilience, Cultivars.

Expression Profiling of Heat Shock Protein Genes in Indigenous Lettuce (*Lactuca Sativa* L.)

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Abstract

Lactuca sativa L. commonly known as lettuce, is a highly nutritious green leafy vegetable consumed worldwide for its health benefits and its role in the treatment of various diseases. This cool-season crop thrives optimally at temperatures 17-28℃, with floral initiation typically occurring at 21-27℃. However, the frequency and intensity of temperature extremes are projected to increase due to global climate change, posing a significant threat to lettuce productivity. Rising temperatures adversely impact the growth and yield of lettuce, leading to rapid declines in productivity. HSPs function as molecular chaperones, facilitating the proper folding and assembly of proteins while preventing irreversible protein aggregation, thereby maintaining cellular homeostasis under both optimal and stressful conditions. In plants, HSPs are categorized into major families based on their molecular weight: sHSP, HSP100, HSP90, HSP70, and HSP60. Studies indicate that HSP genes in lettuce, such as HSP70A, HSP70B, HSP83A, and HSP83B, are activated during heat stress and exhibit an initial response upon exposure to elevated temperatures. Quantitative real-time PCR (qRT-PCR) was employed to measure the expression levels of HSP70A, HSP70B, HSP83A, and HSP83B genes under heat stress at 37℃ on various time periods: 1 hour, 4 hours, 16 hours, and 24 hours. The results, analyzed by using the Livak method for relative gene expression and statistical analysis using ANOVA test, revealed differential expression patterns of these HSP genes under heat stress. The early heat-responsive genes identified in this study highlight their potential as candidates for developing heat-resistant lettuce cultivars. Such advancements could support sustainable lettuce production in warmer climates, addressing the challenges posed by global climate change and ensuring food security in regions increasingly affected by rising temperatures.

Keywords: Heat Shock Proteins, Lettuce, qRT-PCR, RNA.

Validation of SSR Markers for Identification of High-Yielding and Phytophthora *Capsici* Root Rot Resistant Chilli Genotypes

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Abstract

The study was designed to validate the previously reported 34 SSR markers using 78 chilli genotypes to detect significant trait specific markers as well as superior genotypes resistant to Phytophthora capsici root rot (PcRR). In this context, the identification of germplasm with higher yield per plant (YPP) leads to hype in Stress Tolerance Index (STI) in genotypes, Chakwal3 (11.98), Greenfire (10.14), Advanta5017 (9.94) and Chakwal4 (7.8). The identified genotypes were also found as resistant and moderately resistant due to existence of below 50% of disease incidence. Moreover, biplot showed the interrelation of STI with YPP through the formation of acute angle by their respective vectors. In the current study, the markers Hpms1172 and CAMS177 was found significant for STI. However, the marker CAMS066 was found associated with relative cell injury, CA06g27450 with disease incidence and CAMS173 with relative leaf damage. The bright bands on gel pictures of significant markers showed the association of these markers with resistant genotypes i.e. Chakwal3, Advanta-5017 and Chakwal4 as well as with a single moderately resistant genotype i.e. Greenfire. The marker studes confirmed the phenotypic data by showing association of markers i.e. Hpms1172 and CAMS177, r with stress tolerance index. The principal coordinate analysis aligned with the results obtained from marker-assisted selection. Thus, currently practiced marker assisted selection detected high yielding genotypes in PcRR disease stress condition that will be helpful in progressing breeding programs in chilli.

Keywords: Chilli, Marker Assisted Selection, Phytophthora, Validation.

Estimation of Vegetative Traits and Survival Percentage of Chilli (*Capsicum Annuum*) Seedling Under Drought Stress: A Gap Analysis Approach

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Abstract

Seedling stage in chilli is one of the most critical stage for plant growth while good crop establishment could only be guaranteed with vigorous seedling. Vigorous seedling can be maintained when chilli nursery was kept well irrigated. In current study seedlings of 71 chilli genotypes were kept under drought condition to study the influence vegetative traits i.e. hypocotyl length (HL), cotyledon leaf length (CLL), cotyledon leaf width (CLW), hypocotyl color (HC), hypocotyls color intensity (HCI), cotyledon leaf shape (CLS), cotyledon leaf color (CLC), hypocotyls pubescence (HP), hypocotyls stem color (HSC), on survival percentage (SP). The analysis of variance for completely randomized design reported the significant variation among the genotypes for the quantitative traits i.e. SP, HL, CLL and CLW under drought condition. Among the genotypes 24634 with 90.13% has the maximum ratio of survival followed by genotype 32385 with 89.40% and 32321 with 89.33%. Moreover, the percent contribution of gap analysis for survival percentage revealed that hypocotyl stem color, cotyledon width and length were critical factors with gap value of 31.65%, 31.13% and 27.13%, respectively. The current study will ease to develop strategies for cultivating chilli crop under drought condition, focusing on breeding drought-tolerant genotypes using drought tolerant genotypes like 24634, 32385, and 32321, as well as improving key traits i.e. hypocotyl stem color and cotyledon leaf length and width. However, early screening, marker-assisted selection, and optimized seedling management practices will accelerate the crop production of chilli.

Keywords: Seedling, Survival, Chilli, Gap Analysis.

Evaluation of the Symbiotic Efficiency of Rhizobial Strains in Association with Common Bean (*Phaseolus Vulgaris* L.) From the Poonch Region, Azad Jammu and Kashmir

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Abstract

Rhizobia have a considerable importance in agriculture because of their capacity to fix the atmospheric nitrogen in symbiosis with the legume plants. Common bean is an important legume around the globe and major crop in Azad Jammu and Kashmir after maize and wheat. It is a grain legume that provides dietary protein to millions of people in the world. In Pakistan there is no commercial rhizobium inoculum available for inoculation to the bean crop. This study has been designed to examine the symbiotic effectiveness of native common bean rhizobia from Poonch division of Azad Jammu and Kashmir. Soils from 31 different sites with variable altitudes (906 m to 2248 m) were collected and analyzed for different physico-chemical characteristics (organic matter content varied (0.16-2.14 %) and pH (6.52-8.21), While rhizobial population through Most Probable Number (MPN) techniques varied (2.0-104 to 7.0-0.4). Common bean was grown in these soils in pots for determining the nodulation potential (numbers and mass). Rhizobial strains were isolated from these nodules and purified by repeated streaking. In addition, plant infectivity test was carried out to determine the host specificity and effectiveness of the isolates. Likewise, morphology (colony and cell morphology) of the effective isolates and various biochemical tests like phosphate solubilization and Indole acetic acid, zinc mobilization, nitrogen fixation were carried out to determine the potential of the isolates. Out of 31 isolates tested, 13 isolates showed nitrogen fixation ability, 18 isolates were positive for IAA, 10 isolates for zinc mobilization while 5 isolates were found to be able to solubilize insoluble phosphate. On the basis of biochemical analysis 8 potential isolates were tested for their infectivity and growth promotion in vitro through greenhouse conditions. The results showed the all the isolates were able to produce nodulation upon reinoculation to the host plant. By producing maximum shoot length, root length and fresh and dry weight, number of nodules along with fresh and dry weight isolates, BR2 found as the most efficient plant.

Keywords: Biofertilizers, Isolation, Most Probable Number Technique, Nodulation.

Developing Climate-Resilient Traits in Gladiolus Grandiflora Through EMS-Induced Mutagenesis for Sustainable Floriculture

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Abstract

The floriculture industry is facing challenges due to climate change, which demands climate-resilient ornamental crops. Gladiolus grandiflora is the queen of bulbous ornamentals in the cut flower industry and is also very economical, but sensitive to abiotic stresses, raising the need for genetic improvement. As a winter crop, gladiolus cannot tolerate stress in summer in plain areas, and it struggles to propagate under such conditions. To develop climate-resilient traits in gladiolus, genetic variability is induced by the mutagen Ethyl Methanesulfonate (EMS). Gladiolus corms were treated with different EMS concentrations (0.25%, 0.5%, 0.75%, and 1.0%) for several minutes to evaluate the morphological traits, including reproductive, vegetative, and floral attributes under stress-induced and optimal conditions. The exposure time for EMS treatment was fixed at 5 minutes, with a total of 5 treatments, including one control group. Lower EMS concentrations showed higher survival percentages, with 0.25% proving to be the best treatment, ensuring better corm survival and sprouting percentages. The phenotypic variations due to chemically induced mutagenesis result in increased size of corms, better floral attributes, and early emergence of the spike. Some mutants also show potential tolerance to drought and thermal stress. These mutations, being accidental, offer the possibility of achieving stress-tolerant traits. Even if stress tolerance is not achieved, the induced mutagenesis still holds the potential to produce commercially viable gladiolus varieties. To increase genetic diversity in Gladiolus grandiflora, EMS mutagenesis proved to be a vital tool for breeding programs. Mutants with superior morphological and stress-tolerance traits, developed through EMS mutagenesis, are valuable in breeding programs aimed at mitigating climate impacts. Adaptability and sustainability can be achieved in the floriculture industry through genetic and breeding programs.

Keywords: Stress Tolerance, Breeding Programs, Climate-Resilient Floriculture, Ethyl Methanesulfonate.

Genome Wide Analysis of Papaya (*Carica papaya* L.)

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Abstract

Pathogenesis-related 1 (PR-1) is salicylic inducible defense protein which can accumulate to high levels against defense. Genome mining of papaya identify eight PR-1s family members through various bioinformatic tools. All CpPR1 proteins contain intact CAP domain and classify into three major groups. Phylogeny-based inference revealed that majority of Papaya PR-1s distributed in clade I (3 out 8), and clade III (3 out 8), clade II (2 out 8). Gene structure analysis revealed that 7 PR-1s did not contain any introns, whereas the other 1 had 1 intron. Cis element analysis revealed that G-box, GT1-motif present in the promoter region of Cp_PR-1-1 and Cp_PR-1-2 are involved in light response whereas ABRE and DRE in Cp_PR-1-3 involve in drought stress response. Furthermore, Chromosome mapping, Ka/Ks calculations, and protein-protein interaction analysis offer insights into the structural and evolutionary dynamics of the PR-1s genes. Additionally, the sub-cellular localization, reveals the cellular compartment of the PR-1 gene.

Keywords: Cis-Acting Regulatory Elements, Gene Structure, Phylogenetic Analysis

Germplasm Collection and Development of Inbred Lines for Hybrid Development in *Brassica oleracia* Var. Capitata (Cabbage)

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Abstract

Inbred line development is a crucial step in crop improvement for the course of hybrid development. Inbred lines provide a genetically uniform population, making it easier to evaluate, selection of desirable trait, reduction of genetic variation thus making it easier to predict the performance of the line meeting heterosis. This study aimed to develop high-yielding inbred lines in *Brassica oleracia* var. capitata (Cabbage) through selective breeding. A total of 16 lines were collected from different sources and were evaluated for yield and yield related traits over two generations. The results showed significant improvements in focusing traits across the breeding lines. Four promising inbred lines with desirable traits were identified and selected for further evaluation. The developed inbred lines exhibited remarkable increase in yield and improvement in yield traits compared to the control. These inbred lines can be used as potential parental lines for hybrid breeding programs or as pure-line varieties for commercial cultivation. The study demonstrates the effectiveness of selective breeding in improving crop yields and desirable traits.

Keywords: Crop Improvement, Inbred Line Development, Selective Breeding.

Introduction of New Vegetable for Pakistan: Malabar Spinach (*Basella Rubra* L.) Agronomic and Nutritional Behaviour

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Abstract

Current research insights of Vegetable Crops Research Programme, Horticultural Research Institute, NARC on enhancing productivity of spinach through an introduction of vine spinach; Malabar Spinach (*Basella rubra* L.). covering its prolonged availability in the hot months of summer unlike, the local spinach that is restricted for its availability only in winter season. The chief agronomic features were days to first picking which ranged almost from 25 to 28 days after sowing, eight number of pickings were found and almost 2-3 in winter crop, number of leaves per plant were 69 to 75 leaves having leaf size 119 to 140 cm^2. Average yield per acre ranged from 11.6 to 15.561 tonnes and all of these factors cumulatively result in enhancing the productivity of spinach thereby increasing its availability throughout the year with a benefit of increased farmer income. Entomological/pathological advocated no insect/disease incidence. Together with agronomic traits; the nutritional contents comprising of proteins (4.37 %) protein and carbohydrates (3.79 %) with K-calories of 36.51 were found intuitively fit for human as well as for animals and birds. Hence, *Basella rubra* is a potential vegetable and future of spinach availability in summers.

Keywords: Agronomic Behavior, Malabar Spinach, New Vegetable, Nutritional Source.

Exploration of Genetic Diversity and Evaluation of Marigold Germplasm for Breeding and Boost-Up Profitable Farming and Marketing

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Abstract

Floriculture is an admirable industry for producing loose flowers, cut flowers, bedding, and potted plants as they are predominantly grown worldwide due to their fascinating appearance. Ornamental plants are gaining the attention of researchers in scientific research due to their immense scope and commercial value. Marigold (Tagetes spp.) is a well-known multifunctional ornamental plant belonging to a family composite with vast genetic diversity, a wide spectrum of alluring colors, and significant medicinal properties. In Pakistan, the improvement and development of marigold genotypes are in the embryonic stage hence our objective is to collect and explore genetic diversity to develop new cultivars that will enhance the displays of the gardens. In this study, the genotypic relationship among genotypes was observed through a correlation analysis to find the valuable genotypic relationship for different traits. A significant variation was recognized among all the genotypes for the following qualitative and quantitative traits i.e. days to first bud, day to first flowering, days to 50% flowering, plant height, stem pigmentation, stem diameter, leaf area, growth habit, flower color, flower diameter, number of flowers per plant, disc visibility, etc. The results showed that NARC S06 in the golden color range performed the best average yield with 23 flowers per plant and an average flower diameter of 94.6 mm, NARC S02 performed best in the yellow color range with 14 flowers per plant and an average flower diameter of 80.4 mm NARC S26 performed best in the orange range of flowers with 32 number of flowers and an average flower diameter of 83.7 mm. Through correlation study, it is noted that flower diameter in marigold has a positive correlation with days to bud formation, plant height, and leaf area while the number of flowers per plant has a positive correlation with stem diameter. The study will provide valuable insight for future marigold breeding programs.

Keywords: Genetic Diversity, Germplasm Characterization, Marigold, Yield.

Screening of Heat-Tolerant Chilli Genotypes Via Cell Membrane Thermostability Approach

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Abstract

Climate change leads to extreme environmental fluctuations including heat stress which is one of the major challenges faced by chilli pepper production globally. In chillies, temperatures above 18-30℃ (optimum temperature) significantly affects the growth and development, especially during the reproductive stage. It is reported that under heat stress, yield loss exceeds 50%. Therefore, there is a need to identify heat-tolerant genotypes to reduce yield losses. This research study aim was to identify heat tolerance genotypes through cell membrane thermostability as it is a reliable and rapid method of heat tolerance screening. In this experiment, forty chilli genotypes were evaluated. The results narrated that there is significant variation among these genotypes and the highest cell membrane thermostability was exhibited by R-76 (86.07%, CGP-25 (82.76%), R-118 (76.88%), R-26 (74.66%), R-10 v1 (73.34%), and R-57 (71.91%). High thermotolerant genotypes exhibit higher cell membrane thermostability and less electrolyte leakage under heat-stress conditions. These findings suggest that these genotypes could be used for further breeding purposes, including developing heat-tolerant chilli varieties.

Keywords: Chilli, Cell Membrane Thermostability, Heat-Tolerance, Screening.

Combining Ability Analysis for Yield Related Traits Directing Specific Combiners Towards Heterosis in Tomato (*Solanum lycopersicum* L.)

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Abstract

Combining ability and heterosis analysis was done to identify the potential parents and best performing hybrids for yield and yield contributing traits in tomato. Four lines, viz., LA-2711, BL-1174, PB-LO-017904, Pioneer-2761 and four testers 01786, Yaqui, CLN-2413, and BA-1079 were crossed in line × tester crossing fashion to develop 16 F_1 hybrids. Analysis of variance showed significant differences for flowers per cluster, fruit per cluster, fruit setting percentage, clusters per plant, days to first harvest, plant height, fruit weight, fruit length, fruits per plant and fruit yield per plant, days to first flowering, days to 50% flowering, number of branches per plant and fruit width for genotypes. Comparison between parents and crosses were significant for days to first flowering, days to 50% flowering, fruits per cluster, fruit setting percentage, clusters per plant, plant height and fruit length. For testers, flowers per cluster, fruits per cluster, fruit setting percentage, plant height, fruit length and fruit per plant and fruit width showed significant differences. Among crosses, good specific combiners were BL-1174 × BA-1079 for days to first flowering, BL-1174 × Yaqui for flowers per clusters and clusters per plant and Pioneer-2711 × 01786 for clusters per plant, LA-2711 × 01786 for plant height, PB-LO-017904 × 01786 for fruit weight and fruit length and may have the potential to be used for commercial exploitation after further evaluation. On the bases of mid parent heterosis and better parent heterosis, the crosses i.e., BL-1174 × CLN-2413, BL-1174 × BA-1079, BL-1174 × Yaqui, Pioneer-2711 × 01786, LA-2711 × 01786 and PB-LO-017904 × 01786 were turn out to be best hybrids for most of the traits under observation, so these crosses may be used on commercial scale to exploit heterosis after further evaluation.

Keywords: Analysis of Variance, Combining Ability, Heterosis, Hybrids.

Endeavouring Commercial Heterosis for Yield in Indigenous Single Cross (F_1) Hybrids in Chillies (*Capsicum annuum* L.)

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Abstract

Chilli (*Capsicum annum* L) is the third most important member of family *Solanaceae* and has its value in human diet since 7500 BC as a vegetable, spice and condiment. Pakistan has 69.80 thousand hectares of land acquired by chillies, with a production of 178.0 thousand tonnes. Due to its consistent use; chillies has always an escalating demand thus, making it necessary for plant breeders to develop high yielding hybrids. For the purpose of assessing the commercial heterosis for yield and its allied traits in indigenously developed F_1 hybrids. Eight quantitatively inherited traits in seven indigenous chilli hybrids were compared with their parents and one international hybrid (HYB-222/standard). Statistical analysis depicted significant difference for all the parameters considered. Almost all the hybrids showed negative commercial heterosis for the trait i.e.; days to 50% flowering which indicated their earliness. Hybrid 5 × 4 showed maximum earliness (-41.9 %, i.e., 22 days) as compared to standard (53 days). Hybrid 1 × 4 gave maximum commercial heterosis (34.04 %) for plant height over HYB-222. Maximum (35.88 %) commercial heterosis for fruit length was given by hybrid 1 × 2. Commercial heterosis for fruit weight was recorded to be 93.18% greater in 1 × 2 (12.75g) as compared to standard (6.6 g). Hybrid 1 × 4 (697) resulted 80.6 % greater number of fruits per plant than HYB-222 (386). Locally developed single cross F_1 hybrid 1 × 2 gave 168.4% greater green fruit yield than international hybrid which was used as a check. This research work highlighted both early and high yielding chilli hybrids which can be further utilized as promising hybrids after further evaluation.

Keywords: Chilli, Commercial Heterosis, Hybrid, Yield.

Performance of Different Gladiolus Varieties on Growth and Flowering Attributes under Agro-Ecological Conditions of Tandojam

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Abstract

The present research was conducted during 2024-25 at Horticulture Garden, Sindh Agriculture University, Tandojam to evaluate the growth and flowering performance of different gladiolus varieties under Agro-ecological conditions of Tandojam. The experiment was laid out in Randomized Complete Block Design (RCBD) with four blocks. The corms of four varieties of gladiolus viz: Pink, Indian, Yellow and White Prosperity were planted during the month of October, 2024. The results revealed that the maximum plant height (92.65 cm) chlorophyll content of leaves (76.85 SPAD), large size of inflorescence (16.07 cm), maximum length of leaves (21.97 cm), leaves plant^{-1} (12.00) and sturdiness quotient (6.28) were recorded in the Indian variety. Whereas larger flower diameter (82.62 mm), maximum fresh weight of flower (4.63 g), number of florets Spike^{-1} (14.00), maximum plant collar diameter (19.65 mm) and maximum sprouts corm^{-1} (3.00) were recorded in white Prosperity variety. However, total soluble solids of petals (9.75 °Brix), thickness of leaf (0.66 mm) and petal thickness (0.33 mm) were recorded maximum in the Pink variety. It is concluded that vegetative grower parameters were observed in Indian variety while flowering attributes were observed better in white prosperity variety.

Keywords: Ecological Conditions, Flowering Attributes, Gladiolous.

Effect of Different Growing Media on Growth and Flowering of Hollyhock (*Althea rosea* L.)

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Abstract

The present research was conducted in 2021-22 at Horticulture Garden, Sindh Agriculture University, Tandojam to examine the effect of different growing media on the growth and flowering of hollyhock. The experimental trail was performed with three replications in a completely random design (CRD) and includes four different growing media include GM1 = canal silt, GM2 = canal silt + bagass (1:1), GM3 = canal silt + rice husk (1:1) and GM4 = canal silt + bagass + rice husk (1:1:1) which were checked for the growth and flowering of hollyhock. The present study had a significant result for all parameters, the maximum results was observed in GM4 = canal silt + bagass + rice husk (1:1:1) plant height (60.00 cm), fresh weight of single flower (3.71 g), flower diameter (3.75 cm), number of flower plant^{-1} (16.00) and number of leaves plant^{-1} (57.25) followed by GM2 = canal silt + bagass (1:1) plant height (47.05 cm), fresh weight of single flower (2.63 g), flower diameter (3.12 cm), number of flower plant^{-1} (12.00) number of leaves plant^{-1} (41.00) and the minimum result was observed in GM3 = canal silt + rice husk (1:1) plant height (28.52 cm), fresh weight of single flower (1.93 g), flower diameter (2.60 cm), number of flower plant^{-1} (7.75) and number of leaves plant^{-1} (22.50). Based on the growing media, GM4 = canal silt + bagass + rice husk (1:1:1) performed better growth and flowering of hollyhock. The present study concluded that the growing media GM4 = canal silt + bagass + rice husk (1:1:1) showed better result for all parameters and all results were statistically significant.

Keywords: Bagass, Canal Silt, Flowering and Growth, Hollyhock, Rice Husk.

Physiological and Biochemical Responses of Irradiated Germplasm in Acid Limes

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Abstract

Genetic variability could be induced using different approaches including mutagenesis. Gamma irradiated germplasm of acid lime cultivars viz. Mexican lime and Eustis limequat was developed for varietal improvement. After phenotypic screening, selected mutant plants were evaluated for physiological and biochemical variability. Results showed that leaves of mutant plants developed at lower doses of gamma rays (0 Gy to 80 Gy) had positively affected most of the physiological and biochemical properties while higher doses exhibited inhibitory effect on these traits. At 80 Gy irradiation, leaves showed increased photosynthesis (16.30 $molm^{-2}s^{-1}$), reduced transpiration (2.17 mmol) and higher stomatal conductance (0.429 $mmolm^{-2}s^{-1}$). Whereas higher irradiation dose 140 Gy, decreased physiological activity due to disruption in chlorophyll contents. Similarly, improved biochemical activities were also noted up to 100 Gy. Increase in enzymatic activities including SOD (123.46 IU mg^{-1} proteins), POD (35.81 IU mg^{-1} protein), CAT (15.10 IU mg^{-1} protein), elevated chlorophyll (1.63 g mL^{-1}), (0.97 g mL^{-1}) and increased antioxidant activity (111.44 %) was observed. Moreover, with increase in gamma ray dose, enhanced total phenolic contents were also noted which could be beneficial for plant defensive mechanism against various biotic and abiotic stresses. Conclusively, gamma irradiated plants depicted enhanced physiological and biochemical activity indicating higher stress tolerance. Study of genetic relatedness of the mutant germplasm with their respective parents may provide interesting insights of the developed germplasm.

Keywords: Diversity, Irradiation, Mutants, Seedlessness.

Unraveling the Role of PGI Genes in Ascorbic Acid Synthesis: A Comparative Genomic Analysis in Potato and Arabidopsis

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Abstract

PGI (Phospho-glucose isomerase) is a gene family which catalyze reversible conversion of Glucose-6-phosphate (G6P) to fructose-6-phosphate (F6P) in glycolysis and gluconeogenesis to form end product Ascorbic acid (AA). Objective of this study, was comparatively investigate role of PGI gene family for AA synthesis in potato (*Solanum tuberosum*) and (*Arabidopsis thaliana*) through genome wide analysis. Employing bioinformatic tools for genome mining, we identified four members (St-PGI-4) in potato while five in (At-PGI-5) *Arabidopsis thaliana*. Phylogenetic analysis revealed that all St-PGI and At-PGI contain an intact domain means they have common ancestors/similar function, were classified into 3 major groups. One St-PGI and three At-PGI clustered in clade-1, while cluster-2 contain one St-PGI and two At-PGI, cluster-3 contain only two St-PGI proteins which shows retrieved behavior, all expose mainly in cytoplasm. Through gene structure analysis, the presence and location of introns and exons in both families were identified. Analysis of Cis-regularity element identified fixed sequences like TATA-box, CAAT-box, Box-4 and motifs like AAGAA-motif, TGACG-motif, STRE, all show specific functions. Sub-cellular localization studies determine cellular compartments which link with PGI protein. Moreover, other analysis, Chromosome mapping, Ka/Ks calculation, RNA sequence data and Protein-protein interaction studies offer significant observations into structural and evolutionary traits/properties of PGI gene family. The result of this research could provide valuable information to insight into potato PGI family and establish a foundation for further to elucidate function of PGI genes.

Keywords: Ascorbic Acid, Evolutionary Insights, PGI Gene Family.

Germplasm Collection and Characterization of Cauliflower for the Hybrid Development in *Brassica oleracea* Var. Botrytis

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Abstract

Brassica oleracea var. Botrytis also known as cauliflower is considered most important among cole crops. Its immature curd is used for edible purpose which is rich in Vitamin C and minerals. Twenty-five different accessions of cauliflower were collected and evaluated on their performance basis (early, mid and late season varieties, plant structure with open curd, semi covered curd and completely covered curd, number of days to maturity and curd colour). Self pollination was manually ensured to maintain purity and seed production in otherwise self-incompatible natured cauliflower genotypes. Few lines were marked as CMS; seed production and maintenance of such was made by crossing with determined testers. However, a few accessions showed open and semi covered structures while few were completely covered indicating helpfulness to minimize fungal issue in winter. Significant findings highlighted the genotype viz; Local Taxilla selection that showed minimum number of days to mature i.e; 65 days and attained marketable size. The mid-season accessions showed a range from 75-90 days and late season with about 100 days to maturity. The study highlighted the effectiveness of early curd formation, breeding techniques for desirable characters for future prospects.

Keywords: Brassica, Cole Crop, CMS Lines, Curd, Self-Incompatible.

Stomatal and Phenotypic Screening of Colchiploid Germplasm of Guava (*Psidium Guajava* L.) Cultivars

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Abstract

Guava (*Psidium guajava* L.) is a highly nutraceutical and economical fruit crop. Under different research projects a highly diverse germplasm has been collected from different parts of Pakistan including Sindh and KPK and has been conserved as a germplasm unit (GPU) at the institute experimental fruit garden. Polyploids have greater chromosome number, offer gigantism and greater tolerance to various biotic and abiotic stress factors. Hence, the current study was aimed at developing polyploid germplasm in the selected strains form GPU and screen that material for phenotypic and stomatal diversity. Seeds of different strains of round and pyriform varieties were subjected to colchicine treatment for several hours and seedling germplasm was used for further evaluations. Round variety G6 performed better at 0.05% colchicine level compared to other varieties and showed greater leaf size (5.09 cm), leaf area (3.96 cm) and plant height (9.52 cm). In Pyriform varieties, S12 performed better at 0.1% colchicine and showed greater leaf size (4.57 cm), leaf area (2.84 cm) and plant height (11.56 cm). Regarding cytological characterization, results revealed greater stomatal size at 0.1% colchicine with reduced stomatal frequency compared to control. The selected germplasm has been propagated in vitro using nodal segments on modified MS media. Such studies could be helpful to develop genetically diverse germplasm of guava which could be used for future breeding and biotechnology programs.

Keywords: Climate Resilience, Diversification, Gola, Polyploids, Surahi.

Barani Matar 2023: High Yielding Pea Cultivar for Pothowar Region

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Abstract

Vegetable pea (*Pisum sativum* L.) is the most important vegetable belonging to the family Leguminosae. Besides being rich in proteins, it is a good supplier of several minerals and vitamins. In Pakistan, Punjab being a top producer of peas, however, all cultivars released up-till now were only for irrigated areas. Thus in order to improved pea cultivation in rainfed areas of Pothowar region, 1st ever pea cultivar Barani Matar was developed by the Barani Agricultural Research Institute, Chakwal and released in 2023 through farmer field selection. Barani Matar is attractive for consumers with maximum pod length (9.80 cm), number of seeds per pod (9-12), good taste and sweet flavor (TSS = 10.12 °Brix). It exhibited moderate resistance to powdery mildew over the check varieties; Supreme, Meteore and Fsd-09 during different performance trials. As it is a rainfed cultivar, it showed better yield in low rainfall areas (4.5-5.5 tone ha^{-1}) with comparatively better protein content, iron and zinc.

Keywords: Peas, Powdry Mildew, Rainfed, Yield.

Physiological and Bio-Chemical Characterization of Fl Radish Developed by Intra-Specific Hybridization

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Abstract

In agricultural systems, intraspecific hybridization has enormous potential to accelerate the process of intensive crop development and improvement. An experiment was accomplished at Vegetable Research Area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad, with the aim of production of Fl hybrid seeds of radish through intraspecific hybridization and evaluation of the agro-morphological characteristics of radish germplasm. The study included 10 accessions (R-44, R-47, R-50, R-51, R-55, R-61, R-63, R-68, R-80, R-85) and 20 hybrids, derived from controlled crosses among these accessions. Data analysis was conducted using analysis of variance, and treatment means were compared using the LSD test at a 5% probability level. Agro-morphological and biochemical traits showed a wide range of variance. The shortest days to flowering were recorded in R-51 (118.33 days) and hybrids R-61, R-63, R-80, R-63 (139.00 days). The highest leaf count per plant was in R-61 (22.33), while the widest leaves were observed in R-51 and R-63 (21.067 cm). The longest leaves were found in R-85, R-55 (70.33 cm), R-51, R-85 (70.00 cm), and R-51, R-50 (70.00 cm). Maximum root length (36.667 cm) and fresh weight (1.94 Kg) were recorded in R-51, R-85 and R-51-50, while the largest root diameter (96.86 mm) was observed in both hybrids. The highest stem diameter was recorded in R-80 (34.157 mm) and R-47, R-61, R-63 (34.157 mm). Maximum relative chlorophyll content was found in R-61, R-63 (42.433 CCI), while the highest seed germination was observed in R-51 and R-85. Dark purple flowers were found in R-68, R-80, R-55, R-61, R-47, R-61, R-63, and R-55, R-68, while a dark purple core was seen in R-47, R-55, R-68, R-80, R-44, R-63, R-51, R-47, R-61, R-47, R-61 and R-63. Dark purple stems were present in R-51, R-63, R-68, R-80, R-51, R-47, R-85, R-47, R-85, R-68, R-55, R-68, R-61 and R-51. The highest pungency was recorded in R-61, R-80, R-51 and R-63, while R-47 and R-85 were tasteless. Maximum TSS (7.86 °Brix) was observed in R-85, R-63 and the highest TA (0.16%) was observed in R-44. The highest vitamin C content (0.466 mg 100 g^{-1}) was recorded in R-50, R-61, and R-63. The study concluded that significant diversity exists among the ten selected radish accessions and their hybrids. Some inbred lines and hybrids excelled in specific traits, while others performed better in different parameters.

Keywords: Genetic Diversity, Heritability, Intra-Specific, Radish Germplasm.

Screening of Different Genotypes of Tomato Under Cold Stress

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Abstract

Tomato (*Solanum lycopersicum* L.) is one of the most widely cultivated crops worldwide, valued for its nutritional content, including potassium and vitamins A and C. This study aimed to evaluate the growth, development, fruit yield, and quality of various tomato genotypes under cold stress. Growing tomatoes in high tunnels with polythene increases production costs and fruit prices, and temperature fluctuations in tunnels can adversely affect plant performance. Therefore, developing cold-tolerant genotypes is crucial, particularly for the reproductive stage. To address this, a research trial was conducted during the winter season of 2023-2024 at the Vegetable Research Area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad. The experiment was conducted by raising a tomato nursery in 50-cell plastic plug trays. Seedlings with 2 true leaves were transplanted into the field 30 days after sowing, with plant-to-plant and row-to-row spacing of 18 inches, without cold protection. The study followed a randomized complete block design (RCBD) to evaluate 11 tomato genotypes for cold tolerance. Data collected included leaf shape, leaf length, stem pubescence, days to flowering, fruit color (using a color chart), fruit yield per plant (Kg), plant height (cm), fruit diameter (mm), fruit shape, stem thickness (mm), and stem length (cm). Treatment means were analyzed using ANOVA and LSD at a 5% probability level. Results indicated that some local and exotic genotypes exhibited tolerance to low temperatures. Ly6 took less time to emerge under low temperatures. Ly25 exhibited the thickest stem, while Ly6 and Ly7 had dwarf leaf types, with other genotypes showing standard leaf types. The maximum plant height was observed in Ly9, and Ly1 had the longest leaves. Ly1, Ly4, Ly30, and Ly35 produced round-shaped fruits, while Ly25 had the maximum fruit length. Ly22 displayed a good pericarp and the highest yield, while Ly35 recorded the highest total soluble solids (TSS). Ly25 had the highest lycopene content. These findings support efforts to develop cold-tolerant tomato genotypes for resilient and sustainable food production in changing climates.

Keywords: Cold Tolerance, Heritability, Lycopene Content, Tomato Genotypes.

Morpho-Physiological Impact of Gamma Irradiation on Hemp (*Cannabis sativa* L.) at Variable Dose Levels

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Abstract

Hemp (*Cannabis sativa* L.) is a high value crop with diverse and valuable product range and ever increasing global demand. Medicinal cannabidiol (CBD) and industrial hemp has emerged as a game changer in conventional agriculture with immense profit margins and environment friendly status. Pakistan has diverse germplasm of hemp; naturally growing across temperate and sub-temperate areas of the country. Local genetic richness is mostly unexplored and believed with high tetrahydrocannabinol contents (THC). A study was planned to develop superior hemp genotypes with desired traits via radiation mutation. Locally collected hemp seeds were exposed to gamma rays at variable dose levels (150, 300, 450, 600 Gy) in two different conditions, G1 (pre-irradiation hydropriming) and G2 (post-irradiation hydropriming). Radiated plants seeds were sown in fertile medium and studied for germination %age, survival rate and morpho-physiological traits (plant height, stem thickness, leave area, number of leaves and axillary branches, dry shoot and root weight, trichome size and density, total chlorophyll contents and total flavonoids). The findings revealed optimal responses at lower dose levels, demonstrating the lethal impact of gamma rays exposure. Seeds exposed to 150 Gy showed maximum germination %age, survival rate, plant height, shoot weight, root weight, trichome density and total chlorophyll contents. However, maximum phenotypic variability was found in G1 exposed @ 150Gy and G2 exposed @ 450Gy. Mutant population was further categorized for industrial and medicinal traits based on their morphological behavior. This study helped to develop a base line for induced mutation opportunities in local hemp germplasm through optimized gamma rays dose and exposure.

Keywords: Cannabis, Gamma Rays, Hydropriming, Mutants, Pre- and Post-Irradiation.

Enhancing Floriculture Crops through Radiation Mutation: Prospects and Challenges

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Abstract

Floriculture is a vital aspect of the world horticulture industry, with a global market value of more than $55 billion and an annual growth rate of 6-7%. Contributing to aesthetic, economic, and ecological benefits, floriculture holds great potential to contribute significantly more to the economy of Pakistan-with a value of $50-70 million creating jobs, generating foreign exchange, and increasing exports. The demand for new flower varieties continues to grow with enhanced traits notably improved colour, fragrance, stress tolerance, and vase life. Radiation-induced mutation breeding has emerged as a prospective technique for the development of new floriculture cultivars inducing genetic variability above natural mutations. This approach has been successfully applied to improve various horticultural crops, especially ornamentals, whose improvement through conventional breeding is restricted by their long generation cycles and genetic barriers. This review covers the potential of radiation mutagenesis in the enhancement of floriculture crops touching on its applications, mechanisms, and some successful case studies. Different radiations like gamma rays (Cobalt-60), X-rays, and ion beam technology have been effectively used to induce mutations. Challenges from mutation breeding, such as dose applications, preserving desirable traits, and maintaining genetic stability, are discussed also. It reveals the role advanced molecular techniques can play in screening and selection for promising mutants. With climate change and changing markets, the use of radiation mutagenesis in combination with modern breeding techniques can help accelerate the speed of developing resilient and value-added floriculture varieties. The need for continuing research and collaborative efforts in realizing the full potential of mutation breeding in ornamentals is espoused by this study.

Keywords: Floriculture, Mutation Breeding, Ornamental Crops, Radiation Mutagenesis.

Induced Genetic Variability in *Iris kashmiriana* through EMS Mutagenesis for Climate-Resilient Horticulture

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Abstract

The ornamental plant *Iris kashmiriana*, native to the Kashmir region, holds significant horticultural and medicinal value. However, its limited genetic diversity poses a challenge in developing climate-resilient and aesthetically enhanced cultivars. Mutation breeding, particularly through chemical mutagens like Ethyl methanesulfonate (EMS), offers a promising strategy for introducing phenotypic variability and expanding the genetic base of this species. This study investigates the impact of EMS-induced mutagenesis on the morphological, floral, and post-harvest traits of *Iris kashmiriana*. Plants were treated with varying EMS concentrations (0%, 0.25%, 0.5%, 0.75%, and 1.0%) for a controlled duration to induce mutations. Key parameters, including plant height, flower stalk length, rhizome characteristics, petal size, and vase life, were analyzed to assess phenotypic variations. Expected outcomes include the emergence of novel traits such as enhanced flower size, altered petal morphology, and improved post-harvest longevity, contributing to the commercial viability and conservation of *Iris kashmiriana*. This research not only provides valuable insights into the role of EMS in inducing beneficial genetic modifications but also supports the development of climate-resilient horticultural crops with greater adaptability and ornamental appeal.

Keywords: Iris, EMS mutagenesis, Phenotypic Variability, Mutation Breeding.

Screening of Gamma Irradiated Grapefruit Germplasm for Stability of Physicochemical Attributes

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Abstract

Grapefruit (*Citrus paradisi* L.) is a prized citrus species for its unique taste, vibrant color, extended shelf life, more yield and nutraceutical properties. It is highly popular in Europe, Asia, and the United States. It is a natural hybrid of Pomelo and Sweet orange. Most of the leading commercial varieties of grapefruit are either spontaneous or induced mutants indicating great inherent potential of mutagenesis. Despite these traits, grapefruit is a relatively neglected citrus crop in Pakistan and mostly used for fresh juice blended with mandarins and sweet oranges. Both white flesh (Foster, Frost Fresh, Reed) and pink flesh (Shamber, Red Mexican Foster, Red Blush) varieties of grapefruit were selected from maintained germplasm collections at institute gardens and budwood was subjected to grafting in 2015-16 under a funded project. The developed germplasm was screened for initial variability and planted in the field for further evaluations. The analysis of three years results revealed that mutants of cv. RB50-1 developed the heaviest fruit (535 g) with greater diameter (103.93 mm). Fruit length was maximum (92.83 mm) in RB110-2. Fruit diameter was greater in FF20-1 developed fruit with the largest diameter (109.67 mm). Peel thickness was minimum in FF50-110 and SH20 (4.98-5.68 mm). Seed count was minimum 4.33 in SH50-2. The maximum number of developed seeds 9 were found in untreated control plants of SHCont. Juice quantity was much higher in F20, RB50-1 and SH80 (101-136 mL) compared with untreated controls (53-73 mL) in different varieties. Gamma irradiation significantly enhanced total soluble solids (TSS) upto 10.50 Brix in several mutants of R80 and FF20, FF140 whereas ratio TSS:TA was >6 in R20, FF20 and RB50 mutants. Rag weight was minimum 116.75 g in SH50-1. Total sugars were >7% in F20, F50, RM50, SH20 and SH50 mutants. Anthocyanins contents were >0.50 mg in RM50, RB80 and SH50 mutants whereas ascorbic acid contents were >55 mg 100 mL^{-1} juice in RM50, RB50 and RB80 mutants. These findings indicate enormous potential in the selected mutant germplasm for fruit size and quality attributes and stability of the selected traits over the years. The selected mutant germplasm may be utilized for further screening, omics studies and breeding programs.

Keywords: Breeding, Fruit Quality, Mutation, Pomelo.

Introduction of Climate-Resilient Citrus Germplasm: A Key Strategy for Sustainable Production in a Changing Climate

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Abstract

Citrus is one of the most significant horticultural crops, comprising about one-third of Pakistan's fruit production. Pakistan is about the 16th largest citrus producer globally with production steady over the past decade at 2 to 2.4 million tons annually. Citrus is one of the major fruits in Pakistan especially in Punjab. About 94% of citrus is grown in Punjab. Pakistan citrus industry is pre-dominant by monoculture of Kinnow mandarin. Kinnow is admired among consumers due to its attractive peel color, size, easy peeling, high juice content, and its excellent taste and aroma. However, there are some demerits as Kinnow is a late season variety, have alternate bearing and high seed content. Therefore, the citrus industry of Pakistan needs diversification by adding cultivars for fresh consumption and processing (juice industry). Our citrus production is impacted by global climate change, and these effects appear to be becoming worse every day. Significant effects of climate change are being seen in the productivity and quality of Citrus. Over the last decade, the citrus industry in Pakistan has witnessed notable shifts in production trends, with varying impacts across different provinces. Punjab remains the epicenter of citrus production, contributing the major share to the country's overall output. Over the past ten years, the area under citrus cultivation in Punjab has steadily decreased. Pakistan has a tremendous potential for the expansion of citrus industry due to suitability of soil and climatic conditions for citrus production. Any break-through in the production, processing, marketing and export of citrus will have a direct impact on the rural life. There is dire need to introduced the elite citrus germplasm around the world for the diversification and increase harvest window of citrus in Pakistan which will sustain the citrus production and industry.

Keywords: Citrus Germplasm, Harvest Window, Monoculture.

Utilizing Heat Stress Indices for Selecting Heat-Tolerant Genetic Male Sterile Genotypes in Chilli

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Abstract

Pakistan exhibits a significant yield disparity in chilli productivity when compared to leading chilli producing countries which can be attributed to several factors, including adverse effects of heat stress during critical growth stages. This research seeks to address the pressing need for high-yielding and heat-tolerant chilli hybrids to enhance agricultural productivity. Thirty genetic male sterile lines were screened under two distinct temperature regimes: early sowing in October 2023, with harvesting in March 2024, and late sowing in February 2024, with harvesting in May 2024. The trials were conducted using a duplicated randomized complete block design. Principal component analysis explained 98.9% of the total observed variation through two principal components: PC1 (64.6%) and PC2 (34.3%). Among the genotypes, G28 emerged as the most heat-tolerant, excelling in indices that prioritize high productivity and minimal yield reduction under stress, including the tolerance index, mean productivity, geometric mean productivity, stress tolerance index, and yield index. Genotype G12 also demonstrated high values for the stress tolerance index, yield index, and relative stress index. Additionally, G4, G20, and G32 showed strong heat tolerance, with G4 noted for its high value for yield stability index and minimum stress susceptibility index. Inversely, Genotypes G1, G2, G9, G27, G31, G33 and G34 were rendered heat susceptible based upon their high value for stress susceptibility index. The heat-tolerant genetic male sterile lines identified in this study can be utilized to develop commercially viable, high-yielding chilli hybrids in Pakistan, thereby improving productivity and mitigating the adverse effects of heat stress.

Keywords: Heat Stress, Hot Pepper, Hybrid Breeding, Sterility, Yield.

Molecular Studies of Post-Harvest Fungal Peach Fruit Rots

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Abstract

Postharvest fungal rots are a continuous threat to perishable fruits worldwide. Fungal contamination is a significant factor affecting quality of peaches and resulting decline in their quantity. Postharvest health of peaches is of major concern for producers, consumers, marketers, and food industries globally. Early specie level detection of these deteriorating fungal rots is extremely important to adopt timely preventive measures and enhance shelf-life of peaches. In present study five fungal phytopathogenic rots were detected from peaches and identified based on molecular characterization using ITS universal fungal primers. Multi-locus characterization revealed fungal rots viz; *Fusarium sporotrichioides*, *Aspergillus niger*, *Aspergillus flavus*, *Penicillium chrysogenum* and *Cladosporium pseudocladosporioides* respectively. Phylogenetic tree was constructed in MEGAX software using Neighbour-Joining Method and 1000 bootstrap replicates were selected to represent the evolutionary history of the taxa analyzed. Prior to management of various fungal rots, their accurate diagnosis is compulsory. Our results are significant in developing opportune control strategies from the field to storage hence reducing qualitative and quantitative losses and to enhance shelf-life of peaches.

Keywords: Fungal Contamination, Multi Locus, Qualitative Loss.

Genome-Wide Analysis of Short Chain Dehydrogenase/Reductase in Cucumber and their Response Against Begomovirus

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Abstract

In this study, genome-wide analysis of short chain dehydrogenase (SDR) in cucumber was conducted and investigated for their response against begomovirus infection. The begomovirus infection is a serious danger to cucumber production globally, causing significant yield loss. SDR family enzyme is critical to the production of secondary metabolites and have been associated with plant defense mechanisms against pathogens. Therefore, two varieties of cucumber including Oscar and ICS-CU were examined. A full genome sequence of cucumbers was obtained from the database of Cucurbita Genomics, and its SDR domain sequence had been BLAST- searched for it. 55 CsSDR genes that were not redundant were analysed. We excluded from the research proteins that have a compressed CsSDR DNA-binding region or identical gene isoforms. In this study, we used CsSDR38 proteins to demonstrate the interplay between several proteins. For CsSDR41, CsSDR34, CsSDR48, CsSDR33, CsSDR26, CsSDR9, CsSDR12, CsSDR22, CsSDR23, CsSDR11, CsSDR1, and the database of STRING found many functional enrichments, including biological processes, molecular functions and the KEGG path. The study provides insights into the molecular mechanisms underlying the defense reaction of cucumber against begomovirus infection, based on which novel strategies to improve the resistance of cucumber to this important plant pathogen can be developed.

Keywords: Begomovirus, Cucumber, Genome-Wide Analysis, Dehydrogenase.

Horticulture Business & Entrepreneurship

Horticultural Crop Production and Its Role on Food Security and Economic Growth in Nigeria

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Abstract

The study examined the role of horticultural crop production in enhancing food security and economic growth in Nigeria. This study is underpinned by the Agricultural Development Theory. The following concepts among others were clarified: horticulture, food security, economic growth, horticultural crop production and employment opportunities, contribution of horticulture to the Nigerian economy and food security as well as economic growth. The study exclusively utilized secondary data, such as government publications, journal articles, official books, and documents. To ensure the research was of high quality, the work focused on documented evidence for data collection. The researchers concluded that horticulture is a major component of Nigeria's agricultural industry, contributing significantly to food security, economic resilience, and employment generation. Drawing on the three-track approach, the following recommendations are proposed to enhance horticulture's role in Nigeria: the government should employ the services of agricultural extension officers to educate horticulturists and those interested in horticultural farming on modern practices and methods in line with global best practices. Also, the government and private sectors should provide soft loans to horticultural farmers to boost horticultural farming business, among others.

Keywords: Crop Production, Economic Growth, Food Security.

Correlation and Path Coefficient Analysis for Some Growth and Yield-Related Traits in Tomata (*Solanum lycopersicum* L.)

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Abstract

Field trials were conducted during the dry seasons of 2020/2021 and 2021/ 2022 at the Research Farms of the Institute for Agricultural Research, Samaru and Kujama, Kaduna state to investigate association among growth and yield components and their direct and indirect influence on the fruit yield of tomato. The treatments comprised of four tomato varieties (two determinate: Delta F_1 and Platinum F_1, one indeterminate hybrid: Larisa F_1, and one open pollinated variety UC82B), two staking methods (staked and unstaked) and three pruning techniques (no-pruning, pruning on one-stem and two-stems). The treatments were factorially combined and laid out in a randomized complete block design (RCBD) with three replicates. There was highly significant and positive correlation between marketable fruit yield and plant height, shoot dry weight, crop growth rate, relative crop growth rate, fruit diameter, and fresh fruit weight per plant across locations, years and combined. The highest and lowest contribution to fruit yield was from plant height (41.44%) and relative growth rate (0.039%) respectively at Kujama in 2020/2021. In the following season, crop growth rate made the highest contribution to fruit yield (1856.76%), and lowest was fruit diameter (0.02%). In Kujama during the 2020/2021 and 2021/2022 dry seasons, plant height and shoot dry weight had the highest direct effect to fresh fruit yield (0.644) and (4.049) respectively. These two growth components also had the highest combined indirect effect on yield in 2020/2021, while in the second season it was through shoot dry weight via crop growth rate. In Samaru, shoot dry weight and plant height had the highest direct effect to fresh fruit yield in 2020/2021 and 2021/2022 respectively. Based on this findings plant height, crop growth rate and shoot dry weight are traits to consider in tomato for higher yield.

Keywords: Correlation, Direct and Indirect Contribution, Yield.

Effect of Trellis System on Wild Black Raspberry Growth, Yield and Fruit Quality

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Abstract

Black raspberry (*Rubus* sp.) is a deciduous shrub native to temperate regions and closely related to roses. It thrives particularly well in cooler climates. Due to the ideal climatic conditions for its growth, black raspberries can be found wild in Rawalakot, suggesting the potential for large plantations in these areas. To explore their economic potential, trellis systems are employed for cane support with trailing and semi-erect cultivars, keeping the fruit off the ground and improving sunlight exposure, air movement, and spray penetration throughout the canopy. However, no studies have been conducted to optimize their cultural practices and postharvest quality. The proposed research aims to determine the effect of different trellis systems on black raspberries; nutrient and mineral content. In this regard, wild black raspberry plants were trained into three different trellis systems: I-trellis, V-trellis, and Single-side shift trellis. Among these systems, the V-trellis demonstrated superior performance in terms of vegetative, morphological, and fruit quality parameters compared to the other two systems. The highest values for vegetative parameters including plant spread (137.72 cm), number of laterals (4.30), lateral length (83.20 cm), total chlorophyll content (36.19 g mL^{-1}), picking efficiency (200.79 g h^{-1}), morphological parameters such as fruit diameter (109 mm^2), fruit weight (18.63 g) and fruit quality parameters including total soluble solids (9.23%), titratable acidity (0.34 %), pH (4.31), vitamin C (16.78 mg 100 g^{-1}), total flavonoids (16.26 m mol quercetin 100 g^{-1} FW), total anthocyanins (9.37 mg 100 g^{-1} FW), total phenolics (5.58 g gallic acid 100 g^{-1} FW), antioxidant activity (15.79 %), nitrogen (155.00 mg 100 g^{-1} DW), phosphorus (180.50 mg 100g^{-1} DW), iron (125.0 mg Kg^{-1} DW), manganese (38.60 mg Kg^{-1} DW), copper (9.20 mg Kg^{-1} DW) and zinc (26.2 mg Kg^{-1} DW) were observed in V-trellis system. While, the maximum values for plant height (142.07 cm), stem diameter (1.88 cm), and disease rating (7.66 %) were recorded in the Single-side shift trellis system. These findings highlight the effectiveness of trellising systems in enhancing both the productivity and quality of black raspberries and underscoring their economic potential in agricultural practices.

Keywords: Black Raspberry, Minerals, Nutrients, Trellis.

Entrepreneurial Opportunities in the Expanding Blueberry Industry: Cultivation Innovations and Value-Added Products

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Abstract

The global blueberry industry has experienced significant growth, driven by increasing consumer demand for health-promoting fruits. This review examines the current state of blueberry cultivation and its associated products, emphasizing business and entrepreneurial opportunities within the sector. Key areas of focus include advancements in cultivation techniques, such as precision horticulture and climate control strategies, which enhance yield and fruit quality. Additionally, the review explores value-added products like blueberry-based nutraceuticals and processed goods, highlighting market trends and consumer preferences. Challenges such as labor shortages and economic uncertainties are discussed, along with potential solutions like automation and policy adjustments. The review concludes by identifying emerging markets and investment opportunities, providing insights for stakeholders aiming to capitalize on the expanding blueberry industry.

Keywords: Automation, Enterpreneurship, Precision Horticulture, Value-Addition.

Exploring Business Opportunities in Medicinal Plant Cultivation: A Focus on Lavender

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Abstract

The horticulture industry offers significant opportunities for entrepreneurship, particularly through the cultivation and commercialization of medicinal plants. These plants are increasingly sought after in the pharmaceutical, cosmetic, and wellness sectors due to their natural healing properties. Among them, lavender stands out as a highly effective and profitable option for business ventures. Lavender is renowned for its versatility, being utilized in products such as essential oils, soaps, lotions, and aromatherapy items. Its calming scent and therapeutic benefits have led to a steady demand in both domestic and international markets. Cultivating lavender is relatively straightforward; it thrives in well-drained soils and requires minimal maintenance, making it suitable for various climates. The initial investment is modest, and the plant's perennial nature ensures multiple harvests over several years, enhancing profitability. Entrepreneurs can explore various value-added products, including dried lavender bouquets, sachets, and culinary items, catering to diverse consumer preferences. The global shift towards natural and organic products further amplifies the market potential for lavender-based goods. This paper examines the economic benefits of lavender cultivation, highlighting its role in generating sustainable income for small-scale farmers and startups. It also delves into market analysis, cultivation techniques, and strategies to maximize returns. By adopting modern marketing methods and ensuring high-quality production, businesses can effectively penetrate the growing market for natural health and beauty products. Lavender, therefore, not only contributes to health and well-being but also serves as a promising avenue for entrepreneurs aiming to establish a profitable and eco-friendly enterprise.

Keywords: Essential Oils, Horticulture Business, Lavender Cultivation, Medicinal Plants.

Transformation of Horticulture Market with Innovation and New Potential Varieties Through Genetic Modification and Tissue Culture Techniques

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Abstract

Genetic modification is a beneficial and successful tool of biotechnology used in agriculture. The area under biotech crops and countries cultivating and importing are increasing rapidly as in 2006, 102 million hectare area was under biotech crops increase to 206.3 million hectares in 2023. Developing countries contribute 54% and industrial countries represent 46% of the global biotech market. Novel GM crops have the potential to contribute food safety, increase health benefits, prevent diseases, overcome malnutrition, and offer unique traits to ornamental plants. Despite no proven adverse effects of GM crops, the development and adoption of GMOs in horticulture have been low. In recent decades, innovative biotechnologies have become a fast growing business opportunity. Biotech companies worldwide are working on developing GMOs according to consumers needs and demands, ensuring transparency through approval from various regulatory bodies such as the USDA, APHIS, FDA, BCPC, CFIA, Health Canada, FSANZ, OGTR, Bureau of Plant Industry, GEAC, and the Singapore Food Agency. All commercial GMOs are released for sale and import after biosafety assessments by these regulatory bodies, according to certain rules and regulations, to ensure protection of human health and the environment. Examples of GMOs in horticulture that are commercially available include ornamental plants like bioluminescent petunia, blue rose, blue carnations, fruits like rainbow papaya, QCAV-4 banana, Arctic Golden Delicious Apple, Rose pineapple, and vegetables like purple tomatoes, Bt Brinjal, GM sweet pepper, Simplot Innate Potato, GM squash, and GM sugar beet. Agronomic crops like GM canola, rice, cotton, and maize are widely cultivated and adopted by farmers in developed and developing countries due to their capacity to exhibit the most desirable crop traits for farmers and consumers. There is a need for GM horticulture crop adoption and approvals, avoiding misinformation that deprives farmers and consumers of significant economic and health benefits.

Keywords: Approvals, Business, Biotech Crops, Genetic Modifications, Novel Traits.

Plant Tissue Culture Industry: Market Analysis, Growth and Potential Business Opportunities

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Abstract

Plant tissue culture industry has an estimated market value of $480 million in 2024 and is expected to grow at the rate of 9.1% annually from 2024-2031, reaching at $883 million by 2031. For exploring its business potential, an in-depth analysis was conducted for tissue culture markets of USA; Europe including Ireland, United Kingdom, the Netherlands; Canada; Australia and Asia including India, China, Sri Lanka and Thailand. North America is dominating the industry by having the biggest market share of 38.3% in 2024. Asian countries like China, India, and Thailand are also rapidly growing tissue culture markets, with India contributing almost 30% of total banana production. The industry analysis highlights the environmentally controlled labs, sterile growth rooms, greenhouses, and strong R&D facilities. The laboratories are producing 200,000-80 million disease free plants yearly and have phytosanitary and ISO certifications such as ISO 17025 and ISO 14644. The market mainly focuses on crops with high demand and profitability like fruits such as apple, banana, blueberries, grapes etc.; rootstock of apple, citrus, peach etc.; food crops such as potatoes, asparagus etc., and ornamental plants such as alocasia, anthurium, monstera, aglaonema and philodendron etc. The labs offer their products for sale at different growing stages like multiplication and rooting stages or very young plants. They are then securely packaged using protective packaging material and then shipped properly. Moreover, innovative technologies like Plantform Bioreactors are being used for large scale micropropagation to improve cost effectiveness and boost production. Peat free cultivation is also being practiced to control global warming. Given its global success, there is a need to explore plant tissue culture as a potential business opportunity in Pakistan, due to its huge demand of high quality planting material. This will not only cut down on the import of planting material, but will also provide youth with employment opportunities.

Keywords: Enterpreneurship, Horticulture Business.

Emerging Viticulture Industry In Pakistan-An Overview Of Challenges and Prospects

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Abstract

Pakistan has a very long-standing history in the cultivation of grapes, spanning several decades. Contrary to traditional viticulture regions across the globe, optimized grapes cultivation management strategy is still at a developing stage in Pakistan. Multifaceted challenges, in terms of climatic variability, high disease incidence, lack of a robust viticulture breeding programme, poor vineyard management, shortage of skilled labor, inappropriate postharvest handling, lack of storage facilities coupled with market volatility all come together to influence fruit production and net profitability from the vineyard. The objective of this review is to elucidate the current status, challenges and way forward for a profitable grapes cultivation in Pakistan. Traditionally, Balochistan is the main growing region with a chuck share of more than 90%, fertile plains of Punjab have shown a rapid rise with area crossing around 2000 ha. Grapes production in KPK have been varying with years and many new emerging groves show a high potential for these areas. Over the years, the traditional cultivars have faced a major declined and replaced by new early maturing cultivars such as King s Ruby, Flame Seedless, Perlette and Sultanina C particularly in Punjab and KPK areas. Similarly, areas in Kashmir and Gilgit Baltistan are suitable for commercial viticulture. Some traditional commercial grapes cultivation areas in Sindh have been lost due to climatic, lack of irrigation, disease and marketing issues. Amongst the others like lower production, inferior fruit quality coupled with excessive pesticide applications mark as key challenges to the industry. However, opportunities abound with increasing local interest in grape production and the possibility of economic profits through public private collaborations. Choosing a 3R approach i.e., right cultivar, right place and right management production technology, value addition-training and research and supply chain management through a public-private partnerships, could overcome many of the challenges faced by viticulture sector and turn it into multi-million industry in Pakistan.

Keywords: Emergence, Grapes, Practices, Production.

Impact of Salicylic Acid and Humic Acid on Growth and Quality Preservation of Cut Iris (*Iris Hollandica*)

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Abstract

Iris (*Iris hollandica*), a prominent species within the Iridaceae family, is widely recognized for its ornamental value and extensive range of flower colors. The Dutch Iris, in particular, holds significant commercial value due to its striking flowers with three distinct petals, making it a profitable crop for floriculture. Iris has been cultivated for ornamental purposes globally and is native to the Northern Hemisphere, with over 299 species documented. Iris flowers, including those found in northern Pakistan, are utilized in perfumes, cosmetics, and traditional medicine. This study, conducted at the Horticulture Field Area of the National Agriculture Center in Islamabad during the 2020-21 growing season, aimed to assess the effects of humic acid and salicylic acid on the growth and quality of Iris (*Iris* × *hollandica*). Six different concentrations of humic acid and salicylic acid were applied in a randomized complete block design (RCBD), consisting of six treatments (one control and five experimental treatments) with three biological replications. Parameters assessed included plant height, number of leaves, flowering time, stem diameter, spike length, flower count per plant, leaf length, bulb count per plant, bulb weight, bulb size, proline content, and vase life. The results revealed that treatment with salicylic acid and humic acid at a concentration of 0.75 mg L^{-1} resulted in significant improvements in key growth and quality parameters. Specifically, this treatment increased plant height (55.27 cm), flower number (2.88) and bulb weight (30.44 g) notably it also enhanced the vase life of the flowers (07 days), which is critical for post-harvest quality. Among the tested concentrations (ranging from 0.25 mg L^{-1} to 0.75 mg L^{-1}), 0.75 mg L^{-1} was found to be most effective in enhancing growth and quality parameters. All the mention parameters were statistical significant. These findings suggest that the combined application of salicylic acid and humic acid at this concentration can be an effective strategy to enhance both vegetative and reproductive growth, as well as the marketability of Iris flowers. The outcomes of this research provide valuable insights for improving the quality and yield of Iris production in commercial floriculture.

Keywords: Iris, Ornamental, Quality, Vase Life, Vegetative Growth.

Status of Citrus Industry of Pakistan and Causes of Low Production in the Citrus

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Abstract

Allah Almighty bless Pakistan with good soil and excellent environment for crop production. Climatic conditions and different altitude level support production of excellent quality fruits in coastline, tropical and subtropical as well as temperate regions. Pakistan is the 20th largest fruits producing country in the world. Pakistan ranks 4th in Mango (1.88 M Tones), 6th in Guava (2.40 M Tones), Dates (0.72 M Tones) and Citrus (2.10 M Tones) production around the globe. However, Citrus is the prime fruit of Pakistan which is grown in all over the Pakistan. Punjab produces over 95% of the crop and 70% of citrus grown in Punjab is under kinnow. Pakistan has more than two hundred citrus cultivars. Among two hundred 56 was used as rootstock and remaining were used scion. However, the citrus moving toward division Dera Ghazi Khan. Therefore, in the current study, we discussed the status of citrus industry including the available germplasm and causes of low production for citrus in Pakistan.

Keywords: Citrus, Status, Pakistan, Germplasm, Production.

Floral Preservation as A Sustainable Business Model in Horticulture

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Abstract

Floral preservation presents a sustainable and economically viable business model within the horticulture industry, addressing the growing demand for long lasting floral products while minimizing waste. Traditional fresh cut flowers have a limited lifespan, leading to significant post-harvest losses and environmental concerns related to transportation, refrigeration, and disposal. By employing advanced preservation techniques such as silica gel drying, freeze-drying, glycerin drying, and pressing, flowers can retain their natural beauty, color, and structure for years. These preserved flowers cater to diverse markets, including home decor, weddings, event planning, and luxury gifting, offering an eco-friendly alternative to fresh floral arrangements. Floral preservation also reduces the dependency on imported flowers, promoting local flower industries and enhancing sustainability by lowering carbon footprints associated with global floral supply chains. The integration of sustainable sourcing, biodegradable packaging, and innovative marketing strategies can further strengthen this business model, aligning with consumer preferences for environmentally responsible products. With increasing awareness of sustainability and the expansion of the preserved flower market, entrepreneurs and horticulturists have an opportunity to develop a profitable and environmentally conscious business that supports both economic growth and ecological conservation.

Keywords: Entrepreneurship, Enterprise, Floral Preservation, Sustainable Horticulture

Bio-Foliar Application for Optimized Production of *Moluccella laevis* (Bells of Ireland)

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Abstract

Shell Flower (*Moluccella laevis*), is an annual herb native to West Asia, valued for its decorative white blooms within bell-shaped calyces. This plant, can grow up to one meter high, is used in floral arrangements and has potential as a potted or bedding plant. Bio-stimulants, including extracts from *Moringa oleifera*, willow (*Salix babylonica*), and seaweed, can enhance plant growth and flower quality. A study conducted at the Plant Propagation Unit, Arid Agriculture University, evaluated the effects of foliar applications of these bio-stimulants at different concentrations on *Moluccella laevis*. The experiment used a Randomize Complete Block Design with various concentrations of treatments applied every 10 days. The results showed that moringa leaf extract @ 10 mL L^{-1} was the most effective, leading to improved plant height, canopy, leaf area, number of florets, and vase life. Seaweed extract at 10 mL L^{-1} resulted in the highest number of spikes and stalk length. Overall, bio-stimulants enhanced plant quality and spike characteristics compared to control. These findings highlight the benefits of bio-stimulants in sustainable and resilient floriculture.

Keywords: Bells of Ireland, Moringa, Seaweed, Willow.

Analyzing the Market Trends of Imported Ornamental Plants in Pakistan

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Abstract

This study analyzes the market trends of imported ornamental plants in Pakistan. Imported ornamental plants make 10-15% of the surveyed nurseries stock of Islamabad and Haripur which shows that the plants are imported to introduce diversity and new varieties. The plants are being imported from Thailand, China, the USA, Netherland, UK, India and Italy. Plants imported from Thailand are Chinese evergreen, Peace lily and Croton with price range of Rs. 2500-5000, 5000-6500, 10,000, respectively. Similarly, Red robin plant of Rs. 10,000 is imported from Netherland, Golden rain tree of Rs. 2500 from UK, Burning bush of Rs. 2000 from USA and Spider plant of Rs. 2000 from China. Potting media such as peat moss, coco coir, compost and vermicompost is used with pot sizes varying from 8 to 12 inches. These plants are also being sold online through different digital forums like Etree Private Limited, Plant.pk and Baghbani.pk. These platforms provide the detailed description and care instructions about plants. The plants are imported through both, legal and illegal channels. However, illegal import cause significant risks, including the potential spread of insect pests and diseases. To mitigate these risks, illegal importation should be discouraged, and quarantine protocols must be implemented to ensure the safe introduction of non-native plant species. Producing these plants locally can minimize reliance on imports and save foreign exchange. It can also create significant job opportunities for youth by establishing local nurseries and training young generation in plant propagation. This initiative can help alleviate unemployment and foster economic growth in the country.

Keywords: Importance, Job Opportunities, Nurseries, Ornamental Plants.

A Business Approach to Horticulture: A Case Study of Mango Orchard in Sindh Province

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Abstract

Horticulture plays a significant role in the agricultural economy of Pakistan, with mango cultivation standing out as one of the most profitable and widely practiced ventures. Sindh province, known for its fertile lands and favorable climatic conditions, is a major hub for mango production. With varieties like Sindhri and Chaunsa gaining international recognition, the mango industry presents vast entrepreneurial opportunities. This case study explores the business dynamics of a mango orchard in Sindh, emphasizing key factors such as investment requirements, production techniques, market trends, and profitability. By adopting a business-oriented approach, mango orchard owners can optimize yield, implement sustainable farming practices, and expand into export markets. The study examines the business strategies for cost-effectiveness, risk management, and sustainable orchard expansion. The findings emphasize that while mango farming in Sindh has immense profitability, factors such as climate variability, pest control, post-harvest losses, and market fluctuations pose significant challenges. Effective financial planning, investment in value-added products, and improvements in the supply chain can drive sustainability and long-term growth. Additionally, government support in terms of subsidies, export incentives, and technological advancements can further strengthen the industry. By treating horticulture as a structured business rather than a traditional farming practice, mango growers in Sindh can transform their orchards into thriving enterprises that contribute to local economies and global trade. Implement precision agriculture, drip irrigation, and integrated pest management (IPM) to improve yield and quality. Meet international quality standards and certifications (e.g., Global GAP) to access premium export markets like Europe and the Middle East and other countries of the world.

Keywords: Business, Global GAP, Horticulture, Market, Orchard.

The Role of Technology in Modern Horticulture Businesses

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Abstract

The integration of advanced technologies has revolutionized modern horticulture, driving efficiency, sustainability, and profitability. Precision agriculture techniques, including sensor-based irrigation, artificial intelligence (AI)-driven crop monitoring, and unmanned aerial vehicles (UAVs), have optimized resource utilization, enhanced crop health assessment, and improved yield forecasting. Controlled-environment agriculture (CEA), such as greenhouse automation and hydroponics, enables year-round cultivation while mitigating the risks associated with climatic variability. Additionally, the digitalization of supply chains through block-chain technology, Internet of Things (IoT) enabled smart farming, and e-commerce platforms has streamlined market access, enhanced traceability, and improved decision-making. However, challenges such as high capital investment, technological skill gaps, and data security concerns pose barriers to widespread adoption. Continuous research, policy support, and capacity-building initiatives are essential to advancing a resilient, sustainable, and technology-driven horticulture sector capable of meeting the demands of a growing global population.

Keywords: Artificial Intelligence, Profitability, Smart Farming, Technology.

Revival and Advancement of Cottage Rose Industry in Pothwar Region

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Abstract

The Pothwar region has a rich history of fragrant rose cultivation and value-added products such as rose water and Gulqand. However, the industry is in decline due to a lack of interest, insufficient investment, and reduced cultivation area. Given the regions favorable environmental and edaphic conditions, high-quality rose production enriched with unique essential oils particularly from Rosa damascene and Rosa centifolia can be revitalized. Introducing mechanized processing plants for essential oil extraction, rose water distillation, and Gulqand production will enhance product quality and hygiene by minimizing contamination risks. The primary challenges include the persistence of traditional farming techniques, inadequate pest and disease management, and post-harvest losses due to poor handling and storage facilities. Additionally, the absence of government support and research initiatives hinders industry growth. Farmers lack access to modern agricultural practices, resulting in low yields and suboptimal flower quality. Addressing these issues is crucial for revitalizing the rose industry and ensuring its sustainability. This study aims to evaluate the current status of the cottage rose industry in Pothwar, identify and introduce promising local and exotic rose varieties, and enhance production through farmer training programs. A comprehensive approach will be employed, including area surveys, farmer interactions, germplasm collection, and commercial trials. This initiative will foster entrepreneurship, create economic opportunities, and improve the livelihoods of rural communities. The success of this project is expected to attract agribusiness investments and tourism, further boosting the regional economy. Additionally, the revival of the rose industry will contribute to Punjab's agricultural economy by promoting high-value floriculture crops, reducing socio-economic pressures, and ensuring a more stable rural workforce through enhanced employment and entrepreneurial opportunities.

Keywords: Farmer Training, Modernization, Research and Development.

Innovative Strategies for Plant Propagation

Effect of Ascorbic Acid Seed Priming on Germination, Emergence, Growth and Yield of Amaranth (*Amaranthus cruentus* L.)

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Abstract

A field experiment was conducted during the 2021 dry season at the Screen house of the Department of Crop Science, Usmanu Danfodiyo University, Sokoto, to evaluate the effect of priming on germination, emergence, growth and yield parameters of amaranth. The treatments consisted of four soaking durations (2, 4, 6, and 8 hours), five priming concentration (0, 50, 100, 150 and 200 ppm) and control (where no priming was applied).The treatments were laid out in a completely randomized design (CRD) in the laboratory replicated three times for the germination test and randomized complete block design (RCBD) for the field trial. Data were collected on final percentage germination, mean germination time, mean germination rate, germination rate, germination rate index time to 50% germination, emergence percentage, mean emergence time and time to 50% emergence. The results revealed significant effect of Ascorbic acid priming on mean germination time, mean germination rate, germination index, time to 50% germination and time to 50% emergence. Soaking seeds in 150 ascorbic acid for 6 hours reduced the time to 50% germination and emergence and also recorded higher germination. Thus, from the findings of this study, it could be concluded that priming amaranth seeds in 150 ppm ascorbic acid for 6 hours could be applied to enhance the performance of amaranth.

Keywords: Amaranth, Ascorbic acid, Emergence, Germination, Seed Priming.

In Vitro Propagation of Stevia to Increase Leaf and Root Growth Using Murashige and Skoog Culture Media

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Abstract

Steviosides found in stevia (*Stevia rebaudiana* Bertoni) give it a sweet taste without adding any calories. Tissue culture is an appropriate technique for the propagation of stevia. The current research sought to appraise the effects of several plant growth regulators (PGRs) on the development of stevia and to design an efficient process for stevia production on a larger scale. The design of experiment was completely randomized (CRD) with three replications. The different concentrations of BAP (1 - 2.0 mg L^{-1}), Kinetin (1 - 2.0 mg L^{-1}) and IAA (1 - 2.0 mg L^{-1}) combination of BAP and IAA (0.5-2.0 mg L^{-1}) were added to the MS basal medium to enrich it and the MS medium without adding PGRs was used as control. The Benzylaminopurine (BAP) produced better results than kinetin. Because the benzyl group in BAP improves its capacity to cross cell membranes and interact with cytokinin receptors in plant cells more effectively than kinetin, and because kinetin does not interact with the cytokinin receptors as strongly as BAP does, BAP is superior to kinetin in terms of promoting plant growth. Survival percentage of seedlings (%), length of shoots, length of roots, number of roots per plant, number of leaves per plant, plant fresh weight, plant dry weight, and internodal distance were among the parameters taken into consideration during the research period. The percentage of seedling, shoot induction, internodal distance, length of shoot and length of root were significantly increased with BAP (2.0 mg L^{-1}). In comparison to other concentration of various plant growth regulators (PGRs) that were used, the combination of BAP (2.0 mg L^{-1}) and IAA (0.5 mg L^{-1}) significantly enhanced the highest percentage of root induction, number of roots per plant, number of leaves per plant, length of root, plant fresh and dry weight. Therefore, the combination of BAP (2.0 mg L^{-1}) and IAA (0.5 mg L^{-1}) of PGRs is recommended to grow stevia plant.

Keywords: BAP, Cytokinins, IAA, PGRs.

Unleshing *Caralluma tuberculata's* Potential: How Light Regime and Selenium Nanoparticle Boost Antioxidants and Hypoglycemic Bioactivities

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Abstract

In vitro plant cultures have emerged as a viable source of biomass enriched with potent secondary metabolites, holding significant promise for medicinal applications. This study aimed to explore the antioxidative and hypoglycemic potential of selenium nanoparticles (SeNPs) and light stressed mediated in vitro cultures of Caralluma tuberculata callus extract. The development of optimal callus was achieved through a two-week incubation in a dark environment and shifted to normal condition by using Murashige and Skoog (MS) media supplemented with 100 g L^{-1} of Selenium NPs, along with 0.5 mg L^{-1} of 2,4-Dichlorophenoxyacetic acid and 0.5 mg L^{-1} of 6-Benzyladenine, resulting in maximum biomass production at 56 days. This well-developed callus, rich in secondary metabolites, was selected to evaluate its antioxidative and hypoglycemic properties. The antioxidative potential of the callus extract was assessed through various tests, including ABTS+ scavenging, hydrogen peroxide inhibition, hydroxyl radical scavenging, and reducing power. Likewise, the hypoglycemic capacity of the callus extract was probed through assays involving alpha-amylase, alpha-glucosidase, glucose absorption by yeast cells, anti-sucrase, and anti-lipase activities. Notably, concentrations of 200 and 800 g mL^{-1} exhibited pronounced efficacy in mitigating radical species. To delve into the hypoglycemic effects of the callus extract, assessments involving alpha amylase, alpha-glucosidase, and glucose absorption by yeast cells were performed across varying glucose concentrations (5 mmol L^{-1}, 10 mmol L^{-1}, and 25 mmol L^{-1}). The outcomes consistently demonstrated a dose-dependent relationship, with higher concentrations of the callus extract exerting potent inhibitory effects on the catalytic sites of the enzymes. The findings of this study propose a mechanism wherein selenium nanoparticles and light stressed mediated in vitro callus cultures of *C. tuberculata* potentially interact with charged species, operating as competitive inhibitors. This interaction retards the enzyme-substrate reaction, thereby impeding enzymatic degradation. These noteworthy outcomes hold promising implications for future medical applications of extract derived from callus cultures under the nanoparticles and light stressed condition.

Keywords: Antidiabetic, Antioxidant, Selenium Nanoparticle.

Enhancing Seed Germination of *Lavandula angustifolia* Through Cold Stratification-A Germination Strategy in Temperate Region

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Abstract

Lavender (*Lavandula angustifolia*) is commercially important aromatic plant but problematic with lower seed germination due to specific requirements. Most of the lavender species have seed dormancy which vary with genotypes. For commercial propagation, it is necessary to enhance germination of lavender seeds through breaking its dormancy. Therefore, an experiment was performed at PARC-Mountain Agricultural Research Center, Juglote on cultivar of english lavender during 2024. Freshly imported seeds of lavender from Hem Genetics B.V. were stratified for different durations (25, 40, 55 days) along with a control (0 days; no stratification). For the stratification, lavender seeds (n = 40) were positioned in petri dishes, cover with moist filter paper and placed in fridge at 4 C as per treatment duration. After stratification treatments, seeds were sown in plastic pots containing the peat moss as growing substrates. Pots were placed under the green net, having the semi-controlled conditions (Mean minimum and maximum temperature; 8.6 C and 33.2 C, mean minimum and maximum relative humidity; 27.1% and 87.3%). Results revealed that lavender seeds stratified for 55 days showed maximum germination (86.67%) followed by 20 and 40 days stratification (61.67% and 52.5% respectively); which were statistically similar. While, least germination (5.83%) was recorded in control treatment (0 days). Moreover, stratified seeds required lowest days to first germination (8-9 days), while control seeds were germinated after 30 days of sowing. Similarly, minimum time from sowing to transplanting was observed in all stratified seeds (39-42 days) while, control seeds took maximum time from sowing to transplanting (68-69 days). Its concluded that seeds should be artificially stratified for 55 days as best optimal treatment for commercial nursery production of true lavender under the temperate conditions of Gilgit-Baltistan. However, longer stratification duration can also be tested in further experiment(s).

Keywords: Protected Nursery, Stratification, Seed Dormancy, Ture Lavender.

Ensuring Quality and True to Type Stone Fruit Nursery Production: A Key to Sustainable Horticulture and Fruit Industry Development

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Abstract

The sustainable development of the horticulture sector, particularly the fruit industry, is deeply rooted in the availability of high-quality, true-to-type nursery plants. Stone fruits such as peach, plum, apricot, and cherry are economically significant crops in temperate regions, and their successful cultivation begins with the selection of genetically uniform, disease-free, and vigorous planting material. This article explores the critical role of nursery production systems in ensuring orchard longevity, productivity, and profitability. Key focus areas include the establishment and maintenance of certified mother blocks, adoption of improved propagation techniques, implementation of nursery sanitation and phytosanitary measures, and adherence to quality control standards. The article also discusses common challenges such as varietal mix-ups, disease transmission through propagation material, lack of certification protocols, and limited awareness among growers and nursery operators. By addressing these issues through integrated approaches—combining scientific research, capacity building, regulatory enforcement, and stakeholder engagement—we can ensure the reliable production of true-to-type nursery plants. Such efforts are essential not only for achieving sustainable fruit production but also for enhancing food security, increasing farm incomes, and boosting the export potential of the horticulture sector.

Keywords: Stone Fruits, Nursery Production, True to Type Fruit.

Dose Optimization and Comparative Effect of IBA and IAA on Growth and Rooting of Tip Cuttings of Triangle Fig (*Ficus triangularis*)

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Abstract

The triangular fig (*Ficus triangularis* L.) faces rooting problem when propagated asexually with tip cuttings. For this purpose, Plant Growth Regulators (PGRs) were tested to fix this issue by using indole-3-acetic acid (IAA) and indole-3-butyric acid (IBA) at different concentrations (0, 100, 200, 300, and 400 mg L^{-1}). This experiment was carried out at the Floriculture Experimental Area, Institute of Horticultural Sciences, University of Agriculture Faisalabad. In this experiment, investigation was done in a greenhouse with controlled environment to assess rooting process in tip cuttings and doze optimization. In this regard, the experiment was comprised of nine treatment combinations with ten observational units in each treatment. In this experiment, 6-7 inches long tip cuttings of triangular fig having 4-5 nodes were grown. The cuttings were treated with IAA and IBA at different concentrations (0, 100, 200, 300 and 400 mg L^{-1}). The experiment was executed according to Completely Randomized Design with three replications and ten plants in each replication. Collected data revealed that maximum root length (15 cm), root fresh weight (1.16 g), root dry weight (0.089 g), plant height (12.56 cm), leaf area (13.99 cm^2), number of buds (4.5), stem diameter (2.38 cm), fresh weight of leaves (2.16 g), the dry weight leaves (0.014 g), days to root initiation (26.33 days) was attained at the concentration of 200 ppm of the IBA. Analysis of variance technique was used to determine the overall significance of the proposed research trial and treatment means were compared using Tukey's test at 5% significance level.

Keywords: Indole Acetic Acid, Fig, Rooting, Tip Cutting.

Determination of Scion/Rootstock Effects on Leaf Metabolites in Grafted Plants of Citrus

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Abstract

Selecting the appropriate graft combination is crucial for optimizing nutrient uptake, water potential, plant vigor, fruit quality, and yield efficiency. This study examined the impact of nine citrus rootstocks viz., C-35, Carrizo citrange, Troyer citrange, Poncirus trifoliata, Cleopatra mandarin, Cox mandarin, Benton citrange, Rough Lemon, and Sour Orange, on the leaf metabolite profiles of Tarocco and Kinnow as scions using gas chromatography-mass spectrometry (GC-MS). Hundreds of metabolite ion features were detected and analyzed statistically. In the PCA Biplot, the eighteen scion/rootstock combinations were categorized into four quadrants, showing clear differences in leaf metabolomes across rootstocks. PCA1, accounting for 42.8% of the variance, was associated with ferulic acid, alanine, propanoic acid, ribose maltose, glucose, and galacteric acid. PCA2, representing 15.5% of the variance, was linked to proline, malic acid, fructose, talose, and xylose. The heatmap also revealed distinct differences among scion/rootstock combinations. These findings suggest that rootstocks influence the primary and secondary metabolites of citrus scions, thereby affecting their tolerance to various biotic and abiotic stresses.

Keywords: Citrus, GC-MS, Metabolites, PCA.

Optimizing Citrus Cultivation: Role of Rootstocks in Modulating 'Tarocco' Growth and Physiology

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Abstract

The study aimed to investigate the influence of different rootstocks on the growth, leaf mineral composition, and physiological parameters of "Tarocco" when cultivated in calcareous soil. The experiment involved the use of two years old grafted plants of Tarocco' onto nine citrus rootstocks, including *Poncirus trifoliata*, C-35 citrange, Troyer citrange, Carrizo citrange, Benton citrange, Cleoptera mandarin, Cox mandarin, Rough lemon, and Sour orange. The research was carried out over two consecutive years in the Pothowar region, Islamabad, Pakistan. Results revealed that different citrus rootstocks significantly affected 'Tarocco' scion at $P<0.05$ in both years. 'Cox' rootstock resulted in larger scion, rootstock, and graft union diameters, as well as greater leaf number and leaf area during 2023. For leaf mineral compositions, 'Cox' rootstocks led to higher leaf content of essential nutrients such as potassium (K), phosphorus (P), iron (Fe), and zinc (Zn) in both 2022 and 2023. Rough lemon rootstock was associated with higher leaf manganese (Mn) content during both years. Regarding physiological attributes, plants grafted on 'Cox' rootstocks demonstrated elevated levels of intercellular CO_2 concentration (Ci), transpiration rate (E), and water use efficiency (WUE) during the experimental period. Overall, plants grafted on *Poncirus* had lower values of 'VPD', 'gs', 'Ci', 'E' compared to others during the studied period. Significant correlations among the morphological, physiological, and leaf nutrient compositions were identified at both the $P<0.01$ and $P<0.05$ significance levels, which showed that all the investigated parameters were strongly correlated with one another except for the Cu contents. In conclusion, the rootstock 'Cox' displayed better compatibility with the 'Tarocco' scion, showing higher potential for plant growth and nutrient uptake.

Keywords: Carrizo, Citrus, Cox, Nutrient, Physiological Parameters, Rootstocks.

Comparative Analysis of Static and Dynamic Dipping Systems on Rooting Efficiency and Plantlet Quality of Chrysanthemum

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Abstract

Chrysanthemum, a popular ornamental crop, is prized for its vibrant flowers and fragrant foliage. To compare the effectiveness of static and dynamic dipping systems, an experiment was conducted on chrysanthemum (Pina Colada White), employing three treatment methods (ebb and flow system, mist propagation system and continuous immersion method) in combination with different concentrations (100, 500 and 1000 ppm) of Indole-3-Butyric Acid (IBA) along with a control treatment. Experiment was arranged under a CRD design and replicated thrice. Cuttings were planted in plug trays containing a substrate (1:1 peat moss and sand mixture) and placed in a shaded environment. Results showed significant differences among treatments, plant cutting under Ebb and Flow system with 500 ppm IBA treatment took minimum days for root initiation and new leaf emergence (6 days and 10 days respectively). In addition, higher number of new leaves (7.66), maximum plant height (8.49 cm), root length (8.69 cm) and chlorophyll content (54.78 SPAD) were also noted in Ebb and Flow system with 500 ppm IBA treatment as compared to other treatments. These findings emphasize that adopting the Ebb and Flow system can improve plantlet quality and reduce propagation time, benefiting the ornamental industry. By optimizing this method with IBA concentrations (500 ppm), growers can enhance Chrysanthemum propagation efficiency, leading to increased productivity and profitability. Further research needs to explore the application of Ebb and Flow system in other ornamental crops, expanding the scope of this study.

Keywords: Continuous Immersion, Ebb and Flow System, Plantlet Quality, Rooting.

Indole-3 Butyric Acid Enhanced Rooting Efficiency of Rosemary Cuttings (*Rosmarinus officinalis* L.)

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Abstract

Rosemary is popular aromatic plant for its fragrant, colorless to pale yellow essential oil. Inadequate nursery production of rosemary is one of the reasons for limited farming of rosemary in Pakistan. For this, an experiment was conducted at the field research area of Floriculture Horticultural Research Institute, NARC Islamabad. To improve the rooting, rosemary cuttings were treated with IBA (0, 250, 500, 750 and 1000 mg L^{-1} IBA) alone and in combination with talc-based carriers (like Telcom powder). There were 20 cuttings in each treatment, and each treatment was replicated thrice. In the present experiment, cuttings of Rosemary were taken from the mother plant and treated with fungicide Topsin-M at the rate of 3 g L^{-1}. The experiment was laid out according to Complete Randomized Design. Each cutting was of uniform length so that cutting growth could be investigated properly. The cuttings were then planted in Polythene bags of size 3×6 inches (width/height) after applying the hormone. The minimum number of days to root initiation and days to leaf emergence (21.3 and 31.8 days respectively), highest number of new leaves (9), longest root (7.5 cm) and increase in cutting growth (5.2 cm) and chlorophyll content (53.35 SPAD) in 750 mg L^{-1} IBA treatment. Whereas non treated cuttings (Control; 0 mg L^{-1} IBA) took more time for roots initiation and produced weak with poor-quality plantlets than IBA treated cuttings. These findings highlight the efficacy of IBA, particularly at 750 ppm in liquid form, in improving the asexual propagation of rosemary, offering practical insights for optimizing vegetative propagation practices in commercial and research settings.

Keywords: IBA, Rooting, Rosemary, Talc-Based Carriers.

Nursery Plant Production of Guava cv. Riali and Suffada with Different Methods and Timing

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Abstract

Guava (*Psidium guajava* L.) is a tropical and sub-tropical fruit crop widely cultivated in Pakistan. The present study aimed to investigate the effect of suitable growing time/dates and their interaction on cuttings of guava plants to ensure the availability of true-to-type planting material for commercial cultivation. The experiment was carried out from July to September 2023 and it was laid out in randomized complete block design with Softwood cuttings examined for two varieties Suffada and Riali with three replications. The variables studied were sprouting percentage, survival percentage, Plant height, number of roots and root length. The results revealed that sprouting percent, survival percent, and vegetative growth parameters were significantly influenced by different months of cuttings and varieties. The cuttings done in August recorded maximum sprouting percent, survival percent, and vegetative growth. The study concluded that August is the most suitable month for clonal propagation of guava.

Keywords: Control Environment, Rooting, Seasons.

Impact of Grafting on Growth and Yield of Bittergourd (*Momordica charantia* L.)

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Abstract

Vegetable grafting is being practiced to overcome production related issues. In this study, the impact of rootstock on the growth and yield of bitter gourd was assessed. Three combinations of bitter gourd grafting were taken into consideration; Aswad grafted onto Aswad (BG3/BG3), Aswad grafted onto Faisalabad Long (BG3/BG4), and Aswad grafted onto wild type bitter gourd (BG3/WT). Aswad and Faisalabad Long are two bitter gourd varieties while WT is a wild rootstock of bitter gourd. Self-grafted Aswad plants were used as control in this study. Hole insertion and tongue approach methods of grafting were used to prepare the grafted transplants. The outcomes of the study highlighted that Aswad grafted onto Faisalabad Long had improved bitter gourd growth and development as compared with self-grafted Aswad plants and Aswad plants grafted onto wild type rootstock. Aswad grafted onto Faisalabad Long (BG3/BG4) had significantly better plant height, stem girth, number of secondary shoots, number of leaves, fresh weight of root and shoot, dry weight of root and shoot, plant fresh and dry weight, number of male and female flowers, number of fruits per plant, fruit length, fruit diameter, per fruit weight, number of seeds per fruit, and seed weight compared with other grafting combinations (BG3/BG3 and BG3/WT). Some attributes, (BG3/WT) combination showed very poor performance such as plant fresh and dry weight, number of leaves, number of flowers and fruits. Although, control treatment had better performance than (BG3/WT) combination in all attributes except number of seeds per fruit, fruit diameter and fruit length. Both of the rootstocks (BG3 and WT) had an obvious impact on the performance of bitter gourd. Overall, more vigorous and healthy fruits were collected from BG3/BG4 plants. Considering the results, it is suggested that the vitality of Faisalabad Long (BG4) is relatively better as rootstock to improve the growth and yield of bitter gourd under field conditions

Keywords: Grafting, Nutrient uptake, Pakistan, Rootstock.

Performance of Sweet Orange Cultivars After Transplanting in Sandy Soil of Dera Ghazi Khan

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Abstract

Citrus is one of the most important commercial fruit crops grown in all continents of the world, and areas under citrus are in continuous expansion. Therefore, the focus of current study was on growth performance of different mandarin cultivars under sandy soil of Dera Ghazi Khan. Four different oranges cultivars were used in the current study and data was collected in different intervals to check the performance under sandy soil of Dera Ghazi Khan. The result showed that all plants of each replication were grown successfully and no mortality was noted. After placing in the field, highest plant height was found in Morro-blood (6.30 feet) Musambi (5.06 feet) followed by Salustiana (4.80 feet) and Succari (4.10 feet) during interval 2. Similar trends were followed by interval 1. However, the highest number of leafs were found in Morro-blood (408) Musambi (306) followed by Salustiana (203) and Succari (103) during interval 2. Similar trends were followed by interval 1. The highest number of branches were found in Morro-blood (16.67) followed by Musambi (14.00), Salustiana (10.33) and Succari (9.00) and during interval 2. The highest spine length was found in Musambi (2.67 mm) followed by Morro-blood (4.33 mm), Salustiana (0.70 mm) and Succari (0.50 mm) during interval 2. The highest spine length were found in Morro-blood (2.00), Musambi (1.30) Salustiana (0.60) and Succari (0.30) during interval 1. The highest Shoot thickness were found in Morro-blood (7.30 mm) followed by Musambi (6.50 mm), Salustiana (5.80 mm) and Succari (4.80 mm) during interval 2. Similar trends were followed by interval 1. The highest stem thickness were found in Morro-blood (7.60 mm) followed by Musambi (6.60 mm), Salustiana (5.83mm) and Succari (4.70 mm) and during interval 2. Sandy loam soil texture and favorable growth conditions allow for the production of superior citrus cultivars in sandy soil of Dera Ghazi Khan.

Keywords: Citrus, Performance, Sweet Orange, Sandy Soil.

Effect of Micro Grafting on Propagation of Citrus Cultivars

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Abstract

The most well-known evergreen fruit in the ecosystem is the citrus fruit. The Rutaceae family, of which Aurantioideae is a subfamily, is referred to as citrus. Citrus is a shrub that is evergreen. Their high vitamin C content and pleasant flavors are well-known. It is mostly grown in Punjab, in the Sargodha district of Pakistan. Citrus is centered in Sargodha, particularly Kinnow. Citrus production, however, is shifting in the direction of Dera Ghazi Khan Division. In horticulture, grafting is a popular method for propagating plants, especially citrus trees to produce a new plant with desired characteristics.The results showed that the Seedless Lemon had the highest grafting efficiency (80%) followed by Grapefruit and Mitha (40%). While lowest grafting (%) was found in Feutral's early (25%) and Musambi (30%). However, the sprouting interval was shortest in the Feutral's Early and Grapefruit, with an average of about 13 days followed by Mitha and Seedless lemon took about 14 and 15 days, repectively to sprouting. The effects of micro-grafting on plant height, leaf length, leaf width and shoot length have also been recorded and discussed.

Keywords: Citrus, Propagation, Micrografting, Sprouting,

Effect of IBA and NAA to Assess the Rooting Process in Semi Hardwood Cuttings of Fire-Spike Plant (*Odontonema tubaeforme*)

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Abstract

Odontonema tubaeforme, commonly Fire-spike plant, is tropical ornamental species from Mexico. Known for its lush green foliage and striking red blooms, it is a highly prized landscape plant. However, propagating it through semi-hardwood cuttings often faces challenges due to poor root initiation and low rooting success. An experiment is enacted to improve the success of propagules by stem cuttings accompanied by a hastened root initiation process. The experiment comprised of various levels of indole-3-butyric acid (IBA) and naphthalene acetic acid (NAA) against different treatments like 500 mg L^{-1}, 1000 mg L^{-1}, 1500 mg L^{-1}, 2000 mg L^{-1}, 2500 mg L^{-1}, 3000 mg L^{-1}, 3500 mg L^{-1}, and control. Semi-hardwood cuttings; 5-6 inches in length, bearing 3-4 nodes, were collected from mature plants and subjected to a completely randomized design, in a greenhouse optimized at the temperature of 24±2 °C and 18±2 °C, with relative humidity between 70% and 80% with seven treatments plus control, each replicated twenty times. Collected data revealed that maximum the IBA @ 1500 ppm significantly boosted the root length (7.53 cm), root fresh weight (0.106 g), root dry weight (0.08 g), plant height (21.73 cm), number of leaves per plant (6), leaf area (12.24 cm^2), number of buds (8.6), stem diameter (2.67 cm), fresh weight (2.13 g), the dry weight (1.06 g), and days to root initiation (28.3 days) compared to the other treatments of IBA and NAA. Data was analyzed using Analysis of variance technique to determine the overall significance of the proposed research trial and treatment means were compared using Tukeys test at 5% significance level.

Keywords: IBA, Fire-Spike, NAA, Rooting, Semi-Hardwood Cuttings.

Response of Different Growing Media on Root Initiation in Air Layering of Magnolia (*Magnolia grandiflora* L.)

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Abstract

Magnolia tree has been a feature of ornamental gardens and parks since ages. Their rich scented blooms, pinkish, and white in colour are admired and desired by the garden owners. They have delicately unfurling petals, saucer sized flowers and peculiar foliage never cease to enthrall the viewer. Considering the demand in commercial landscape business and demand of this plant, an experiment was designed to assess the response of different recipes of growing media in air layering method of plant propagation. The treatment combinations that were composed of T_o = garden soil, T_1 = peat moss + farm yard manure, T_2 = vermiculite + farm yard manure, T_3 = perlite + farm yard manure, T_4 = peat moss + garden soil, T_5 = vermiculite + garden soil, T_6 = perlite + garden soil, T_7 = peat moss + farm yard manure + garden soil, T_8 = vermiculite + garden soil + farm yard manure, T_9 = perlite + garden soil + farm yard manure was applied to the plants with 5 replications under Randomized Complete Block Design at D-ground area, University of Agriculture, Faisalabad. Data was collected for different root parameters. Recorded data showed that T_4 (Peat moss + Garden soil) showed high number of roots (20.4) units, the number of primary roots (21.8), the length of primary roots (7.4 cm), the diameter of primary roots (3.31 mm), the number of secondary roots (5.6), the length of secondary roots (2.51 cm), the diameter of secondary roots (1.46 mm), the weight of roots (2.71 g), the total length of roots (9.92 cm), the percentage of rooting success (96.20%), the longest root (7.54 cm), days to root initiation T_4 have shortest root initiation (83 days) and the shortest root (1.43 cm). Data was analyzed using ANOVA techniques and means was compared using Least Significant Difference (LSD) test at 5% level of probability.

Keywords: Air Layering, Growing Media, Propagation Method.

Annual Flowers Seed Pelleting and Coating Enhance Uniform Seedling Growth and Value Addition

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Abstract

A study was conducted to optimize various seed pelleting and coating techniques to evaluate the best performing materials, which improve seed germination, growth behavior and seed quality characters of selected winter annual flower seeds viz., dianthus, marigold, paper flower and petunia. Two experiments, 1. comparison of various seed pelleting materials on selected flower seeds and 2. comparisons of various seed coating materials on selected flower seeds were conducted. In expt. I, there were four treatments regarding seed pelleting materials including control (no pelleting), pelleting with local materials (Talcum powder + Binder), pelleting with local materials (Talcum + Bentonite + China powder) and Pelleting with imported materials. In expt. II, four treatments regarding coating materials including control (no coating), coating with 'Bacillus MN54', coating with 'Bacillus AS54' and coating with moringa leaf extract (MLE) were compared. In expt. I, results revealed that least mean germination time (6 days), highest seedling germination index (171.1) and vigor index (421.6) was recorded in seeds pelleted with local materials (Talcum + Bentonite + China powder), while least time taken to 50% germination (19 days), seedling length (4.9 cm) and dry matter per 10 seedlings (1 g). Moreover, in petunia seeds, least mean germination time (15 days), highest seedling germination index (224.2) and vigor index (378.5) was recorded in seeds pelleted with local materials (Talcum powder + Binder), while least time to 50% germination (10 days), tallest seedling length (2.4 cm), highest dry matter per 10 seedlings (2.3 g) and seed moisture content (10.21%) were highest among seeds pelleted with local materials (Talcum + Bentonite + China powder). In expt. 2, results demonstrated that in marigold and paper flower highest seedling germination index (221.6 and 225.5), vigor index (412.4 and 416.5), seedling length (3.2 and 3.6 cm). In summary, for high seed quality germination characters, pelleting with local materials (Talcum + Bentonite + China powder) and imported materials. Coating with 'Bacillus MN54' microbes and moringa leaf extract can be used to get uniform and quality seedling establishment.

Keywords: Bacillus MN54, Bentonite, Germination, Moringa Leaf, Seedling Vigor Index.

Growth of Basella Cuttings Using Different Growing Media

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Abstract

Malabar spinach (*Basella rubra* L.) tends to exhibit higher growth in sand compared to other media like silt, farmyard manure, hydroponics, garden soil and gravel because of the unique properties of the sand. The well-aerated environment in sandy soil allows roots to access oxygen more easily, enhancing nutrient uptake and overall plant vigor. Moreover, the loose structure of sand enables roots to penetrate deeper and spread more efficiently, which is crucial for water and nutrient absorption. In contrast, other media like silt or soil may retain too much moisture, leading to poor root aeration while water or gravel may lack the necessary support or nutrients for optimal growth. Thus, the combination of good drainage, aeration and root development in sandy conditions contributes to the superior growth of malabar spinach in this medium. Among different media used in experiment, sand is considered best media for Basella cutting growth.

Keywords: Cuttings, Growing medias, Growth.

Efficient Epicotyl Grafting: An Multiplication Technique in Mango (*Mangifera indica* L.)

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Abstract

Epicotyl grafting is considered to be most efficient grafting technique, to augment the success and survival rate of grafting in mango (*Mangifera indica* L.). It is also well documented for timely seedling production of desired varieties. Therefore, the present study was perceived to assess the success and survival rate of epicotyl grafting. A container based study consisted of two factors viz. three varieties including, Langra, Sindhri and chaunsa and four rootstock ages viz., 20, 30, 40 and 50 days. The experiment was carried out in Completely Randomized Design with 36 treatment combinations distributed equally in three replications. The findings revealed that all the studied traits were significantly effected by varieties and rootstock ages. The interactive results showed that the maximum for rootstock length (cm), rootstock diameter (mm) and leaves plant^{-1} was significantly recorded in chaunsa variety grafted onto 50 days old rootstock and earliest flush was observed in langra variety grafted onto 20 days rootstock. In case of variety, maximum rootstock length (cm), rootstock diameter (mm), scion length (cm), scion diameter (mm), stionic height (cm), number of leaves plant^{-1},success rate (%) and survival rate (%) was significantly observed in chaunsa variety. While earliest bud break and first flush exhibited in langra variety. On the other hand, maximum rootstock length (cm), rootstock diameter (mm), scion length (cm), scion diameter (mm), stionic height (cm), number of leaves plant^{-1}, success rate (%) and survival rate (%) was significantly observed in 50 days rootstock. While 20 days rootstock had best performance for bud break and first flush (days). It is concluded that well established rootstock of 50 days and chaunsa variety are found best for epicotyl grafting in mango

Keywords: Epicotyl Grafting, Rootstock, Success, Survival, Varieties.

Evaluating the Role of Priming in Improving *Ipomoea Hederacea* Jacq Germination Efficiency

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Abstract

Seed priming is a simple, cost-effective, and eco-friendly technique that enhances seed germination and early seedling growth. In this study, two priming methods hydropriming and osmopriming were applied to evaluate their impact on the germination and growth of Ipomoea hederacea (ivy-leaved morning glory) seeds. The experiment was conducted under greenhouse and laboratory conditions at the Botany Department, Minhaj University, Lahore. Three time intervals (6, 12, and 18 hours) were used to soak the seeds for hydropriming; the 18-hour treatment produced the greatest outcomes, including the highest germination. Potassium phosphate (K_3PO_4) at doses of 0.5%, 1.0%, and 1.5% was used for osmopriming. With noticeable gains in the pot experiment, the maximum germination and growth performance was noted at a 1.5% K_3PO_4 concentration. In the periplate and pot studies at 1.5% potassium phosphate, the smallest and highest seedling root lengths were 3.9±0.04 cm and 7.5±0.06 cm, respectively, and in the control group. Likewise, the periplate and pot tests at 1.5% potassium phosphate and the control group recorded the smallest and longest seedling stem lengths, respectively, at 2.30±0.01 cm and 14.36±0.08 cm. Additionally, the pot and periplate studies at 18 hours and the control group, respectively, showed the largest and lowest seedling leaf lengths, measuring 3.90±0.04 cm and 0.09±0.01 cm. In Both hydropriming and osmopriming greatly improved seed germination and seedling development in comparison to the control group (unprimed seeds). In the pot and periplate trials, the 1.5% potassium phosphate treatment and the control group had the highest fresh weight (1.40±0.02 g) and lowest dry weight (0.01±0.001 g), respectively. Both hydropriming and osmopriming greatly improved seed germination and seedling development in comparison to the control group (unprimed seeds). These results demonstrate seed priming potential as a useful, economical, and efficient method of enhancing crop establishment and yield. The study shows how it can be applied to contemporary agriculture, opening the door to more effective and sustainable farming methods.

Keywords: Agriculture, Eco-friendly, Priming, Seeds, Sustainable.

Integrated Disease & Pest Management

Field Incidence, Severity and Farmers Perception on Tomato Yellow Leaf Curl Virus in Sokotoo Sudan Savannah, Nigeria

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Abstract

Tomato Yellow Leaf Curl Virus (TYLCV) poses a significant threat to tomato production in Nigeria. A survey was conducted in three local governments (Wamakko, Gwadabawa, and Kware) of Sokoto State to document disease incidence, severity, and farmer's perception. A total of 48 symptomatic and asymptomatic plant samples were collected across six locations. The samples were analyzed for TYLCV incidence and severity. The major symptoms observed included stunting, chlorosis, necrosis, leaf curling, and leaf distortion. The highest disease incidence was recorded in Kware (25%), while the lowest was in Wamakko (8%). Disease sevrity ranged from 5.8% to 17.%, with the highest infection rate in Kware and the lowest in Wammako (5.8%). The distribution of TYLCV ranged from 8.5% in Wamako to 18.5% in Kware. Farmer's perception on TYLCV management is limited, with most farmers unaware of the virus's role in disease symptoms. To combat TYLCV, farmers are recommended to adopt best agricultural practices, including regular weeding, crop rotation, and using resistant tomato varieties. This study highlights the need for increased awareness and adoption of integrated pest management strategies to mitigate the impact of TYLCV on tomato production in Nigeria.

Keywords: Incidence, Severity, TYLCV, Tomato, Disease.

Occurence and Distribution of Sweet Potato Leaf Curl Virus in Some Selected Local Government Areas of Sokoto State

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Abstract

Sweet Potato Leaf Curl Virus (SPLCV) is a significant threat to sweet potato production worldwide. This study investigated the occurrence and distribution of SPLCV in Sokoto State, Nigeria. A survey was conducted in three local government areas (Gwadabawa, Kware, and Wammako) of Sokoto State. Sweet potato farms were randomly selected, and data on disease incidence and severity were collected. A total of 48 sweet potato farms were surveyed, and disease incidence and severity were assessed. The results showed that SPLCV is widespread in the study area, with disease incidence ranging from 3.6% to 4.5% and severity ranging from 26% to 26.25% across the three local government areas. The highest disease incidence was recorded in Gwadabawa Local Government Area (4.5%), followed by Kware (3.95%) and Wammako (3.6%). Farmer's perception of SPLCV revealed that while most farmers were aware of the disease, they lacked knowledge on its management. The majority of farmers (80%) practiced mixed cropping, and 60% used chemical pesticides to protect their crops. The study highlights the need for a comprehensive approach to manage SPLCV and improve sweet potato production in Sokoto State. The high disease incidence and severity recorded in this study indicate that SPLCV is a significant threat to sweet potato production in the study area. Therefore, there is a need for farmer education and training on integrated pest management (IPM) practices, as well as the development of resistant sweet potato varieties. The study identified alternative hosts of the virus, including *Boerhavia erecta*, *Phyllanthus urinaria*, and *Verbascum thapsus*. Farmer's perception of SPLCV was also assessed, revealing that while most farmers were aware of the disease, they lacked knowledge on its management. The majority of farmers practiced mixed cropping and relied on chemical pesticides to protect their crops.

Keywords: Farmer, Incidence, Perception, Severity, SPLCV.

Farmers Pesticide Use, Disposal Behavior, and Pre-Harvest Interval: A Case Study from Nigeria

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Abstract

In Sub-Saharan Africa, small farmers rely heavily on synthetic pesticides, the overuse of which poses significant risks to human health, the environment, and food safety. Yet detailed empirical evidence on the knowledge and drivers of pesticide management practices remains scarce, limiting insights for policymakers and development practitioners. To address this gap, we leveraged data collected from 1556 tomato producers in Northern Nigeria to investigate the determinants of pesticide use behavior using a sequential-exploratory mixed-method approach. We found substantial non-compliance with the recommended practices: 45% of farmers reuse empty pesticide containers for other purposes, 14% discard them on the farm, 15% burn containers in open fires, and 40% harvest tomatoes within 15 days after pesticide application, violating the 7-day PHI guideline. These findings suggest that many tomato farmers adopt unsafe practices, which have adverse implications for their health, the environment, and the safety of food for consumers. Overall, our results underscore the need for targeted training programs to enhance farmer's awareness of safe pesticide application, disposal practices, and PHI adherence. These efforts should be complemented by stronger regulatory frameworks and mechanisms to align farmer pesticide use practices with consumer preferences for safe products, as observed in the higher PHI adherence among farmers selling to midstream actors.

Keywords: Disposal, Food Safety, Integrated Pest Management, Pesticides.

Enforcement for Illegal Pesticide for Safety and Food Security

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Abstract

The enforcement of regulations regarding illegal pesticide use is essential for public health, environmental protection, and food security. The Department of Agriculture (DOA) is strengthening enforcement strategies to address these critical issues. Illegal pesticides pose significant risks, including acute poisoning and long-term health problems such as cancer and neurological disorders. Moreover, they can harm beneficial insect populations, contaminate water sources, and lead to biodiversity loss. The improper use of unregistered pesticides can also compromise food safety, affecting both local markets and international trade, thus threatening food security. To combat these issues, a clear regulatory framework has been established, including legislation and pesticide classification. Regulatory bodies like the Environmental Protection Agency (EPA) enforce these rules by registering, monitoring, and regulating pesticide use. These agencies maintain updated lists of approved pesticides and ensure public awareness of safe products. Enforcement strategies include regular monitoring and inspection of farms and markets, anonymous reporting systems, and training for farmers on pesticide risks and proper management. Community involvement also plays a key role, as local organizations can act as watchdogs, reporting illegal pesticide practices. Collaboration with health, environmental, and agricultural agencies further enhances enforcement efforts. Additionally, the use of technology such as drones and mobile apps allows for more efficient monitoring. Strict penalties, including fines and criminal charges, serve as a deterrent to illegal pesticide use. Finally, consumer awareness campaigns can encourage the demand for certified organic or sustainably farmed products. In conclusion, enforcing regulations against illegal pesticide use is vital for protecting public health, the environment, and food security. A combination of monitoring, education, penalties, and community engagement can effectively address the challenges posed by illegal pesticide use.

Keywords: Environmental Protection Agency, Illegal Pesticides, Technology.

UPM's Food Security Blueprint: Providing Impact to the Nation

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Abstract

The UPM (Universiti Putra Malaysia) blueprint for food security is a comprehensive framework aimed at enhancing food security in Malaysia, with potential to serve as a model for other nations. It addresses multiple facets of the food system, offering strategic insights to improve agricultural practices, policies, and sustainability. The blueprint emphasizes research and innovation in agricultural technologies, such as biotechnology, precision farming, and alternative methods like vertical farming and hydroponics. It also focuses on promoting sustainable practices to reduce environmental impact, such as integrated pest management and organic farming. Policy and governance play a critical role in strengthening food security, with the blueprint advocating for robust policies that cover the entire food supply chain. Collaboration with government agencies and stakeholders is vital to align these initiatives with national objectives. Capacity building is another essential component, with a focus on educating and training farmers on best practices and modern technologies to optimize food production. The blueprint also prioritizes enhancing food system resilience by diversifying crop production to mitigate risks from pests, diseases, and climate change, as well as preparing for emergencies that may disrupt supply chains. Community engagement is encouraged through local initiatives and partnerships between academia, industry, and government. Strengthening food safety and quality is another key aspect, with the blueprint aiming to implement stricter regulations and educate consumers on the importance of supporting local and sustainable food products. Finally, the UPM blueprint utilizes data and information systems to improve decision-making and monitor food security indicators. Through these strategies, the blueprint seeks to enhance food security, foster economic growth, promote environmental sustainability, and improve public health, positioning Malaysia as a global leader in sustainable agriculture and food security.

Keywords: Blueprint, Organic Farming, Policy, Sustainable.

Exploration and Identification of the Unfolded Protein Response During Begomovirus Infection in Cucumber

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Abstract

Viral diseases severely affect cucumber productivity in the Indian subcontinent. To control diseases in an eco-friendly way, it is essential to understand the molecular mechanisms of viral resistance in cucumber. Unfolded Protein Response (UPR) genes are known to provide broad-spectrum resistance to various phytopathogens including plant viruses. However, their utilization in biotic stress is constrained due to limited information on cucumber UPR genes and their role in biotic stress-resistant genetic breeding. Genome mining of cucumber was done using various bioinformatics approaches and the response of the putative UPR gene against begomovirus infection was evaluated using real time PCR. Promoter regions of cucumber UPR genes contained biotic stress-related cis-elements, signifying their involvement in biotic stress responses. Moreover, these gene promoters included components related to light, development, and hormone responsiveness, suggesting their roles in plant hormone responses and development. Inoculation with the tomato leaf curl virus adversely affected chili plant growth, resulting in stunted development, fibrous roots, and visible virus symptoms. This also led to decreased chlorophyll and carotenoid levels but increased phenolic compounds, flavonoids, and antioxidant enzyme activity in virus-infected leaves. The q-rtPCR analysis of two local cucumber varieties, one susceptible (V1) and the other resistant (V2) to begomoviruses, indicated that cucumber UPR genes likely provide extended resistance and play a role in cucumber plant defense mechanisms, while the remaining genes are activated during the early stages of infection.

Keywords: Genome, Protein Response, Cucumber.

Understanding the Pathobiome in Horticulture: Balancing Microbial Interactions for Healthier Crops

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Abstract

The pathobiome concept has revolutionized our understanding of plant health in horticulture by highlighting the complex interactions between harmful pathogens and the broader microbial communities within plants and their environments. These interactions are crucial in determining whether a plant remains healthy or succumbs to disease. Factors such as soil composition, farming practices, and environmental conditions significantly influence the balance between beneficial and harmful microbes. For instance, in tomato cultivation, diseases caused by pathogens like Ralstonia solanacearum and Fusarium oxysporum are affected by the surrounding microbial community. Beneficial microbes, such as rhizobacteria, can suppress these pathogens by competing for resources or by triggering the plants natural defense mechanisms. However, disruptions in the microbial balance can lead to increased disease severity. Understanding the dynamics of the pathobiome opens up new avenues for sustainable disease management in horticulture. Strategies such as introducing beneficial microbes, employing biological control agents, and optimizing farming practices can help maintain a healthy microbial balance, thereby enhancing plant resilience and productivity. This holistic approach reduces reliance on chemical pesticides and promotes eco-friendly farming methods, ensuring sustainable food production and improved crop yields.

Keywords: Horticulture, Pathobiome, Plant health, Tomato Cultivation, Sustainable.

Diversity of Aphid's Fauna in District Dera Ghazi Khan

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Abstract

The aphids (Hemiptera: Sternorryhncha: Aphididae) are soft, small bodied (0.5-0.7mm long), phloem feeding insects. Aproximately 5000 species of aphids including in 24 subfamilies have been described so far throughout the world. About 1000 species are injurious pest of more than 250 agricultural and horticultural crops worldwide. The aphids can decrease the yield of agricultural crops upto 90%. Aproximately 300 species of aphids have been identified from Pakistan so far. The current research was conducted to explore the diversity of aphids and their host plant association occurring in district Dera Ghazi Khan. For this purpose the aphid samples were collected from the different localities of district Dera Ghazi Khan during the year 2021-2022. The host plant associations of different aphid species were also recorded. The samples were preserved in 75% ethanol. The collected aphids were mounted on glass slides identified under the stage microscope using taxonomic keys and published literature. A total of 12 aphid species *Macrosiphum euphorbiae* Thomas from *Rosa rubiginosa*; *Aphis gossypii* Glover from three host plant species *Gossypium* spp., *Nicotiana tabacum* and *Calotropis procera*; *A. nerii* Boyer de Fonsecolombe from *Calotropis procera*; *A. nasturii* Kaltenbach from *Triticum aestivum*; *A. craccivora* Koch from *Saccharum bengalense*, *Bauhinia variegate*, *Cassia fistula* and *Dalbergia sissoo*; *A. fabae* Scoppoli from *Dalbergia sissoo*; *Acyrthosiphon kandoi* Shinji from *Medicago sativa* and *Triticum aestivum*; *A. pisum* Harris from *Rosa rubiginosa*; *Rhopalosiphum maidis* Fitch from *Zea mays*; *Aphis illinoisensis* Shimer from *Calotropis procera*; *Bravicoryne brasiccae* Linnaeus from *Saccharum bengalense* and *Hysteroneura setariae* Thomas from *Calotropis procera* belonging to the subfamily Aphidinae were recorded. *Macrosiphum euphorbiae* Thomas and *A. nerii* Boyer de Fonsecolombe were recorded by on same host plants. *Aphis gossypii* Glover from Gossypium, *Nicotiana tabacum* and *Calotropis procera* while previously it was identified from *Rosa rubiginosa*, *Gossypium*, *Eriobotrya japonica* and *Cassia fistula*; *Bravicoryne brasiccae* Linnaeus was identified by *Saccharum bengalense* but previously it was recorded from *Brassica oleracea* var. capitata, *Brassica rapa* subsp. Pekinensis, *Brassica oleracea* var. botrytis, *Brassica rapa* subsp. and *Brassica nigra*.

Keywords: Aphids, Biodiversity, D.G. Khan, Host Plants.

Selective and Sensitive Colorimetric Detection of Endocrine Disrupter Fungicides Carbenzimt Through Secnidazole Capped Silver Nanoparticles

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Abstract

Pesticides and fungicides are extremely useful to hinder the attacks of pests and fungi to secure crops, vegetables, fruits and other plants but due to their endocrine disrupting and carcinogenic risks in humans and animals through their continued addition in water resources they are extremely important to monitor carefully. In this investigation we synthesized silver nanoparticles (AgNPs) via the reducing action of sodium borohydride in the presence of Secnidazole (SEC) as capping agent under various optimized parameters such as the concentration of $NaBH_4$, silver nitrate ($AgNO_3$), SEC and pH. These SEC-AgNPs were characterized through various techniques including ultra-violet visible (UV-vis) spectroscopy, Fourier Transform Infra-Red (FTIR) spectroscopy, Field Emission Scanning Electron Microscopy (FESEM), Atomic Force Microscopy (AFM), Dynamic Light Scattering (DLS) and Zeta-Potential Analysis (ZPA) in order to investigate their diverse properties. As prepared SEC-AgNPs were proved as extremely sensitive for trace level sensing of fungicide carbendazim (CARB) with Limit of Detection (LOD) equal to 0.021 M and R2 value of 0.9964. SEC-AgNPs were tested for CARB sensing under the presence of several pesticides with negligible interference thus verifying its exclusive selectivity for the targeted analyte. This SEC-AgNPs was further applied to find out the concentration of CARB in real samples of tap water and human blood plasma with reference to standard addition method.

Keywords: Colorimetric Sensor, Carbendazim, Secnidazole, Silver Nanoparticles, Tap Water.

Fruit Fly Color Perception and Role of Different Colors in Attraction of Mango Fruit Flies

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Abstract

Mango fruit flies (*Bactrocera zonatus* and *Bactrocera dorsalis*) are important pest of mango fruits in Mango orchards. Farmers mostly use Male Annhiliation Technique (MAT) to reduce the number of fruit flies in orchard, however, commercially used traps are transparent with black or green lid. Insects vary in response to colors for attraction. In this experiment, we studied the attraction of mango fruit flies to blue, black, green, red, orange, and yellow color. The traps were installed in cluster on tree at Mango Research Station Shujabad, Mango Research Institute Multan and two farmer orchards. Data was taken weekly for two years during 2021-2023 round the year. The population dynamics of mango fruit flies was established. Overall, maximum number of male fruit flies was captured in yellow colored traps (34.02 - 40.10%) throughout the year while lower number of fruit flies were captured in black colored traps (4.42 - 6.54%). Male fruit flies preferred yellow colored traps followed by white, red, green, blue and black colored traps. So, it can be concluded that yellow colored fruit flies traps should be installed in the fields for better management of mango fruit flies. The market established white traps with black or green lid reduce the attraction of mango fruit flies.

Keywords: Colors, Fruit Flies, Annhilation Technique, Visual Perception.

Application of Si-Nanoparticles and Its Effects on Virus Inoculated Cucumber Plants

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Abstract

Cucumber (*Cucumis sativus*) is an important worldwide crop, and is known to be infected by a number of viruses, including begomoviruses, which can adversely affect both crop health and yield. This study aimed to assess the effect of silicon nanoparticles (SiNPs) as a tool to alleviate begomoviruses infections in cucumber plants. 80 healthy plants were divided into groups based on exposure to the virus strains (G1: NDVA + NDVB, G2: Multan + Kokran), and treatment combinations (control, virus only, SiNPs only, and virus+SiNPs). The SiNPs were prepared using *Cucumis sativus* leaf extract and sodium etasilicate, then applied through root-zone irrigation. Chlorophyll content, disease ratings, and soil analysis (pH and EC) were some of the parameters to be evaluated. The findings showed that SiNPs greatly diminished the severity of the disease and enhanced the resistance of the plants to viral infections. Compared to virus only groups, SiNPs-treated plants exhibited higher chlorophyll content, a marker of photosynthetic efficiency. Indeed, SiNPs further promoted soil nutrient uptake by decreasing soil pH and increasing electrical conductivity (EC), both of which are essential for maintaining plant health. This study suggests that SiNPs may provide biocompatible and eco-friendly strategy to enhance plant immune against Begomovirus infection, paving the way for sustainable agricultural practices.

Keywords: Begomovirus, Silicon Nanoparticles, Sustainable Practices, Virus Titer.

Integrated Pest and Disease Management in Horticulture: Sustainable Practices for Regenerative Agiculture

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Abstract

Integrated Pest and Disease Management (IPDM) is a cornerstone of supportable horticulture, aligning agricultural productivity with environmental stewardship. This abstract explores the principles, strategies, and implementation of IPDM in horticulture, highlighting its role in fostering regenerative agriculture. IPDM integrates biological, cultural, mechanical, and chemical control methods to alleviate pest and disease challenges while minimizing reliance on synthetic contributions. Such an approach not only preserves crop yields but also promotes biodiversity, soil health, and ecosystem resilience. Important mechanisms of IPDM include pest and disease monitoring, risk assessment, and the use of decision-support gears to confirm timely and targeted interventions. Biological control agents such as predatory insects, parasitoids, and microbial biopesticides are integral to reducing pest populations. Cultural practices like crop rotation, intercropping, and habitat management improve the effectiveness of these measures. Mechanical implements, including traps and fences, provide additional layers of protection against pests, while selective and sensible use of chemical controls ensures minimal ecological influence. The abstract also acmes the role of emerging technologies, such as remote sensing, artificial intelligence, and precision agriculture, in attractive IPDM practices. These innovations qualify real-time monitoring and predictive modeling, emailizing farmers to make data-driven decisions. Furthermore, case studies from diverse horticultural systems demonstrate the fruitful implementation of IPDM in controlling pests like fruit flies, aphids, and fungal pathogens while reducing chemical pesticide use. However, the adoption of IPDM faces challenges such as knowledge gaps, initial costs, and the need for policy support. Addressing these barriers through teaching, stakeholder collaboration, and financial incentives is vital for widespread application. This abstract underscores the dangerous role of IPDM in sustainable horticulture, supporting a holistic and adaptive approach to pest and disease management. By mixing traditional practices with modern novelties, IPDM offers a trail to regenerative agriculture, ensuring long-term productivity and environmental health.

Keywords: Biological Control, IPDM, Regenerative Agriculture, Sustainable.

Potential of Foliar-Applied Gibberellic Acid and Seaweed Extract to Improve Tree Health and Fruit Productivity in Huanglongbing – Affected Mandarin 'Kinnow'

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Huanglongbing (HLB) disease, caused by *Candidatus Liberibacter asiaticus* (*C*Las), is a serious threat to citriculture worldwide. Upon *C*Las-infection, tree health and fruit productivity in 'Kinnow' mandarins are declining in Punjab. Currently, there is no cure for HLB and no citrus germplasm exhibits resistance to this disease. Preliminary studies suggest gibberellic acid (GA_3) and cytokinins improve vegetative growth and fruit productivity in HLB-affected sweet orange. Therefore, this study aimed to evaluate whether GA_3 (33 mg L^{-1}) and seaweed extract (SE) (1 mL L^{-1}, rich in natural cytokinins) can mitigate HLB severity symptoms. Ten-year-old 'Kinnow' trees grafted on rough lemon rootstock grown in Horticulture Experiment Area (PARS), University of Agriculture, Faisalabad were used in this study. Treatments were as follows: 1. Untreated control (unsprayed); 2. Seaweed (cytokinins; 1 mL L^{-1}); 3. GA_3 (33 mg L^{-1}); 4. Seaweed + GA_3 (1 mL L^{-1} + 33 mg L^{-1}). Supplemental treatments were foliar applied at six time points with 45-day interval. Each treatment consisted of three replications and each replicate consisted of two trees under a Randomized Complete Block Design. The results showed that the combination of SE + GA_3 enhanced canopy improved canopy volume and canopy density, and reduced preharvest fruit drop. Fruits were collected at their physiological maturity, and results suggested that SE + GA_3 treatment also improved fruit quality development. In sum, foliar application of SE combined with GA_3 improved vegetative growth and productivity of 'Kinnow' trees affected by HLB. Fruit juice biochemical analyses will be assessed. With this research, we aim to better understand the effective dose and rate of plant growth regulators in improving fruit yield and productivity of HLB-affected mandarins grown in Punjab, ultimately strengthening and sustaining citrus sector in Pakistan.

Keywords: Citrus, Cytokinin, Huanglongbing, Kinnow, Seaweed.

Genetic Characterization of Major RNA Viruses Infecting Cucurbits in Dera Ghazi Khan Division

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Abstract

Cucurbits have significant importance among the horticultural crops due to their prominent nutritional, antioxidant, anti-inflammatory and antidiabetic properties, and income source for smallholding farmers. Among various biotic factors, plant viruses in general and RNA viruses in particular are considered major factors hampering successful production of cucurbits. This study was designed to identify and characterize the RNA viruses infecting cucurbits in different areas of Dera Ghazi Khan division based on their CP gene sequences. Samples consisting of cucurbits leaf exhibiting symptoms of RNA viruses i.e. mosaic, yellowing, mottling, interveinal chlorosis, were collected from the farmer fields and brought to Plant Virology Lab MNS-University of Agriculture, Multan in ice box and tested for Cucurbits aphid borne yellows virus, Cucumber Mosaic Virus (CMV) and Cucumber Green Mottle Mosaic Virus (CGMMV) using RT-PCR with PococpR-140 and PococpF-139 degenerate primers, CMVF45 and CMVR45 and CGMMVF52 and CGMMVR53 respectively. CABYV isolate (ASCuMG) shared 90.60-96.87% nucleotide identity with already reported Pakistani, Indian and Chinese isolates retrieved from Genbank. Phylogenetic analysis resulted in three main clads and ASCuMG grouped with two Pakistani isolates (OL828567 and OL828567) and four Indian isolates (MN862007, MN843966, MN688220 and MN688219). CMV isolate (ASRGMG) shared 96.95-97.66% sequence identity with the isolates retrieved from the Genbank and grouped with German isolate (PP256259) and Australian isolate (OL423424) infecting beet and banana respectively in phylogenetic analysis. CGMMV isolate (ASCuDGK) shared 99.02-99.6% nucleotide sequence with those already reported in Pakistan (MW732114-25) and gropued with (MW732124) in a separate clad in phylogenetic analysis. This study has provided the information about the prevalence of RNA viruses in Dera Ghazi Khan division. This study will help the scientists to focus on the fluctuating dynamics and phylogeny of RNA viruses in cucurbits for developing effective disease management practices and sustainable agriculture.

Keywords: Aphid Borne Yellows Virus, Green Mottle Mosaic Virus, RT-PCR.

RNA Interference as A Tool for Crop Protection

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Abstract

Sustainable agriculture involves creating and utilizing eco-friendly technologies and methods that are easily available and beneficial to farmers for enhancing crop growth and yield. For the last twenty years, double-stranded RNA (dsRNA) has gained prominence in the field of gene silencing. dsRNA is now acknowledged as a multifaceted resource, appropriate for various uses in biopesticide products, such as managing insect pests and pesticide resistance. The process of RNA interference (RNAi) operates at the level of messenger RNA (mRNA), using a sequence-specific method that distinguishes it in terms of both efficacy and precision when compared to traditional agrochemicals. Additionally, RNAi can be applied in crop protection using plant-incorporated protectants via plant transformation or through non-transformative methods like formulations of sprayable RNAs that serve as direct control agents, resistance factor inhibitors, or disruptors of development. Systematic risk evaluations are essential to guarantee environmental safety when extensively utilizing exogenous dsRNA-induced RNAi technology. The combination of appropriate conservation biocontrol methods with RNAi technology can significantly improve the efficiency of sustainable crop protection. Biopesticides based on RNA offer farmers more options to tackle the difficulties posed by climate change and aid in managing resistance.

Keywords: Biopesticides, dsRNA, Gene Silencing, Plant Protection.

Current Status and Molecular Characterization of Cucumber Mosaic Virus Infecting Roundgourd in DG Khan Division

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Abstract

Round gourd (*Praecitrullus fistulosus*), a member of the Cucurbitaceae family, is a nutritionally rich vegetable widely cultivated in South Asia. It is crucial due to its composition as it contains certain necessary fibers, vitamins, and minerals. It also aids in digestion, boosts immunity, and supports overall health with its cooling and detoxifying properties. Round gourd is vulnerable to RNA viruses, and Cucumber Mosaic Virus (CMV) is a constant threat towards the production of round gourd. The proper management of CMV depends upon the accurate diagnosis. This study was designed to check the prevalence of CMV in DG Khan Division and for the molecular characterization of CMV infecting round gourd based on the coat protein (CP) gene sequence. Extensive surveys were conducted for collection of round gourd samples exhibiting CMV symptoms like leaf distortion, mottling, yellowing, and mosaic pattern, brought to lab, and subjected to DAS-ELISA. ELISA-positive samples were further validated with RT-PCR using CMVF-45 and CMVR-45 primers followed by bidirectional sequencing of positive products. Obtained sequences were subjected to blast analysis and aligned with the highly matching sequences by Clustal W in Bioedit V. 7.5 followed by phylogenetic analysis in MEGA 11. A total of 388 suspected samples were tested by DAS-ELISA, out of which 160 were positive. Results revealed that the overall DI of CMV in the DGK division was 41.23% during 2022-23. During 2022, total DI was recorded to be 40.79% and the highest DI was recorded in D.G.K district. The study offers a comprehensive characterization of CMV isolate that will serve as crucial information for the breeders to develop varieties resistant against CMV. CMV has a wide host range, which requires a comprehensive study to understand its prevalence across various crop species in the area. In addition, vector population estimation is also required for the effective management of CMV.

Keywords: Cucurbits, Cucumber Mosaic Virus, ELISA, RNA, RT-PCR.

Comparative Analysis of Host Fruit Selection and Larval Development in Peach Fruit Fly (*Bactrocera zonata*) and Oriental fruit Fly (*Bactrocera dorsalis*) FRUIT FLY (Diptera: Tephritidae)

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Abstract

Fruit fly species, *Bactrocera zonata* and *Bactrocera dorsalis* (Diptera: Tephritidae) are major the pest of horticultural crops in tropical and subtropical regions worldwide. Both species have overlapping host range in nature but their host preferences has rarely been compared in the lab. This study compares the adult's preferences (attraction and oviposition), as well as larval development of the two species in relation to different fruit substrates, specifically peach, mango, and guava. In four-choice experiments, both species preferred peach and mango substrates with significantly higher attraction and oviposition rates compared to guava substrate and control (agar substrate only). *B. zonata* was more attracted to peach substrate with no significant differences in attraction when compared to mango substrate. Similarly, *B. dorsalis* showed preference for mango substrate, but the differences in attraction were not significant compared to peach substrate. Larval development assays revealed that peach and mango substrates yielded significantly faster development times, higher pupation rate, higher pupal weight as well as greater number of adult's emergence. This study provides valuable insights into the ecological preferences and developmental biology of *B. zonata* and *B. dorsalis*, informing more effective pest management strategies.

Keywords: Attraction, Behavioral Response, Host Preference, Larval Survival, Oviposition.

Foliar Application of Natural Antioxidants and Calcium Salts to Reduce the Impact of Citrus Greening in Citrus

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Abstract

Citrus greening, also known as Huanglongbing (HLB), that has devastating impact on citrus production globally. It is caused by the bacterium *Candidatus Liberibacter spp*, that is commonly transmitted by Asian citrus psyllid (*Diaphorina citri*). This study analysis efficacy of an integrated treatment regime of combine foliar application from natural antioxidants and calcium salts to mitigate the influence of citrus greening on citrus orchards. The study was conducted using citrus trees infected by HLB that were arranged in a randomized complete block design over a period of six months. Four treatment protocols were evaluated, these were denoted as T_1, T_2, T_3 and T_4 respectively. T_1 was addition of foliar with natural antioxidants including 2% ascorbic acid and 1% glutathione, for T_2, the calcium salts of 2% calcium chloride and 1% calcium nitrate was added. The treatment T_3 was combined addition of foliar antioxidant and calcium salt while T_4 was control containing untreated HL-B infected trees. Foliar treatments were applied weekly by directly injecting precise dosage syringes into xylem and plant performance was monitored through fruit yield, production, juice quality and pathogen suppression. Sensory analysis was carried out by 25 judges who evaluated on basis of taste, aroma and texture respectively. The results concluded that T_3 gained maximum increase in chlorophyll content of 34% and 40% reduction in pathogen load as well. The fruit yield was enhanced by improved juice quality with 13.2 °Brix followed by 0.7% acidity and vitamin C 42 mg 100 mL^{-1}. The sensory evaluation consistently recorded highest score of 9.1/10 for T_3 among the panel of judges. The study concluded with positive results and that such combination can be used for managing adverse effect of citrus greening. The dual strategy not only impacted the yield and quality but also lowered the pathogenic load. Future research should focus on optimizing treatment intervals and exploring cost-benefit analyses for large-scale implementation.

Keywords: Citrus, Foliar, Sensory, Injection, Huanglongbing, Impact

Landscape Design & Amenity Horticulture

Innovations in Global Floriculture and Prospects for Pakistan

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Abstract

Floriculture – a potential horticultural enterprise- offers higher returns to the growers and stakeholders to fulfill local demands and earn foreign exchange along with generating year-round employment opportunities. During the last couple of decades, several modern trends and interventions are being used in producing high quality ornamentals and rapid shift is being witnessed towards floricultural crop production both locally and internationally. This talk describes some of the modern trends, which are being adopted in different parts of the world, developments in local floriculture particularly at University of Agriculture, Faisalabad, Pakistan, and opportunities for floriculture stakeholders in Pakistan to fetch higher returns from their floricultural enterprises using these interventions. These interventions include but not limited to greenhouse and open field cut flower production, cut foliages production, high quality containerized ornamental plant production for local and export markets, flower seed production, supply chain management, virtual marketing, flower dehydration and value-added product development from flower crops etc. Use of these modern trends and technologies would not only help improve floricultural production in Pakistan and help Pakistani stakeholders to enter in global trade, but also improve socio-economic livelihood of local farmers by growing comparatively low cost but high value floricultural crops compared to other horticultural or agronomic crops grown in the country.

Keywords: Crop Production, Cut Flower, Floriculture Enterprise.

Enhancing Sustainable Landscape Design and Amenity Horticulture through Mutagenesis in Gladiolus

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Abstract

Gladiolus belongs to the family Iridaceae, globally known for its aesthetic appeal and economic significance as a cut flower and border plant in landscape design. Gladiolus grandiflora cv. White Prosperity among its varieties holds significant value due to its large spikes, parallel florets and higher vase life. The adaptability of this cultivar to different climatic conditions increases its value in sustainable landscape design and amenity horticulture. Breeding innovations through mutagenesis in past years increased the development of new gladiolus varieties with improved traits such as floral characteristics, aesthetic appeal and enhanced stress tolerance. These mutated breeds require less input for growth and development which is helpful against urbanization and climate change. The focus of this study is to examine the potential of White Prosperity for landscape applications, improving its morphological traits by inducing chemical mutagen Ethyl Methanesulfonate (EMS). EMS mutagenesis induces genetic variability, helpful for the selection of desirable traits like more flowering duration, vibrant colors, change in petal shape and size also increases resistance to biotic and abiotic stresses. The role of White Prosperity in creating visually appealing urban green spaces is explored, also it is most compatible with various garden designs due to its low-maintenance nature. Conserving gladiolus germplasm through advanced biotechnological tools ensures the availability of genetic resources for future breeding programs. Importance of involving ornamentals like gladiolus in sustainable landscaping architecture enhances biodiversity, ecological balance, and aesthetic value in urban environments. Innovative horticultural practices with environmental sustainability contribute significantly to advancing landscape design and amenity horticulture.

Keywords: Biodiversity, Gladiolus, Landscape, Mutagenesis, Sustainable Horticulture.

Fragrance and Form: Unveiling The Potential of Rosa 'Gruss an Teplitz' Hybrids

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Abstract

This study assesses the flower phenology, biochemical properties, and fragrance profile of six hybrids originated from Rosa 'Gruss an Teplitz' (renowned rose variety for its vivid red blossoms and powerful aroma) hybridization with various varieties from Rosa Hybrida. The research sought to determine morphological changes in color, number of stamens, carpels, fresh and dry weight, flavonoid content, phenolic concentration, anthocyanin levels, and carotenoid content by spectrophotometric analysis. Scent profiles were evaluated via an olfactory method. The research, employing a randomized complete block design, revealed substantial genetic variability among the hybrids. Hybrid 3, a hybrid of Gruss an Teplitz × Mr. Waqar, demonstrated the highest flavonoid concentration, resulting in its intense red hue and possible health advantages. Hybrid 4, a crossbreed with Annie Marrine × Traschlin, distinguished itself by its aroma, rendering it appealing for both ornamental and commercial use. Hybrid 5, a crossbreed of Gruss an Teplitz × Elina, exhibited the greatest phenolic concentration, signifying robust antioxidant capabilities. The results highlight the necessity of choosing hybrids with unique characteristics to satisfy customer preferences and increase the market value of roses. These findings can guide future breeding initiatives focused on developing roses with improved aesthetic, therapeutic, and commercial attributes.

Keywords: Biochemical Components, Colour, 'Gruss an Teplitz', Scent Attributes.

Studies on Rooting Behavior and Scion Relationship in Dufferent Species of Cactus

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Abstract

Cacti are significantly important plants due to their aesthetics appeal and unusual leaf growth pattern. Cacti needs proper management for optimum growth due to associated problems in production. Therefore, this study was designed to investigate the rooting behavior of different cactus rootstock species and associated impact of media formulations. Scion-Stock relation was also explored to optimize grafting process. Research work was carried out at Plant Propagation Unit, Department of Horticulture PMAS-Arid Agriculture University, Rawalpindi. Five different species of cacti Opuntia microdays, Echinopsis ssp., Pereskia acculatea, Acanthocerus trigonus/Acanthocerus tetragonus were selected as rootstock and cuttings were grown in five different media compositions. Scion used for grafting were Gymnocalycium and Asteria. Three different root promoters were used i.e., Indole Butyric Acid, Aloe vera gel and coconut water for the treatment of cacti rootstock. Rootstock cuttings were assessed for their compatibility with various scion species for growth, hardiness, and pest resistance. Results showed the highest rooting success percentage in formula number 05 (rice husk, vermicompost, burnt rice husk, pumice and leaf manure) followed by formula number 02 (pumice, leaf manure and burnt rice husk) and formula number 03 (pumice, vermicompost and rice husk) whereas formula number 01 (pumice, leaf manure and rice husk) and formula number 04 (pumice, vermicompost and burnt rice husk) showed better performance to all other media combinations. Acanthocereus rootstock showed best grafting success than others. Rootstock and scion relationship was also best in plants grown in formula no. 05 (rice husk, vermicompost, burnt rice husk, pumice and leaf manure).

Keywords: Cactus, Cactacea, Grafting, Scion-Stock.

Exploration of Salinity Tolerance in Warm Season Turf Grasses for Sustainable Urban Development

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Abstract

Review explores the salinity tolerance of warm-season turfgrasses, which are commonly used in urban landscaping due to their adaptability to hot climates. Focusing on species such as Bermudagrass (*Cynodon dactylon*), Zoysiagrass (*Zoysia* spp.), and St. Augustinegrass (*Stenotaphrum secundatum*), the review synthesizes current research on the physiological and morphological responses of these grasses to salinity stress. It examines key factors such as growth rate, chlorophyll content, root development, and overall turf quality under varying salinity conditions. The review also discusses the genetic and biochemical mechanisms that contribute to salinity tolerance, highlighting advances in breeding programs aimed at enhancing salt resistance. Furthermore, it evaluates the potential of these turfgrass species to contribute to sustainable urban landscaping by reducing water usage, minimizing maintenance needs, and maintaining aesthetic quality in saline environments. By consolidating existing knowledge, this review provides valuable insights for landscape architects, urban planners, and researchers looking to promote environmentally sustainable practices in urban development through the use of salt-tolerant turfgrass species.

Keywords: Growth, Salinity, Sustainable, Urban Development, Turf Grasses.

An Insight on Physio-Morphic Diversity of *Chrysanthemum morifolium* Ramat.

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Abstract

Chrysanthemum morifolium Ramat. is an extremely popular ornamental plant, cultivated principally in East Asia, although it has minor cultivation in Western Europe. Over 1,600 years of selection work have resulted in noticeable improvements in the level of several various floral phonologies, among them the traditional, spray cut, disbud cut, potted, groundcover, and wild chrysanthemums. The exploitation of this plant is extremely high in cut flowers, pot mums, borders, and as loose flowers for decorations, garlands, bouquets, and religious offerings. Chrysanthemum morifolium is also widely used for its multi bioactivities of essential oils, useful in medical cosmetology, health care, and against a variety of diseases. The color gradation of the flowers is very broad, with a lot of morphological diversity, hence modifying the general aesthetic effect. In this study, 13 classes of chrysanthemum were selected and characterized based on floral attributes, leading to the identification of 8 classes and 11 variants. Morphological analysis revealed significant variations among genotypes, particularly in Class 3 (Spoon), which showed the highest variations in plant and floral traits, including the number of buds, plant height, stem thickness, leaf area, and shoot length. Other classes exhibited variations in specific traits, such as the number of stamens, fresh weight, vase life, leaf count, petal size, and branch number. The study successfully classified genotypes into eight distinct groups, validating the previous phenotypic variation-based classification using Principal Component Analysis (PCA). This reclassification provides a robust framework for future research and breeding efforts, with detailed morphological traits aiding in the registration of novel varieties.

Keywords: Classes, Chrysanthemum, Cut Flower, Physico-Morphic.

Exploring the Aesthetic and Functional Significance of Vines in Urban Landscapes

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Abstract

Growing vines in the Landscape is an excellent technique to maximizing vertical space and enhancing appearance, particularly in regions with little or no space. Vines enhance vertical appeal with diverse textures, and brilliant colors, softening the hardscape objects and providing focal points. Vines provide numerous advantages, from erosion prevention to aesthetic appeal. Vines are a versatile and visually appealing element in any landscape, and they can be used for a various purposes like covering unsightly walls or fences, providing shade and cooling effects to buildings, creating natural barriers to reduce wind and noise pollution, enhancing air quality by filtering pollutants, and helping to prevent erosion and water runoff. Another benefit of using vines is their ability to manage and regulate temperature and humidity levels. This is especially advantageous in regions with hot summers or dry climates, where the cooling effects of vines can help reduce energy costs and improve comfort. Ivy is a popular landscaping vine known for its durability and ability to thrive in a diverse environments. In addition to ivy, wisteria, jasmine, and climbing roses are favored for their aesthetic appeal and various functional benefits.

Keywords: Erosion, Focal Point, Hardscape, Texture.

Shaping the Future Landscapes in A Water Scarce Environments

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Abstract

The scarcity of water resources has become a major problem especially in the arid regions and there is a need for the introduction of new approaches in sustaining the landscapes. Water-wise gardening provides a solution for water conservation which will keep ecological balance and aesthetics in balance. But it depends entirely on public perception, awareness, and willingness of adopting such practices. This study examined the public understanding of benefits and implications of water wise gardening in an arid environment and examines the potential barriers to adoption as well as socio demographic influences of acceptance of this type of gardening. The findings have application to policy development, urban planning, and community strategies meant to encourage sustainable gardening. Where results are anticipated, while awareness of water wise gardening is present, the lack of practical implementation rests on socio economic constraints, lack of technical knowledge and aesthetic considerations. The study discerned that the individuals who are younger, educated, and environmentally concerned were more likely to apply water wise gardening. Financial incentives as well as community awareness and support by the government might also help in overcoming the adoption hurdle. Furthermore, the research indicated that certain public receptivity to water efficient landscaping is predicated upon delivery of tangible benefits, such as lower water bills and increased value for the property. This shed light on the effective design of strategies in arid zones towards the promotion of water wise gardening for long term sustainability and resilience in the face of water scarcity.

Keywords: Arid-Zone, Gardening, Public-Perception, Water-Scarcity, Water-wise.

Prospects of Tropical Cut Flower Production and Marketing in Pakistan: A Global Perspective

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Abstract

Pakistan, with its favorable climate and geographical location, has immense potential for tropical cut flower production and export. The global cut flower market is a rapidly growing industry, driven by increasing demand for exotic and high-quality flowers. Tropical cut flowers, in particular, are in high demand due to their unique characteristics, vibrant colors, and extended vase life. Pakistan cut flower industry is still in its infancy, with limited production and export. However, the country has made significant strides in recent years, with the establishment of flower farms, export-oriented units, and research institutions. The government has also introduced initiatives to promote the industry, including subsidies, training programs, and infrastructure development. Despite these efforts, the industry faces several challenges, including lack of infrastructure, inadequate research and development, and limited access to international markets. To overcome these challenges, a comprehensive strategy is required, including investment in research and development, infrastructure development, and market promotion. Pakistan can learn from the experiences of other countries, such as Colombia, Ecuador, and Kenya, which have successfully developed their cut flower industries. By adopting best practices, technologies, and marketing strategies, Pakistan can accelerate the growth of its tropical cut flower industry. This study provides an in-depth analysis of the prospects of tropical cut flower production and marketing in Pakistan, highlighting the opportunities, challenges, and strategies for growth. The findings of this study can inform policy decisions, guide investments, and support the development of a vibrant and competitive cut flower industry in Pakistan. The study objectives include assessing the current status of Pakistan's cut flower industry, identifying opportunities and challenges, and recommending strategies for growth. The study methodology includes a review of existing literature, surveys of flower farmers and exporters, and analysis of industry data. The findings and recommendations can contribute to the development of a thriving tropical cut flower industry in Pakistan.

Keywords: Cut Flowers, Industry, Market Analysis, Production, Survey.

Landscape Design and Amenity Horticulture

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Abstract

Gladiolus belongs to the family Iridaceae, globally known for its aesthetic appeal and economic significance as a cut flower and border plant in landscape design. *Gladiolus grandiflora* 'White Prosperity' among its varieties holds significant value due to its large spikes, parallel florets and higher vase life. The adaptability of this cultivar to different climatic conditions increases its value in sustainable landscape design and amenity horticulture. Breeding innovations through mutagenesis in past years increased the development of new gladiolus varieties with improved traits such as floral characteristics, aesthetic appeal and enhanced stress tolerance. These mutated breeds require less input for growth and development which is helpful against urbanization and climate change. The focus of this study is to examine the potential of 'White Prosperity' for landscape applications, improving its morphological traits by inducing chemical mutagen Ethyl Methanesulfonate (EMS). EMS mutagenesis induces genetic variability, helpful for the selection of desirable traits like more flowering duration, vibrant colors, change in petal shape and size also increases resistance to biotic and abiotic stresses. The role of '*White Prosperity'* in creating visually appealing urban green spaces is explored, also it is most compatible with various garden designs due to its low-maintenance nature. Conserving gladiolus germplasm through advanced biotechnological tools ensures the availability of genetic resources for future breeding programs. Importance of involving ornamentals like gladiolus in sustainable landscaping architecture enhances biodiversity, ecological balance, and aesthetic value in urban environments. Innovative horticultural practices with environmental sustainability contribute significantly to advancing landscape design and amenity horticulture.

Keywords: EMS Mutagenesis, Gladiolus, Sustainable Landscape, Urban Green Spaces.

Nutrient & Water Management

Influence of Topographic Position and Soil Depth on Soil Chemical Properties in the Guinea Savanna of Nigeria: Implications for Soil Fertility Management and Sustainable Horticultural Crop Production

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Abstract

The study analyzed soil pH in water, finding no significant influence from topographic position or depth. In contrast, pH in $CaCl_2$ exhibited significant variation at Makusidi and within the combined data. The highest pH levels in H_2O were observed at the upper slope in Baddeggi (6.31) and mid-slope in Makusidi (6.15), while the lowest values were found in the mid-slope (6.05) and bottomland (5.98), suggesting moderately to slightly acidic soils. Soil depth significantly influenced organic carbon content at Baddeggi, whereas topographic position did not, with elevated values observed in surface layers. The maximum organic carbon content was observed at the mid-slope in both Baddeggi (3.53 g Kg^{-1}) and Makusidi (10.80 g Kg^{-1}). Total nitrogen varied significantly across topographic positions and depths, with the highest value (4.31 g Kg^{-1}) at Baddeggi's lower slope and lowest (0.08 g Kg^{-1}) at the upper slope. Available phosphorus was highest at the lower slope in Baddeggi (6.00 mg Kg^{-1}) and Makusidi (5.75 mg Kg^{-1}), with values decreasing with depth. Exchangeable magnesium reached its peak at the mid-slope in Makusidi, measuring 3.50 cmol (+) Kg^{-1}. Cation Exchange Capacity (CEC) exhibited a notable variation based on topographic position, with the maximum value of 16.90 cmol(+) Kg^{-1} observed at the upper slope of Makusidi. At the bottom slope of Makusidi, exchangeable acidity reached its maximum value of 0.070 cmol(+) Kg^{-1}.

Keywords: Baddeggi, Bottom-Slope, Horticultural Crops, Lower Slope, Makusidi.

Integrated Nutrient Management for Sustainable Apple Production and Quality Enhancement at High Altitude Temperate Zone (Swat)

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Abstract

An experiment was carried out during 2022 and 2023, at Kalam Summer Station, Agriculture Research Institute North Mingora Swat, Khyber Pakhtunkhwa Pakistan. The experiment was laid out in Randomized Complete Block Design with three factors arrangement. Factor A was the foliar application of boron (B), calcium (Ca) and silicon (Si) in combination at various doses i.e. T_1= 0.75B + 4.50Ca + 6.00Si (g L^{-1}), T_2 = 1.50B + 9.0Ca + 12.0Si (g L^{-1}), T_3 = 2.25B + 13.50Ca + 18.0Si (g L^{-1}), T_4 = 3.0B + 18.0Ca + 24.0Si (g L^{-1}) along with control as water spray, factor B was apple cultivars (Royal Gala, Mondial Gala and Treco Gala) and factor C was the experimental years 2022 and 2023. Analysis of the data revealed that foliar application of boron, calcium and silicon at the rate 1.50B + 9.0Ca + 12.0Si (g L^{-1}) increased flowers $plant^{-1}$ (1021.04), fruits $plant^{-1}$ (794.11), least percent of fruit drop $plant^{-1}$ (9.22), least percent deformed fruits (0.30%), highest fruit moisture content (86.37%), fruit protein (0.69%) fruit anti-oxidant activity (77.13 DPPH), maximum total sugar (11.52 °Brix), minimum ion-leakage (33.83%), titratable acidity (0.59%) and maximum boron in leaves (13.13 ppm. As concerned to apple cultivars, the maximum number of flowers $plant^{-1}$, (1000.11), fruit set $plant^{-1}$ (48.41%) leaf chlorophyll content (48.41 mg cm^{-2}), leaf area (40.79 cm^2), more yield $tree^{-1}$ (110.95 Kg), fruit firmness (3.04 Kg cm^{-2}), fruit protein (0.54%), flavonoid content (1.98%), phenolic content (4.40%), fruit anti-oxidant activity (69.53 DPPH), total soluble solids (12.57 °Brix), total sugar (11.11%), reducing sugar (9.01%), ascorbic acid (5.86 mg 100 g^{-1}), leaf boron content (11.85 ppm), fruit calcium content (8.22 ppm), leaf calcium content (76.95 ppm), leaf silicon (0.28%) and fruit silicon (0.25%), with less scab infested fruits (2.67%), cracked fruits (1.04%), bitter pit affected fruits (1.99%), deformed fruits (0.57%) noted in apple cultivar Royal Gala. It is concluded that the apple cv. Royal Gala could be treated with combine application of 1.50B + 9.0Ca + 12.0Si (g L^{-1}) at different growth stages to obtain better growth with maximum fruit yield. Similarly, the apple cultivars should be sprayed with 2.25B + 13.50Ca + 18.0Si (g L^{-1}) in order to obtain quality fruit with minimum physiological disorder.

Keywords: Apple, Biochemical, Disease, Quality.

Evaluating the Impact of Nitrogen on Seed Germination, Morphological and Physiological Attributes of Stevia Under Salinity Stress

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Abstract

Stevia rebaudiana is known as natural sweetest shrub that contains steviol glycosides which are non-toxic and with zero calories. Salinity stress significantly inhibit plant growth by causing osmotic stress and oxidative damage. Nitrogen is crucial for plant development and yield optimization. A pot experiment was carried out at research area in University of Agriculture Faisalabad, to examine the impact of nitrogen under salinity stress. Nitrogen fertilizer was used in the form of urea. Seeds of stevia were collected from Ayub Agricultural Research Institute, Faisalabad. Two salinity levels (0 and 100 mM NaCl) and four nitrogen treatment levels (0, 0.1, 0.2 and 0.3 g N Kg^{-1} soil) were applied to analyse the impact on germination, morphological and physiological parameters. Three replications of this pot trial were conducted using a completely randomized design. The results showed that nitrogen (0.2 g N Kg^{-1} soil) considerably reduced shoot Na^{+} ions content in shoot and significantly increased the germination energy, germination percentage, germination index, mean germination time, vigor index and plant growth by increasing plant height, number of leaves, number of branches, fresh root and shoot weight, ascorbic acid, shoot mineral ions (K^{+} and Ca^{2+}) and greater accumulation of total soluble sugars and total free proline. Therefore, moderate nitrogen application can enhance growth by alleviating the toxicity of salt stress in stevia. Consequently, field use of moderate levels of nitrogen is suggested to combat salinity in stevia and other plants.

Keywords: Germination and Growth, Nitrogen Levels, Salt Stress, Stevia.

Impact of Local Plant-Based Potting Mixes on Horticultural Crop Growth and Sustainability

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Abstract

The effects of various local plant materials like coconut coir, date palm coir, rice hulls, sawdust, and corn cob on the growth and health of horticultural crops. Potting mixes are essential for plant development, affecting water retention, aeration, and nutrient availability. Using locally sourced, sustainable materials can offer cost-effective and environmentally friendly alternatives to traditional potting mixes, which often rely on peat or synthetic components. Coconut coir, date palm coir, and rice hulls are known for their good water-holding capacity, drainage, and light texture, making them suitable for various plants. Sawdust, rich in organic matter, requires careful management due to its tendency to compact, while corn cob promotes aeration and prevents waterlogging. The study assessed these materials by observing their impact on plant growth, root development, and overall health. Results indicated that coconut coir and rice hulls supported the best plant growth, while sawdust and corn cob showed mixed results depending on plant species. This research highlights the potential of local plant materials as sustainable and effective potting mix alternatives, offering valuable insights for horticulturists aiming to reduce reliance on non-renewable resources and improve crop production.

Keywords: Coconut Coir, Plant Growth, Renewable Resource, Sawdust, Sustainable.

Impact of Drip and Sprinkler Irrigation Systems on Water Efficiency and Crop Yield

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Abstract

Sustainable agriculture depends on effective water management, especially in areas with limited water resources. Sprinkler and drip irrigation systems have become cutting-edge innovations that maximize crop output while conserving water. Drip irrigation reduces evaporation and runoff by supplying water straight to the root zone, resulting in up to 90% water use efficiency rates. On the other hand, sprinkler systems provide consistent water distribution throughout the field by simulating rainfall. Both approaches drastically cut down on water waste when compared to more conventional irrigation methods like flood irrigation. An additional noteworthy advantage of these systems is the increase in crop yields. With its accurate water distribution, drip irrigation maintains soil moisture levels, which encourages the plant growth. Comparing drip irrigation to traditional methods, crops like fruits, vegetables, and cereals have shown yield improvements of up to 300%. Similarly, by guaranteeing uniform moisture distribution and lowering the water stress sprinkler irrigation increases crop output in crops including wheat, maize, and alfalfa. The advantages for the economy and environment emphasize how crucial it is to implement these systems. Sprinkler systems work well in a variety of soil types and topographies, whereas drip irrigation inhibits weed growth and nutrient leaching. Both systems are financially feasible despite their higher initial costs because of their long-term advantages, which include increased yields and water savings. To guarantee wider usage, governments and politicians are urged to support these technologies through training initiatives and subsidies.

Keywords: Crop Yield, Drip Irrigation, Sprinkler Irrigation, Water Efficiency.

Climate Smart Agriculture Practices in Nutrient and Water Management

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Abstract

A revolutionary strategy called Climate-Smart Agriculture (CSA) aims to lower greenhouse gas emissions, improve climate change resistance, and boost agricultural productivity. Because they have a direct impact on crop output, soil health, and resource efficiency, efficient nutrient and water management is essential to CSA methods. Farmers may maximize resource utilization while reducing environmental consequences innovations like precision agriculture, integrated nutrient management (INM), and sophisticated irrigation systems. By applying organic and inorganic fertilizers in equal amounts, CSA improves soil fertility, lowers nutrient runoff, and guarantees sustainable food production. These innovative technologies and approaches that increase water-use efficiency and tackle the problems of water shortage are the main emphasis of water management in CSA. Rainwater collecting, soil moisture conservation, and micro-irrigation are among practices that can guarantee crops get enough water, even in unpredictable weather. Adaptive capacities are further strengthened by including crop varieties that use less water and using decision-support systems to track water requirements. These tactics limit energy use in the extraction and application of water in addition to reducing water waste. The adoption of CSA practices in nutrient and water management offers significant benefits, including increased agricultural resilience, enhanced soil carbon sequestration, and reduced environmental degradation. However, access to climate-resilient technologies, capacity-building initiatives, and supportive policies are necessary for these practices to succeed. To increase the adoption of CSA and create sustainable agricultural systems that satisfy the objectives of global food security, cooperation between farmers, academics, and policymakers is crucial.

Keywords: Climate Resilience, Integrated Management, Soil Health, Water Efficiency

Optimal Nutritional Regimes and Postharvest Preservatives for Cut *Limonium sinuatum*

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Abstract

Limonium (*Limonium sinuatum* L.), a member of the Plumbaginaceae family, is a captivating choice to be used as filler flower and is a cherished versatility in both fresh and dried flower arrangements. However, limited literature is available indigenously on its optimal nutritional requirements and postharvest preservatives to ensure its longest possible vase life. Therefore, a study was conducted to optimize its nutritional requirements and postharvest preservatives for recommending to the growers and industry stakeholders. In Exp. I., various nutritional regimes were evaluated, which revealed that limonium plants supplied with 50:25:25 NPK + 0.4% isabion had the shortest production time (77 days) with tallest plants (82.1 cm). Limonium plants supplied with NPK + micronutrients resulted in the highest leaf potassium contents (3.6%). Experiments II and III evaluated various pulsing and vase preservatives to extend postharvest longevity. Both experiments were laid out individually in completely randomized design (CRD) with five replications of two stems placed in each glass jar. For overnight pulsing, combination of 2% sucrose + 100 mg L^{-1} gibberellic acid + 100 mg L^{-1} 6-benzylaminopurine + 300 mg L^{-1} citric acid or Chrysal Clear Professional flower food maintained the postharvest quality of stems and extended vase life. Whereas, the use of lemon/lime soda (7 Up) + distilled water (33:66) until termination extended the longevity of cut stems as a vase preservative. It is concluded that NPK + isabion is best nutrient combination for getting good quality limonium stems. Moreover, cut stems may be pulsed with 2% sucrose + 100 mg L^{-1} gibberellic acid + 100 mg L^{-1} 6-benzylaminopurine + 300 mg L^{-1} citric acid solution for 24 h and can be kept in lemon/lime soda (7 Up) + distilled water (33:66) as vase solution until termination and may be recommended to florists and stakeholders for longest vase life of cut *Limonium sinuatum* stems.

Keywords: Homemade Folk Recipes, Nutritional Regimes, Pulsing, Vase Life.

Evaluation of Sweet William (*Dianthus barbatus* L.) Potential for High Quality Flower and Seed Production in Punjab, Pakistan

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Abstract

A study was conducted to optimize sowing time, planting method along with planting density and nutrient regimes for quality flower and seed production. Three production experiments, viz., 1. sowing times, 2. planting methods along with planting densities and 3. nutritional regimes were conducted. Sowing times experiment had five treatments, viz., (15 Sept, 01 Oct, 15 Oct, 01 Nov, and 15 Nov.), while planting densities, viz., (22.5×22.5 cm, 22.5×30 cm and 30×30 cm) along with three planting methods, viz., (flat beds, raised beds and ridges) were compared. In experiment III, six nutritional regimes were compared including control, N @ 90 kg ha^{-1}, NPK (90: 45: 45 Kg ha^{-1}), NPK (90:45:45 Kg ha^{-1} + micronutrients (1% Fe, B and Zn each), NPK (90:45:45 Kg ha^{-1} + Isabion 0.5%) and NPK (90:45:45 Kg ha^{-1} + Humic acid 0.5%). All experiments were laid out individually according to randomized complete block design (RCBD) having three replications of 30 plants each. In experiment I, least production time (68 days), greatest leaf area (2.7 cm^2), leaf total chlorophyll contents (59.6 SPAD), highest seed yield per plant (5.7 g), 1000 seed weight (0.62 g) and highest harvest index (18.8%) were recorded in 01 October sowing, however, greatest plant canopy diameter (28.6 mm) and tallest plants (46.7 cm) were recorded in 15 October sowing. In experiment II, tallest plants (46.12 cm), greatest plant canopy (23.71 cm), longest blooming period (67 days), least production time (73 days), highest leaf total chlorophyll contents (69.0 SPAD) and highest 1000 seed weight (0.86 g) were recorded in plants spaced at 30×30 cm with ridge plantation. In experiment III, tallest plants (48.8 cm), greatest plant canopy diameter (37.3 cm), longest blooming period (59 days) and highest harvest index (26.10%) were recorded in plants supplied with NPK + micronutrients (1% Fe, B and Zn each). Highest seed yield from primary (0.81 g), secondary (0.74 g) and tertiary (0.62 g) branches were recorded in plants supplied with NPK + Isabion (0.5%). In summary, application of NPK + Isabion (0.5%) and NPK + micronutrients (1% Fe, B and Zn each) with ridges or raised beds planting methods proved best along with plant spacing of 30×30 cm for best flower quality and seed yield.

Keywords: Bedding Plants, Indigenous Seed Production, Production Protocols.

Influence of Willow Bark Extracts and Application Times on the Production of Roselle

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Abstract

Roselle is a herbaceous perennial and short-day plant widely recognized for its medicinal properties. It is primarily cultivated for its fiber and, more notably, for calyx production. Given its importance, an experiment was conducted to examine the effect of willow bark extracts and their application timings on the growth and yield of roselle. The study was carried out at the Ornamental Horticultural Nursery, The University of Agriculture, Peshawar using a randomized complete block design with a split-plot arrangement. The experiment consisted of two factors: Factor A, the time of application (20, 40, and 60 days after transplantation), assigned to the main plot; and Factor B, concentrations of willow bark extract (0%, 2%, 4%, 6%, and 8%), assigned to the subplot. In total, 15 treatments were evaluated, each treatment replicated three times. The results revealed that plants treated with 8% willow bark extract exhibited the best performance, recording the least days to flowering (139.26), the highest chlorophyll content (45.60), maximum leaf area (143.88 cm^2), the greatest number of branches (21.11), the highest number of calyces per plant (64.55), calyx yield (4096.11 Kg ha^{-1}), and seed yield (2302.56 Kg ha^{-1}). The effects of 8% extract were statistically similar to those of 6% extract in most cases. Furthermore, spraying willow bark extract at 60 days after transplantation resulted in a significant increase in the number of calyces per plant (62.73) and seed yield (2285.87 Kg ha^{-1}).

Keywords: Calyx Production, Biostimulants, Flowering, Growth and Yield.

Exploring the Pre-Harvest Application of Oxalic Acid in Enhancing Grape Color and Anthocyanin Synthesis

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Abstract

Grape (*Vitis vinifera* L.) is cultivated worldwide in temperate and subtropical regions and is a valuable source of carbohydrates, vitamins, minerals, and antioxidants. In Pakistan, it is an emerging and promising crop, particularly in the Pothohar region. However, monsoon rains during the maturation period pose significant challenges, leading farmers to harvest grapes prematurely and resulting in poor color development in early-maturing varieties such as King's Ruby. This study aimed to assess the effects of foliar application of oxalic acid on grape color and overall quality. Oxalic acid concentrations were prepared at 2 mL L^{-1}, 4 mL L^{-1}, 6 mL L^{-1}, and 8 mL L^{-1} and were sprayed to plants at grapes veraison stage. The experiment was conducted using a Randomized Complete Block Design. The results showed that 2 mL concentration achieved the highest cluster weight (236.50 cm) and ascorbic acid content (2.71 mg 100 g^{-1}). In contrast, the 4 mL L^{-1} concentration gives the highest flavonoid content (2.63 mg QE g^{-1}), number of berries per cluster (21.75), average weight of 10 berries (64.33 g), and total soluble solids (20.4 °Brix). The 6 mL and 8 mL did not show significant results in improvements of any quality parameters. Overall 4 mL concentration of oxalic acid was better in improving grapes fruit quality traits. These findings suggest that pre-harvest foliar application of oxalic acid can significantly enhance grape quality.

Keywords: King Ruby, Maturity, Color development, Foliar, Quality Parameters.

Evaluation of Natural Biostimulants for Quality Improvement in Grapes

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Abstract

Biostimulants are substances derived from natural sources that have the potential to enhance plant growth, crop productivity and quality. These compounds have derived attraction globally due to eco-friendly and are being used as an alternative to conventional agricultural practices. There is excessive use of synthetic chemicals to improve the quality of grapes. However, these chemicals have harmful effects on human health. Therefore, the objective of this study was to use a natural and sustainable approach to enhance grapes production. The current study was performed at the commercial vineyard to examine the effect of natural biostimulants [moringa leaf extract (3% and 6%) and jasmine oil (2% and 4%)] on the morphological fruit quality parameters of grapes cv. King Ruby. The foliar application of biostimulants was applied on vines at two growth stages (before and after veraison) and morphological parameters such as cluster length, cluster width, bunch weight and number of berries were measured. The result revealed that fruits treated with moringa leaf extract at 6% had maximum cluster length (27.25 cm) and cluster width (10.75 cm) while highest number of berries (225 per bunch) and bunch weight (429.26 g) were observed in fruits treated with 2% jasmine oil as compared to other treatments. The study concluded that moringa leaf extract (6%) and jasmine oil (2%) were effective in improving fruit qualitative traits of grapes.

Keywords: Berry Quality, Bunch Weight, Natural Stimulant, Verasion Stage.

Optimizing Crop Productivity Through Integrated Water and Nutrient Management

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Abstract

Effective nutrients and water management play an important role in maintaining sustainable crop production in dry land where shortage of soil nutrients combines with water scarcity. Crop productivity mainly depends on soil water condition because they influence both how well nutrients move through the soil and their absorption by plants. Soil water level below the threshold makes the nutrients less available to plant and excessive irrigation leads to nutrient leaching. Hence, correct equilibrium between nutrient and water management is essential which leads to better crop production and increases the efficiency of plants to use nutrients properly. Plants experience drought tolerance when they receive an adequate amount of water because it facilitates the absorption of essential nutrients like N, P and K. Soil fertility management is essential for long-term sustainable agricultural productivity using organic and inorganic fertilizer. Organic fertilizers like manure and compost increase the soil fertility and soil structure by enhancing water holding capacity and building stronger microbial activity. The deliberate use of chemical fertilizers delivers rapid nutrients to the soil but also prevents them from escaping by volatilization through appropriate techniques. Plants display increased nutrient concentration spans under dry-based conditions through lower solution dilution, yet their nutrient uptakes remain limited because roots lack adequate activity. Strategies for site-specific management of nutrients and water enable crops to adapt better to changing environmental conditions thereby lowering their vulnerability to drought together with nutrient deficiencies. Successful management of water and nutrients in dryland systems requires an interconnected approach between these elements to achieve optimal farm production outcomes. When soil fertility management systems combine with water conservation practices these methods provide substantial benefits to both crop production and soil well-being and ecological sustainability of farming operations.

Keywords: Fertilizer Application, Soil Moisture, Sustainable, Water Holding Capacity.

Response of Different Nitrogen Doses on Growth and Flowering of Ornamental Sunflower (*Helianthus annuus* L.)

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Abstract

Ornamental sunflower (*Helianthus annuus* L.) is well famous due to its vibrant appearance and commonly grown in beds as well as in different containers. Nitrogen is considered as important nutrient for proper growth and flower production. In this regard, a field experiment was conducted during 2024-25 at Gul Florist/ Z-organic Agricultural Farm, Badin, Sindh, Pakistan to evaluate the effects of different nitrogen doses on the growth and flowering performance of ornamental sunflower. The experiment followed a Randomized Complete Block Design. The seeds of ornamental sunflower variety was provided by Sakata Seed Company Ltd. Nitrogen fertilizer in the form of urea was applied in split doses @ 45, 60, 135 and 180 Kg ha^{-1}. The untreated plants were maintained as control. The application of nitrogen significantly influenced various morphological and reproductive traits. The highest plant height (108.43 cm), number of leaves $plant^{-1}$ (24.00), flower diameter (134.17 mm), leaf length (18.67 cm), leaf width (15.90 cm), collar diameter (20.83 mm), and petiole length (5.73 cm) were observed in the plants treated with 135 Kg ha^{-1} nitrogen. Furthermore, this treatment also enhanced flower characteristics, including single flower weight (23.91 g), number of petals $flower^{-1}$ (27.66), and weight of disk florets (19.69 g). However, an increase in nitrogen application beyond this level (180 Kg ha^{-1}) resulted in reduced growth and flowering performance, indicating a threshold level beyond which excessive nitrogen has detrimental effects. The findings suggest that a nitrogen application rate of 135 Kg ha^{-1} is optimal for achieving maximum vegetative growth and floral productivity in ornamental sunflower under the given agro-climatic conditions. These results provide valuable insights for commercial growers and horticulturists aiming to optimize nitrogen fertilization strategies for sunflower cultivation.

Keywords: Collar, Growth, Morphological Traits, Petals, Urea.

Morpho-Physiological Evaluation of Stock (*Matthiola incana* L.) Cultivars in Faisalabad, Punjab, Pakistan

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Abstract

Matthiola incana L., commonly known as stock, is a magnificent aromatic flowering plant highly valued for its use as a specialty cut flower and is widely cultivated for its rich fragrance and diverse range of colors. There is limited research on the identification and evaluation of cultivars best suited to specific agro-climatic conditions. Therefore, a study was undertaken to evaluate various cultivars to select best suited one with optimal growth and flowering in the agro-climatic conditions of Faisalabad, Punjab, Pakistan. Experiment was conducted at Floriculture Research Area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad, during 2023-2024. Three cultivars, viz. 'Katz Lavender', 'Column Rose Pink' and 'High Double Cheerful White' were evaluated. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Data analyses were carried out using Fisher's analysis of variance technique and LSD test at 5% significance level for comparing treatment means. Tallest plants (64.1 cm) with widest leaf area (41.2 cm^2), highest leaf total chlorophyll contents (115.3 SPAD), widest raceme diameter (59.6 mm), widest stem diameter (12.4 mm), highest stem fresh weight (60.2 g), highest stem dry weight (8.2 g), best flower quality (9) and longest vase life (10.5 days) was recorded in 'Katz Lavender'. In conclusion, 'Katz Lavender' Matthiola performed best among all tested cultivars and is recommended as the best option for cultivation to meet market demand for cut flowers in local markets.

Keywords: Cultivar, Plant Height, Specialty Cut Flowers, Vase Life.

Evaluation of Various Blends of Growing Medium on the Growth and Performance of Blackberry (*Rubus* Spp.)

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Abstract

Blackberry is a nutritious fruit with certain nutraceutical and immune-stimulatory properties. The fruit is consumed fresh and processed in different forms like juices, jellies, jams, and sweets. The demand of blackberry fruit among the consumer is not only due to the unique aroma, colour, and taste but also depends on its the nutritional value and health benefits. The quality and yield of blackberry rely greatly on pollination and suitable growing media. The pollination problems cause less fruit set, decreased drupes formation and less seeds with poor fruit quality. On the other hand, growing media with poor draingae and aeration causes high disease incidence with lower yield and poor fruit quality. To overcome these issues different media compositions containing vermicompost and plant growth-promoting rhizobacteria (PGPRs) is being assessed for the growth and production of blackberries. To access the media composition role in controlling the quantity and quality of the blackberries, four combinations with different ratios of garden soil, sand, farm yard manurs, vermicompost and PGPRs are used. Moreover, natural and manual pollination is performed and is being assessed to increase the fruit quality and yield in blackberries. In these experiments plant growth parameters, reproduction parameters, fruit quantity and quality parameters with soil nutritional profile are under study. Disease incidence was also observed for the plants treated with different treatments. From the early data analysis, it can be concluded that the combination of garden soil with sand, vermicompost, and PGPRs have the best nutritional profile. It has the most excellent results in terms of disease incidence control as well as the fruit quantity and quality parameters. While for the pollination the combination of natural and manual pollination proves to be the most effective treatment.

Keywords: Fruit Quality, PGPRs, Pollination, Soil Media, Vermicompost, Yield.

Effect of Supplemental Foliar-Applied Boron on Tree Health, Fruit Quality Development at Harvest and Shelf-Life of Huanglongbing-Affected Mandarin 'Kinnow'

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Abstract

Fruit from Huanglongbing (HLB)-affected citrus trees are small, lopsided, green peel retention, acidic and bitter in taste which makes them unmarketable. There is no cure for HLB and no citrus germplasm is tolerant against HLB. Literature suggest that boron can improve fruit quality in different fruit crops. So, a preliminary study was set up to evaluate foliar-applied boron on fruit quality development and tree health in HLB-affected mandarin 'Kinnow'. Ten-year old 'Kinnow' trees grafted on rough lemon rootstock grown in PARS, University of Agriculture, Faisalabad were used in this study. Following foliar-applied born treatments were applied at 45-day intervals during fruit growth stages: 1. control (untreated); 2. 0.015 Kg tree^{-1}; 3. 0.030 Kg tree^{-1}; 4. 0.060 Kg tree^{-1} of boron (B). There were three replicates and each replicate consisted of three trees under Randomized Complete Block Design. Results indicated that B (0.030 Kg tree^{-1}) improved canopy density and reduced preharvest fruit drop. Fruit were harvested at physiological maturity and stored for seven days (at 20°C plus 75% relative humidity). Boron (0.030 Kg tree^{-1}) improved fruit size, fruit weight, juice content, total soluble solids, and total soluble solids to total acidity ratio when compared to the control trees. Sensory quality at harvest exhibited better scoring for fruit palatability and overall acceptance as well as exhibited better storage potential. In sum, foliar-applied B application (0.030 Kg tree^{-1}) improved tree vegetative growth and fruit productivity of HLB-affected 'Kinnow' trees. With this study, we hope to improve fruit quality development of HLB-affected mandarin 'Kinnow', ultimately boosting Pakistan citrus industry.

Keywords: Boron, HLB, Kinnow, Shelf-life, Quality.

Evaluation of Seed Germination and Growth Response of Zinnia (*Zinnia elegans*) Genotypes Against Salt Stress

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Abstract

The salinity is serious problem in agriculture throughout the world. Salinity in the early stages of the plants is very sensitive as it hampers the germination of seedlings and also alters the nutrient uptake which in turn reduces the plant growth. The pot experiment was conducted for the evaluation of seed germination and growth response of zinnia genotypes under salt stress. The trial was set up at the Department of Horticulture, Sindh Agriculture University Tandojam in a three replicated completely randomized design (CRD) factorial. The treatments included S1 = canal irrigation water (Control), S2 = 2.0 dS m^{-1}, S3 = 4.0 dS m^{-1}, S4 = 6.0 dS m^{-1}, S5 = 8.0 dS m^{-1}, and S6 = 10.0 dS m^{-1}. The effect of salinity levels on zinnia growth and development showed that Control group showed 90.62% germination, 1.21 germination index, 9.45 number of leaves $plant^{-1}$, 904.92 seedlings vigor index, 9.98 cm shoot length, 0.88 g fresh root biomass, and 44.53% electrolyte leakage of leaf. The pots irrigated with 2.0 dS m^{-1} produced 88.38% germination, 1.11 germination index, 8.99 number of leaves $plant^{-1}$, 860.49 seedlings vigor index, 9.73 cm shoot length, 0.86 g fresh root biomass, and 46.43% electrolyte leakage of leaf. The pots treated with 4.0 dS m^{-1} produced 74.38% germination, 0.78 germination index, 6.90 number of leaves $plant^{-1}$, 528.62 seedlings vigor index, 7.81 (cm) shoot length, 0.71 g fresh root biomass, 10.99 (cm) root length, 1.67 g fresh shoot biomass and 57.37% electrolyte leakage of leaf. The pots irrigated with 8.0 dS m^{-1} resulted in 49.53% germination, 0.37 germination index, 3.86 number of leaves $plant^{-1}$, 226.08 seedlings vigor index, 4.56 (cm) shoot length, 0.44 g fresh root biomass, 7.09 (cm) root length, 1.15 g fresh shoot biomass and 79.45% electrolyte leakage of leaf. The pots given 10.0 dS m^{-1} resulted in 35.63% germination, 0.23 germination index, 2.61 number of leaves $plant^{-1}$, 121.02 seedlings vigor index, 3.39 (cm) shoot length, 0.29 g fresh root biomass, 5.51 (cm) root length, 0.88 g fresh shoot biomass and 87.65% electrolyte leakage of leaf. Among the genotypic performance, the super yoga rose showed relatively better results as compared to the super yoga dark red.

Keywords: Canal Silt, Flowering, Growth, Germination Index, Seedling Vigor.

Effect of Foliar-Applied Potassium on Tree Health, Fruit Quality and Postharvest Storage life of Huanglongbing-affected Kinnow Mandarin

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Abstract

Huanglongbing (HLB) presents a serious risk to the global citrus industry wherever it is present. HLB-affected trees exhibit feeder root loss, leaf nutrient deficit, and poor fruit quality development, thus reducing fruit yield. Recent reports suggest that HLB-affected trees need an enhanced amount of nutrition for proper growth and development. Literature suggest that potassium (K) helps to improve fruit quality in different fruit crops. A study was set up to investigate the effect of foliar-applied K on tree health, fruit quality, and postharvest storage life of HLB-affected mandarin cv. Kinnow. Ten-year-old Kinnow scion grafted on rough lemon rootstock trees located at PARS, University of Agriculture, Faisalabad were used. The following treatments were applied: 1. untreated (control); 2. 0.055 Kg K per tree; 3. 0.11 Kg K per tree; 4. 0.22 Kg K per tree, in the form of KNO_3. Supplemental K treatments were applied at six different time points in each year during fruit development stages. There were three replications and each replication consisted of three trees. At physiological maturity, fruit was harvested and stored at 20 °C plus 70% relative humidity for one week. Results indicated that foliar-applied K (0.11 Kg K per tree) improved fruit size, diameter, peel thickness, compression forces and reduced juice segment granulations and decay incidence during storage. The same treatment had improved canopy volume, canopy density, and reduced preharvest fruit drop, indicating more vegetative growth along with improved fruit productivity. With this study, we hope to understand better mineral nutrition requirements for HLB-affected mandarins grown in Punjab.

Keywords: Canopy Management, Huanglongbing, Kinnow, Shelf-life, Quality.

Rootstocks Improve the Nutrient Use Efficiency of Vegetable Crops

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Abstract

The fertilizer application is essential to improve the growth, development and yield of vegetables. Considering the finite sources of nutrients and higher costs of inorganic fertilizers, improvement of fertilizer use efficiency remains a long adhered aim of plant biologist. Different approaches such as development of improved cultivars, modification of root architecture, use of efficient fertilizer application methods and soil microbiota are implemented to maximize the crops yield with minimum use of fertilizer. The use of rootstocks provides an alternative to improve the fertilizer use efficiency of fruit and vegetable crops. The use of rootstocks is comparatively new for vegetable crops. The selected species are utilized as a rootstock for the elite scion cultivars. Normally, vigorous rootstocks are utilized that have the capacity to explore more soil area and absorb water and nutrient and transport to the above ground plant parts (scion). Additionally rootstocks improve the nutrient assimilation by improving the supply of cytokinins to the scion. According to one of our study, pumpkin rootstock improved the nitrogen use of efficiency (NUE) of watermelon under normal and low nitrogen supply. Several other reports suggest that rootstocks can improve the nutrient use efficiency of vegetable crops. The use of rootstocks/grafting for vegetable crops is a new concept in Pakistan and this can be utilized to improve the fertilizer use efficiency without compromising the yield and quality. The development of protected cultivation further necessitates the use of rootstocks for vegetables.

Keywords: Grafting, Ion Uptake, Nitrogen Use Efficiency, Protected, Rootstock

Influence of Seed Priming of GA_3 and Boron on Growth and Production of Bottle Gourd

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Abstract

Bottle gourd (*Lagenaria scireria* L.) is widely cultivated vegetable because of its nutritional importance. Gibberellic acid (GA_3) is an essential plant hormone for improving physiological processes and reducing the negative effects of climate change on agricultural productivity. In addition, boron is an important micronutrient that plays crucial role in carbohydrates and proteins metabolism, as well as in improving yield and quality of crops. Present study was conducted with aim to investigate sole and combine impact of GA_3 and boron seed priming on germination, growth and yield of bottle gourd. Four levels of B (0 ppm, 5 ppm, 10 ppm and 15 ppm) and three levels of GA_3 (0 ppm, 50 ppm and 100 ppm) were used to prime seeds for 24 hours. Application of GA_3 and B significantly influenced the growth, germination and production of bottle gourd. Highly significant results were observed for germination percentage, seedling emergence index, seedling vigor index, number of nodes per vine, seedling length, vine length, fruit setting percentage, number of male and female flowers, sex ratio and yield per vine at sole treatment of B at 10 ppm concentration compared with control treatment. While, combined treatment of 5 ppm B + 50 ppm GA_3 and 15 ppm B + 50 ppm GA_3 provided significant results for leaf fresh and dry weight, relative chlorophyll content, TSS and ascorbic acid content. In conclusion, seeds priming using sole B at 10 ppm concentration for 24 hours could be beneficial to improve growth and yield while combine application of boron and GA_3 could be useful to improve quality traits of bottle gourd.

Keywords: Fruit Production, Gourd, Nutripriming, Seed Germination.

Mitigating Salinity Stress in Plants: The Role of Moringa Leaf Extract and Salicylic Acid in Seed Priming and Foliar Application

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Abstract

Salinity is one of the significant abiotic stress that is adversely affecting growth and productivity of crop, especially in arid and semiarid regions. Pea (*Pisum sativum*), particularly susceptible to salinity, encounters challenges in such environments. A total of 42 treatment combinations, with three replications, were evaluated. This study investigated the effectiveness of Moringa Leaf Extract (10% MLE) and Salicylic Acid (2 mM SA), applied through seed priming and foliar application, in mitigating salt stress at two salinity levels (2 dS m^{-1} and 8 dS m^{-1}). Growth performance was accessed by measuring germination rate, root and shoot length, relative water content, membrane stability index and spade value of leaf to evaluate plant response to salinity. At high salt stress 8 dS m^{-1}, plant growth was severely inhibited, showing reduced seed germination, plant growth and biomass. But both MLE and SA treatments mitigated the negative effects of salinity, with combined SA and MLE treatments exhibiting improvement in plant growth significantly observed at 2 dS m^{-1} level. Overall, the combined effect of seed priming and foliar application of MLE and SA elevated pea endurance to salinity, offering a potential sustainable approach to improve crop productivity under saline stress.

Keywords: Leaf Extract, Pea, Salt Stress, Seed Priming.

Integrated Nutrient Management for Grapes (*Vitis Vinifera* L.) Production in Pothwar

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Abstract

Integrated nutrient management is recognized globally as one of the best farming practices. Grape cultivation is a relatively new venture for farmers in Pothwar area, having gained traction only in recent years. Farmers primarily use chemical fertilizers for grape production, often neglecting alternatives such as manures and biofertilizers. Therefore, a study was conducted to evaluate the impact of integrated applications of chemical fertilizers, organic amendments, and biofertilizers on soil nutrient availability and the yield of the grape cultivar NARC Black. The treatments included control; compost; recommended NPK; compost + NPK; compost + biofertilizer; compost + NPK + biofertilizer; and compost + NPK + biofertilizer. These treatments were applied to grapevines in an established vineyard at the university research farm Koont, PMAS Arid Agriculture University, Rawalpindi. The study results showed that the treatments slightly altered soil pH and EC, while organic matter content increased significantly, from 0.54% in the control to 0.82% in the compost + biofertilizer treatment. Available nitrogen also increased with different treatments, with a maximum value of 13.54 mg Kg^{-1} observed for recommended NPK and 9.49 mg Kg^{-1} for compost + NPK + biofertilizer. Available phosphorus contents were statistically similar across treatments but significantly higher than the control. Recommended NPK showed the highest value for available potassium at 88 mg Kg^{-1}, though values were slightly higher than various integrated nutrient treatments. Micronutrient availability was highest in treatments combining organic and inorganic fertilizers, with compost + NPK + biofertilizer yielding the best results for most micronutrients. Total nitrogen, phosphorus, and potassium content in plants were highest with recommended NPK, though compost + NPK + biofertilizer produced statistically similar values. The study demonstrates the potential of integrated nutrient management for grape production in the rainfed areas of Pothwar. Based on these findings, it is recommended that an integrated nutrient management approach be adopted to ensure maximum crop yields and reduce dependence on chemical fertilizers.

Keywords: Biofertilizer, Compost, Grapes, Nutrition, Pothwar.

Enhancing Brinjal Growth through Iron Application and Farm Manure from Calcareous Soils

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Abstract

Brinjal is essential dietary vegetable crops with high nutritional value. Iron sulfate enhance growth and yield of vegetables crops but its effects not well known on calcareous soil. Therefore, a pot experiment was conducted to evaluate the impact of foliar and soil application of iron sulphate ($FeSO_4$) on brinjal (*Solanum melongena* L.) growth and yield growing on calcareous soils. Experiment was conducted eight treatments and three replications include control (uncontaminated), $FeSO_4$ 0.5% spray $FeSO_4$ (30 and 45 after sowing), $FeSO_4$ soil application 20 Kg ha^{-1}, FeSO4 soil application + spray (30 and 45 after sowing), FYM @ 20 t ha^{-1}, FM + $FeSO_4$ 0.5% Spray (30 + 45 after sowing), FYM + $FeSO_4$ @0.12 g pot^{-1} soil application, FM + $FeSO_4$ 0.5% spray + $FeSO_4$ @0.12 g pot^{-1} soil application. Result indicated that a good response was recorded in treatment where we applied Farm Manure (FM) along with soil and foliar application of Iron Sulphate. However, maximum plant height, root length, plant leaves, plant fresh weight, plant dry weight, fruit fresh weight, fruit dry weight and chlorophyll content of brinjal was observed with Farm Yard Manure along with soil and foliar application of Iron Sulphate and minimum was observed in control. Farm manure improve the quality of calcareous soil and increase plant productivity while iron sulphate mitigates negative effects of alkaline soil.

Keywords: FYM, $FeSO_4$, Calcareous Soil, Yield.

Proline and Ascorbic Acid Seed Priming to Combat Salinity Stress in Carrot

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Abstract

Saline stress is one of the major abiotic stresses that reduces crop productivity and is also responsible for global food insecurity. Being directly in contact with the soil, seed germination and root growth of carrot is highly affected by saline stress. An experiment was conducted at Institute of Horticultural Sciences (IHS), University of Agriculture, Faisalabad during winter season to investigate the impact of seed priming on germination and seedling growth of carrot under saline stress condition. Seeds of carrot cultivar (*Daucus carrota* L.) cv. T-29 were primed with different concentrations of proline (25, 50 and 75 ppm) and ascorbic acid (25, 50 and 75 ppm). Untreated seeds were used as control. The experiment was laid out according to Completely Randomized Design with three replications. Results showed that seed priming with proline at 50 ppm concentration was most effective to improve seedling length, root length, and fresh and dry weight of carrot seedlings while ascorbic acid at 25 ppm concentration was highly effective in improving germination rate index, mean germination time as well as final germination percentage of carrot seeds compared with any other treatments. Minimum germination and growth was observed in control. In conclusion, seed priming with ascorbic acid and proline can be used as effective strategy to improve seed germination and seedling growth of carrot under saline stress conditions.

Keywords: Carrot, Germination, Seed Hardening, Salinity.

Investigating the Role of Gibberellic Acid in Fruit Drop Mitigation and Fruit Quality Improvement in Date Palm Cultivars

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Abstract

Fruit drop is a serious challenge in date palm production, and it can be mitigated through various approaches. One of the most effective approach is the foliar application of plant growth regulators to mitigate the fruit drop. Gibberellic acid (GA_3) is a promising growth regulator that plays a pivotal role in plant growth and development, particularly in enhancing fruit quality and mitigating fruit drop. Exogenous application of GA_3 has been extensively explored to address pre-harvest fruit drop in horticultural crops. This investigation is targeted to assess the impact of GA_3 to mitigate fruit drop and enhancing the quality of fruits in Hillavi and Khudravi date palm cultivars. This study was carried out at the Postgraduate Agriculture Research Station using a randomized complete block design. At the Kimri stage of date fruit development, three concentrations of GA_3 (75 ppm), GA_3 (150 ppm), and GA_3 (225 ppm) were applied. The results manifested that exogenous spray of GA_3 significantly reduced fruit drop while improving fruit development and growth. Notable improvements were noticed in reducing and non-reducing sugars, bunch weight, pulp weight, fruit breadth, fruit weight, total sugar content, moisture percentage, fruit length, ascorbic acid, total soluble solids (TSS) and tannins content. Additionally, the exogenous application of GA_3 improved antioxidant enzyme activities, including peroxidase, catalase along with flavonoids, and phenolic contents as compared to the control treatment (CK). This research highlights the potential of phytohormones, particularly GA_3 as an effective strategy to mitigate fruit drop while enhancing fruit quality in date palm, underscoring its importance in sustainable horticultural practices.

Keywords: Gibberellic acid, Nutrient Management, PGRs, Phoenix.

Integrative Strategies to Enhance Vegetable Resilience Under Abiotic Stress: The Role of Biostimulants and Biochar

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Abstract

Abiotic stresses, including drought, salinity and heavy metal toxicity, pose significant challenges to global vegetable production, threatening food security and economic stability. Innovative approaches are needed to mitigate these stresses while ensuring sustainable crop yield and quality. This study explores the synergistic application of biostimulants such as melatonin, hydrogen sulfide, and nitric oxide, alongside biochar, as effective tools for enhancing vegetable resilience under abiotic stress conditions. The integrative use of these compounds modulates physiological and biochemical pathways, including oxidative stress alleviation, osmotic adjustment and nutrient homeostasis. Biochar further enhances soil health by improving water retention, nutrient availability, and microbial activity. Through a series of experiments on economically important vegetables, including bell pepper, broccoli, and lettuce, this research highlights how these strategies improve stress tolerance, increase antioxidant enzyme activities, and promote growth even under adverse environmental conditions. A significant increase in the production of vegetables (broccoli, lettuce and bell pepper) overall plant growth, number of leaves, leaf area, plant height and fresh weight was recorded under abiotic stresses and in control conditions. Furthermore, the addition of biochar to the soil not only enhanced antioxidant levels but also boosted their activity. Its application effectively mitigates plant stress, improving overall resilience.

Keywords: Food Security, Melatonin, Nitric Oxide, Physiology, Production, Stress.

Evaluating the Effects of Various Agricultural Practices on the Growth, Yield, and Quality of Potatoes *(Solanum tuberosum* L.) for Chipping Industry

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Abstract

Cultural techniques including planting time, ridge size, and fertilizer treatment have an impact on the growth, productivity, and quality of potato tubers. Climate change also contributes to a decline in potato quality for the chip sector. Three factors gowing windows, ridge diameters, and three dosages of potash fertilizer were examined in two-year research to evaluate the potato production and quality at progressive farmer fields in the Kasur area of Punjab from the fall of 2017-2019. In comparison to early sowing in mid-September, the results indicated that sowing on October 15 and September 30 produced statistically significant results in the following areas: germination percentage (90.0% and 89.24%), number of leaves per plant (45.84 and 53.35), plant vigor (3.13 and 3.95), plant height (34.2 cm and 38.29 cm), large tuber weight (126.11 g and 153.79 g), average weight (61.43 g and 73.60 g), yield (27.82 t ha^{-1}), total solid (22.06%), specific gravity (1.03%), and less green tuber per plant (3.22%). Agronomic and qualitative attributes were significantly impacted by ridge sizes of (95 cm and 115 cm). Because of ridge breakage, which causes tuber greening, typical ridge sizes (75 cm) exhibited the most green tubers per plant, whereas 115 cm and 95 cm showed the fewest green tubers per plant. Due to various variations in the weather, the 2018 year had the highest levels of agronomic attributes and quality qualities as compared to the 2019 year. For a greater yield and higher-quality potato in the context of a changing environment, it is recommended that potatoes be sown on September 30 at 95 cm intervals between ridges and that 125 Kg ha^{-1} of potassium fertilizer be used.

Keywords: Nutrient Management, Planting Window, Ridge Sizes, Tuber Greening.

The Impact of NPK Fertilization on Nutrient Use Efficiency in Tomato *(Solanum lycopersicu*m) Varieties Grown Under Poly Tunnel Conditions

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Abstract

Soil and plants are impacted by increased nutrient inputs. Sustainable plant productivity necessitates to apply sufficient amount of fertilizer. The current study was carried out to examine the impact of NPK fertilization on nutrient use efficiency in tomato varietie grown under poly tunnel houses viz. Sahil and Nagina. Nutrient Use efficiency of tomato varieties was assessed by recording different yield related and morphological parameters. Results showed that, recommended NPK dose of 100-80- 40 Kg ha^{-1} gave maximum yield (3.33 Kg) in both tomao varieties. Regarding morphological traits, highest number of leaves (25.83), number of flowers $plant^{-1}$ (52.167) and fruits $plant^{-1}$ (7.08) were exhibited in T_2 (NPK 100-80- 40 Kg ha^{-1}) in both varieties. Between varietal comparisom, Sahil performed better for all growth parameters than Nagina. These results indicated that the recommended NPK dose was highly effective with regard to enhancing the growth and productivity of tomato plants under poly tunnel conditions. This study indicates the effective management of nutrients to improve tomato production and optimization fertilization practices toward higher yields with better nutrient use efficiency

Keywords: Nutrient Management, Soil Sustainability, Tomato.

Enhancing Horticulture Efficiency with Polyacrylamide: Opportunities for Pakistan

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Abstract

Polyacrylamide (PAM), a water-soluble polymer, is revolutionizing horticulture by improving water use efficiency and soil health. PAM reduces soil erosion by 90-95% in furrow irrigation systems and increases water infiltration by 15-30%. Its hydrophilic properties enhance soil water-holding capacity by up to 400%, enabling plants to thrive in arid and semi-arid regions. In Pakistan agriculture contributes 24% to GDP, with horticulture being a key component. Given that Pakistan's agriculture land is in water-scarce regions, PAM offers a transformative solution. It reduces irrigation frequency by 30-40%, saving up 50% of water while boosting crop yield by 20-50%, depending on the crop and soil type. Trials with vegetables and fruit crops in sandy soils showed improved root growth and higher marketable produce. Economically, the adoption of PAM is cost-effective. The estimated application cost ranges between PKR 6,000-10,000 per hectare annually, but saving on water and fertilizer, couple with increased yields, results in a net profit increase of 30-60%. In horticulture crops such as tomatoes, citrus, and strawberries, the investment recovery time is as short as one growing season due to improved productivity. PAM also supports sustainable agriculture by mitigation the effects of climate change. It minimizes water stress during droughts and stabilizes soil structure, reducing nutrient leaching and erosion. These attributes align with Pakistan's goal to enhance agriculture sustainability and productivity. In conclusion, polyacrylamide presents a promising avenue for addressing Pakistan's water scarcity and soil degradation challenges while offering substantial economic and environmental benefits for the horticulture sector. Pilot projects, farmer training , and government subsidies could catalyze its widespread adoption, transforming the county's agricultural landscape.

Keywords: Productivity, Soil Degradation, Water Scarcity.

Postharvest Technology & Supply Chain Management

Abiotic Stress-Induced Changes in Black Currant Fruit Cell Wall Composition and Texture During Storage

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Abstract

Black currant (*Ribes nigrum*) is a high-value fruit known for its rich antioxidant content and health benefits. However, its cultivation is increasingly affected by abiotic stressors such as drought, salinity, and temperature fluctuations, which can alter fruit cell wall composition and lead to textural deterioration, ultimately impacting postharvest quality. Understanding the biochemical and structural changes in fruit cell walls induced by abiotic stress is critical for improving storage potential and consumer acceptability.This study investigates the effects of pre-harvest abiotic stress on black currant fruit cell wall composition and its subsequent influence on texture during storage. Field and greenhouse experiments were conducted, where black currant plants were exposed to controlled drought, salinity, and temperature stress conditions. Biochemical analyses were performed to evaluate changes in cell wall polymers, including pectin, hemicellulose, and cellulose, along with enzymatic activities of polygalacturonase (PG), pectin methylesterase (PME), and cellulase. Postharvest texture parameters such as firmness, juiciness, and structural integrity were monitored over various storage durations under controlled conditions. In addition, transcriptomic and metabolomic approaches were used to identify key regulatory genes and metabolites associated with stress-induced modifications in the cell wall. This study underscores the critical role of abiotic stress in modifying black currant fruit cell wall composition, which affects postharvest texture and storage quality. By integrating biochemical, physiological, and molecular approaches, the research demonstrates that pre-harvest interventions such as biostimulants and calcium treatments can help mitigate stress-induced textural deterioration, thereby improving fruit storage potential. These findings provide a foundation for developing sustainable black currant cultivation practices and postharvest strategies to enhance fruit quality under changing environmental conditions.

Keywords: Cellulose, Hemicellulose, Polygalacturonase, Postharvest Quality.

Role of Postharvest Horticulture in Food Safety and Security

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Abstract

Currently over two billon people in the world are facing feed insecurity. Similarly, out of eleven one person is facing hunger in the world. Especially in low-income countries over 70% population cannot afford healthy diet. The biggest challenge faced by agriculture scientists is to improve output of this sector to fulfil food requirement of increasing population of the world. According to the World Food Program, during 2024, Pakistan attained the 109th position among 127 nations on the Global Hunger Index. Postharvest losses of horticultural produce, including fruits and vegetables, can range from 30% to 80%, depending on the specific crop. Postharvest horticulture plays a fundamental role in ensuring food safety and security globally by reducing losses of fresh commodities through preventing microbial infections and physiological disorders. The absence of modern postharvest management expertise and technology, including temperature regulation for cold chain preservation, value addition, and packing, has resulted in significant economic and food security challenges, including elevated poverty rates and malnutrition. Worldwide, the use of postharvest technologies, such as appropriate harvest maturity, harvest methods, storage environments (cold storage, controlled atmosphere, modified atmosphere, and hypobaric storage), processing (hot water, vapor heat, and cold treatments), pre-storage chemical treatments (1-methylcyclopropene, putrescine, nitric oxide, and amino acids), edible coatings (*Aloe vera*, gum arabic, and tragacanth gum), and packaging practices, has shown efficacy in reducing postharvest losses of fresh produce. Furthermore, chemical and non-chemical approaches are effective for managing spoilage and harmful microorganisms. Postharvest technologies are viable strategies to mitigate postharvest losses of fruits and vegetables, enhance food and nutritional security. Simultaneously, the misuse of sanitizing agents and pesticides must be prevented to guarantee customer safety. Thus, the use of postharvest technology is crucial for minimizing losses of fruits and vegetables and sustaining food safety and security.

Keywords: Citrus, Status, Pakistan, Germplasm, Production.

From Research to Action: Value Chains for Sustaining Nutrition in A Changing Climate

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Abstract

A constant increase in world's population, novel economic and political pressures, competition for land and water and the double burden of malnutrition i.e., under-nutrition and over-nutrition are serious challenges to be addressed. Lack of dietary diversity and dependency on only few crops for food and feed purposes is a great challenge too. The changing climatic scenarios are also seriously affecting the sustainable food supply systems. Moreover, problems with production and distribution of food are also causing serious postharvest physical and nutritional losses along the chain. Though there could be many solutions to address these acute problems. However, the use of underutilized fruit species could be the sensible approach if their potential is exploited through breeding, production, agro-processing and marketing. Numerous underutilized fruit species worldwide have been reported to be rich in vitamins, minerals and other micronutrients, suggesting that they have the potential to play a role in addressing the major problem of malnutrition. Using indigenous underutilized fruit species to address these acute problems could be the cheapest and sustainable solution for local as well as global communities. However, to unlock the full potential of these naturally grown underutilized fruit species, many barriers exist. These barriers include non-availability of nutritional information and non-existence of proper supply chain systems. To achieve that, a demand-led research across the whole value chain is needed. Further efforts are also required to establish certified nurseries, small scale value addition units and a proper supply chain system for these fruit species.

Keywords: Malnutrition, Supply Chain, Postharvest Losses, Underutilized Fruit.

Managing Horticultural Crop Waste for Global Sustainability – An Introduction to Asia-Pacific Postharvest Network

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Abstract

The horticultural commodities including fruits, vegetables, condiments and herbs are regular part of human diet and possess high nutritional value and commercial importance. Due to rich water contents, most of the horticultural commodities are highly perishable in nature and suffer high postharvest losses. Almost 25-40% quantity of fruits and vegetables is physically lost along supply chains before reaching to the consumer. Apart from the significant proportion of raw material loss, the non-consumed parts, peel-outs and even the seeds are wasted at house hold level, retail and wholesale markets as well as juice/syrup processing industries, even they contain significant nutrition, medicinal properties and agricultural usage. In the developed countries, several value-added products are being developed from fruit and vegetable wastes including bio-fuels, composts, extracts and many other products. However, in case of less developed or developing countries like Pakistan, usually the horticultural wastages are mixed with the general rubbish, thrown away in the dump-yards and are allowed to rotten thereby plaguing and pollute the environment and creating health issues among the communities residing around the dump-yards and overall public in general. In such countries, most of the research efforts are focused towards reducing postharvest losses; while negligible attention is given to conduct research work how to utilize the wasted parts. Research based strategies need to be established for developing value added products from agricultural wastes; and demonstrated to the stakeholders including farmers, marketing personnel, traders and consumers. This approach will create value along the fresh commodity chains but will also help contribute towards environmental sustainability and social development through food security, nutrition, employment generation and profitability. Asia-Pacific Postharvest Network has been recently launched to address the postharvest challenges in the region.

Keywords: Agricultural Waste, Environmental Protection, Sustainable Supply Chains, Value Addition.

Food Safety Issues in Pakistan: Challenges and Solutions

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Abstract

Food safety is a critical public health concern in Pakistan, with widespread challenges undermining the quality and safety of food consumed by the population. Pesticide residues in fruits and vegetables are a critical issue due to the overuse and misuse of chemical pesticides, often applied in quantities exceeding recommended levels. This practice not only contaminates food but also endangers ecosystems and water sources, leading to long-term health risks such as cancer, neurological disorders, and endocrine disruption. The issue of food contamination is further aggravated by poor water quality, unclean handling, and improper storage practices, which contribute to the proliferation of harmful bacteria, viruses, and parasites. These pathogens are a leading cause of foodborne illnesses, particularly among vulnerable populations such as children and the elderly. Meat safety is also a significant concern, as unhygienic slaughtering practices, lack of cold chain maintenance, and the sale of diseased or adulterated meat remain widespread due to insufficient oversight. Furthermore, the excessive and unregulated use of artificial food colors in confectionery, beverages, and snacks introduces toxic compounds into the diet, which can have adverse effects such as allergic reactions, behavioral issues in children, and long-term organ damage. Awareness campaigns and training for farmers, vendors, and food handlers can improve adherence to hygiene and safety standards. Establishing modern slaughterhouses and ensuring proper meat handling and storage practices can enhance meat safety. Regulations on the use of artificial food colors, coupled with regular inspections, can ensure compliance with international safety standards. By implementing these measures, Pakistan can significantly reduce food safety risks and protect public health.

Keywords: Artificial Food Colors, Contamination, Food Safety, Pesticide Residues.

Effect of Sodium Alginate-Based Edible Coating and Thyme Essential Oil on Quality and Microbial Safety of Fresh Peach Fruit

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Abstract

Peach is a popular and highly perishable fruit limits their shelf life. Therefore, postharvest handling is essential to minimizing spoiling and preserving quality. In order to increase the shelf life of peaches, this study investigates the potential benefits of using Sodium Alginate-based edible coating (EC) with Thyme Oil together as a bio-based coating. Thyme oil offers antibacterial and antioxidant qualities because of its high concentration of bioactive chemicals like thymol and carvacrol, while sodium alginate, a natural polymer made from seaweed, edible coating that lowers moisture loss, respiration rates, and microbial development. This study aims to investigate the efficacy of using a sodium alginate coating infused with thyme essential oil to enhance the post-harvest quality of peach fruit. The experiment will be carried out using a factorial arrangement and a completely randomized design. Using common statistical methods, an analysis of variance will be performed on the data. Consumer acceptability was ensured by the incorporation of sodium alginate and thyme oil, which also preserved color and flavor and greater antioxidant levels. Growing consumer demands for natural products were met by the bio-coating, which offered a sustainable and environmentally benign substitute for synthetic preservatives. This study demonstrates how adding natural polymers and essential oils to peaches can extend their shelf life and postharvest quality, reducing food waste and increasing their marketability.

Keywords: Antimicrobial, Edible coating, Peach, Postharvest, Sodium, Theyme Oil.

Postharvest Treatment of Apricot by Using Combination of Tragacanth Gum and Peppermint Essential Oil

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Abstract

Apricot (*Prunus armeniaca*) belongs to the genus Prunus in the Rosaceae family. Classified as a drupe, or stone fruit, its nutritional profile is impressive rich in vitamins A and C, dietary fiber, and potassium. Despite these benefits, apricots are known for their relatively short shelf-life. Postharvest treatment of apricots is essential to maintain their quality, extend shelf life and reduce postharvest losses. This study explores the efficacy of a combined application of Tragacanth gum and peppermint essential oil as a natural and eco-friendly postharvest treatment for apricots. Tragacanth gum, a biopolymer known for its excellent film-forming and moisture-retaining properties, was paired with peppermint essential oil, a potent antimicrobial and antioxidant agent. Apricots were treated with varying concentrations of Tragacanth gum and peppermint essential oil, and their effects on physicochemical properties, microbial load, and sensory quality were evaluated during storage. Results indicated that the combination significantly reduced microbial spoilage and delayed ripening while preserving the fruit's texture, color, and nutritional quality compared to untreated control samples. The synergistic effects of Tragacanth gum and peppermint essential oil provide a promising alternative to synthetic preservatives, aligning with consumer demand for natural and sustainable food preservation methods. This approach highlights a potential strategy for improving postharvest management of apricots and other perishable fruits.

Keywords: Apricot, Essential Oil, Postharvest Treatment, Tragacanth Gum, Peppermint.

Challenges and Opportunities in Dragon Fruit Cultivation and Consumption in Pakistan

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Abstract

Dragon fruit (*Hylocereus* spp.) is a visually striking and nutritionally rich exotic fruit with significant potential for cultivation and consumption in Pakistan. However, its production remains limited due to various factors. A lack of awareness among consumers and farmers about the fruits nutritional and medicinal value is a primary obstacle. Technological constraints, including inadequate research on production techniques, limited post-harvest handling practices, and insufficient storage infrastructure, further hinder its growth. Quality issues, such as susceptibility to pests and diseases, short post-harvest shelf life, and lack of standardized production protocols, exacerbate the challenges. Economic barriers, such as high initial costs and underdeveloped market structures, also limit its adoption. To address these issues, a comprehensive approach is needed. This includes creating awareness through educational campaigns, conducting research on climate-adapted production methods, and improving post-harvest handling and storage facilities. Governmental and private sector initiatives to provide financial incentives, training programs, and market development can play a pivotal role in enhancing dragon fruit production and ensuring its quality in Pakistan. Overcoming these challenges will unlock the potential of this fruit, benefiting both farmers and consumers.

Keywords: Dragon Fruit, Inadequate Research, Postharvest Handling, Quality Issues, Shelf Life.

Comparative Evaluation of Various Dehydration Techniques on Quality Preservation of Statice (*Limonium sinuatum*)

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Abstract

Statice (*Limonium sinuatum*), a member of family plumbaginaceae, is an everlasting specialty cut flower, whose vibrant colors and reasonably long vase life make it favorite among florists. In the realm of dried flowers, statice is one of the versatile and enduring options. Therefore, a study aimed at evaluation of various dehydration techniques for preservation of statice was carried out at Commercial Floriculture Research Laboratory, Institute of Horticultural Sciences, University of Agriculture, Faisalabad, during 2024. Five dehydration methods, viz, glycerine drying, oven drying, shade drying, silica gel drying, and solar drying were compared. Results demonstrated that the greatest color retention (100%) was recorded for stems dried in silica gel. The highest dry weight (7.12 g) was recorded of oven dried stems. The least drying time (1 d) was recorded in sun drying method. No flower shattering (0%) was observed in shade drying. The greatest handling ease (100%) was recorded for stems dried in glycerin. The highest cost effectiveness (100%) was recorded for stems dried in shade. The greatest ease to use (100%) was recorded in glycerin. Among tested drying methods, shade drying method demonstrated best results regarding quality in terms of color retention with least flower shattering and in terms of cost effectiveness and may be used by the florists for flower drying.

Keywords: Glycerine Drying, Oven Drying, Shade Drying, Silica Gel Drying, Solar Drying.

Postharvest Application of Edible and Environmentally Safe Edile Gum Arabic Coating Extends Storage Life and Maintains Quality of Loquat Fruit

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Abstract

Loquat [*Eribotrya japonica* (Thunb) Lindl.] is a nutritious fruit that belongs to subtropical climatic conditions. It is a minor fruit crop of Pakistan with respect of its area and production. Its maturity during early summer (first week of April) makes it popular among consumers due to limited choices for available fresh fruits in the domestic market. It is mostly used as fresh fruit because of its distinctive taste, aroma and flavour. The fruit is soft, juicy and nourishing which contain vitamins, minerals, and carbohydrates. Due to high perishability, it exhibits very limited postharvest shelf life. Hence study was conducted to investigate the effect of pre-storage application of environmentally safe edible gum arabic (GA) costing to extend the storage life and maintain the quality of two commercial loquat cvs. viz. 'Sufaid' and 'Surkh', respectively. Treated (10% GA) and untreated (control) fruit of both cultivars were stored at 4±1 ºC with 90±5% for 20 days. Data were collected regarding changes in fruit physicals, biochemicals, organoleptic and phytochemicals quality characteristics at five days intervals. Results indicated that irrespective of the cultivars under study, GA-treated fruits stored at low temperature exhibited higher fruit firmness, TSS, TA, fruit visual quality and ascorbic acid than in contrast to untreated fruits. In conclusion, postharvest application of 10% GA edible and ecofriendly coating showed promising results and can be used for maintaining higher storage life of commercial loquat cultivars with better quality during 20 days of cold storage.

Keywords: Antioxidants, Edible Costings, Loquat, Phytochemicals, Quality.

Postharvest Application of Aloe Vera Gel Coating Improves Storage Life and Maintains Quality of Loquat Fruit

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Abstract

After harvest, loquat a non-climacteric fruit exhibits very limited shelf and storage life. High perishable nature increases its rapid quality deterioration at ambient conditions. In recent times, there have been promising developments in the utilization of Aloe vera (ALV) gel coating for postharvest purposes, with the aim of prolonging the storage life of diverse perishable commodities. The current research investigation was undertaken to assess the impacts of pre-storage application of ALV gel coating (0, 10, 20 or 30% ALV) on the storage life along with quality characters of loquat cv. 'Surkh' fruit. After treatment applications loquat fruit were kept at 4±1 ºC with 90±5% RH for 24 days. The data revealed that ALV-coated loquat fruits had lower mean values for fruit weight loss disease incidence, chilling injury and browning index than control group of fruits, while the firmness values were found to be higher in the coated fruits in comparison to control fruits after 24-days cold storage. Organoleptic parameters also showed a higher score in ALV-coated fruits than control. Regarding the biochemical traits, the ALV-treated exhibited higher levels of total soluble solids, titratable acidity and ascorbic acid contents after 24 days of cold storage. In comparison to the control, the ALV-coated fruits showed high amount of antioxidants and total phenolics. Additionally, despite the consistent increase in the levels of malondialdehyde and hydrogen peroxide over the entire storage period, ALV treatment inhibited this increase, resulting in treated fruits maintaining lower level malondialdehyde and hydrogen peroxide during 24 days of cold storage. The activities of superoxide dismutase, catalase, and ascorbate peroxidase enzymes were significantly increased by ALV treatments; whereas, ALV-treated fruits exhibiting decreased level of peroxidase and polyphenol oxidase activities during 24 days of storage. Hence, the postharvest application of ALV treatment during cold storage of loquat cv. 'Surkh' fruit can be utilized to enhance postharvest longevity and preserve overall quality.

Keywords: Aloe Vera, Edible Coatings, Fruit Quality, Storage Life, Postharvest.

Role of Plant Growth Regulators on Fruit Quality in Kinnow Mandarin

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Abstract

Citrus is one of the most in-demand fruits in the world. Kinnow mandarin holds a significant contribution in the overall citrus production of Pakistan due to its delicious aroma, premium taste, high juice contents and nutritional profile. However, its export from the country is drastically affected during the past few years possibly due to poor fruit quality. On the other hand, plant growth regulators are organic chemical compounds that play an important role in regulating the physiological processes, developmental stages, cell growth and over all fruit quality of citrus including Kinnow mandarin. These plant growth regulators includes auxins, gibberellins, Cytokinins, abscisic acid and ethylene that regulates the fruit quality in Kinnow mandarin. Previously, it is well documented that exogenous application of auxin and gibberellins reduce fruit drop with increases in fruit size, yield, total soluble solid, juice contents, total phenolic contents and antioxidants in Kinnow mandarin. Cytokinins are plant growth regulator that play role in cell division and delay senescence in Kinnow mandarin. Ethylene and abscisic acid also play role in ripening and color development. It is well reported that exogenous plant growth regulators are proven effective to improve fruit quality. This review summarize the possible role of PGRs in regulating the fruit quality of Kinnow mandarin.

Keywords: PGRs, Fruit Quality, Kinnow Mandarin.

Impact of Foliar Application of Bio-Stimulant, Potash and GA_3 on Fruit Quality of Mango cv. Sindhri

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Abstract

Fruit quality is the major problem of yield reduction in mango. Various factors including nutrients and growth regulators deficiencies, intra-fruit competition and drought conditions are responsible for fruit drop in mango. Therefore, the present study was planned to evaluate the impact of foliar application of Bio stimulant, Sulphate of Potash and GA_3 on quality improvement of mango cv. Sindhri. The study was executed at Muzaffar Nagar Farm Multan (Bakhal Bher, Dunyapur Rd, Multan, Punjab, Pakistan). Healthy and vigorous trees of Mango cv. Sindhri was selected and treated at pea and marble stage with: T_0: control, T_1: Bio stimulant (1%), T_2: Sulphate of Potash (1.5%) and T_3: GA_3 tablets (75 ppm). After harvesting fruits were shifted to Post harvest lab, MNS University of Agriculture, Multan and kept at shelf for postharvest analysis. Results revealed that significant variations were found among treatments. Among physical fruit quality parameters, the highest fruit weight (379 g) and firmness (143.67 N) was recorded in T_2: Sulphate of Potash (1.5%) as compared to minimum fruit weight (239 g) and firmness (101.21 N) in T_0: control. Similarly, among biochemical parameters, maximum TSS (24.9 ºBrix) and Vitamin C (155.21 mg 100 mL^{-1}) was recorded in T_2: Sulphate of Potash (1.5%) as compared to minimum TSS (20.1 ºBrix) and Vitamin C (101.23 mg 100 mL^{-1}) in T_0: control. However, higher juice pH (5.19%) and TA (0.345%) were recorded in T_0: control. So, it was concluded that the foliar application of Bio stimulant, Potash and GA_3 improved the fruit quality of mango cv. Sindhri.

Keywords: Mango, Fruit Quality, Biostimulant, Foliar Application.

Effect of Postharvest Treatment of Putrescine on Chilling Injury and Fruit Quality of Peach cv. Florida king During Low Temperature Storage

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Abstract

Peach (*Purnus persica* L.) is second most important stone fruit of Pakistan after apricot. The area under the crop has increased significantly especially after the introduction of some low chill cultivars. Being perishable in nature, peach fruit has very limited shelf life. Therefore low temperature storage is used to extend the postharvest life of the fruit. Yet, the fruit faces problem of chilling injury under low temperature storage resulting in browning, ultimately resulting in losses in quality. The effect of postharvest application of putrescine (Put) @ 1, 2 and 3 mM on chilling injury index and quality of peach fruit cv. Florida King was investigated during low temperature storage (1 C, 90 % RH) during the year 2022-23. The results obtained showed that after 6 weeks of storage, compared to untreated one, higher treatments of Put significantly reduced weight loss, decay index, browning index, ethylene biosyntheses and losses in firmness. Furthermore, higher treatments were also effective in slowing down decreases in soluble solid contents (SSC), titratable acidity (TA), SSC:TA and ascorbic acid (AA) contents. Moreover, higher treatments were also proved to be effective in marinating the fruit color (L*, a* and b*) values. Amongst all the treatments applied Put 2 mM was the most effective treatment in maintaining the fruit quality by lowering the chilling injury and decay index during low temperature storage during both years under study.

Keywords: Browning Index, Shelf Life, Weight Loss.

Optimal Production and Postharvest Handling Protocols for China Aster (*Callistephus chinensis* L.) - A Newly Emerging Specialty Cut Flower

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Abstract

A study aimed at evaluation of various production and postharvest management protocols for cut China aster was envisaged. Four production experiments: 1. planting times, 2. planting methods and planting densities, 3. macro and micronutrients along with bio-stimulants and 4. cultivar evaluation were conducted. Moreover, six postharvest experiments: 1. harvest stage, 2. water quality, 3. pulsing preservatives 4. vase preservatives, 5. floral foam and 6. storage procedures, were conducted. In Expt. I, least production time (72.8 d) along with tallest plants (47.2 cm) were recorded when China aster was sown early in the season on 15 October. In Expt. II, shortest production time (79.8 d) and tallest plants (47.8 cm) were recorded when China aster were planted on raised beds and spaced 22.5×22.5 cm. In Expt. III, tallest plants (39.5 cm) were recorded when plants were supplied with NPK at 90:45:45 Kg ha^{-1} + micronutrients at 2 mL L^{-1}. In Expt. IV, tallest stems (62.2 cm) with greatest flower diameter (4.9 cm) were recorded for China aster cultivar 'Bonita'. Among postharvest trials, in Expt. I, stems harvested at closed bud stage exhibited longest vase life (18.0 d) followed by partially opened bloom stage (14.6 d). In Expt. II, stems kept in distilled exhibited longest vase life (13.3 d). In Expt. III, stems pulsed with 2% sucrose + 100 mg L^{-1} aluminum sulphate exhibited longest vase life (18 d). In Exp. IV, stems placed in lemon/lime soda + distilled water (33:66) exhibited the longest vase life (19 d) with least change in flower quality until termination. In Expt. V, stems treated with 1% sucrose + 100 mg L^{-1} aluminum sulphate without floral foam exhibited longest vase life (15.1 d) followed by Chrysal (14.3 d). In Expt. 6, stems stored wet or dry for 2 days exhibited almost similar vase life (9.0 d) as unstored stems. Moreover, stems harvested at closed bud stage, kept in distilled water, pulsed with 2% sucrose + aluminum sulphate and kept in lemon/lime soda + distilled water (33:66) as vase solution without foam until termination exhibited longest vase life.

Keywords: Bio-stimulants, Nutritional Regimes, Planting Periods, Specialty, Vase Life.

Comparative Postharvest Fruit Quality of Conventional and Customized Handled Apple After Low Temperature Storage

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Abstract

Apple (*Melus domestica* L.) a climacteric, temperate, nutrient-rich fruit which is in high market demand. However, the physical bruising during harvest greatly influence the fruit quality, especially during extended low temperature storage. The conventional apple harvesting system being practised in core apple production area of the country have many faulty practices and need improvement. Keeping in view the facts, a study was executed to investigate comparison difference of apple harvesting practices on fruit quality of two commercial apple cvs. Red Delicious (Kala Kulu) and Golden Delicious (Shin Kulu). So, the physiological mature fruit of both apple cvs. were harvested under conventional and customized harvesting methods from apple orchards of tehsil Kadkucha, District Mastung, Balochistan. The conventional harvesting included local old practice of apple harvesting, however, in customized apple harvesting some inventions were introduced like harvesting with proper cloth bag followed by filed heat removal, sorting and packing in corrugated cardboard boxes. These harvested apple fruits were immediately transported and stored for 4 months in low-temperature storage (0-2 °C 80-85% RH). Then upon removal from storage, fruit samples of both apple cvs. were subjected for quality analysis to determine any differences between the two harvesting methods on physiological, biochemical and anti-oxidative attributes of the fruit during storage at ambient conditions (25±2 °C 55-60% RH) upto day-9 of storage at 24-hours interval. However, irrespective of the days at shelf, fruit harvested through customized harvesting method exhibited significantly lower fruit weight loss, ethylene respiration rate, more fruit firmness, higher membrane stability index, total soluble solids, juice pH and vitamin C contents and anti-oxidative attributes as compared to fruit harvested through conventional practices in both apple cvs. Overall, customized harvested method showed less fruit quality losses and maintained higher anti-oxidative attributes in both apple cvs. as compared to fruit harvested from conventional practices during ambient conditions followed by prolonged low temperature storage.

Keywords: Apple, Golden Delicious, Red Delicious, Postharvest, Total Antioxidative.

Postharvest Fresh and Dry Fruit Quality of Early- and Late-Maturing Apricot Cultivars of Killa Saifullah, Balochistan

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Abstract

Fruit quality is governed by variations in genetic makeup and fruit maturty. Despite the huge production volume of apricot fruit, the apricot core production areas within Pakistan lack fresh apricot storage facilities resulting in excessive losses of fruit after harvest. Moreover, there is a need to explore value-addition startegies for apricot fruit as well. Therefore, a comprehensive study was conducted to evaluate the fruit quality of fresh and dry early fruit-maturity and late fruit-maturity apricot cultivars after harvest. The fruit of selected apricot cultivars including two early fruit- maturing apricot cultivars: 'Charmaghuz', 'Surbaghali', and two late fruit-maturing apricot cultivars: 'Badaghur' and 'Nuri' were harvested from the orchard of Killa Saifullah, Balochistan. The harvested fruit was evaluated for postharvest quality in fresh and dry form. In experiment I, the harvested fruits were evaluated at ambient conditions (25±2 ºC; RH 60-65%) for various fruit quality attributes as fresh fruit, while; experiment II investigated proximate fruit quality attributes of selected apricot cultivars after drying. Irrespective to early and late fruit-maturity apricot cultivars, all the fruit exhibited significant changes and fruit quality as the fruit ripening processed. Overall, among various cvs, early fruit-maturity ‘Surbaghali’ apricot exhibited lower fruit weight loss, ethylene emission, lower respiration rate with higher TSS and fruit taste at the shelf as compared to others. Moreover, relatively higher vitamin C content, TSS/TA ratio, and pH value were recorded in early fruit-maturity ‘Charmaghuz’ apricot. However, catalase (CAT) enzyme activity, antioxidant content, and better organoleptic attributes were observed in both early fruit-maturity apricot cvs. In the 2nd experiment, dried apricots developed from fresh apricots harvested from early and late fruit-maturity cultivars were evaluated for proximate and organoleptic attributes. The results showed that dry apricots developed from early and late maturing apricot cvs., ‘Charmaghuz’ apricot exhibited higher moisture content, ash content and retained higher taste and aroma than others. Conclusively, ‘Surbaghali’ apricot retained better fruit quality as fresh fruit, while, ‘Charmaghuz’ performed better as dry apricot.

Keywords: Apricot cultivars, Biochemical Characteristics, Fruit Nutrition.

Postharvest Management of Lemon: Role of Chitosan and Aloe Vera Gel Coatings

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Abstract

The shelf life and quality of lemons are critical factors affecting their postharvest handling and marketability. This research investigates the use of chitosan and aloe vera gel as natural coatings to enhance the preservation of lemon fruits, specifically targeting the small size maturity stage. The study evaluates the effects of 1% and 1.5% chitosan, along with 10% and 15% aloe vera gel, on the shelf life, quality attributes, and microbial load of lemons during storage. The treatments were applied individually and in combination to assess their synergistic effects. Results revealed that the combined application of 1.5% chitosan and 15% aloe vera gel significantly extended shelf life, reduced weight loss, and preserved firmness, color, and overall appearance of the lemons. Furthermore, the coatings were effective in reducing microbial growth, particularly fungi, which are a major cause of postharvest spoilage. The findings suggest that the use of chitosan and aloe vera gel as natural coatings offers a promising and eco-friendly alternative for improving the shelf life and quality of lemons, with potential applications in the commercial handling of citrus fruits.

Keywords: Aloe Vera, Chitosan, Lemon, Natural Coatings, Shelf life.

Effect of Chemical Treatments and Storage Methods on Post-harvest Storage of Ginger Seed

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Abstract

Proper seed storage is important to maintain the quality of seeds. Ginger rhizomes are very perishable and highly prone to rotten, sprouting, rooting and shrinkage during storage causing huge losses. Therefore, adopting an efficient storage technique in ginger may go a long way in minimizing the storage losses of valuable planting material. This study mainly emphasized on the standardization of storage methods for ginger seed and improvement in its shelf life. The local accession of ginger seed was selected and storage treatments were applied in 2 factorial design. Pits and cold storage were used for storage of seeds (traditional pits, pits with sand layers and cold storage), seeds were treated with different chemical treatments (control, Carbendazin + Mancozeb @ 4 g L^{-1}, Fipronil 0.075% and Mancozeb 0.3%). The results showed that with Fipronil 0.075% and Mancozeb 0.3% treated ginger seeds in pits with sand layers showed the best results in terms of less fresh weight loss after storage, zero disease severity percentage, less shriveling percentage and less sprouting. The study highlighted the efficacy of storing ginger rhizomes in pits with sand layers for 02 months before planting which appreciated the maintenance of its quality thereby also improved the growth of ginger in the field.

Keywords: Zingiber Officinale, Chemical Treatments, Post-harvest, Storage, Shelf life.

Assessment of Potato Germplasm for High Yield, Quality Attributes and Value-Addition

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Abstract

Potato, an important vegetable and staple food for human beings. A wide range of processed products can be derived from it, effectively enhancing its market value, marketability, and overall desirability. In Pakistan, the focus of production lies in large-scale manufacturing of potato crisps and French fries, with limited emphasis on producing value-added products. The suitability of a potato variety for processing is determined by several factors, including dry matter content, color, length, and shape. Improving the availability of suitable potato varieties could positively impact the potato processing industry in Pakistan. Therefore, the study aimed to evaluate different local and exotic potato germplasm for superior yield, dry matter content, and potential for value addition. Fifteen potato clones were sown in a Randomized Complete Block Design with a planting distance of 10 cm between plants and 75 cm between rows at glass house of potato program, Horticultural Research Institute, NARC, Islamabad during year 2023-24. Yield-related parameters, including tubers/plant, weight of tubers plant^{-1}, number of small tubers, number of medium tubers, number of large tubers, weight of small tubers, weight of large tubers, weight of medium tubers, total tubers, weight of total tubers and yield were measured at time of harvesting. Quality parameters, such as dry matter content and specific gravity were assessed using a hydrometer. Based on the evaluation of dry matter and specific gravity, two varieties, CIP-19 and HRI-P2 were selected for the development of value-added products, namely potato flour and potato starch. Clones having high yield, dry matter and specific gravity were screened out and were used for the development of potato flour and potato starch. The study successfully identified high-yielding potato clones with desirable traits such as high dry matter content and specific gravity, making them ideal candidates for the development of value-added products. The selected varieties, CIP-19 and HRI-P2 demonstrated significant potential for processing into potato flour and starch, which can contribute to the agricultural economy by meeting market demands for processed potato products.

Keywords: Hydrometer, Potato Flour, Potato Starch, Value Addition.

Postharvest Quarantine Heat Treatments and their Effect on Mango Fruits in Different Cultivars of Mango

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Abstract

Mango (*Mangifera indica* L.) (Anacardiaceae) is a very delicious tropical fruit grown in the most parts of the world. It is second major fruit crop after citrus in Pakistan. Mango is produced in Pakistan in two provinces Punjab and Sindh. Among these, 63% of mango is produced in Punjab only. In 2021, Pakistan exported 130 thousand tons of mangoes to Middle East, UK, Iran, South Korea, China and Japan. Pakistan exports mango fruits of cultivars Sindhri, Sufaid Chaunsa, Sammar Bahisht Chaunsa, Chenab Gold, and Azeem Chanusa. Although Pakistan, produce considerably higher amount of mangoes but still most of the mangoes are sold in the local market and then to nearby countries including Afghanistan, China, Iran, UAE, Saudi Arabia, Malaysia, and Oman. However, countries included in the region America and Europe require certain phytosanitary measures for the mango fruits before being imported. Among them are Vapor heat treatment and hot water treatment, and irradiation. Mango fruit fly is one of the dreaded pest that attack at mature fruits and deposits eggs inside the fruits. If the fruit is not passed through necessary quarantine measures, the exported fruits are rejected and exporter suffer from extreme losses. Farmers in Pakistan mostly use different techniques including Male annhiliation technique, insecticidal spray, removal of fallen fruits, orchards cleanliness to reduce the fruit fly infestation inside the fields. However, implementation of these practices does not ensure safety from maggots development inside mature fruits. This noxious pest may even cause 5.65 tons per hectare of yield loss costing around 3428.97 US dollars per hectare. Hence, the exporters often adopt VHT, HWT, or irradiation technique according to the requirement of importing country to eliminate the chance of infestation of fruits. Although these methods are crucial for the export, however, softening period of the fruit is shortened through adoption of heat treatments. This review describes the importance of heat treatments and their effect on mango fruit quality in different cultivars of mango.

Keywords: Heat Treatments, Mango Fruit Fly, Organoleptic Properties, Physiochemical Properties.

Nutritional Evaluation of Quince (*Cydonia oblonga*) Fruits Grown in Gilgit-Baltistan, Pakistan

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Abstract

Quince *(Cydonia oblonga*) belongs to the Rosaceae family and subfamily Maloideae. They are cultivated worldwide. In Pakistan, quince fruits are an untapped fruit. It is also called "Chatore" in Gilgit Pakistan. Quince has 0.1 g of fat per 100 g, a high fiber content, and helps reduce cholesterol. Quince fruit is used for medicine treatments like diarrhea, dysentery, and constipation, and the pulp is used for the treatment of diabetes and urine issues. In this study, two different varieties, apple-shaped and pear-shaped quince fruit samples were collected from different locations in Gilgit Baltistan Pakistan, and analysis was conducted at PMAS-Arid Agriculture University Rawalpindi, Department of Horticulture, Post-harvest laboratory, and data was recorded for different physicochemical parameters. Values were found higher in an apple-shaped variety of quince fruit as compared to pear-shaped which are as follow in apple-shaped, total soluble solids (14.3 ºBrix), ascorbic acid (19.6 mg 100 mL^{-1} juice sample), titratable acidity (24.48 mg 100 mL^{-1}), total phenolic (15.70 mg GAE 100 g^{-1}), moisture content (5 g 100 g^{-1}), ash content (13 g 100 g^{-1}), pH (3.11) were found whereas in pear-shaped variety TSS was (11.2 ºBrix), ascorbic acid (16.6 mg 100 mL^{-1} juice), TA (20. 31 mg 100 mL^{-1}), phenolics (11.27 mg GAE 100 g^{-1}), moisture content (4 g 100 g^{-1}), ash content (11 g 100 g^{-1}), pH (2.92). Physical parameters like fruit average weight (279.80 g) and firmness (8.74 Kg cm^2) were recorded high in an apple-shaped variety of quince fruit as compared to a pear-shaped variety (93.48 g), (7.26 Kg cm^2). Quince fruits were stored at two different storage conditions, room temperature 25±2 ℃, and cold storage 05±2 ℃, from which low-temperature (05 ℃) storage was more effective for extending the shelf life of quince fruit. The Least Significant Difference method was used to calculate the mean separations at 5% significance levels. In conclusion, the apple-shaped variety of quince was found to be superior in terms of both physical and biochemical properties when compared to the pear-shaped quince variety, whereas 05 ℃ was the appropriate temperature for the storage of both apple and pear-shaped varieties.

Keywords: Nutritional, Quince, Evaluation, Physicochemical, Storage Conditions.

Evaluating the Posharvest Quality of Tomato by Ozonator and Sinicator

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Abstract

Post-harvest quality of fruits and vegetables can be enhanced by various techniques including ozonator and sonicator. Therefore, current study was done to check the effect of ozonator and sonicator on postharvest quality of tomato. Tomatoes were harvested from MNS-University of Agriculture, Multan research farm (C-Block). After harvesting tomatoes was brought to postharvest lab, MNS-University of Agriculture, Multan for further analysis till marketable. Fruit was treated with normal water, ozonator and with sonicator for five min. After this fruits were kept at shelf for 4 days at room temperature and parameters were taken. Results revealed that ozonator and sonicator showed significant influence on postharvest quality of tomato. Among physical fruit quality parameters, maximum fruit weight (40.83 g) and color (4 score) was recorded in sonicator as compared to minimum fruit weight (30.08 g) and color (2 score) was recorded in control. Among biochemical parameter higher TSS (9.66 ºBrix) and vitamin C (50.34 mg 100 mL^{-1}) was recorded in ozonator as compared to lower in control. As for as phytochemical parameters are concerned, maximum antioxidant (70.90% inhibition), TPC (85.62 mg GAE 100 g^{-1}) and SOD (18.39 U mg^{-1} protein) was recorded in sonicator as compared to minimum antioxidant (30.46% inhibition), TPC (71.63 mg GAE 100 g^{-1}) and SOD (15.55 U mg^{-1} protein) in control. So, it was concluded that postharvest fruit quality of tomato is significantly affected by ozonator and sonicator treatments.

Keywords: Tomato, Ozonator, Sonicator, Postharvest Fruit.

Vase Life Optimization of *Matthiola incana* L. through various Harvest and Postharvest Handling Procedures

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Abstract

Matthiola incana, commonly known as stock, is a popular flowering plant, which belong to the Brassicaceae family. Post-harvest losses are a major concern due to which cut flowers are vulnerable to these losses both qualitatively and quantitatively. Therefore, a study aimed to evaluate various post-harvest handling protocols for cut *Matthiola incana* 'Column Rose Pink' was conducted at Commercial Floriculture Research Laboratory, Institute of Horticultural Sciences, University of Agriculture, Faisalabad, during 2023-24. There were four post-harvest studies, viz. harvest stage, harvest time of the day, handling procedures and vase water quality. Data were collected on change in fresh weight (g), dry weight (g), water uptake (mL), change in flower quality (1-9), raceme diameter (mm), change in solution EC (dS cm^{-1}), change in pH, vase life (d) and termination symptoms. Data analyses were carried out using Fisher's analysis of variance technique and LSD test at 5% significance level for comparing treatment means. In Expt. I, Matthiola with 2-3 opened florets had longest vase life (10.3 days). For harvest time of the day, stems harvested in the morning (6:00-8:00 AM) had longest vase life (10.4 days). In Expt. III, wet + wet handling resulted in longest vase life (9.0 days). In Expt. VI, Matthiola stems kept in distilled water + 5% sucrose exhibited longest vase life (9.7 days). In summary, for longest vase life, Matthiola stems should be harvested at earlier development stages. The best time to harvest Matthiola stems is early in the morning, preferably between 6:00-8:00 AM and kept in water while handling. Vase life of cut stems increased when placed in distilled water + 5% sucrose during handling.

Keywords: Harvest Stage, Harvest Time, Handling Procedures, Vase Water Quality.

Role of Phenolic Compounds in Mitigating Postharvest Losses and Enhancing Quality of Horticultural crops under Climate Change Challenges

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Abstract

Climate change is causing substantial effects on horticultural crop productivity as well as quality. The global rise in temperature has forced the farming community to early planting and harvesting of Horticultural crops. Fruit and vegetables in the horticulture sector play an important role in human nutrition requirement of vitamins and minerals for dietary requirements, but the lack of proper produce-handling methods, and poor infrastructure for storage and processing, results in waste of the produce between 10% and 40%. These losses restrict production within the domestic market. In Pakistan, the horticulture sector contributes to 12% of GDP. Phenolic compounds (PCs) are secondary metabolites extracted from fruits, vegetables, grains, and tea. Their antibacterial and antioxidant properties are key characteristics for inhibiting susceptible fungus and improving quality of postharvest fruits. But the solubility and volatility of PCs significantly limit their availability in postharvest preservation, thus PCs are usually combined with other treatments to increase their efficiency. Some PCs have their own volatile and aromatic smells, which may affect the volatile properties of fruits, and need to be well-investigated. Additionally, it has not been investigated whether PCs would combine with fruit cell wall components and enzymes in the cell matter. More precise physical simulation methods are needed to determine the specific action sites. The specific action mechanism of PCs on specific fruits needs to be further studied by using metabolomics, transcriptome, proteome, and other omics-based approaches to decipher the information on the changes in biological processes and their interactions in fruits.

Keywords: Phenolics, Volatile, Postharvest, Metabolism, Climate Change.

Evaluation of Nanoparticles Application on Yield and Physiochemical Characteristics of Cucumber (*Cucumis sativus*) Grown under Protected Environment

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Abstract

Cucumber is one of the most important and highly consumed cucurbit. It carries immense value due to its nutritional importance and high demand and also have a huge potential in Pakistan as its origin is over Himalayas. However, cucumber is facing negligence and problems in its cultivation due to the unexplored potential of this crop, less stress tolerance, and favorable conditions for its hosts, pests, and diseases. To mitigate these issues this research focuses on the use of Silver (Ag) and Zinc (Zn) nanoparticles due to their ability to tackle with the microbes and elevate stress tolerance in plants. These nanoparticles are also known to enhance nutrient uptake efficiency, enhance the physiological processes, and increases nutritional values as well as the shelf life of plant edibles. In this research effect of these nanoparticles on plant size, number of leaves and fruits, days to harvesting, yield per plant, phenolic content, ascorbic acid, antioxidant activity, and shelf life were studied. The morphological, physiochemical, fruit quality as well as fruit shelf life attributes were improved by the combine application of silver and zinc oxide nanoparticles. So, it can be concluded that the zinc and silver nanoparticles successfully elevates the negative impact of heat stress and promote healthy crop. The fruit production and fruit quality attributes i.e. fruit length, fruit diameter, fruit weight, total soluble solids, titrable acidity, antioxidant capacity, ascorbic acid content, total phenolic content, pH improves with fruit postharvest attributes during storage life with the separate as well as combine application of zinc oxide and silver nanoparticles. The combine application of silver and zinc oxide nanoparticles effectively improved the overall characteristics of plant and fruits of cucumber as compared to the separate application of silver and zinc oxide nanoparticles.

Keywords: Cucumber, Silver Nanoparticles, Zinc, Stress, Shelf life

Tragacanth Gum Coating Improved the Shelf Life of Persimmon by Delaying the Fruit Softening

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Abstract

Persimmons are highly perishable fruit crops that undergo various biochemical changes after harvest, which accelerate fruit softening. A study was conducted to evaluate the impact of tragacanth coatings on persimmons in order to preserve fruit firmness for an extended period. In this study, fruits were harvested at the physiological maturity stage (turning stage) and subjected to the following treatments: T_0 = distilled water (CK), T_1 = 0.5% tragacanth gum (0.5-TG), T_2 = 1% tragacanth gum (1-TG), and T_3 = 1.5% tragacanth gum (1.5-TG). Followed by the coating and drying at ambient temperature, the fruits were stored at cold storage, and postharvest evaluations of weight loss, firmness, total soluble solids, titratable acidity, ascorbic acid, and antioxidant content were assessed every ten days. The results indicated that all treatments significantly affected fruit quality as the storage period progressed. Both 1-TG and 1.5-TG coatings resulted in the highest levels of fruit firmness and the lowest weight loss compared to the control (CK) and 0.5-TG. Additionally, ascorbic acid and antioxidant capacity were best preserved in the 1-TG treatment, followed by 1.5-TG, 0.5-TG, and CK. These findings suggest that pre-storage application of tragacanth coatings can effectively delay fruit softening and help maintain the biochemical profile of persimmons for a longer duration.

Keywords: Tragacanth, Modified, Persimmon, Sustainable.

Postharvest Quality Management of Fig by Integrated Practices

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Abstract

Fresh figs have a distinctive taste but are widely recognized as highly perishable climacteric fruit. Several factors during both the pre-harvest and post-harvest handling processes pose significant challenges for farmers in preserving the fruit's quality. Key factors include disease management, water supply, fertilizer use, fruit maturity at harvest, and post-harvest handling. Therefore, effective pre- and post-harvest practices are crucial for enhancing the storage quality of fresh figs. This article reviews studies focused on extending the storage life of figs, including the practices employed during both pre- and post-harvest handling. Pre-harvest strategies such as deficit irrigation, the use of the plant growth regulator 1-methylcyclopropene, and pollination have been implemented to improve the quality of fresh figs. Post-harvest treatments, including coating, modified atmosphere packaging, and optimizing storage temperature and relative humidity, have proven effective in maintaining the post-harvest quality of fresh figs.

Keywords: Cracking, Irrigation, Pre-Harvest, Nutrient Supply.

Evaluation of Non-Traditional Method to Maintain the Berry Quality During Cold Storage

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Abstract

Grape (*Vitis vinifera* L.) is an extensively cultivated crop around the globe. However, berry quality management for longer storage period by applying sustainable methods is a major handicap. Adequate storage techniques constituted an indispensable mechanism for both the preservation of fruits and the prevention of post-harvest damages. Traditional storage methods that involved using mud containers existed within Asian countries, but researchers had not confirmed their functional validity. This research investigated how different storage environments affected grape berry shelf stability and the maintenance of quality characteristics. In this study, our aim was to evaluate the quality loss of grape berries using unbaked mud pot. The bunches of grape were harvested at physiological stages and divided into two groups viz., corrugated boxes (control) and unbaked mud pot. Both groups were kept at 6±1°C with 80-85% relative humidity for 60 days. Results showed that, unbaked mud pot has the promising results for quality retention of grape fruit as compared to the control. Fruit of unbaked mud pot had minimum weight loss, berry decay, and berry shatter. On the other hand, fruit in control group showed the high incidence of decay, and berry shatter at the end of the trial. Besides this, both groups showed high rachis browning score. Berry color and visual appearance was also reduced in control group as compared to the unbaked mud pot group. Through these storage methods, weight loss decreased while decay and berry shatter experienced notable reductions compared to standard storage approaches. Research findings facilitated the development of better post-harvest management techniques, which delivered improved fruit quality and reduced food waste during storage. Finally, the unbaked mud pot is an eco-friendly, sustainable promising technique to extend the shelf life of grape fruit.

Keywords: Corrugated, Deterioration, Decay incidence, Rachis.

Tailoring Cultivar-Specific Strawberry Nursery Practices: Evaluating Runner Health and Yield Potential in Diverse Climates of Poonch District

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Abstract

Strawberries are renowned for their delectable taste and nutritional richness, making them a beloved fruit among many. The prevailing climate where strawberry runners are cultivated significantly impacts nursery productivity. Despite the favorable climate in Azad Jammu and Kashmir for producing high-quality strawberry runners, there remains a need for standardized guidelines regarding site selection and cultivation methods for different cultivars. To address this gap, we conducted three distinct studies in the Poonch district, assessing the runner health of three strawberry cultivars: Chandler, Sea Scape, and Tribute. Utilizing a randomized complete block design, we evaluated the performance of these cultivars at Chotta Galla, Khai Galla and Hajira. Our findings underscore the influence of temperature on runner production; cooler climates foster robust runner growth, whereas warmer climates correlate with increased yields and superior fruit quality. Additionally, variations in flower and fruit yields among cultivars were observed, with some cultivars exhibiting source-limited fruit yields, directly linked to the fruit-to-leaf ratio. Overall, our research highlights the importance of considering site-specific factors in strawberry cultivation, particularly the impact of temperature on runner dynamics and yield. These insights contribute to the development of tailored strategies for optimizing strawberry yield across diverse climatic conditions.

Keywords: Climate, Strawberry, Fruit, Nutrition, Quality.

Postharvest Low Temperature Quarantine Treatment Influences Storage Life and Quality of Kinnow Mandarin Fruit

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Abstract

'Kinnow' mandarin (*Citrus reticulata* Blanco) is the commercial citrus cultivar of Pakistan with the highest share in the fruit exports of the country. However, from the last couple of years significant decline in its exports has been observed. This reduction in exports may be ascribed to the nonfulfillment of low-temperature quarantine treatment in high-end export markets. Hence, a study was conducted to investigate the influence of cold storage quarantine treatment on the long-term storage life and quality of 'Kinnow' mandarin. Freshly harvested and processed 'Kinnow' mandarin fruit from a commercial 'Kinnow' processing unit was kept at 2 ℃ for 21 days (for quarantine treatment) and then stored at 4 ºC for 70 days. After every 7 days of cold storage interval, fruit were kept at ambient temperature (20 ºC), and data were collected after 5 days on various fruit quality parameters. Results indicated that highest feel color (65 L*, 70 b*) was recorded in quarantine-treated fruits on 21 days, while untreated fruits showed (60 a*) at 91 days of storage period. Quarantine-treated fruits were found most effective in reducing the weight loss and maintaining the firmness as compared to the untreated fruits. The size and thickness of the peel of 'Kinnow' mandarin was greater in treated fruits (45 mm, 1.75 mm) than the untreated fruits (40.3 mm, 1.5 mm) at the end of storage. As the storage period progressed, treated fruits maintained the TA at a higher level (2%) than the untreated fruits (0.15%). The fruit quality traits, such as TSS:TA ratio, increased as the cold storage period progressed. The pH of untreated 'Kinnow' mandarin fruits was higher (6) as compared to the treated fruits (5.8). The quarantine-treated fruits showed less decline (41 mg 100 mL^{-1}) in ascorbic acid contents, in contrast to the untreated control fruits (35 mg 100 mL^{-1}) on 91 days of storage. Phytochemical traits of 'Kinnow' mandarin fruit showed highly significant variations among storage period and treatment. Higher TPC and antioxidant contents were recorded in quarantine-treated fruits (300 µg mL^{-1} FW, 1.98) as compared to the untreated control Hence, the low-temperature quarantine treatment is a potential practice in retaining the fruit quality as well as meeting the export requirements.

Keywords: Cold Storage, Fruit Quality, Kinnow Mandarin, Weight Loss.

Changes in Nutritional and Phytochemical Quality of Mango Fruit During Ripening: An Overview

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Abstract

Mango (*Mangifera indica* L.) is well-recognized fruit in Anacardiaceae family. It is one of the top five major fruits consumed globally and referred as the King of Fruits. It is produced in more than one hundred countries with different colours, tastes, smells, flavours and nutritional values. It is a nutrient-dense tropical to sub-tropical fruit with diversity in its macronutrients, micronutrients, and phytochemical profile. As the climacteric peak of respiration rises, various physiological and biochemical changes occur in mango fruit. A spectrum of molecular, biochemical, and physiological changes occur that give edible fruit the desired quality during ripening period. Phytochemicals like phenolic acids, flavonoids, xanthones, carotenoids and volatile constituents account for its antioxidant, anti-inflammatory, and aroma characteristics. In the ripening process, starch hydrolyses to sugars, chlorophyll breaks down, carotenoids build up, and volatiles develop, which adds to flavour and colour. In the past various studies have observed diverse changes in nutritional and phytochemical quality characteristics of various mango varieties during ripening both before and following cold storage. Mango fruit is rich in phenolic compounds, which play a crucial role in enhancing human health and strengthening the immune system due to their antioxidant properties. The dietary intake of phenolic compounds can help manage various chronic neurodegenerative disorders associated with oxidative stress in humans. As the ripening of mango fruit progresses it exhibits significant increase in TSS, flavour, protein, taste, and sugar content, with minimal variation in peel chlorophyll degradation, whereas ascorbic acid and TA levels declines. The nutritional and phytochemical content of the fruit differs among cultivars, maturity, and agro-climatic conditions, which supports the necessity of optimized pre- and postharvest practices for maintaining quality and valorizing waste. Hence, this overall review focuses on the changes in nutritional and phytochemical quality parameters during ripening of mango fruit.

Keywords: Antioxidants, Cold Storage, Mango, Phytochemical Profile, Ripening,

The Effects of Climate Change on the Table Grape Production: Global Perspectives and Local Adaptations

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Abstract

Table grapes are an important non-climacteric fruit, widely consumed worldwide. The leading producers of table grapes in 2023-2024 include China (48%), India (11%), Turkey (7%), Brazil (6%), and Uzbekistan (6%). The production of table grapes is influenced by various climatic factors, including temperature, rainfall, humidity, frost, and heatwaves, which vary across different regions. These climatic conditions significantly impact both the yield and quality of table grapes, with varying effects on different grapevine varieties depending on regional climates. In the Murcia region of Spain, for example, the Muscatel variety of table grapes has been adversely affected by temperature variations during the year 2021. The average temperature for table grape production in this region is approximately 27 °C. In 2021, the temperature in July and August differed by 3-4 °C compared to the previous year, with 2021 being the hottest year on record. This period coincided with the fruit setting phase, during which elevated temperatures contributed to berry shattering, resulting in substantial production losses. To mitigate these adverse effects, techniques such as shading, as well as the use of heat-resistant rootstocks and varieties, are recommended to improve yield and quality under changing climatic conditions. Similarly, in the Skierniewice region of Poland, the Evita and Philip varieties of table grapes experienced significant frost damage due to variations in air temperature during the years 2017 and 2018. Poland's temperate climate typically has an average air temperature above 5 °C. However, frost events occurred in January 2017 and February-March 2018 due to temperature fluctuations, resulting in 85-90% bud damage. To counteract these impacts, practices such as the use of wind machines, mulching, and the cultivation of frost-resistant varieties have been employed. To mitigate the effects of climatic fluctuations on table grape production, it is crucial to develop resistant grapevine varieties and implement climate-resilient horticultural practices. These strategies are essential to ensuring sustainable production and enhancing grape quality in the face of climate change.

Keywords: Berry Quality, Climate Change, Global Temperature Rise.

Red Chili Consumers in Pakistan: Identifying Segments and Preferences

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Abstract

Pakistan's Red Chili value chains hold significant potential for driving socio-economic growth. However, this potential cannot be realized without addressing the challenges relating to competitiveness and stakeholder performance. A major obstacle is the lack of insight into consumer preferences for red chilies. By understanding these preferences, value chain actors can enhance their competitiveness and performance, ultimately boosting the sector's growth. Thus, this study aimed to reveal the value preferences of different segments of red chili consumers in Pakistan. Data were collected through an intercept survey of 180 red chili consumers in three major cities of Pakistan, including Karachi, Lahore, and Faisalabad. Collected data were analyzed using descriptive statistics, hierarchical cluster analysis, Mean ANOVA, and post-hoc tests for identifying consumer segments and their value preferences. Using preferences for various attributes of red chilies, the study identified three consumer segments labeled as traditionalists (45.6%), quality seekers (38.6%), and saftey and marketing conscious (15.8%). The identified consumer segments differed significantly in their desired quality attributes, consumption and purchase preferences, and socioeconomic composition. To improve competitiveness and stakeholders' performance, the study findings urge private and public stakeholders to understand and respond to the preferences of different consumer segments. The Red Chili value chain actors are needed to upgrade and align their practices with consumer requirements. To this end, the related public sector institutions can facilitate the red chili value chain actors in accessing the technical and financial resources needed.

Keywords: Red Chili Value Chains, Consumer Segmentation, Competitiveness, Stakeholders Performance.

Improving Citrus Value Chains in Pakistan through Research and Development with Small-Scale Growers and Industry Stakeholders

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Abstract

Citrus is leading fruit crop in Pakistan and holds major share in national fruit exports. Kinnow mandarin is a dominant citrus variety contributing more than 70% to total citrus production and 90% to total citrus exports from Pakistan. Major share in citrus production comes mainly from smallholder growers. Unfortunately, a significant share of Kinnow mandarin produced in Pakistan fails to compete in high-end markets, depriving smallholder citrus growers and other stakeholders of equitable returns. A research for development project funded by Australian Centre for International Agricultural Research was launched in Sargodha district of Punjab province to improve smallholder well-being through their participation in inclusive citrus value chains, focusing on monitoring and managing fruit quality, value chain governance and marketing, and enhancement in citrus sector knowledge system. Key issues identified during the project activities included citrus production and supply chains with disproportionate gender inclusion, poor production practices leading to inferior fruit quality and high cost of cultivation, at the face of growing challenges caused by climate change and inadequate private and government extension services. In collaboration with motivated smallholder citrus growers, contractors and processors, we attempted to resolve critical issues by employing interdisciplinary teamwork, participatory action research, and gender-inclusive value chain approach. Kinnow-specific fruit quality standards, promoting quality-enhancing measures and identifying local chain champions, which when scaled up could enhance the performance of the citrus industry.

Keywords: Kinnow Mandarin, Small-Scale Grower, Fruit Quality, Gender-Inclusion.

Recent Advances in Postharvest Management of Fruits and Vegetables at IUB

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Abstract

Recent advancements at The Islamia University of Bahawalpur have significantly improved postharvest strategies to enhance the quality and shelf life of fruits and vegetables. In strawberries, the application of 30% eucalyptus leaf extract (ELE) effectively maintained fruit quality and antioxidant potential. ELE-treated strawberries exhibited reduced weight loss, fungal decay, respiration rate, and electrolyte leakage. Enzymatic activities, particularly superoxide dismutase (SOD), catalase (CAT) and peroxidase (POD) enhanced, contributing to improved antioxidant levels compared to control. ELE also preserved sensory attributes, including firmness, flavor, and general acceptance, while maintaining total phenolics, ascorbic acid, and anthocyanin content. These treatments extended the strawberries' shelf life up to 15 days, suggesting ELE as an eco-friendly postharvest strategy. For green chilies, combining hot water treatment (HWT) with ELE significantly improved the storability. The treated chilies showed reduced weight loss, fungal decay, and reactive oxygen species (H_2O_2 and O^{-2}). Antioxidative properties, including DPPH radical scavenging activity, ascorbic acid, and phenolic content enhanced. Enzyme activities, such as CAT, POD, and APX, also increased. This combination treatment maintained higher chlorophyll content, reduced wrinkling, and improved marketable fruit quality compared to controls, extending shelf life while preserving nutritional value. Recently, UV-C light treatment (13.5 kJ m^{-2}) in combination with hot water treatment has proved to be promising technique for preserving tomatoes and chilies. It maintained the freshness of both commodities by regulating the physiological changes like juice pH, soluble solid content, ascorbic acid content, titratable acidity and weight loss. The calli of goji berry exhibited significantly higher antioxidant and polyphenolic contents compared to others, with enhanced enzyme activities (CAT, SOD, POD, and APX). Overall, these methods collectively offer sustainable and effective solutions to enhance the postharvest longevity, nutritional value, and marketability of fruits and vegetables.

Keywords: Antioxidant Capacity, Chilies, Eucalyptus Leaf Extract.

Variation in Fruit Quality of Kinnow Mandarin Produced in Sargodha Region

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Abstract

Citrus is the leading fruit crop in Pakistan and holds the major share of the national fruit export profile. Among citrus varieties, Kinnow mandarin dominates and contributes 90% of total citrus exports from Pakistan. Unfortunately, a significant share of Kinnow mandarin produced in Pakistan fails to compete in high-end markets, depriving citrus growers and other stakeholders of equitable returns. This study was initiated in 2024 under an ACIAR-funded citrus value chain project (HORT/2020/129) to understand underlying issues hampering quality production in Sargodha region. Commercially harvested and graded Kinnow fruits from six different orchards were inspected for surface blemishes and other physical and biochemical attributes. Fruit from all orchards qualified for the minimum export requirement for peel colour. However, results from quality assessment highlighted wind injury (66-96% fruit) as the major cosmetic issue in all orchards. In addition to that, red scale (7-53% fruit) and mites (15-47% fruit) were dominant issues. Graded fruits were observed to have out-of-grade quality benchmarks as well. Overall, 58-82% of fruits in grade A lots from six orchards were actually qualified for grade A quality benchmarks (56 mm diameter and >80% colour development). Though reduction in surface blemishes remains a key strategy for quality improvement, the data further suggests the need to improve fruit size and peel colour to shift fruit from grades B and C into higher quality grades. So, reducing its surface blemishes may help reduce farm-gate rejection (reduction in grade C fruit percentage) and increase the percentage of marketable fruit (grade A and B fruit). Though the differences in any fruit quality attribute among orchards could not directly be related to the differences in any specific cultural practice, a set of improved cultural practices could collectively be attributed to improved fruit quality in orchards of progressive farmers.

Keywords: Kinnow Mandarin, Sargodha Region, Quality Grades, Rind Blemishes.

Impact of 1-MCP Application Methods on Storage Life and Quality of Mango Fruit cv. Sufaid Chaunsa

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Abstract

Mango (*Mangifera indica* L.) is a commercially important tropical fruit with a short storage life, which limits its export through sea shipments. 1-Methylcyclopropene (1-MCP), an ethylene inhibitor, is known to delay ripening and extend the postharvest life of mango fruits. This study aimed to evaluate the effects of different 1-MCP application methods on the storage life and quality of mango fruit. Healthy mango fruits cv. Sufaid Chaunsa were stored in modified atmosphere packaging at 12°C either without 1-MCP treatment (control) or after treating with 1-MCP, employing fumigation (1.5 ppm), aqueous dip (1.2 ppm), or 1-MCP Card® (Log Fresh, China). The ripening quality of stored fruits was assessed at 7-day intervals. 1-MCP treatments exhibited better storage potential and ripening quality than the control. Among 1-MCP treatments, mango fruits aqueous-treated with 1-MCP maintained lower weight loss, higher firmness, sugar acid ratio, ascorbic acid, total phenolic, and antioxidant contents than those fumigated or treated with 1-MCP Card®. Overall, findings suggested that aqueous treatment with 1-MCP effectively extended storage life and maintained postharvest quality of mango fruits for one more week compared to other 1-MCP application methods.

Keywords: 1-MCP, Application Methods, Fruit Ripening, Mango, Quality.

Postharvest Application of Sodium 4-CPA with Wax-Based Formulations to Enhance Storage Quality of Kinnow Mandarin

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Abstract

Citrus fruit is a rich source of dietary fibre and health-promoting nutrients, including vitamin C and other antioxidants. Kinnow mandarin is a major citrus variety produced in Pakistan and holds a significant share in fruit exports. However, various postharvest issues (chilling injury, weight loss, green mould, blue mould mechanical damage, and temperature fluctuations) during storage and transit pose challenges to its profitable export to high-end markets. Postharvest fungicides, thiabendazole and Imazalil, are commercially used to prevent decay and extend the storage life of Kinnow mandarins. To explore an alternate postharvest management approach, this study evaluated the efficacy of 4-chlorophenoxyacetic acid (4-CPA) and Prochloraz applied in wax-based formulations on the storage quality of Kinnow mandarins. Treatment included postharvest coating with either shellac wax only (control, T1) or with wax containing 0.33% Thiabendazole + 0.15% Imazalil (T_2), 0.33% Thiabendazole + 0.15% Imazalil + 0.075% 4-CPA (T_3) or 0.075% 4-CPA + 0.06% Prochloraz (T4). After treatment, fruits were stored at 4 ºC and analysed for changes in fruit quality at 0, 21, 35, 49, 63, 77, and 91 days. Overall, regardless of fungicide used, fruits treated with 4-CPA retained better storage quality (91 days) as compared to fruits treated with Thiabendazole and Imazalil (77 days). In conclusion, results suggested that 4-CPA can be used as a potential wax-based postharvest approach to extend storage life of Kinnow mandarins.

Keywords: Citrus, Kinnow, Postharvest, Storage Quality, 4-CPA.

Evaluation of the Effects of Preservative Solutions on Shelf Life and Quality of Cut Gladiolus (*Gladiolus grandiflorus* L.)

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Abstract

Gladiolus grandiflorus L., the most common species of bulbous flowers, also known as sword lily, belongs to the Iridaceae family. Native to South Africa, it is considered a high-value floral crop and ranks fifth in international trade. It is well-known around the world for its vibrant floret color, robust spike, size, appealing appearance, and enduring quality. Renowned for its use as a cut flower gladiolus spikes, are ideal for floral arrangements, ornamental garden plants and high-end bouquets, its postharvest quality and vase life are often compromised due to factors such as temperature sensitivity, water uptake, ethylene susceptibility, floret abscission, and microbial activity. To mitigate these challenges and extend the longevity of cut stems, this study evaluated the efficacy of various pulsing solutions with different chemical compositions. The experiment conducted using a completely randomized design with 11 treatment combinations, each replicated four times with two stems per replication. The experimental treatments included a control (distilled water), 2% sucrose, and combinations of cobalt chloride (40 ppm, 80 ppm, 120 ppm), calcium chloride (800 ppm, 1200 ppm, 1600 ppm), and aluminium sulfate (25 ppm, 50 ppm, 75 ppm), with 2% sucrose incorporated into all solutions as a preservative. The results showed that application of $CoCl_2$ at the concentration of 120 ppm the improved vase life (14 days), flower quality (9.00), stem dry weight (7.375g), total number of open buds per stem (6.23), number of opened florets (3.75), and percentage of opened buds (83%). While, change in pH of vase solution (3.72), change in EC (30.13 µS cm^{-1}), water uptake (75 mL) was maximum at the treatment concentration of 75ppm of $Al_2 (SO_4)_3$. Data was subjected to analysis of variance, and mean comparisons were performed using the Tukey's test at a 5% significance level.

Keywords: Gladiolus, Vase Life, Preservative Solutions, Cut Flowers.

Comparative Effects of Different Pulsing Solutions to Impropve the Display Life of Cut Carnation (*Dianthus caryophyllus* L.)

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Abstract

The Carnation (*Dianthus caryophyllus* L.), belongs to the Caryophyllaceae, family and holds a prominent position as one of the highly sought-after cut flowers in the international floriculture industry. Display life and postharvest longevity are the major concerns in this flower, if improved or hastened way adds to its quality. To address this malady an experiment was envisaged to study the comparison of different organic preservatives. It was observed that various combinations of organic floral preservatives significantly enhanced the longevity of cut flowers. The pulsing solutions used in this study were composed of multiple treatment combinations, including distilled water (control), 2% sucrose only, 20 mg L^{-1} and 40 mg L^{-1} Chitosan, 2 mg L^{-1} and 4 mg L^{-1} Thymol, 2 mg L^{-1} and 4 mg L^{-1} Eugenol. In order to preserve the samples, a 2% sucrose solution was added to all treatment combinations. The efficacy of different concentrations of various organic compounds was evaluated by applying them as pulsing solutions to determine their impact on the display life. Data regarding postharvest attributes including solution uptake, morphological, floral, and display life was collected. An experiment was executed using a completely randomized design consisting of 8 treatment combinations, each replicated 4 times. The proposed research study was evaluated for its overall significance through the utilization of the analysis of variance technique. The treatment means were subsequently compared utilizing Tukey's test at a significance level of 5%. The results showed that application of 2% sucrose+4 mg L^{-1} Thymol improved vase life (7.25days), flower quality (7.5), change in EC (29.363 ds cm), relative fresh weight (11.73 g) stem dry weight (1.43 g), water uptake (38.75 mL), and delayed stem bending (5.7 days) and stem necrosis (6.62 days). Change in pH of vase solution (7.2) and water loss (102.25 g h^{-1}) was maximum in 2% sucrose + 40 mg L^{-1} Chitosan. It is concluded that 2% sucrose+4 mg L^{-1} Thymol improved vase life, relative fresh weight, stem dry weight, flower quality and water uptake.

Keywords: Carnation, Vase Life, Preservatives Solution, Cut Flowers.

Effect of Aloe Vera Gel Coating on Physico-Chemical Properties and Shelf Life Evaluation of Low Seeded Kinnow Fruit

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Abstract

Kinnow is top ranked fruit crop grown of Pakistan and cannot be stored for long periods at ambient conditions. Present study was carried out to evaluate the effect of aloe Vera gel coating on Physico-chemical properties and shelf life evaluation of low seeded kinnow fruit was conducted at University of Agriculture, Faisalabad Sub-campus Burewala. Freshly harvested Kinnow fruit were dipped in 0%, 10%, 20% and 30% aloe vera gel concentrations and stored at ambient temperature 25±2°C for shelf life analysis. Kinnow fruits were analyzed physico-chemical and bioactive compounds analysis for during 12 days storage at ambient temperature. Aloe Vera gel coating was found to have a significant positive effect on fruit quality parameters. Results revealed that 30% aloe vera gel coating exhibited higher TSS and ascorbic acid contents, total phenolics and antioxidants. The coated kinnow fruits had a better quality and higher shelf life of up to 12 days under ambient conditions, in comparison to control.

Keywords: Kinnow, Aloe Vera Gel, Shelf Life.

Effect of Thiabendazole and Imazalil Fungicides on Storage Quality of Kinnow Mandarin

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Abstract

Citrus is one of the most widely grown fruit crops in Pakistan. It is renowned for its nutritive values, taste and health benefits. Kinnow mandarin is the top-ranked fruit crop for its significant share in citrus production and national exports. Kinnow fruit is mainly exported through sea shipments, which requires extended storage. Since fungal infection is a common issue during sea shipments, this study was conducted to evaluate the efficacy of postharvest fungicides in reducing fungal decay without compromising fruit quality during storage. Freshly harvested Kinnow mandarins were coated with either wax only (T_1) or with wax containing 275 µL L^{-1} Thiabendazole (T_2), 125 µL L^{-1} Imazalil (T_3) and 275 µL L^{-1} Thiabendazole + 125 µL L^{-1} Imazalil (T_4). After fungicide application, Kinnow fruits were stored at 4°C, simulating storage and export shipment conditions. Changes in fruit quality were assessed at 15-day intervals. The results revealed that the control fruits retained their fruit quality for 35 days, whereas fruits coated with Imazalil maintained storage quality for 49 days. However, Thiabendazole, with or without Imazalil, was most effective in inhibiting fungal decay and delaying weight loss and softness for 63 days. Overall, the study recommended coating citrus fruits with 275 µL L^{-1} Thiabendazole for the extended storage of Kinnow mandarins.

Keywords: Kinnow, Postharvest, Fruit Quality, Fungicide, Cold Storage.

Effect of Sodium 4-Chlorophenoxyacetic Acid and Prochloraz on Storage Quality of Kinnow Mandarin Fruit

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Abstract

Kinnow mandarin (*Citrus reticulata Blanco*) is a member of Rutaceae family. It is highly valued in the Pakistan fruit industry for its unique flavour, attractive colour and export potential. However, major postharvest issues like fungal infections and physiological disorders are the leading factors that adversely affect fruit quality during cold storage and export. The proposed research aimed to evaluate the efficacy of sodium 4-chlorophenoxyacetic acid (4-CPA) and Prochloraz for extending the storage and marketability of the Kinnow mandarin. Treatments included spray coating either with water (control) or with 0.25% 4-CPA and 0.20% Prochloraz. Coated fruits were stored at 4°C. Changes in fruit quality during storage were evaluated at 0, 21, 35, 49, 63, 72, and 91 days. Fruits coated with 4-CPA and Prochloraz exhibited delay in weight loss, reduced shrivelling, better firmness retention, and lower incidence of fungal infection than control fruits. Overall, 4-CPA and Prochloraz delayed deterioration in fruit quality and enhanced the storage life of Kinnow fruits by 63 days compared to the control (35 days). Findings suggested that 4-CPA and Prochloraz can be used as a viable coating treatment for the cold storage of Kinnow mandarins. However, the potential use of 4-CPA and prochloraz should also be explored in combination with commercial wax coatings to further extend the storage life of citrus fruits.

Keywords: Kinnow Mandarin, Postharvest Quality, 4-CPA, Prochloraz, Export

Postharvest Quality Preservation of Table Grapes with Oligochitosan Coating under Low Temperature and Ambient Storage Conditions

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Abstract

The higher perishability of table grape fruits makes them susceptible to postharvest rachis browning, berry shriveling, berry shattering and overall quality deterioration thereby resulting in short potential after harvest. In the present work, table grapes were coated with oligochitosan (0, 025%, 0.5% and 1%) and stored under ambient temperature storage (ATS) at 20 ºC and during cold storage conditions (CSC) at 5 ºC for 15 and 30 days, respectively. Oligochitosan (1%, OGC) treated fruit showed reduced weight loss, disease rate and berry shattering percentage than the control. The 1% OGC coated grapes showed less accumulation of malondialdehyde, ion leakage, superoxide anion, hydrogen peroxide with lower ethylene production and respiration rate. Grapes coated with OGC exhibited higher activity of catalase, ascorbate peroxidase, superoxide dismutase and peroxidase. In addition, OGC application preserved higher glutathione content, total phenols, ascorbic acid, and total flavonoids compared with the controls. The OGC treated grapes revealed lower total soluble solids and higher titratable acidity in comparison with the controls. So, OGC coating could be used for preserving quality of table grape fruits under ATS and CSC appropriately.

Keywords: Antioxidant Enzymes, Berries, Chitosan, Preservation.

Physico-Chemical Characterization of Selected Sweet Orange (*Citrus sinensis*) Cultivars Grown in Taxila-Khanpur Valley

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Abstract

This study investigated the physico-chemical properties of 17 sweet orange cultivars grown in the Taxila-Khanpur Valley to assess their quality attributes and potential for commercial utilization. Physical characteristics, including size, geometric mean diameter, sphericity, surface area, and weight, were measured, revealing significant variability among cultivars. Proximate analysis showed moisture content ranging from 75.12% to 84.31%, ash content from 0.09% to 0.65%, protein content from 0.69% to 0.70%, fat content from 0.35% to 4.43%, fiber content from 1.33% to 5.34%, and nitrogen-free extract from 10.26% to 14.24%. Nutraceutical analysis indicated significant variation in ascorbic acid (44.06-61.81 mg 100 g^{-1}), total phenolic contents (117-298 µg GAE g^{-1}), total flavonoid contents (45.39-79.12 mg QE g^{-1}), and radical scavenging activity (50.17-89.17%). Mineral analysis showed Na (2.18-2.53 mg 100 g^{-1}), iron (0.21-0.57 mg 100 g^{-1}), and K (144-240 mg 100 g^{-1}). A significant correlation ($R^2 = 0.91$, $p < 0.05$) was observed between ascorbic acid and radical scavenging activity. Principal Component Analysis (PCA) classified the cultivars into four major groups based on their physico-chemical attributes. This study provides valuable baseline data for stakeholders to understand the potential of indigenous orange varieties for commercial use and further research.

Keywords: Ascorbic Acid, Sweet Orange, Nutraceutical Analysis, Mineral Composition.

Methyl Jasmonate as an Eco-Friendly Approach to Alleviate Oxidative Stress and Pulp Softening in Papaya Fruits During Cold Storage

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Abstract

Fruit senescence driven by maximum ethylene production that significantly influences postharvest quality by accelerating ethylene production and oxidative stress. Papaya is recognized for its vibrant orange color and nutritional richness making it popular among consumers for its various health benefits. However, papaya industry faces substantial challenges such as inadequate postharvest preservation, pulp softening that contribute to significant economic losses. Methyl jasmonate (MeJA) enhances fruit quality during storage by reducing weight loss, inhibiting ethylene production, and advancing antioxidant activity, thereby extending shelf life. For this, numerous concentrations of MeJA including control, 0.5 mM, 1 mM, and 1.5 mM were sprayed on papaya fruits at the mature green stage (10% yellowing) and fruits were harvested at the color break stage (25% yellowing) and were kept under cold conditions (10 C) with 80-85% relative humidity for 28 days. Results exhibited that preharvest 1.5 mM MeJA application noticeably suppressed an increase in the weight loss, disease incidence, chilling injury, total soluble solids content, ripening index, while maintaining higher firmness compared to the control. Subsequently, MeJA application markedly elevated the defensive mechanism activities such as superoxide dismutase, peroxidase, catalase, ascorbate peroxidase, and phenylalanine ammonia-lyase thereby slowed down the softening enzymes activities i.e., polygalacturonase, pectin methyl esterase, and cellulase while maintained the quality of fruits than control group. In general, preharvest application of MeJA is both safe and environmentally friendly while also demonstrating to be effective in preserving and enhancing the quality of papaya fruits during low-temperature storage.

Keywords: Ascorbate Peroxidase, Ethylene Production, Methyl Jasmonate, Pulp Softening, Senescence.

Exploring Valine Application in Grapes as A Novel Approach to Improve Postharvest Quality and Extend Shelf Life During Cold Storage

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Abstract

Grapes are susceptible to softening, which restricts their shelf life and poses significant challenges for long-distance transportation. This study investigated the effect of pre-storage application of valine (VAL) on reducing the moisture loss, berry shattering, oxidative stress by maintaining the quality and prolonging the shelf life of Sultanina-C cultivar of grapes during low-temperature storage. For this, different concentrations of valine (control, 1 mM, 2.5 mM, and 5 mM) were applied on grapes to preserve their quality traits during storage period of 28 days. Results showed that postharvest 5 mM application of VAL on grapes noticeably suppressed an increase in weight loss, decay incidence, rachis browning, berry shattering, thereby maintaining the soluble solids content, TSS:TA ratio and firmness than control fruits. Pre-storage valine application remarkably inhibited maximum synthesis of oxidative stress i.e., hydrogen peroxide, malondialdehyde, lipoxygenase, electrolyte leakage thereby modulated the activities of antioxidant enzymes such as superoxide dismutase, peroxidase, catalase, ascorbate peroxidase, polyphenol peroxidase during prolonged storage duration. Following this, Valine application on Sultanina-C prior to storage notably preserve maximum acidity, ascorbic acid, total phenolics, anthocyanin, and DPPH-scavenging activities while slowing down the softening process by inhibiting polygalacturonase, cellulase, and pectin methyl esterase activities compared to control fruits. Therefore, pre-storage application of valine on grapes is proposed as a promising strategy in postharvest management to enhance quality traits during storage, thereby improving their overall shelf life and marketability.

Keywords: Berry Shattering, Lipoxygenase, Marketability, TSS: TA ratio, Valine.

Acacia Seed Oil Based Nano-Emulsion Coating Maintains the Postharvest Quality of Guava Fruits

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Abstract

Guava (*Psidium guajava* L.) is an important fruit crop in tropical and subtropical regions of the world. Guava has high nutritional importance, available in abundant amount, round the year with high yield. However, it tends to be sensitive to physiological and environmental deterioration. This problem can be managed by adopting pre and post-harvest managements. The aim of the study was to determine the efficacy of nano-emulsion based edible coating on the shelf life of guava fruit. Nano-emulsion was prepared by using 3% Acacia seed oil. Coated and non-coated (control) fruits were stored at 18 °C and 80±5% RH. Nano-emulsion coating reduced weight loss, membrane leakage, lipid peroxidation and hydrogen peroxide concentration as compared to the non-coated fruits. Nano-emulsion acted as a barrier in the way of degradation of ascorbic acid and citric acid. Nano-emulsion suppressed the activities of softening enzymes such as polygalacturonase, pectin methylesterase and cellulase enzymes whereby strength the cell wall. Furthermore, the coated fruit exhibited increased activities of ascorbate peroxidase, catalase, superoxide dismutase and peroxidase and antioxidant capacity. Nano-emulsion coated fruits preserved total soluble solids, pH and ripening index as compared to control fruits. Nano-emulsion coating showed the significant effect on sensory attributes like color, taste, aroma, disease incidence and overall acceptability.

Keywords: Acacia Seed, Coating, Membrane Leakage, Nano-Emulsion.

Antifungal Potential of Neem and Aloe Vera Crude Extracts Against Post-Harvest Pathogens of Banana and Tomato

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Postharvest diseases should begin before or once harvest domestic. Plants and fruits infected within the subject may not develop signs and symptoms until hold. Once in storage infection nevertheless expand on the culmination. In the existing take a look at numerous culmination markets have been selected from one of a kind regions of Harappa, Sahiwal Pakistan. Various culmination like Banana and tomato were gathered from the chosen vicinity. The intensely damaged and rotted selected samples were inoculated on malt extract agar (MEA) medium and studied under microscope for morphological traits. MEA medium become first off prepared by means of adding 20, 20 g of malt extract and agar in 1000 mL of distilled water. The medium became in addition autoclave observed via pouring in pre sterilized petri plates in aseptic situations. After 7 days of incubation duration exclusive isolated fungus had been purified in 2 % MEA medium and similarly examine under microscope for identification characteristics. The result revealed various fungi isolated from the selected samples of banana and tomato are mucor sp. and *Musicullium theobrome*. So far packing material of soppy fruits ought to be petually soft and sterile. Unfold of post-harvest fungi is additionally attributable to poor hygenical techniques followed by the go down house owners. Fruits sales in markets ought to be beneath a clean safe setting that will be unfavorable setting for the expansion of such Fungi. The regarding bodies ought to hold their responsibilities in following up fruit sales markets to make sure high quality and toxic free. Further in vitro study impact of different fungicides i.e. Aloe vera and neem extract on the growth (dry mycelial weight) was conducted in laboratory. Various concentration (2%, 4%, 6% and 8%) of selected fungicides were prepared in malt extract liquid broth. The isolated fungi from the rotted banana and tomato were grown in the prepared liquid broth (containing various fungicides). The result of application of aloe vera extracts the tested fungus M. theobrome was significantly reduce with the increasing concentrations of aloe vera extracts. The result showed by neem extracts on tested fungus M. theobrome was declined with the increasing concentration of neem extracts. The impact of aleovera on isolated fungus Mucor sp. was noticed that significantly inhibited. The application of aleovera extracts on isolated fungus Mucor sp. showed the significant decline with the increasing concentrations of extracts.

Keywords: Aloe Vera, Antifungal, Biological Control, Neem Extract, Post-Harvest.

Precision Tech & Climate Smart Innovations in Horticulture

Assessing the Robustness of Process Based STICS Crop Model for Predicting Key Growth Stages of Table Grape Cultivars

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Abstract

Climate change poses a major challenge for sustainable viticulture as many traditional viticulture regions are set to lose owing to increasing earth temperature. Exploring the possibility of early prediction of phenological timings of table grape cultivars has huge socio-economic benefits for the growers and viticulture industry as they can timely plan vineyard operations to get higher yield with better fruit quality. The objective of this study was to calibrate and evaluate the robustness of the STICS crop model to predict the onset timings of key growth stages of grapevine cultivars under the agro-climatic conditions of Pothwar region. Phenology and crop growth data were recorded for cvs. Kings Ruby, Perlette, NARC Black and Sugra One at Islamabad and Chakwal districts in Northern Punjab, Pakistan. The data were recorded for key growth stages i.e., budburst, blooming, berry set, veraison and harvest timing at least twice in a week at both locations for 2019 and 2020 vintages, using the BBCH phenological scale. The results indicated that STICS, being a robust model, can effectively simulate phenology stages of table grape cultivars. The model provided an efficient decision support tool (DST) for the viticulture industry though crucial phenology predictions. For instance, it indicated up to 13 days early maturity for the relatively hotter location i.e., Chakwal compared to Islamabad. Almost all phenological stages were attained earlier for cv. Perlette compared to other cultivars, however blooming and berry set were reached earlier for cv NARC Black. The STICS simulations regarding phenological timings are highly valuable in timely managing crucial vineyards operations such as pruning, nutrient management, spray scheduling and harvest decision. STICS, being a robust model, can effectively capture the effects of seasonal variability on key growth stages of grapevine cultivars thus it provides a valuable insight and DST in timely managing vineyards operations.

Keywords: Crop Growth Models, Grapevine Phenology, Seasonal Variability, STICS.

Blockchain and IoT-Enabled Trust Mechanisms in Agricultural Supply Chains: A Systematic Approach

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Abstract

Trust is a critical component of agricultural supply chains, ensuring transparency, efficiency, and sustainability in food production and distribution. However, traditional supply chain systems often suffer from inefficiencies, fraud, and a lack of real-time traceability. This study explores the integration of Blockchain and Internet of Things (IoT) technologies to enhance trust mechanisms in agricultural supply chains. Blockchain, with its decentralized and tamper-proof ledger, provides immutable records of transactions, while IoT enables real-time data collection through smart sensors, improving traceability and decision-making processes. This research adopts a systematic approach to analyze how Blockchain and IoT can collectively mitigate challenges related to data integrity, authentication, and security in agricultural logistics. By leveraging smart contracts, automated quality assurance, and decentralized data validation, the study highlights how these technologies improve trust among stakeholders, including farmers, suppliers, retailers, and consumers. The findings underscore the potential of Blockchain-IoT integration in reducing fraud, enhancing transparency, and optimizing supply chain operations. Furthermore, we discuss implementation challenges such as scalability, interoperability, and regulatory compliance, providing recommendations for overcoming these barriers. This study contributes to the evolving discourse on digital transformation in agriculture and offers insights into developing more resilient, transparent, and trust-driven agricultural ecosystems.

Keywords: Agricultural Supply Chain, Blockchain, Digital Agriculture, IoT, Smart Contracts.

Coping of Climate Change in Annually Twice Crop Producing Brazilian Hybrid Grapes Through Exogenous Abscisic Acid Application

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Abstract

'BRS Isis' is new hybrid colored table grapes grown in Brazil. However, due to climate change, the rising temperature may inhibit anthocyanin accumulation causing the lack of a pink and uniform color of berry skins when this cultivar is grown in warm climates, with double cropping pattern. The endogenous plant growth regulator, abscisic acid (ABA), the concentration of which increases in grape berry skins at the onset of maturation (veraison), seems to be involved in the regulation of anthocyanin accumulation. Recently, an efficient S-ABA production method developed so that it can be used on crops, which led to the evaluation of different concentrations applied at or around veraison to colored table grapes. Thus, a trial was carried out during two consecutive seasons in a commercial vineyard of 'BRS Isis' table grape trained on an overhead trellis system, located at Marialva, Paraná state, Brazil. A randomized block design was used with five treatments and four replications, with five vines per plot. 1) Control (no application); 2) S-ABA at 200 mg L^{-1} at 7 days after veraison (DAV); 3) S-ABA at 400 mg L^{-1} at 7 days after veraison (DAV); 4) S-ABA at 200 mg L^{-1} at 7 days (DAV) + 200 mg L^{-1} at 14 days after first application (DAFA); and 5) S-ABA at 400 mg L^{-1} at 7 days (DAV) + 400 mg L^{-1} at 14 (DAFA). The exogenous use of S-ABA does improve the color of new hybrid 'BRS Isis' grapes, especially when it is applied twice, i.e., 400 mg L^{-1} 7 days after veraison and 400 mg L^{-1} 14 days after first application. Regardless of the concentrations or application timing, there is no alteration in the berries physical characteristics.

Keywords: S-ABA, Color Index, Anthocyanin, Hybrid Grapes.

Soil Applied *Cymbopogon schoenanthus* Extract Improves the Physiological Attributes and Phytoextraction Potential of *Mathiola incana* via Alleviating the Ni-polluted Soil Toxicity

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Abstract

Globally, soil health is seriously deteriorating with Ni contamination mainly due to unplanned urbanization, industrialization, agricultural practices and human anthropogenic activities, ultimately lowered the field crop productivity and quality. Plants and human health is seriously concerning with the soil Ni contamination due to less degradability, solubility and longer persistence in the environment. So there is a dire need to find out the most effective and sustainable strategy to remediate the Ni polluted soil. Phytoextraction, the most effective, sustainable, economic technique implies the capacity of plants to extract the Ni and clean the contaminated soil. Ni toxicity on growth and productivity of *Mathiola incana* and positive responses of lemongrass extract (LGE) on phytoextraction is unknown. Therefore, current study was directed to evaluate the phytoextraction potential of *M. incana* assisted with LGE to remediate the Ni contaminated soil. Our findings revealed that Ni contamination significantly lowered the plant growth attributes, water content, photosynthetic pigments, gaseous exchange attributes, antioxidative enzymes, meanwhile LGE treated plants showed remarkable improvement in growth and phytoextraction potential of *M. incana*. This study provides a valuable strategy as a combination of LGE and *M. incana* to bring down the Ni concentration to a safe limit for better crop productivity.

Keywords: Nickel, Phytotoxicity, Phytoextraction.

Molecular characterization of *Pectobacterium atrosepticum* Infecting Potato and its Management through Chemicals

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Abstract

Potato farming is a vital component of food security and the economic stability especially in the under developing countries but it faces many challenges in production, blackleg disease caused by *Pectobacterium atrosepticum* (Pa) is one of the main reason for damaging crop yield of the potato. Effective management strategies are essential to control these losses and to get sustainable potato crop yield. This study was focused on characterizing the Pa and the investigating new chemical options for its management. The research was involved a systematic survey across the three district of Punjab, Pakistan (Khanewal, Okara, and Multan) to collect samples exhibiting the black leg symptoms. These samples were analyzed in the laboratory where gram-negative bacteria were isolated and identified through biochemical and pathogenicity tests for Pa. DNA sequencing further confirmed these isolates of Pa strains. Six different chemicals were tested to control blackleg problem in both vitro and vivo at different concentrations. *In-vitro* experiment, Cordate demonstrated the highest efficacy with a maximum inhibition zones of 17.13 mm, followed by Air One (13.77 mm), Profiler (10.16 mm), Blue Copper (7.77 mm), Spot Fix (7.6689 mm), and Strider (7.0667 mm). *In-vivo*, Cordate maintained its effectiveness with the lowest disease incidence of 14.76%, followed by Blue Copper (17.49%), Air One (16.98%), Spot Fix (20.67%), Profiler (21.45%), Strider (24.99%), and the control group (43.00%). The results highlight Cordate's potential as a most effective chemical against Pa, offering promising role for managing blackleg disease in potato and to improve overall productivity.

Keywords: Chemicals, Black Leg, Management, Potato.

Horticultural Plant Production by Using Hydroponic Technique

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Abstract

Lettuce (*Lactuca Sativa* L.) is widely distributed around the world, a leafy herb has its origin in Mediterranean region. Lettuce contains many useful nutrients that can easily overcome the threats to food security in third world countries by adding fiber/bulk, folate and other available nutrients. In Pakistan, its production and farmer's interest in it are increasing day by day. In 2020, almost 220 metric tons of lettuce were produced. This high production and demand needs attention. Southern Pakistan is facing water crises and Hydroponic system is one revolutionary technique which can make the region to meet its food demand. This experiment was carried out at Department of Horticultural Sciences, The Islamia University of Bahawalpur. In this experiment, different treatments combinations were used to see their effects and evaluate the best combination of nutrient to get maximum production of lettuce. The present study's results are concluded on the basis of last week (5th Week) production of shoot and root mass. Treatment one (T_1) performed outstanding overall the four parameters. Maximum average root and shoot length (RL, SL) was observed in treatment one (T_1) replicates 5.94 cm and 15.50 cm respectively. Increased shoot length is directly proportional to the increased production of head of the plant. For root and shoot weight (RW, SW) treatment 1 (T_1) is more effective than treatment 2 (T_2) but the difference of effectiveness is lesser than the treatments impact on root and shoot length. For treatment 1 root weight (RW) was recorded 0.09 g and shoot weight (SW) was 0.22 g. Hydroponic systems demand huge capital investment which can compensate with high production of crop. To increase the efficiency of system there is dire need to calculate optimum nutrient combinations application to the crop for a sound food security plan.

Keywords: Food Security, Hydroponic, Lettuce, Root, Shoot.

Integrated Approaches for the Production of High-Quality Potted Mango Nursery Plants

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Abstract

Mango (*Mangifera indica* L.), a globally significant fruit crop, demands innovative techniques to ensure high-quality planting material for sustainable orchard establishment. Therefore, a series of experiments were conducted to enhance the growth and quality of potted mango nursery plants. Five stone soaking treatments in water (T_1: Control, T_2: 24 hours, T_3: 36 hours and T_4: 48 hours and T_5: 72 hours) following with stone conditions (T_1: without seed coat and T_2: with seed coat) and supplemented with nutrition doses [S_0: control, S_1: NPK (5 grams), S_2: DAP (2.17 g) + SOP (1.7 g) + Urea (1.78 g) and S_3: NP (5g) +SOP (1.7g)] and time of application [T_1: at transplanting, T_2: 1 week after transplanting, T_3: 2 weeks after transplanting and T_4: 3 weeks weak after transplanting] to evaluate the impact of all these approaches on production of potted mango nursery plants. Results from 1st study indicated that minimum days (9 days) to 1st seedling emergence was recorded in T_3 (36 hours) followed by T_4 (48 hours) (11 days) as compared to maximum (22 days) in T_1 (control). Similarly highest seedling emergence (80%) was recorded in T_3 (36 hours) as compared to T_5 (72 hours) (35%). In the 2nd study results showed that minimum days (7 days) to 1st seedling emergence was recorded in T_1 (without seed coat) as compared to T_2 (with seed coat) (18 days). Moreover, the highest seedling emergence (85%) was recorded in T_1 (without seed coat) while lowest (52%) in T_2 (with seed coat). In the 3rd study results revealed that highest seedling survival (85%) was noted in nutrition source S_2 (DAP (2.17 g) + SOP (1.7 g) + Urea (1.78 g) at T_4 (3 weeks weak after transplanting) followed by S_3 (NP (5 g) + SOP (1.7 g) as compared to lowest seedling survival (43%) in S0 (control). The findings indicate that 36 hours stone soaking in water without seed coat along with the supplementation of DAP (2.17 g), SOP (1.7 g), and Urea (1.78 g) after 3 weeks of transplanting, promoted early sprouting and increased the survival rate of potted mango nursery plants.

Keywords: Integrated Approaches, Mango Nursery Plants, Nursery Management.

Precision Technology & Climate Smart Innovations in Horticulture

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Abstract

Over time, emerging challenges increasingly impact the agricultural sector, particularly horticulture. Precision technology and climate-smart innovations have become essential to address these issues, playing a pivotal role in enhancing horticultural production. Precision technology and climate-smart innovations help to reduce the impact of climate change, lower greenhouse gas emissions and improve the crop production.The collection of data, analytics, and data management make orchard more profitable and valuable. The use of updated remote sensors, geographic information systems (GIS), optical sensors, and nanotechnology can be helpful in detecting stress and managing specific functions. Artificial intelligence (AI) is fundamental to the functionality of robotic and autonomous systems. Advanced technology such as problem-oriented innovation system (PIS), solar-based irrigation methods, and high-efficiency irrigation systems are used to collect and analyze data related to water requirements and availability for crops along with environment conditions and weather activities. Advancements in technology and innovations in horticulture are key components for future directions like back chain robotics, 3-D printing, and virtual or augmented reality. Precision tech and climate-smart innovations are very important for the future of horticulture. The application of sustainable practices while addressing global challenges, create a stronger and more adaptive agricultural industry for the future.

Keywords: Climate Smart, GIS, Nanotechnology, Optical Sensors, Precision Technology.

Impact of Climate Change on Citrus Production: Adaptation Strategies and Future Challenges

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Abstract

Climate change poses significant challenges to global citrus production, an industry that generates over $10 billion annually and produces more than 140 million tons of fruit. This review analyzes the multifaceted impact of climate change on citriculture and evaluates adaptation strategies while addressing future challenges to the citriculture industry. Rising temperatures, altered precipitation patterns, and increasing atmospheric carbon dioxide (CO_2) levels have significantly affected citrus physiology, disease dynamics, and pest populations. Research indicates that sustained temperatures above 35°C reduce photosynthetic efficiency by up to 40% in mature citrus trees, whereas irregular precipitation can increase irrigation requirements by 40-45%. Climate change altered disease epidemiology, particularly increasing the prevalence offungal pathogens and Huanglongbing (citrus greening), with infection rates rising by 25-35% in the affected regions. This review examines various adaptation strategies, including the development of climate-resilient varieties, advanced irrigation systems, and precision-monitoring technologies. These interventions have shown promising results, with some adaptive measures reducing water usage by 25-30% and improving pest management efficiency by 30-35%. The analysis highlights the urgent need for sustained investment in agricultural resilience and adaptive strategies to ensure long-term food security and economic stability. This review also presents a strategic roadmap for navigating the complex challenges posed by climate change in global citrus production, emphasizing the interconnected nature of environmental transformation and agricultural sustainability. Moreover, it identifies future research needs and economic considerations for implementing climate adaptation strategies in citrus production systems.

Keywords: Agricultural Adaptation, Citrus Production, Sustainable Agriculture.

Screening of Exotic and Indigenous Chilli Germplasm Against Chilli Leaf Curl Disease

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Abstract

Chili (*Capsicum annum* L.) member of Solanaceae family, is an important vegetable crop known for its spice and global significance. Chilies are a rich source of vitamins and possess numerous medicinal properties. Several pathogens, including viruses, that pose significant challengesto chili production. Chili Leaf Curl Virus Disease (ChiLCV) is one of the most devastating diseases of chilies belonging to the family Geminiviridae, genus begomovirus, causing yield loss upto 100%. During the current study, 56 exotic and indigenous genotypes were evaluated against ChiLCV in the field based on the disease severity scale. Responses ranged from complete immunity to high susceptibility. Viral presence was confirmed through molecular based detection techniques - Polymerase Chain Reaction was done by applying the Primers of CPF/CPR 5 to amplify DNA-A. The immune plant gave a negative response to primers due to lack of viral pathogen and the remaining symptomatic plants showed positive responses which were confirmed through gel electrophoresis. Correlations between disease severity and environmental factors were analyzed by using SPSS software. Temperature show a highly significant positive correlation ($P<0.05$). Humidity was positively correlated with significant results and rainfall was negatively correlated with disease incidence and gave non-significant results. The finding of this study will help in suggesting suitable genotypes for cultivation and incorporation of resistance genotypes in chili breeding programs for future varietal development.

Keywords: Chili, ChiLCV, Correlation, Molecular Detection.

Aeroponic Technology: Game Changer for Seed Potato Production in Pakistan

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Abstract

Potato is an important food and cash crop worldwide, but in Pakistan its production faces several challenges. These challenges include soil fertility issues, pest and disease pressures, and shortage of high-quality seed potatoes. The limited availability of quality seeds is a major issue in Pakistan, where farmers frequently reuse seeds or acquire them from informal sources. This practice contributes to the deterioration of seed quality and the spread of tuber-borne diseases, leading to reduced yields. Aeroponic techniques present a promising solution to this issue. Aeroponics is an innovative method for producing high-quality seed potatoes and overcoming seed shortages. This technique is already in commercial use in various countries., this study highlights the potential of aeroponic technology and how it could enhance seed potato production in Pakistan. The conclusion of this overview highlights the advantages of aeroponic seed production, including better yields, enhanced resistance, and conservation of natural resources. Despite challenges, aeroponic seed production provide a sustainable and effective solution to seed potato production in Pakistan.

Keywords: Aeroponic, Seed Potato, Soil-Less Technology, Virus-Free Seed Potato.

Harnessing the Challenege of Food Security Through Internet of Things (IoT) in Horticulture

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Abstract

As information technology is revolutionizes s industriesworldwide and making every field more efficient, the agriculture sector mustbe modernized to ensure food safety and security. Internet of Things (IoT) is a promising technology that enhances precision and efficiency in agricultue. IoT is a system of connected devices through wired and wireless system to monitor the working softwares and sensors that carry out the farm operations. Feasibility of operations/practices can be monitored and judged automatically and modifications are suggested with the help of Big Data analysis produce locally (Fog Computing). Vast applications of this technology from research to commercial agriculture with the help of cloud computing (a centralized information system) and fog computing make the smooth flow of correct information possible. System automation enables the precision farming through devices including climate sensors, smart irrigation, soil sensors, smart tractors, drones and farm management software. There are some challenges in adopting a smart technology specially for a developing country like Pakistan on capital investment grounds and novelty adaptation grounds. Pakistan being an agricultural and fifth most populated country in the world demands to be modernized in every aspect to feed the millions of people and to beat the economy crises by using its potential at fullest.

Keywords: Big Data, Cloud Computing, Fog Computing, Smart Technology.

Harnessing Beneficial Microbes for Sustainable Horticultural Crop Production

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Abstract

Global climate change exerts a significant impact on sustainable horticultural crop production and quality. To optimize crop production and ensure food security, synthetic fertilizers have been widely used in high-input agricultural practices to address both major and minor nutrient deficiencies in soils. However, the repeated use of these environmentally harmful fertilizers has negatively impacted soil fertility and, ultimately, crop productivity. Given these risks, scientists are urgently seeking inexpensive, environmentally friendly, and easy-to-use alternatives to reduce reliance on synthetic fertilizers. In this context, plant growth-promoting microorganisms (PGPM) have gained the attention of agricultural communities due to their low cost, easy accessibility and straightforward application methods. PGPM are bioactive and eco-friendly agents that can promote plant growth under stressful conditions and help control postharvest decay. Microbial antagonists, such as *Bacillus subtilis*, are effective in managing postharvest diseases affecting various fruits, vegetables, and flowers. Their use leads to extended storage periods and shelf life while preserving quality and minimizing weight loss.. Long and complex sentence should be broken into two lines

Keywords: Climate Change, Horticulture Crops, Sustainable Agriculture.

Weaving the Food Security Tapestry: The Role of the SDGs in Ensuring Global Food Security

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Abstract

Food security plays a crucial role in achieving the United Nations (UN) Sustainable Development Goals, particularly SDG 1 (No Poverty) and SDG 2 (Zero Hunger). With the global population increasing, ensuring equal access to safe and Nutritious food is esential . Food security and the SDGs are interconnected beyond just food production challenges; they also relate to environmental sustainability, resource depletion, and political instability. Addressing these complex issues requires effective policy measures, innovative technologies, and collaborative efforts. Key strategies to improve food security while advancing global sustainable development include adopting sustainable agricultural practices, minimizing postharvest losses, and enhancing the resilience of food systems. Developing early-maturing, climate-resilient crop varieties that are tolerant to biotic and abiotic stresses, along with bridging the gaps between farmers and research institutions, will help us achieve sustainable development goals in this era of climate change.

Keywords: Climate Change, Food Security, SDGs, Sustainability.

Effect of Biostimulant on the Growth, Quality, and Yield of Tomato (*Lycopersicon esculentum*)

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Abstract

The unpredictable changes in climate present a significant challenge to global food security. Vegetable crops suffer yield losses of up to 60-70% due to biotic and abiotic factors., tomato is in high global demand but highly prone to the adverse climatic conditions, necessitating organic approaches to overcome these hindrances in crop production. In this regard, the present research was conducted during 2022-23 to investigate the effect of biostimulant on the growth, quality and yield of tomato (*Lycopersicon esculentum*). The experiment was conducted at the Horticultural Garden, Department of Horticulture using a Randomized Complete Block Design. The experiment was run with two factors viz. varieties and different concentrations of biostimulant. The seeds of two varieties, Ayusman and TO-1057 were planted first for raising of nursery and then seedlings transplanted in the raised bed filed. The biostimulant relay of Kanzo Company was applied at the concentration of 10, 20, 30 and 40 mL L^{-1} on tomato plants. The results showed that the spray of biostimulant at 40 mL resulted maximum plant height (134.00 cm), branches $plant^{-1}$ (37.16), fruits $plant^{-1}$ (94.16), weight of single fruit (114.72 g), fruit diameter (2.30 cm), total soluble solids (3.68), total acidity (0.57%) and fruit yield $plant^{-1}$ (19.83 Kg). However, the untreated-tomato plants were observed with minimum plant height, branches $plant^{-1}$, fruits $plant^{-1}$, weight of single fruit, fruit diameter, total soluble solids, total acidity, fruit yield $plant^{-1}$. In case of varieties, TO-1057 produced maximum vegetative, reproductive and quality growth as compared to the other variety (Ayusman). It is concluded from the present study that application of Rely biostimulant at 40 mL L^{-1} had beneficial effects on the growth, quality and yield of TO-1057 variety.

Keywords: Abiotic Factors, Bio-stimulant, Tomato.

Nanoparticle-Mediated Salinity Stress Alleviation in Tomato Plants: A Green Technology Solution

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Abstract

To mitigate the impact of salinity on tomato plants nanoparticle seed priming was done on tomato (*Solanum lycopersicum* L.). Plants exhibit biochemical, physiological, and morphological changes in response to salt stress. developing effective nanoparticle-based strategies for reducing salt stress and increasing agricultural yield is vital. The use of nanoparticles, as an emerging strategy, is an effective way to enhance agricultural productivity. In the CRD experiment, tomato plants were sown under the influence of two levels of NaCl salt stress (7 ds m^{-1} and 10 ds m^{-1}). The seed priming was done before sowing for 24 hours in a 100-ppm solution of zinc oxide and magnesium oxide nanoparticles. Results showed that ZnNP and MgNP enhanced the activity of antioxidant enzymes (chlorophyll, peroxidase, polyphenol oxidase, and catalase), and increased metabolic activity by phenolic substances. The study reveals the reduction of salt stress in tomatoes by treatment of ZnNP and MgNP has a minimum effect by seed priming than the foliar method. under control conditions, ZnNP and MgNP significantly improved germination and overall plant physiology. It concludes that the green synthesized ZnNP and MgNP nanoparticles are beneficial in terms of tomato development and physiology.

Keywords: Antioxidant, Nanoparticles, Physiological, Salinity Stress.

Evaluation of Zinc Oxide Nanoparticle at Grapes Veraison Stage to Enhance Grape Berry Color and Quality of Flame Seedless

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Abstract

Uneven color development is a significant challenge in the earlymaturing grape cultivars. In red grapes, uniform color development is a key quality factor affecting consumer acceptance and the potential for grape's economic value. Nanotechnology is widely being employed in the agriculture industry due to its unique properties. Foliar application of zinc oxide nanoparticles may be utilized to enhance the berry coloration by stimulating anthocyanin accumulation in berries at veraison stage. Therefore, this research examines the impact of zinc nanoparticle application at 0, 25, 50 and 75 ppm application at the veraison stage of flame seedless grapes. The experiment was conducted in a randomized complete block design with three replications at vineyard of Koont Research Institute Chakwal. The results indicated that 50 ppm zinc oxide nanoparticle application significantly improved the berry color, anthocyanin content, total phenolic content, antioxidant activity and increased sugar content. On the other hand, 25 ppm and 75 ppm treatments showed variation for morphological and biochemical traits. Overall, this research highlights the effectiveness of zinc oxide nanoparticle in enhancing the quality characteristics and berry color of Flame Seedless.

Keywords: Color, Early Maturing, Grapes, Nanotechnology.

Potassium Enrichment Enhances Capsicum Productivity Through Modification of Ionic Contents, Physiological and Secondary Metabolites Under Partially Controlled Greenhouse

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Abstract

The adaptation of fertilizer dosages recommended for temperate greenhouse regions to arid and semi-arid regions limits the potential productivity of soilless greenhouses. The present study was conducted to evaluate the influence of potassium enrichment in the nutrient solution (NS) on capsicum cultivars (cv. Bachata and Red Jet) under a partially controlled greenhouse environment. In this study, the impact of various potassium treatments (0, 280, 317 and 420 mg L^{-1}) were evaluated on growth promoting attributes, nutrient uptake, ionic traits, gaseous exchange relations, antioxidant defense mechanisms, and yield in capsicum crop. The results indicated that plants grown without showed a marked reduction in studied parameters. In comparison to control, potassium treated plants (317 mg L^{-1}) demonstrated the highest increase in fold in shoot length (1.54), root length (1.86), stomatal conductance (1.81), leaf photosynthetic rate (2.51), and carboxylation efficiency (1.54) along with the highest nutrient K (1.62) content. The soluble solid content (1.48), phenolic compounds (1.84) and ascorbic acid (1.56) along with activity of antioxidant enzymes including catalase (1.36), peroxidase (1.37) and superoxide dismutase (1.91), respectively, resulting in a higher fruit yield (3.05). On the other hand, a remarkable improvement was found in the Red Jet cultivar compared to Bachata. Therefore, the present study supports potassium enrichment (317 mg L^{-1}) in nutrient solution and cultivation of Red Jet cultivar under semi controlled soilless greenhouse.

Keywords: Climate Smart, Hydroponics, Precision Horticulture, Year-Round Production.

Grafting Improves Watermelon Yield and Fruit Quality by Modulating Morpho-Physio-Biochemical and Gaseous Attributes Under Protected Conditions

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Abstract

Globally, climate change is recognized as one of the most significant constraints to crop production. Watermelon is highly sensitive to abiotic stresses and requires appropriate care for optimal yield and quality. Therefore, a dire need for an alternate environment-friendly t alternatives like grafting for improving the watermelon growth, yield and quality by utilizing the indigenous watermelon landraces. In this connection, a field study was carried out to explore the indigenous and exotic bottle gourd rootstocks in watermelon (cv. Augusta F1) under the Randomized Complete Block Design with three replications. The results illustrated that indigenous bottle gourd landrace showed maximum shoot length (48.52%), root length (39.43%), shoot fresh weight (34.73%), shoot dry weight (51.30%), root fresh weight (38%), root dry weight (56.5%), stem diameter (27.40%), rind thickness (82.20%). Similarly, higher leave nitrogen (55.30%), phosphorus (44.4%), and potassium (29.09%) along-with Photosynthesis rate (38.3%), Stomatal Conductance (39.90%), Sub-Stomatal Conductance (34.50%), Transpiration (38.41%) and Water use efficiency (39.20%) was recorded in watermelon plants grafted onto indigenous bottle gourd. Moreover, maximum fruit firmness (32.80%), TSS (68.80%), pH (25.80%), TA (61.50%) and Vitamin C (49%) was recorded in indigenous bottle good landrace. Overall, use of indigenous bottle gourd landrace may be utilized as rootstock for watermelon production and quality under protected cultivation in semi-arid climate of south Punjab.

Keywords: Abiotic Stress, Protected Cultivation, Sustainable Agriculture.

Prospects of Hemp Cultivation in Pakistan's Horticulture Sector

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Abstract

Hemp (*Cannabis Sativa* L.) is gaining global prominence as a multipurpose crop with applications in textiles, bio-composite, construction, and pharmaceuticals. The global hemp market is projected to grow from $6.82 billion in 2022 to $25.68 billion by 2028, with an annual growth rate of 24.3%. Pakistans legalization of industrial hemp cultivation in 2020 creates opportunities o to enter the lucrative market, with projected revenue of $1 billion over the next three years. Hemp requires 50-70% less water compared to cotton, making it a viable alternative for Pakistan, where agriculture consumes 93% of the available freshwater resources. Yields for hemp fiber range between 1.5-2.5 tons per acre, while its seeds can yield up to 1,000 £ 1,200 Kg per hectare, fetching market prices of $300-500 per ton for fiber and $1,000-1,800 per ton for seeds. Export opportunity is immense, with global demand for hemp based products like textiles and global demand for hemp based products like textiles and cannabidiol increase significantly. In 2023, Pakistan imported hemp-based products worth $18 million, highlighting the potential to save foreign exchange by fostering domestic production. The domestic cultivation of hemp, paired with value-added processing can create employment opportunities for over 500,000 individuals in rural areas. Economically, the input cost of hemp farming in Pakistan is estimated at PKR 50,000-70,000 per acre, including seeds, fertilizers, and labor. However, the net profit margin can reach 40-60%, depending on yield quality and market prices. Furthermore, hemp sequesters 9-15 tons of CO_2 per hectare. Annually, promoting sustainable farming and contributing to climate change mitigation. With appropriate government support, including subsidies, farmer training, and processing infrastructure, hemp cultivation could transform Pakistan horticulture landscape, reduce dependence on cotton, and positiohn the country as a key player in the global hemp economy.

Keywords: Economic Diversification, Hemp, Industrial Hemp, Water Efficient Crop.

Simulation of Climate Change Impact on Potato Cropping System Under Semi-arid Environment and Designing of Adaptation Strategies

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Abstract

Climate change in the form of heat waves, torrential rains and floods is showing impact on the food security in Pakistan. Potato is the main cash crop of the region affected by climate change. However, impact assessment of climate change for the potato-potato cropping system has not been studied yet. Hence, in the present study, we studied the impact of projected climate change and key adaptation options on the potato-potato cropping system using the DSSAT-CSM-SUBSTOR-Potato model. The model was calibrated using 2019 spring and fall season field experiments data, while evaluation was made using spring and fall season data of 2019 and 2020 respectively. After calibration and evaluation, model sensitivity analysis for carbon, temperature, water and nitrogen (CTWN) was performed, and after that, it was applied to determine the impact of climate warming and change in rainfall on spring and fall potato during midcentury. Furthermore, it was projected that autumn potato will be more influenced due to climate change than spring potato. Under future projections, temperature change for spring planted potato will be 2.7 to 3.8 °C for T_{min} and 2.1 to 3.4 °C for T_{max}. However, for the autumn seasons, potato increase in maximum temperature will be from 2.4 to 3.6 °C and for minimum temperature the change will be from 2.7 to 4.0 °C. Simulation outcome showed that without adaptation strategies, tuber yield will be reduced from 23 to 29% and from 19 to 36% in spring and fall potato, respectively. While with adopting suitable adaptation strategies such as fertigation, planting date adjustment (earlier planting of spring potato by 15 days and delayed planting of fall by 20 days), higher thermal time requiring cultivars, increase of 12% in plant population and nitrogen quantity, tuber yield can be increased by 9 to 13% during spring and by 10 to 14% during autumn potato during mid-century. Therefore, farmers should adopt suitable adaptation strategies as mentioned to reduce the negative impact of climate change on potato yield.

Keywords: Adaptation, Climate, Decision Support System, General Circulation.

Protected Cultivation of Horticultural Crops

Analysis of Solar Radiation Changes in Chinese Solar Greenhouses with Different Roof Structures Based on a Solar Radiation Model

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Abstract

Chinese solar greenhouses are important agricultural production facilities. In the absence of -artificial heating conditions, solar radiation is the only CSGs energy source. It is highly important to optimally obtain solar energy in greenhouse construction and production. In this study, a solar radiation model for solar greenhouses was adopted to explore the quantities of solar radiation in greenhouses considering different front roof forms and angles. Herein, the solar radiation amounts corresponding to five roof forms, namely, double-section arc, parabolic, oval, arc, and linear roofs, are compared andanalyzed during the four solar periods (beginning of spring, vernal equinox, beginning of winter, and winter solstice). It wasfound that the solar radiation of oval roof greenhouses on the ground was the largest and was 4.44-23.68% higher than that ofparabolic roofs. In addition, the cumulative sum of light on the linear roof greenhouse wall is also the largest and was 6.02-12.08% higher than the parabolic roof greenhouse in the four solar terms. Moreover, the solar radiation in CSGs was compared with front roof angles of 25, and 35 It was observed that the solar radiation amount gradually increases with increasing angles. Notably, the variation at an angle of 35nfluences the solar radiation of the paraboloidal CSGs ground and elliptical CSGs north wall to the greatest extent, which increased by 8.23% and 12.74%, respectively. This study confirms the role of front roof form and inclination angle in enhancing the greenhouse solar radiation level.

Keywords: Chinese Solar Greenhouse, Roof Structure, Roof Angle, Solar Radiation Model.

Additional Far-Red Light Promotes Healing and Adventitious Rooting of Double-Root-Cutting Grafted Watermelon Seedlings

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Abstract

Graft healing and root regeneration are important factors influencing the survival of double-root-cutting grafting watermelon (*Citrullus lanatus*) seedlings. In this study, the effects of different light treatments on root regeneration were determined. The study revealed that addition of far-red light (FR) could significantly expedite root formation in the rootstock. A red to far-red ratio of 0.3 significantly increased the activities of SOD and POD and reduced the accumulation of reactive oxygen species (H_2O_2) and MDA in the graft union, which was conducive to the production of callus cell and the healing of grafted union. Moreover, transcriptome analysis revealed that plant hormone pathway and auxin-related genes were greatly induced by FR. In addition, the expression of Phytochrome Interacting Factor (PIFs) was remarkably increased by FR. It is suggested that FR could induce healing and adventitious root formation in rootstocks, which may be associated with the auxin accumulation by regulating the transcriptional level of auxin-related and PIF genes.

Keywords: Auxin, Double-Root-Cutting Grafting, Far-Red Light, Watermelon.

The SLWRKY42-SLMYC2 Modules Synergistically Enhance Tomato Saline-Alkali Tolerance by Activating the Jasmonic Acid Signaling and Spermidine Biosynthesis Pathway

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Abstract

Tomato (*Solanum lycopersicum* L.) is an important vegetable crop worldwide. Throughout its growth cycle, the tomato is susceptible to various abiotic stresses, which lead to a decline in yield and quality. Among these, saline-alkali stress is one of the most detrimental abiotic stresses to plant growth and development. Globally, saline-alkali land covers over 1.2 billion acres, affecting approximately 9% of the world's land area and more than 30% of irrigated land. Our previous research indicates that exogenous spermidine (Spd) can significantly enhance the salt-alkali tolerance of tomato seedlings, with high concentrations of Spd and jasmonic acid (JA) playing an important role. However, the molecular mechanism of interaction between Spd and JA is unexplored yet. Here, we identified a WRKY transcription factor, SlWRKY42, that responds to saline-alkali stress. Overexpression of SlWRKY42 improves tomato tolerance to saline-alkali stress. SlWRKY42 directly binds to the promoters of SlSPDS2 and SlNHX4 genes, promoting the accumulation of Spd and the balance of Na^+ and K^+ ions, respectively. Furthermore, we found that SlWRKY42 interacts with SlMYC2 at the protein level. Importantly, SlMYC2 can also bind to the promoter of the SlSPDS2 gene to promote Spd accumulation and positively regulate salt-alkali tolerance. In addition, the interaction between SlMYC2 and SlWRKY42 enhances the transcriptional activity of SlWRKY42 on SlSPDS2, thereby further improving tomato salt-alkali tolerance. Overall, our findings suggest that SlWRKY42 and SlMYC2 promote salt-alkali tolerance by facilitating the Spd biosynthesis pathway.

Keywords: Saline-Alkali Stress, SlMYC2, SlWRKY42, Tomato.

Effect of Different Mulching Materials on Tomato Hybrids in Walk-in Tunnel under the Agro-Climatic Conditions of Dera Ismail Khan

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Abstract

Tomatoes are among the most widely consumed vegetables with good nutritive value and a wide array of advantages. Globally yields have been increasing worldwide because of better cultivars and more intensive use of modern technology however in Pakistan, there has been a slow progression. Based on the above analysis, manipulation of growing environment has the potential to improve tomato yield. Therefore, the current study was conducted to evaluate the influence of manipulation of root microclimate using different mulching materials on two tomato varieties growth. The research was performed at the Agricultural Research Institute in Dera Ismail Khan. The research was laid out in a randomized complete block design with split plot arrangement having three repeats. Main plot was consisted of mulching materials including black polythene film, transparent polythene film, rice straw and control. However, varieties such as Sundal and Sahel were subjected to the sub-plots. The study showed that black polythene film greatly improved all growth and yield attributes such as fruit length, fruit diameter, vine length, number of trusses plant^{-1}, number of fruits truss^{-1}, single fruit weight and total yield, demonstrating its superiority as the most effective mulch among other mulches. Additionally, Sahel variety excelled Sundal variety by showing improved growth and yield. The interaction of black polythene mulch and Sahel variety augmented growth and yield of tomato. The current study therefore concluded that using black polythene mulch at Sahel variety is the beneficial way to boost tomato production.

Keywords: Mulching, Tomato, Tunnel.

Exogenous Melatonin and Salicylic Acid as A Mitigation Strategy to Enhance Defense System and Reduce Cadmium Uptake and Translocation in Tomato

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Abstract

Cadmium (Cd) contamination in agriculture caused serious threats to global food safety and human health. The present study investigated potential role of melatonin (MEL) and salicylic acid (SA) on tomato under Cd stress. MEL and SA individually and interactively improved the growth, physiological and biochemical attributes along with a significant reduction in Cd in root, stem, and leaf of tomato. Cd stress negatively regulated plant biomass, photosynthetic efficiency, compatible solutes, and endogenous hormonal production. Contrarily, MEL and SA considerably improved antioxidant defense system of plants by enhancing activities of superoxide dismutase, catalase, peroxidase, ascorbate peroxidase, and reducing oxidative damage under Cd stress. MEL-seed priming significantly reduced Cd content in roots while foliar in stem and leaf. In addition, the combine applications of MEL+SA play a crucial role in regulating physiological and enzymatic responses with improved endogenous level of melatonin and salicylic acid. Our results suggested that the individual application of MEL and SA showed positive impacts on tomato under Cd but their combine role exhibited a significant and progressive improvement in plant metabolism under Cd stress. Overall, exogenous use of MEL and SA could be a beneficial approach to reduce Cd contamination in tomato and other grain crops along with enhanced crop growth and biomass. This study provided new insights to induce Cd-stress tolerance in crop plants facing Cd toxicity in the agricultural lands.

Keywords: Antioxidant, Biomass, Cadmium, Growth, Photosynthesis, Tolerance.

Growth and Yield Response of Off-Season Cucumber to Different Training Systems and Plant Spacing Under Protected Culture

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Abstract

A field experiment title in quotes should not be part of the sentence was conducted in Horticulture Section, Agriculture Research Institute, Dera Ismail Khan during growing season 2023-24. The experiment was performed in walk-in tunnel (13×180×8 feet) and was covered with polyethylene sheet. The experiment followeda Randomized Complete Block Design with split plot arrangement. There were two factors i.e., plant spacings and training systems. Different plant spacing levels viz. (S1 = 45×60 cm, S2 = 60×60 cm and S3 = 75×60 cm) were assigned in main plot, whereas different training system levels viz. (T_1 = Drape system, T_2 = Pinch system, T_3 = allowing only 2 side branches from the base to grow and T4 = Control) were kept in sub-plot. Each treatment was replicated thrice. Results revealed that 75 cm plant spacing (S3) out classed all the other plant spacing levels as it gave best results in taken minimum days to first picking (46.3 days), maximum fruits vine^{-1} (26.5), fruit weight (135.0 g), fruit length (15.7 cm), fruit diameter (35.0 cm), fruit volume (148.49 cm^3), longest vine length (160.58 cm), minimum inter nodal length (5.5 cm) and maximum fruit yield vine^{-1} (3.62 Kg). Thus the combined effect of wider spacing (75 cm) along with drape system of training resulted the best growth and yield response for off-season cucumber production as it yielded least days (8.3) to 50% cucumber seed germination, nodal position of first female flower (2.2), first fruit picking (43.0 days), and exhibited maximum fruits vine^{-1} (29.0), fruit weight (148.0 g), fruit length (16.9 cm), fruit diameter (36.6 cm), fruit volume (162.9 cm^3), vine length (167.33 cm) and fruit yield vine^{-1} (4.3 Kg) in comparison to other combinations. Thus it can be concluded that a combination of drape system of cucumber training along with wider spacing (75 cm) has a profound effect on the growth and yield response of cucumber under protected culture.

Keywords: Cucumber, Plant Spacing, Protected Culture, Training Systems.

Evaluation of Different Bagging Material and Application of Salicylic Acid on the Quality and Shelf Life of Avocado Fruits

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Abstract

Avocado fruit (*Persea americana*) is a nutrient-rich fruit, packed with Fiber, Vitamins E, K, B_6, Folate, potassium, and antioxidants, while being low in sugar. It supports skin health, aids in weight managements, and strengthens the heart. Despite its robust growth, avocado fruit is vulnerable to pest infestation, particularly from fruit flies, which along with other pests, pose significant threats. Due to their ability to puncture fruit skins, lay eggs within, cause rot, and cause premature fruit drop, these pests can result in significant financial losses. During fruit or cluster growth, bagging is a protective horticultural technique involves enclosing them with permeable bags made of paper, fabric, or mesh. To ascertain their effects on protecting produce from pests, especially fruit flies, and environmental stress. In this experiment, organza fabric bags, polythene bags, and double bags (a mix of organza and paper) were used for fruit protection, with salicylic acid applied at a uniform concentration of 1 mM across all treatments to assess its effectiveness. Salicylic acid, which is well-known for its function in plant defense mechanisms, was used as a therapy to evaluate its impact on fruit quality and shelf life after harvest. Although polythene bags were less successful at controlling moisture, it accumulates fungus but they provided superior protection against environmental elements including sunburn. By combining the advantages of both materials, double bagging offered better defense against environmental harm and pests. Furthermore, the use of salicylic acid preserved the fruits freshness during storage and improved its resilience to biotic stress. The findings showed that application of different bagging materials with salicylic acid significantly reduced the danger of contamination and damage by keeping fruit flies from laying eggs and protecting fruits against infestations. This study concludes that the combination of double bagging with salicylic acid treatment offers a promising strategy for sustainable avocado farming, enhancing fruit quality, minimizing chemical pesticide reliance, and providing superior protection against pests and environmental stress.

Keywords: Avocado, Organza Cloth Bag, Polythene Bag, Salicylic Acid, Sunburn.

Effect of Oxalic Acid on Fruit Quality and Storage Life of Black Berries

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Abstract

Blackberry fruit holds significant economic value and is known for its high nutritional and high nutritional content. Blackberries have a relatively short shelf life typically 2 to 3 days when stored at temperature of 0 °C. Inadequate and inconsistent post harvest practices results in a decline both and the quality and shelf life of agricultural produce. In Pakistan, production and cultivation area of blackberries are significantly limited. The aim of the study was to find the impact of oxalic acid on the post-harvest impact on black berry fruit quality and shelf life. This t study is grounded in two experimental investigation, and nutraceutical evaluations. Thorny varieties was obtained from Ijaz Khans farm located in Madrota Attock, while thorn less varieties were sourced from Agriculture Research Institute Mingora Peshawar. Following the process of characterization the thorny variety was chosen due to its superior performance, and subsequently oxalic acid is applied.The research was conducted at the post-harvest laboratory, Department of Horticulture at Arid Agriculture University Rawalpindi. To determine the optimal reaction of blackberry fruit to various oxalic acid (OA) applications, a selection of four distinct post-harvest treatments (T_0, T_1, T_2, and T_3) were made. The parameters include firmness, skin color, soluble solids content, titrable acidity, and fruit weight, at harvest and weight loss, vitamin C, total phenolic content. Total antioxidants, total flavonoids, total sugars, reducing sugars, ascorbic acid, and pH. The temporal spacing between readings for the specified parameters was set at a duration of 3 days. Oxalic acid treatment with 1.5 mM shows the best performance compared to oxalic acid treated T_3 and T_4. The efficiency of oxalic acid treatment was observed to be significantly in the presence of T1 (1.5 mM) and it continued to exhibit optimal performance even after storage period of 12 days. Oxalic acid is widely acknowledged as being safe for consumption. This suggests the use of oxalic acid treatments holds potential as a post-harvest tool for improving the physiochemical properties of blackberry fruits and helps extend storage life.

Keywords: Blackberry, Flavonoids, Nutraceutical, Physiochemical.

Co-Application of Copper Nanoparticles and Metal Tolerant *Bacillus* sp. for Improving Growth of Spinach Plants in Chromium Contaminated Soil

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Abstract

Chromium (Cr) is a toxic metal that negatively affects both plants and human life. Bacterial-assisted nano-phytoremediation is an emerging and environment-friendlytechnique t for the detoxification of such pollutants. In this study, pot experiment was conducted in which spinach plants were grown in soil containing chromium (0 mg Kg^{-1}, 5 mg Kg^{-1}, 10 mg Kg^{-1}, 20 mg Kg^{-1}) and treated with selected strain of *Bacillus* sp. and Cupper oxide-Nanoparticle (CuO-NPs). Data related to plant growth, physiological parameters, and biochemical tests was collected and analyzed using an appropriate statistical test. It was observed that under chromium stress, all plant growth parameters were significantly enhanced in response to co-application of CuONPs and *Bacillus* sp. Similarly, higher levels of catalase, superoxide dismutase, malondialdehyde, and hydrogen peroxide were also observed. However, contents of anthocyanin, carotenoid, total chlorophyll, chlorophyll a and b, were lowered under chromium stress, which were raised in response to the combined application of CuONPs and *Bacillus* sp. Moreover, this co-application has significant positive effect on total soluble protein, free amino acid, and total phenolics. From this study, it was evident that combined application of *Bacillus* sp. and CuO-NPs alleviated metal-induced toxicity in spinach plants. The findings from current study may provide new insights for agronomic research for the utilization of bacterial-assisted nano-phytoremediation of contaminated sites.

Keywords: Bacillus, Chromium Stress, CuO-NPs, Nano-Bioremediation, Spinach.

Exogenous Application of Melatonin Improves Plant Growth of Cucumber Under Drought Stress Conditions

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Abstract

Cucumber (*Cucumis sativus* L.) is a widely cultivated vegetable and is sensitive to drought stress. Therefore, implementing effective methods to enhance drought stress tolerance is crucial. Melatonin has been recognized for its significant role in alleviating drought stress in various crops. However, limited information is available regarding its effects on cucumber. This experiment was carried out to determine the impact of exogenous melatonin on growth and development of cucumber under drought stress conditions. Different concentrations of melatonin (0, 50, 100 were applied through foliar and soil application at 35% and 100% field capacity. However, the applications of melatonin notably reversed all these negative effects at both 35% and 100% field capacity conditions compared with control. Overall, the foliar applications of melatonin proved best treatment method to reduce the adverse impacts of drought stress and improve plant growth of cucumber plants. Hence, application of melatonin proved a cost effective and sustainable approach for cucumber plants to minimize the negative effects of drought in contrast it could boost the growth of cucumber for better development and to survive in the upcoming severe environment.

Keywords: Foliar Application, Melatonin Application, Soil Drought.

Role of Exogenous Application of GA3 and Salicylic Acid in Growth, Yield and Quality Improvement of Chilies

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Abstract

Chili (*Capsicum frutescens* L.), a member of the Solanaceae family, is a widely cultivated vegetable worldwide, due to its unique spicy flavor and diverse culinary applications. Plant growth regulators have been discovered to increase the growth, yield as well as quality of numerous crops including chilies. This study was conducted with the aim to examine the impact of two plant growth regulators GA3 and salicylic acid on growth and yield of chilies. A field experiment was conducted and seedlings of chili variety Gola Pishawri were used as planting material. Plants were exposed to three levels of GA3 (0 ppm, 50 ppm and 100 ppm) and four levels of salicylic acid (0 ppm, 200 ppm and 300 ppm and 400 ppm) as treatment. The combined treatment of 100 ppm GA3 + 300 ppm salicylic acid provided significant results regarding number of leaves per plant, fruit length, fruit weight, total soluble solids, firmness, vitamin C content, yield per plant and leaf width. Highly significant results were observed for fruit diameter, pericarp thickness and chlorophyll content at 400 ppm salicylic acid treatment compared to control. Whereas, 100 ppm GA3 + 400 ppm salicylic acid treatment significantly improved plant growth by exerting positive effects on the vegetative as well as other reproductive growth-related parameters in chilies. These findings highlight the potential of GA3 and salicylic acid as a valuable tool in chili cultivation, providing insights for farmers and researchers aiming to optimize crop production and quality.

Keywords: Fruit Production, Gibberellic Acid, Plant Growth Regulators, Quality.

Foliar Application of Trehalose Improves Salinity Stress Tolerance in Eggplant

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Abstract

Pakistan is faces several problems regarding agriculture. Salinity remains a presistent and complex challenge for sustainably regarding agriculture in Pakistan. this study aimed to evaluatethe effects of salinity and the role of trehalose in the alleviation of salt stress. A research trial was conducted to evaluate the impact of the foliar application of trehalose on growth, yield, and biochemical traits of three eggplant varieties under salinity stress at the vegetable research area, University of Agriculture Faisalabad, during the winter season of 2022-2023. NaCl was used to simulate salt stress. Plants were irrigated with different concentrations of NaCl (1.5, 3.5, and 7.0 dSm^{-1} NaCl). The plants were sprayed with 30 mM trehalose which was applied 2 times in 5-day intervals. The following parameters were studied: days to germination, germination percentage, plant height, stem diameter, leaf area, leaf area index, days to flowering, flower to fruit time, fruit weight, fruit diameter, fruit length, shoot fresh weight, shoot dry weight, root fresh weight, root dry weight, plant fresh weight, plant dry weight, relative root shoot ratio, SOD, POD, CAT, APX, H_2O_2, MDA, TSS, TA, TSS:TA ratio, and ascorbic acid. The experiment was laid out according to a two-factor factorial under a completely randomized design and each treatment was replicated thrice. The salinity affected both the growth and physiological attributes of the eggplant whereas the foliar application of trehalose successfully increased the salinity tolerance in eggplant. The results showed that the application of 30 mM of trehalose had significant effects on all the selected parameters.

Keywords: Eggplant, Malondialdehyde, Salt Strees, Trehalose.

Effect of Foliar Application of Gibberellic Acid and Salicylic Acid on the Growth, Physiology and Anatomy of Cockscomb

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Abstract

Cockscomb (*Celosia cristata* L.) is an ornamental plant that withstands moderate temperature and moisture during the summer season. This study aims to investigate how plant growth regulators can alleviate stunted growth and flower head drop in celosia, a common issue affecting its development. This study checked the effect of foliar application of GA3 and SA on Celosia. Different concentrations of GA3 50 mg L^{-1}, 100 mg L^{-1}, 150 mg L^{-1} and SA of 50 mg L^{-1}, 100 mg L^{-1}, and 150 mg L^{-1} were used. A total of seven treatments, and each treatment replicates three times. Complete Randomized Design was used to organize the experiment. Data was collected for different morphological parameters, physiological and anatomical parameters. Recorded data showed that T2 GA3 (100 mg L^{-1}) showed maximum plant height (99.66 cm), number of leaves (89.66 count), plant stem diameter (28.10 cm), leaf area (29.5 cm^2), fresh mass of flower (101.93 g), dry mass of flower (97.55 g), flower quality (9), total chlorophyll content (23.93), SOD (1.05), POD (0.41), abaxial stomata density (2015.3), adaxial stomata density (2914 m^2), lamina thickness (296.84, lamina thickness (656.32), adaxial stomatal area (456.63 m^2), abaxial stomatal area (530.4 m^2), number of vascular bundles (36.66 count), phloem area (275.51 m^2), and meta xylem area (623.93 m^2) as compared to all other treatments. It is concluded that that GA3 foliar spraying is an effective approach to enhance the quality and productivity of celosia.

Keywords: Celosia, Gibberellic Acid, Growth Regulators, Salicylic Acid.

Effect of Different Growing Media on Seed Germination and Seedling Growth of Tomato, Cucumber and Lettuce

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Abstract

This study was carried out to evaluate the impact of various soilless media on the germination and seedling growth of tomato (*Solanum lycopersicum* L.), cucumber (*Cucumis sativus* L.), and lettuce (*Lactuca sativa* L.). The controlled laboratory tests used seven different media treatments, including silt, cocopeat, compost, sawdust, and cocopeat: perlite: vermiculite combinations. Key growth characteristics, like seed germination (%), seedling height, and leaf length were defined using a completely randomized design with three replications. The results indicate that the combination of cocopeat, perlite, and vermiculite (03:01:01) consistently produced the highest germination rates, seedling heights, and leaf lengths of the three crops. Soilless medium is such a good means of crop establishment and growth that these results demonstrate how well soilless medium can be used for propagation under a protected environment and can improve situations where soil fertility and water shortage are challenges.

Keywords: Cocopeat, Perlite, Soilless Media, Vermiculite.

Assessing the Impact of Various Dehydration Techniques on the Quality and Shelf Life of Strawberry

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Abstract

Strawberries are popular, tasty, and nutrient-dense fruits of the Rosaceae family. Strawberries are widely cultivated due to their appealing organoleptic features. Strawberries are a popular choice for healthy diets because they are low in calories, high in antioxidants, including anthocyanins, which give them their vibrant red color, and high in vitamins, particularly vitamin C. In addition to being often eaten fresh, strawberries are also utilized in a wide range of goods, including jams, juices, desserts, and even as a flavoring in processed meals. They require slightly acidic, well-drained soils and thrive in temperate climates . Although they are usually cultivated annually, certain strawberries are perennials, meaning they may bear fruit for several seasons. Strawberries deteriorate rapidly because of their fragile structure and high moisture content, making them particularly perishable. In this research, a variety of preservation techniques, including freeze-drying, sun-drying, osmotic-drying, oven-drying, and room-drying, are employed to increase their shelf life. Each method offers a unique advantage in preserving the fruits quality. Freeze-drying effectively retains the flavor, nutrients, and color by removing moisture at low temperature, while sun drying is a traditional, cost-effective method using natural heat. Osmotic drying involves the use of osmotic solutions to draw out moisture, preserving texture and flavor. Oven drying provides controlled heat to reduce moisture content efficiently, while room drying is a simple, cost-efficient technique. These methods help prevent spoilage, extending the shelf life of strawberries while maintaining their nutritional value. The findings demonstrate that all methods were effective but freeze and osmotic drying proved to be the most beneficial in enhancing the shelf life, texture, and nutritional value of strawberries. On the other hand, room drying is more cost-effective but requires more time than oven drying. When properly stored, these dried strawberries can last for extended periods, making them ideal for long-term use in various products.

Keywords: Freeze-Drying, Osmotic-Drying, Oven-Drying, Room-Drying, Strawberry, Sun-Drying.

In Vitro Shoot Tip Grafting of Citrus Species

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Abstract

Citrus greening disease, scientifically referred to as Huanglongbing (HLB), poses a significant challenge to citrus production on a global scale. HLB, caused by the phloem-limited bacterium *Candidatus liberibacter* spp., leads to significant yield losses, fruit drop, diminished tree vigor, and, in the end, the death of the tree. Considering the economic importance of citrus crops, there is a considerable amount of research underway aimed at creating effective strategies to lessen the effects of HLB and to produce planting material that is free from disease. Among these approaches, in-vitro shoot tip grafting has shown great potential for propagating citrus plants that are free from pathogens. This research aimed to assess how effective shoot tip grafting is across various citrus cultivars when carried out in controlled tissue culture environments. Fruit samples were gathered from a nearby citrus orchard and taken to the Tissue Culture Laboratory at the Department of Horticultural Sciences, Islamia University of Bahawalpur, for additional analysis. A two-factor factorial experiment was crafted, focusing on two essential variables: the variety of citrus (Kinnow, Feutrell Early, Mosambi, and Grapefruit) and the various types of growing media used. This research examined essential growth factors such as germination rate, root length, shoot length, and leaf count to evaluate how various cultivars respond to in-vitro conditions. This research seeks to improve the efficiency of citrus tissue culture techniques by refining micropropagation protocols and assessing the impact of different growing media. The results will play a significant role in creating disease-free citrus planting material, providing a sustainable method for managing HLB and enhancing the productivity of citrus orchards.

Keywords: Candidatus, Kinnow, Pathogen, Tissue Culture.

Citrus Peel Augmented Wheat Straw Alters Growth and Yield Performance of White and Grey Oyster Mushrooms

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Abstract

This study aimed to find the optimum concentration of citrus peel powder for better yield of mushrooms and to assess the impact of wheat straw augmented with citrus peel powder on the physical and chemical quality of the White and Grey oyster mushrooms. Wheat straw without citrus peel powder was used as control T_0 = wheat straw (100%) along different treatments T_1 = 99% wheat straw +1% citrus peel powder, T_2 = 98% wheat straw + 2% citrus peel powder and T_3 = 97% wheat straw + 3% citrus peel powder. Data was recorded on no. of days required to start mycelium growth, completion of mycelium growth (25%, 50%, 75% and 100%), No. of days required for initiation of pinheads, No. of pinheads, days to completion of flushes (1st, 2nd and 3rd flush), weight of flushes (1st, 2nd and 3rd flush), yield, SOD, POD, CAT, reducing sugars, total sugars and non-reducing. Yield was greater by increasing the concentration of citrus peel powder within the wheat straw as compared to control. Both strains of mushrooms (white and gray oyster) indicated total soluble solids (2.4-2.7 °Brix), titratable acidity (1.3-1.5%), ascorbic acid (2.8-3.18 mg 100 mL^{-1}), moisture (85-90%), CAT (1.8-3.67 U mg^{-1}), SOD (3.52-5.57 U mg^{-1}), POD (2.59-4.75 U mg^{-1}) on different levels of wheat straw supplemented with citrus peel powder. In this study, it was indicated that white oyster mushrooms produced better results than grey oyster mushrooms. Overall results indicated that T_2 and T_3 performed better in biochemical analysis and various physical parameters. This study offered baseline data on the possible impact of citrus peel powder-enriched wheat straw on the growth and chemical behavior of white and grey oyster mushrooms.

Keywords: Flush, Mushroom, Production, Yield.

Regenerative Horticulture

Exploring the Role of Neurotransmitters Foliar Spray in Mitigating Salinity Stress in Tomato (*Solanum lycopersicum* L.) Crop

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Abstract

Abiotic stresses including salinity stress owing to climate change has become most concerning issue with respect to crop growth and yield worldwide. Plant possesses a complex mechanism to adopt these environmental changes. However, various signaling molecules and hormones make conducive environment for plant growth under salinity stress, but neurotransmitters such as melatonin, glutamate and dopamine can also stimulate plant growth under abiotic stress. A pot study was performed by using factorial design under CRD to evaluate the interactive effect of various levels of salinity stress (control, 4 dSm^{-1}, 6 dSm^{-1}, and 8 dSm^{-1}) mediated by sodium chloride (NaCl) and neurotransmitters foliar spray (control, melatonin @ 20 µM, glutamate @ 20 µM, dopamine @ 20 µM and melatonin @ 20 µM + glutamate @ 20 µM +dopamine @ 20 µM) either sole or in combination on two different varieties of tomato; salt tolerant and salt sensitive. The growth variables, physiological and biochemical attributes and yield were measured during different growth stages of tomato crop. The findings indicated that under each salinity stress, foliar spray of neurotransmitters either single or in combined formulation reduced oxidative stress and increased plant growth variables (Plant height, fruit weight, number of fruits, fruit color, plant fresh biomass, plant dry biomass, root fresh biomass, root dry biomass) and antioxidant enzymes (SOD, POD, CAT, APX) activity. Furthermore, photosynthetic rate, chlorophyll contents, stomatal conductance, Membrane stability index and transpiration rate was also improved under all formulations of foliar spray of neurotransmitters. In contrast electrolyte leakage and ROS species were decreased under foliar treatment. However, all types of neurotransmitter improved tomato growth but maximum improvement in both tomato verities was observed under combined foliar spray of all neurotransmitters. This study was limited to pot experiment and required to explore in various ecological regions.

Keywords: Chlorophyll Content, Melatonin, ROS, Salinity.

Evaluating Kiwifruit Varities for Drought Stress Tolerance at Seedling Stage Using Polyethylene Glycol Induced Osmotic Stress

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Abstract

Drought stress significantly impacts growth and productivity of Kiwifruit (*Actinidia deliciosa*). This study aimed to assess the drought tolerance of three kiwifruit varieties Bruno, Hayward, and Greenflesh under polyethylene glycol (PEG) 6000 induce osmotic stress at level of 0%, 20%, and 25%. Morphological and physiological parameters were recorded to assess stress tolerance of three varieties. Leaf relative water content (LRWC) decreased across all treatments but remained significantly higher in Bruno as compared to Hayward and Greenflesh. Stress tolerance index (STI) values decreased under stress, but Bruno maintained the highest STI (0.72%), followed by Hayward (0.70 %) and Greenflesh (0.68%). Growth parameters such as root and shoot length, fresh and dry weights, and seedling vigor index (SVI) were negatively impacted by increased PEG concentrations, with Bruno showing the highest SVI (310%) compared to Hayward (281%) and Greenflesh (274%). Biochemical analyses revealed increased enzymatic activities under drought stress, with Bruno consistently showing higher enzyme activities, particularly at 25% PEG. SOD activity in Bruno increased to 30.0 mg g^{-1} protein, compared to 28.0 mg g^{-1} protein in Hayward and 33.0 mg g^{-1} protein in Greenflesh. The results suggest that Bruno exhibits superior drought tolerance through better water management, membrane stability, photosynthetic efficiency, and enzymatic defense mechanisms compared to Hayward and Greenflesh. Among all treatments of PEG 6000, 25% is considered as sensitive concentration as on this level all parameters significantly decreased for all varieties whereas Bruno showed significantly more resistant. Therefore, our study evaluated sensitive concentration of PEG 6000 to simulate drought stress on kiwifruit varieties and revealed physiological adaptability of Bruno to drought stress.

Keywords: Kiwifruit, Polyethylene Glycol, Stress Tolerance, Water-Use Efficiency.

Regenerative Horticulture: A Sustainable Approach to Crop Cultivation

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Abstract

Regenerative horticulture offers a transformative approach to sustainable crop cultivation by prioritizing ecosystem health, biodiversity, and long-term environmental resilience. Unlike conventional agriculture, which degrades soil fertility and harms the environment, regenerative practices focus on rebuilding soil health, enhancing water retention, and promoting biodiversity through methods such as crop rotation, cover crop, intercropping, composting, and reduced tillage. These practices improve soil organic matter, boost microbial diversity, and enhance nutrient cycling, leading to higher crop yields and carbon sequestration, which helps mitigate climate change. Water conservation is also promoted through mulching and contour farming, which reduce runoff and improve groundwater recharge. Biodiversity is central to regenerative horticulture, integrating diverse plant species, agroforestry systems, and habitat corridors to enhance beneficial interactions between plants, pollinators, and natural pest controllers, thereby reducing reliance on synthetic chemicals. In addition to environmental benefits, regenerative horticulture offers social and economic advantages by reducing input costs, improving produce quality, and accessing markets for sustainably grown crops. However, widespread adoption requires overcoming challenges such as the need for technical knowledge, initial investments, and market access, which can be addressed through collaboration, education, and policy support, fostering more resilient and sustainable food systems.

Keywords: Cover Crop, Crop Rotation, Intercropping, Regenerative Horticulture, Sustainable

Optimizing Okra (*Abelmoschus esculentus* L.) Cultivation Strategies for Weed Management to Enhance Quality and Yield

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Abstract

Weed management is a crucial element of sustainable crop production. In okra (*Abelmoschus esculentus* L.) cultivation, implementing effective strategies for weed control is imperative to optimize both yield and quality. This study focuses on diverse approaches to weed management in okra, including cultural practices, organic mulching, and chemical control methods. Cultural practices play a pivotal role in weed management within okra cultivation. Research emphasizes the significance of timely and appropriate spacing, mulching, and intercropping as effective cultural practices to suppress weed growth and competition. Intercropping, particularly with cover crops, has been shown to be a sustainable and eco-friendly approach to weed management in okra fields. The incorporation of organic mulches, such as sugarcane mulch, has demonstrated promising results in weed suppression. This underscores the potential of organic mulches not only in conserving soil moisture but also in mitigating weed-related challenges in okra cultivation. Herbicides like pendimethalin and metolachlor have shown significant potential in controlling weeds while minimizing phytotoxic effects on okra plants. Integrated approaches that combine both pre-emergence and post-emergence herbicides have been recommended for comprehensive weed management in okra. A novel approach to weed management involves the development of herbicide-resistant okra varieties. Genetically modified okra with herbicide resistance traits provides an innovative tool for controlling weeds while minimizing the environmental impact of herbicide application.

Keywords: Chemical, Herbicides, Organic Mulch, Weeds.

Effect of Different Mulching Material on Yield and Quality of Peas (*Pisum Sativum*) Under Rainfed Conditions

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Abstract

The pea (*Pisum sativum* L.) belongs to the family Leguminosae, is an important rabi season vegetable. Pea originated in the eastern Mediterranean region and Near East. Pea is an excellent human food, either eaten as vegetables or in soup. It is a rich source of protein, fat, carbohydrate, calcium, phosphorus and ascorbic acid. Different mulching techniques are successfully reduce the effect of crop production and water stress on different varieties of peas under rainfed conditions. Mulches reduce soil water evaporation, maintain uniform soil moisture also decrease requirement of irrigations, which is very important in different crops in rainfed conditions of Pakistan. Mulching techniques are helpful to avoid the instabilities in temperature at 20-30 cm depth of soils. Facilitating root development, the elevation of soil temperature in the planting bed accelerates crop growth and leads to an earlier harvest. However, the use of plastic mulch in agriculture poses challenges associated with managing plastic waste and its environmental impact. Presently, only a minor proportion of the continually increasing volume of agricultural plastic waste undergoes recycling, primarily due to the expensive and time-consuming recycling process. High labor costs for the proper collection of plastic films at the end of cultivation further contribute to this limitation. As a result, a significant quantity of plastic films is either left on the field or burned by farmers, releasing harmful substances and causing adverse environmental consequences.

Keywords: Mulching Techniques, Plastic Mulch, Rainfed, Temperature.

Response of Chinese Cabbage Leaf (*Brassica Rapa* var *Chinesis*) to Moringa Extract

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Abstract

Chinese Cabbage (*Brassica rapa*) belongs to the mustrad family (Brassicaceae) and originates from China. Moringa leaf extract has superior potential as a galactagogue and, simultaneously, a highly nutritious supplement . Moringa leaf extract used in horticultural crops to enhance growth and yield of chinnese cabbage. The present study was conducted to evaluate four different levels of moringa leaf extract (0, 30, 60 and 90 g ha^{-1}). The analysis of the data revealed that moringa levels significantly influenced the growth and yield of chinese cabbage. Among the different levels of moringa leaves extract, 90 g ha^{-1} of moringa leave resulted in highest number of $leave^{-1}$, plant diameter, root length, edible leaves weight, biological leaves weight and yield were recorded. In conclusion, the moringa leaves extract significantly increased the growth and edible part of chinese cabbage. Hence moringa leaves extract application at the rate 90 g ha^{-1} is recommended for the better growth and production of chinsese cabbage.

Keywords: Chinese Cabbage, Extract, Moringa, Morphological.

Optimizing Zinc Foliar Application for Maximum Yield and Quality in Garden Pea Cultivation

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Abstract

The garden pea (*Pisum sativum*) is an important global crop , known for its high nutritional value, being rich in protein, fiber, micronutrients, and bioactive compounds beneficial to human health. It is widely cultivated in temperate regions, including Pakistan, where it thrives in both plains and highland areas. Zinc, a vital micronutrient, plays a critical role in various physiological processes such as protein synthesis, auxin production, carbohydrate metabolism, cellular membrane preservation, and pollen formation. This study aims to evaluate the effect of foliar zinc application on the growth and yield of garden pea, with five treatments and three replications, T_1 (0% Zn, control), T_2 (0.25% Zn, 11.9 g $ZnSO_4$ L^{-1}), T_3 (0.50% Zn, 23.8 g $ZnSO_4$ L^{-1}), T_4 (0.75% Zn, 35.7 g $ZnSO_4$ L^{-1}), and T_5 (1.00% Zn, 47.6 g $ZnSO_4$ L^{-1}). Zinc was applied twice, at 20 and 35 days after sowing, with varying concentrations. The results indicate that zinc application significantly improves pea growth and yield up to a certain concentration, beyond which further increases may hinder growth. The optimum concentration for maximizing yield and quality was found to be 0.50% Zn (23.8 g $ZnSO_4$ L^{-1} of water). Foliar zinc application enhances seedling establishment, pod formation, and seed quality, while promoting nutrient uptake, photosynthesis, and enzyme activity. These findings highlight the benefits of zinc in increasing the resilience, growth, and overall productivity of garden peas.

Keywords: Foliar Application, Micronutrients, Physiological Functions, Quality.

Effect of Foliar Application of Bio-stimulants on the Growth and Seed Yield of Pea

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Abstract

Among winter vegetables, pea (*Pisum sativum*) has great importance for its edible seeds, which are used in several dishes. Seed quality is affected by different factors during crop production. Biostimulants have been used in different crops to stimulate crop growth and yield but studies on seed crop are limited in pea. Therefore, an experiment was carried out to evaluate the effect of foliar application of bio stimulants (Isabion, Seamax and moringa leaf extract [3%]) on plant growth and the seed yield of peas. These biostimulants were applied twice at one month interval starting one month after sowing. It was observed that plant height, number of leaves, pod length and hundred seed weight was highest in Seamax treatment while more number of seed per pod and seed yield per plot were obtained from Moringa leaf extract as compared to control and other treatments. It was concluded that bio-stimulants are effective to enhance plant growth and seed yield of peas.

Keywords: Isabion, Moringa Leaf, Pisum, Seaweed Extract, Yield.

Integrating Cover Crops in Horticultural Systems: Enhancing Soil Health and Biodiversity

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Abstract

Integrating cover crops into horticultural systems offers significant benefits for soil health, biodiversity, and overall ecosystem resilience. Cover crops, including legumes, grasses, and brassicas, serve as a powerful tool in sustainable agriculture, providing numerous ecological services such as improving soil structure, preventing erosion, enhancing nutrient cycling, and increasing organic matter content. These crops also play a crucial role in reducing the reliance on synthetic inputs by promoting natural processes of nutrient fixation and recycling. Additionally, cover crops foster biodiversity by creating habitats for beneficial organisms, including pollinators, pest predators, and soil-dwelling faunaThe adoption of cover crops in horticultural systems leads to improved soil quality through better water retention, increased microbial activity, and enhanced nutrient availability. Moreover, the diversification of plant species in agricultural systems supports a more balanced ecosystem, reducing the vulnerability of crops to pests and diseases while improving resilience to environmental stressors. The integration of cover crops into horticultural systems is a holistic strategy that addresses the intertwined challenges of sustainable food production, soil conservation, and biodiversity loss. By leveraging the multifunctional benefits of cover crops, horticultural practices can transition toward more resilient and productive systems that ensure long-term agricultural sustainability while safeguarding environmental health.

Keywords: Ecological Balance, Nutrient Cycling, Sustainable Agriculture.

Role of Salicylic Acid and GA_3 in Fostering Summer Cauliflower Growth and Yield

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Abstract

Cauliflower (*Brassica oleracea* var. botrytis L.) is a valuable herbaceous vegetable because of its high nutritional value and various health advantages. There are five groups of cauliflower which are cultivated at different times starting in May-June. However, this summer season crop of cauliflower is severely affected by high temperatures. A study was conducted to evaluate the effect of GA_3 (10 ppm) and salicylic acid (SA 100 ppm and 200 ppm), alone or in combination (GA_3+SA 100 ppm, GA_3+SA 200 ppm) using cauliflower variety Faisalabad Early 1. Results showed that maximum plant height, whole plant weight, fresh weight of curd, dry weight of curd, number of leaves were observed for GA3 (10 ppm) treatment followed by GA_3+SA (10 ppm+100 ppm) treatment. While, maximum curd diameter was observed in SA (100 ppm) and maximum chlorophyll content in SA (200 ppm). However, maximum leaf fresh weight and leaf dry weight were showed in GA_3+SA (10 ppm+100 ppm). It was concluded that GA_3 can improve growth and yield of summer grown cauliflower and can be combined with SA (100 ppm).

Keywords: Cauliflower, GA_3, Growth, Salicylic Acid, Yield.

Alleviation of Heat Stress in Lettuce Through Foliar Application of GA_3

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Abstract

Lettuce (*Lactuca sativa*) is an important vegetable used mostly for salad purpose. It is a cool-weather crop that shows thermo-dormancy and tip burn at high temperatures. Because of its year-round demand, there is need to increase its thermal tolerance. Therefore, experiment was carried out to evaluate the response of lettuce to high temperature and the mitigation of the heat effect using different doses of GA_3. Seedlings were exposed to 25 °C or 35 °C and treated with GA_3 at 0, 25, 50, 75, or 100 ppm. The results showed that application of GA_3 (25 ppm) showed better results for plants height, number of leaves per plants, number of normal leaves, normal/abnormal leaves ratio, leaf width, root length, TSS and vitamin C. While, the application of 100 ppm GA_3 retarded the growth. So, farmers and researchers can grow lettuce up to 35 The results showed that in experiment 1, application of GA_3 (25 ppm) showed better results for plants height, number of leaves per plants, number of normal leaves, abnormal leaves, leaves normal/abnormal ratio, leaf width, root length, TSS and vitamin C. however, the application of T4 (100 ppm GA_3) retarded the growth. So, farmers and researchers can prolong lettuce growing season to a few weeks using GA_3 (25 ppm).

Keywords: GA_3, Heat, Lettuce, Thermal Dormancy, TSS.

Enhancing Carrot Seed Yield and Quality Through Paclobutrazol Application

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Abstract

Carrot exhibit variable quality and quantity of seed obtained from different umbel orders that affect crop stand establishment. This study aimed to improve carrot seed yield and quality using paclobutrazol. Four PBZ concentrations T_1 = (25 mL L^{-1}), T_2 = (50 mL L^{-1}), T_3 = (75 mL L^{-1}), and T_4 = (100 mL L^{-1}) were applied after 15 days of stecklings transplantation. Increasing paclobutrazol concentration significantly reduced plant height, while increasing number of secondary, tertiary and quaternary umbels. However, seed weight from primary and secondary umbels was reduced, particularly at the highest concentration, but seed weight from tertiary and quaternary umbels was increased. altough total yield per plant was also reduced but thousand seed weight was increased while germination was slightly improved over control. Results imply effective plant height control and increase in seed quality due to paclobutrazol application.

Keywords: Carrot, Carrot Seed, Paclobutrazol, PBZ, Yield.

Assessment of Chilli Accessions Grown in Pakistan

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Abstract

Chilli is an important vegetable and spice crop known for its numerous health benefits. It is globally cultivated, with a diverse range of 6,232 accessions. Understanding and evaluating this diversity is essential for developing new varieties with desirable traits. The present study was conducted to characterize 10 chilli accessions grown in Pakistan. These accessions were analyzed based on qualitative traits, including stem color, stem shape, stem pubescence, and fruit shape, as well as quantitative attributes such as plant height, plant canopy width, fruit length, and fruit width. Biochemical evaluations were also performed to assess the quality of the chillies by determining peroxidase, catalase, and phenolic content. The results revealed substantial diversity among these accessions. The cotyledonous leaf color ranged from light green to dark green, and the plant growth habit varied from intermediate (compact) to erect. The plant height ranged from 57 to 98.66 cm, and the plant canopy width varied from 39.66 to 103.73 cm. Significant variation was also observed in the biochemical attributes, with phenolic content ranging from 0.29 to 1.18. Additionally, the catalase activity varied between 0.67 to 1.2 µg g^{-1}. These findings highlight considerable variability in the accessions, suggesting their potential for future breeding and crop improvement efforts.

Keywords: Accessions, Chilli, Qualitative, Quantitative, Variability.

Vertical Farming & Urban Horticulture

Uplifting Food Security Through Rooftop Gardening: A Contemporary Approach to Urban Agriculture

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Abstract

A novel approach to addressing the problems caused by increasing urbanization and a shortage of green space is rooftop gardening, which has great promise for improving food security in urban settings. The idea of rooftop gardening is explored, with a focus on its guiding principles,which include enhancing air quality, increasing space efficiency, and encouraging sustainability. Insightful case studies from cities throughout the worldwide highlight the diverse application and advantages of rooftop gardens, emphasizing their contribution to the production of fresh food, the mitigation of urban heat islands, and the promotion of community involvement. Rooftop gardening has potential but it alsofaces challenges , such as structural restrictions, expensive initial expenses, and care requirements. In order to overcome these obstacles, this study suggests creative alternatives, including modular systems, community collaborations, and lightweight soil media. For rooftop gardens to be widely adopted, they must be integrated into urban planning. Encouraging policies for green roofs, zoning laws, and assistance for urban farmers are necessary to establish an atmosphere that is favorable for rooftop gardening.repeat . A favorable climate for rooftop gardening requires zoning laws, policies that encourage green roofs, and assistance for urban farmers. Technological developments that can further improve the effectiveness and productivity of rooftop gardens include smart sensors and automated irrigation systems. These are some future thoughts on this issue.In summary rooftop gardening is a practical and comprehensive strategy for enhancing food security and sustainability in urban settings. Resilient food systems and the future of urban agriculture may be greatly influenced by rooftop gardens through their integration with urban planning and resolution of present issues. In addition to improving food security, this modern strategy raises urban living standards generally and makes cities more sustainable and livable.

Keywords: Food Security, Fresh Food, Rooftop, Sustainability, Urban Planning.

Vertical Farming and Urban Agriculture: Innovations, Challenges, and Future Prospects

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Abstract

Urban agriculture has emerged as a promising solution to address food security, sustainability, and resource efficiency in the face of rapid urbanization and climate change. Vertical farming, a key component of modern urban agriculture, adopts innovative technologies such as hydroponics, aeroponics, and aquaponics to optimize resource use, reduce water consumption, and enable year-round crop production. the sentence is long and lack of clearitySimilarly, urban horticulture, including rooftop gardens and IoT-enabled systems, is revolutionizing food production in constrained urban areas. However, challenges such as limited land availability, water access, heat stress, and regulatory barriers must be addressed. Public awareness, advocacy, and community engagement are essential to fostering support for urban farming initiatives. By developing innovative strategies, fostering collaboration among stakeholders, and implementing supportive policies, urban agriculture can significantly contribute to meeting the food demands of growing populations, promoting sustainable development, and enhancing urban resilience.

Keywords: Public Awareness, Sustainable, Urban Agriculture, Vertical Farming.

Studies Exploring the Growth and Yield Performance of White and Yellow Pleurotus spp. Cultivated on Wheat Straw Enriched with Banana Peel Powder

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Abstract

Oyster mushrooms (*Pleurotus ostreatus*) are edible fungi with a distinctive oyster-shaped cap, cultivated globally for their mild flavor and texture. In recent years, oyster mushrooms have attracted much consumer interest, due to their nutrient-rich versatility. The cultivation of Yellow and White oyster mushrooms is practiced in several regions worldwide. This study aimed to increase production and examine the effect of banana peel powder treatment on two cultivars of oyster mushrooms, White and Yellow. Various concentrations of banana peel powder (T_1 = 120 g, T_2 = 240 g, and T_3 = 360 g) along with T_0 = control 100% wheat straw was used. The response of mushrooms was evaluated based on different physical, and physiological, parameters. In this experiment, a Completely Randomized Design under the two-factor factorial structured arrangement was used. An analysis of variance technique was used for statistical analysis of the recorded data to compare the productiveness of the treatments. The parameters that showed good response under T_2 (240 g banana peel powder) were number of days for completion of second flush. The parameters i.e., number of days for completion of 1st flush showed better results under T0 (Control). This study indicated that T_2 followed by T_3, performed best among oyster mushroom production while T_1 and T_3 showed minimum performance respectively. This experiment indicated that White Oyster mushroom showed better performance than Yellow Oyster mushroom. Overall, this research provided valuable insights into the effect of banana peel powder concentrations on the growth and nutritional content of white and yellow oyster mushrooms. The findings highlight the potential of banana peel powder application as a strategy to enhance mushroom cultivation and improve their nutritional value. We believe that wheat straw supplemented with banana peel powder can serve as a novel substrate for cultivating white oyster mushrooms.

Keywords: Oyster mushroom, Cultivation, Growth, Yield.

Optimizing The Growth and Yield Performance of Grey and White Oyster Mushrooms Through the Utilization of Wheat Straw Infused with Guava Pomace

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Abstract

White and grey oyster mushrooms are grown all over the world using a variety of growth methods in various geographical areas. The mild flavor and versatile culinary uses of these mushrooms make them a popular choice for both cultivation and consumption around the world. A study was carried out at the Medicinal and Mushroom Lab, Institute of Horticultural Sciences to investigate the effects of guava pomace powder on the nutrition and growth of two oyster mushroom cultivars Grey and White. T_0 = Control, T_1 = 1%, T_2 = 2%, and T_3 = 3% were used in varying amounts of guava pomace powder. Fresh mushroom weight, pinhead initiation, total number of reducing and non-reducing sugars, total soluble solids, etc. were observed following the conclusion of mycelium growth. The weight of the mushrooms was carefully tracked, and the range for Grey oyster mushrooms was 62.31 g to 182.43 g, while the range for White oyster mushrooms was 62.53 g to 125.45 g. These results implied that the mushrooms growth and development were impacted differentially by varying amounts of guava pomace. Additionally, during each flush, the number of pinheads, early mushroom primordia, was noted. This study employed a two-factor factorial arrangement with a completely randomized design. The recorded data was statistically analyzed using the analysis of variance technique (ANOVA) to compare the effectiveness of the various treatments. Overall, this study shed important light on how guava pomace concentrations affect the development and nutritional value of white and grey oyster mushrooms. The results demonstrated the potential of applying guava pomace as a method to improve mushroom cultivation and raise the nutritional content of the crop. The mushroom business may be significantly impacted by these findings, which could lead to the development of more robust and nutritious mushroom crops.

Keywords: Oyster Mushroom, Cultivation, Growth, Yield.

Research Investigations on Cultivating Grey and White Oyster Mushrooms Utilizing Wheat Straw Enhanced with Potato Peel Powder

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Abstract

Oyster mushrooms are cultivated worldwide and are famous for their distinctive flavor and texture. An experiment was conducted to enhance mushroom production and to examine the impact of potato peel powder of varying concentrations on two cultivars of Oyster mushrooms, Grey and White. The study aimed to assess the effect of various concentrations of potato peel powder (PPP) (1% = 120 g; PPP 2% = 240 g PPP; PPP 3% = 360 g) incorporated in the compost of two varieties of mushroom V1 (Grey) and V2 (White). The impact was measured based on various physical and physiological parameters. The four treatments, T_0 (100% - wheat straw), T_1 (99% - wheat straw + 1% PPP), T_2 (98% wheat straw + 2% PPP), and T_3 (97% - wheat straw + 3% PPP) were applied to assess the growth of mushroom. This study employed a Completely Randomized Design with a two-factor factorial setup, featuring four replications for each treatment. To assess the effectiveness of the treatments, an analysis of variance method was utilized for the statistical evaluation of the collected data. Results indicated that time taken for completion of mycelium growth (25%, 50%, 75% and 100%), initiation of pinheads, no of pinheads, days for completion of flushes (1st, 2nd, and 3rd flush), weight of flushes (1st, 2nd and 3rd flush) were significantly influenced by treatment T_3 as compared to control. The yield of mushrooms was greater by increasing the various combinations of PPP within the wheat straw as compared to the control. The findings indicated that the White Oyster mushroom outperformed the Grey Oyster mushroom.

Keywords: Growth, Oyster Mushroom, Potato Peel Powder, Yield.

Growth, Yield and Biochemical Composition of Yellow and Pink Oyster Mushroom Cultivated on Wheat Straw Enhanced with Apple Pomace

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Abstract

Oyster mushrooms are a highly sought-after fungus that are grown all over the world because of their delicate flavor and texture. Because of their biological characteristics, economic feasibility and nutritional makeup yellow and pink oyster mushrooms are highly valued in the mushroom industry. A study was conducted at Medicinal and Mushroom Lab, Institute of Horticultural Sciences, University of Agriculture, Faisalabad to monitor the development and production of pink and yellow oyster mushrooms. The purpose of this study was to boost output and examine the development and nutritional characteristics of oyster mushrooms grown on compost enhanced with powdered apple pomace. T_0 = control wheat straw, T_1 = wheat straw + 1% apple pomace powder, T_2 = wheat straw + 2% apple pomace powder and T_3 = wheat straw + 3% apple pomace powder were used. A variety of physiological, biochemical and physical characteristics were evaluated. A completely randomized design with two factor factorial arrangements served as the foundation for the investigation. The results indicated that, in comparison to all other treatments, T_3 = wheat straw + 3% apple pomace powder significantly increased the growth and yield of pink and yellow oyster mushrooms as depicted by enhanced weight of first, second and third flush and total yield. Across all treatments, pink oyster mushrooms routinely produced better results than yellow oyster mushrooms. From outcomes we concluded that with the increase in apple pomace concentration mushroom growth boosted up as compared to control.

Keywords: Mushroom, Pomace Powder, Yield.

A Comparative Assessment of Various Oyster Mushroom Types (White, Grey) Grown on Wheat Straw Supplemented with Peach Pomace

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Abstract

The oyster mushroom (*Pleurotus ostreatus*) is part of the Pleurotaceae family and is a macro fungus recognized for its significant nutritional benefits. A study was carried out at the Medicinal and Mushroom Laboratory, Institute of Horticultural Sciences, University of Agriculture Faisalabad, to assess yield and growth of Pleurotus species. Wheat straw and peach pomace powder were utilized both individually and in various substrate combinations. The wheat straw without any peach pomace powder was used as the control T_0 = wheat straw 100%, T_1 = 99% wheat straw + 1% peach pomace powder, T_2 = 98% wheat straw + 2% peach pomace powder, and T_3 = 97% wheat straw + 3% peach pomace powder. The response of Grey and White Oyster mushrooms to different treatments was assessed by measuring the onset of mycelium growth, the completion of mycelium growth at 25%, 50%, 75% and 100%, the initiation of pinhead, the number of pinheads, the duration to complete harvests (1st, 2nd and 3rd flush), the weight of flushes (1st, 2nd and 3rd flush), the yield, reducing sugars, total sugars and non-reducing sugars. The yield of mushrooms increased with the incorporation of various combinations of peach pomace powder into the wheat straw differentiated to the control group. Both varieties of mushrooms, white and gray oyster, exhibited total soluble solids ranging from 2.4-2.7 °Brix. The titratable acidity was measured between 1.3-1.5%, while the ascorbic acid content ranged from 2.8-3.18 mg 100 mL^{-1}, with moisture percentages varying from 85-90% across different levels of wheat straw supplemented with peach pomace powder. The findings indicate that the white oyster mushroom yielded more favorable outcomes than the grey oyster mushroom

Keywords: Growth, Oyster Mushroom, Production, Yield.

Synergistic toxicity of *Steinernema carpocapsae* combined with chlorantraniliprole against *Bactrocera dorsalis* (Hendel)

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Abstract

Oriental fruit fly, *Bactrocera dorsalis*, is cosmopolitan pest of fleshy fruits in Pakistan with severe economic losses, causes fruit losses in crops with insecticide resistance is major issue globally. We evaluated the effects of individual and combined applications of *Steinernema carpocapsae* with chlorantraniliprole against larvae, pupae and adults, of *B. dorsalis* at different media source with three type of soil. The combined applications of *S. carpocapsae* showed greater mortality against L3 instar larvae than individual applications in all combinations where *S. carpocapsae* was least effective in sand media soil type. In a sand soil bioassay, highest mortality was recorded against different stages were encountered with individual application of chlorantraniliprole than combined while L3 instar larvae were recorded most susceptible then pupae and adult. These results indicated that how particular mixtures of entomopathogenic nematodes and chlorantraniliprole might be implemented in integrated pest management strategies against tephritids fruit flies under filed conditions.

Keywords: Biological Control, Entomopathogenic Nematode.

Foliar Application of Natural Antioxidants and Calcium Salts to Reduce the Impact of Citrus Greening in Citrus

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Abstract

Citrus greening, also known as Huanglongbing (HLB), that has devastating impact on citrus production globally. It is caused by the bacterium *Candidatus Liberibacter spp*, that is commonly transmitted by Asian citrus psyllid (*Diaphorina citri*). This study analysis efficacy of an integrated treatment regime of combine foliar application from natural antioxidants and calcium salts to mitigate the influence of citrus greening on citrus orchards. The study was conducted using citrus trees infected by HLB that were arranged in a randomized complete block design over a period of six months. Four treatment protocols were evaluated, these were denoted as T_1, T_2, T_3 and T_4 respectively. T_1 was addition of foliar with natural antioxidants including 2% ascorbic acid and 1% glutathione, for T_2, the calcium salts of 2% calcium chloride and 1% calcium nitrate was added. The treatment T_3 was combined addition of foliar antioxidant and calcium salt while T_4 was control containing untreated HL-B infected trees. Foliar treatments were applied weekly by directly injecting precise dosage syringes into xylem and plant performance was monitored through fruit yield, production, juice quality and pathogen suppression. Sensory analysis was carried out by 25 judges who evaluated on basis of taste, aroma and texture respectively. The results concluded that T_3 gained maximum increase in chlorophyll content of 34% and 40% reduction in pathogen load as well. The fruit yield was enhanced by improved juice quality with 13.2 °Brix followed by 0.7% acidity and vitamin C 42 mg 100 mL^{-1}. The sensory evaluation consistently recorded highest score of 9.1/10 for T_3 among the panel of judges. The study concluded with positive results and that such combination can be used for managing adverse effect of citrus greening. The dual strategy not only impacted the yield and quality but also lowered the pathogenic load. Future research should focus on optimizing treatment intervals and exploring cost-benefit analyses for large-scale implementation.

Keywords: Citrus, Foliar, Injection, Huanglongbing, Sensory.

Nanoparticle-Mediated Salinity Stress Alleviation in Tomato Plants: A Green Technology Solution

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Abstract

To mitigate the impact of salinity on tomato plants nanoparticle seed priming was done on tomato *(Solanum lycopersicum L.)*. Plants exhibit biochemical, physiological, and morphological changes in response to salt stress. Creating effective strategies for reducing salt stress and increasing agricultural yield is vital. The use of nanoparticles, as an emerging strategy, is an effective way to enhance agricultural productivity. In the CRD experiment, tomato plants were sown under the influence of two levels of NaCl salt stress (7ds/m and 10 ds/m). The seed priming was done before sowing for 24 hours in a 100-ppm solution of zinc oxide and magnesium oxide nanoparticles. Results demonstrated that supplementation of ZnNP and MgNP nanoparticles enhanced the activity of antioxidant enzymes (chlorophyll, peroxidase, polyphenol oxidase, and Catalase), and metabolic activity is increased by phenolic substances. The study reveals the reduction of salt stress in tomatoes by treatment of ZnNP and MgNP has a minimum effect by seed priming than the foliar method. However, in control conditions, they have a great impact on plant germination and physiological, morphological, and biochemical reactions. It concludes that the green synthesized ZnNP and MgNP nanoparticles are beneficial in terms of tomato development and physiology.

Keywords: Antioxidant, Nanoparticles, Salinity Stress, Physiological.

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