IHC 2021

# International HORTICULTURE e-CONFERENCE

FEBRUARY 22-23, 2021

# ABSTRACT BOOK

**Editors**
Ahmad Sattar Khan, PhD
Muhammad Usman, PhD

**Organized by**
Pakistan Society for Horticultural Science

*In collaboration with*
Institute of Horticultural Sciences,
University of Agriculture, Faisalabad

# ABSTRACT BOOK

# International Horticulture e-Conference 2021 (February 22-23, 2021)

**Organized by:**
**Pakistan Society of Horticultural Sciences**
**in Collaboration with**
**Institute of Horticultural Sciences, UAF**

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| Date | Events | Time |
|---|---|---|
| **22-02-2021** | **DAY-1** | |
| | **INAUGURAL SESSION**<br>**Moderator:** Dr. Raheel Anwar, Assistant Professor, IHS, UAF | |
| | Recitation of Holy Quran | 09:30 am |
| | Naat Sharif | 09:35 am |
| | Welcome Address<br>Prof. Dr. A.U. Malik, Director, IHS, UAF | 09:40 am |
| | Inaugural Address by Chief Guest<br>Prof. Dr. Asif Tanveer, Pro Vice Chancellor, UAF | 09:50 am |
| | Vote of Thanks<br>Prof. Dr. C.M. Ayyub, President, PSHS | 10:00 am |
| | **BREAK** | 10:20 am |
| | **TECHNICAL SESSION-I (Key Speakers)**<br>**Session Chair:** Prof. Dr. A.U. Malik, Director, IHS, UAF<br>**Session Co-Chair:** Prof. Dr. Ishtiaq Ahmad Rajwana<br>Chairman, National Agriculture Education Accreditation Council, HEC, Islamabad<br>**Moderator:** Dr. Adnan Younis, Associate Professor, IHS, UAF | |
| | Ethylene Management Interventions to Mitigate Postharvest Losses in Fresh Horticultural Produce by **Prof. Dr. Zora Singh**, Australia | 10:30 am |
| | Current Status, Challenges and Way Forward to Improve Export of Fruits and Vegetables by **Mr. Waheed Ahmad**, Patron-in-Chief, All PFVA, Pakistan | 11:00 am |
| | Use of E-learning Technologies for Advancing Horticultural Postharvest Education: Recent Experience, Challenges, and the Way Forward by **Dr. V.Y. Tokala, Dr. L. Kitinoja and Dr. S. Khalid**, USA | 11:30 am |
| | Healthy Food for Healthy Cities by **Dr. Charles L. Wilson**, USA | 12:00 pm |
| | Innovative Soilless Substrate for the Future of Container Plant Production by **Dr. Brian E. Jackson**, USA | 12:20 pm |
| | New Zealand Kiwifruit Industry; Status, Technology, Role of Zespri – Learnings for Pakistan, by **Dr. Abdul Jabbar**, New Zealand | 12:40 pm |
| | Remarks by the Session Chair/Co-Chair | 12:55 pm |
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| | **TECHNICAL SESSION-II**<br>**Session Chair:** Prof. Dr. Muhammad Akbar Anjum<br>Chairman, Department of Horticulture, BZU, Multan<br>**Session Co-Chair:** Dr. M. Javed Tareen, D.G., Agri. Res. Inst., Sariab, Quetta<br>**Moderator:** Dr. Adnan Younis, Associate Professor, IHS, UAF | |
| | Landscape Horticulture Work on Sukkar-Multan Motorway (M-5) by **Dr. Muhammad Aslam Khan**, Pakistan. (Key Speaker) | 02:00 pm |
| | Worldwide Occurrence and Phylogeography of Watermelon Chlorotic Stunt Virus Infecting Cucurbits by **Dr. Muhammad Naeem Sattar**, KSA (Key Speaker) | 02:30 pm |
| | Display Characteristics of Different Varieties of Gladiolus (*Gladiolus grandiflorus* L.) In Landscape by **Dr. Adnan Younis** | 02:50 pm |

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| | Genetic Diversity and Population Structure of Date Palm Male Accessions by Using SSR Markers by **Mr. Muhammad Kashif Raza** | 03:10 pm |
| | Mitigating Citrus Huanglongbing Pathogen Through Core Functional Endophytes: Focused on Model Citrus Pathosystem and Inhibition of Quorum Sensing Signals by **Mr. Shahzad Munir**, China | 03:20 pm |
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| | Impact of Runners Harvest Date and Delayed Transplanting on Growth and Productivity of Strawberry cv. "Chandler" by **Dr. Kashif Razzaq** | 03:40 pm |
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# KEYNOTE SPEAKERS

# Ethylene Management Interventions to Mitigate Postharvest Losses in Fresh Horticultural Produce

**Z. Singh**
*Horticulture, School of Science, Edith Cowan University, 270 Joondalup Drive, Joondalup, Western Australia 6027, Australia.*
Email: z.singh@ecu.edu.au

Ethylene triggers fruit ripening and shortens storage life by promoting senescence and deteriorates quality in fresh horticultural produce. Horticultural fresh produce is highly perishable, and the global postharvest losses vary from 30% - 44%. Ethylene is one of the major causes of postharvest losses in horticultural fresh produce. The postharvest losses caused by ethylene can be mitigated by inhibiting ethylene biosynthesis and its action as well as managing the exposure horticultural produce to ethylene. Mitigation of postharvest losses in fresh horticultural produce during storage and supply chain with effective management of ethylene will ensure global food and nutritional security. Over two decades, my research group have investigated various approached to mitigate the negative impact of ethylene during storage and supply chain in fresh horticultural produce. Various approaches to inhibit ethylene biosynthesis using various ethylene biosynthesis inhibitors, 1-aminocyclopropane-1-carboxylic (ACC) synthase (ACS) and ACC oxidase (ACO) antisense gene technology and overexpression of ACC deaminase have been successful to inhibit ethylene biosynthesis in various horticultural crops. The beneficial effects of these technologies are reversed when the horticultural produce is exposed to external ethylene during the postharvest phase. Moreover, a majority of consumers do not accept genetically modified fruit or vegetables. Cold storage, modified atmosphere packaging and controlled atmosphere storage have also been used commercially to mitigate the negative impact of ethylene, extend the storage life, and maintain quality of fresh fruits and vegetables. Carbon-heat hybrid ethylene scrubber and Palladium-promoted zeolite materials have also been investigated to negate the detrimental effects of ethylene on fresh horticultural produce. Beneficial effects of various ethylene catalytic oxidants such as potassium permanganate ($KMnO_4$), ozone ($O_3$), and titanium dioxide ($TiO_2$) and film-based packaging containing ethylene scavenger have also been examined to overcome the harmful effects of ethylene on fresh horticultural produce. Inhibition of ethylene action using ethylene antagonists in preharvest phase, storage and supply chain has proved to be a very effective practical approach in inhibiting ethylene action and downregulating the deterioration of quality in fresh horticultural produce. Inhibitor of ethylene action such as 1-methylcyclopropene (1-MCP) is widely used to inhibit ethylene production and its action by irreversibly blocking the ethylene receptor sites in the plant organs. The efficacy of 1-MCP to antagonise ethylene action varies among genotypes, concentrations applied, storage temperature, treatment duration and difficult to handle because it is highly unstable at room temperature. Several commercial products involving different delivery methods of 1-MCP are available from AgroFresh (fumigation and liquid form) Hazel® (fumigation) and Logfresh® (dust powder form). New robust ethylene antagonists have been discovered by my research group such as 1H-cyclopropabenzene (BC) and 1H-cyclopropa[b]naphthalene (NC) to antagonize the ethylene action in a similar mechanism to that of 1-MCP. Structurally these compounds are different from 1-MCP, making them more stable at room temperature than 1-MCP in natural form. These ethylene antagonists can be applied as fumigation, spray, coating, or waxing and their impact on storage life and quality of fresh horticultural produce will be discussed. In conclusion, effective management of ethylene in

postharvest phase will extend storage life, maintain quality, and address the international challenge of minimizing postharvest losses in fresh horticultural produce.

## Healthy Cities, Cities of Tomorrow

**C.L. Wilson**
*Founder/CEO, World Food Preservation Center ® LLC (Food Preservation Revolution™), USA.*
Email: worldfoodpreservationcenter@gmail.com

The World Food Preservation Center. LLC was established in response to a pending global food shortage that is destined to increase world hunger if not sustainably addressed. The world's food supply is being shrunk by a rapidly expanding world population and a deteriorating agricultural environment. Now global warming has come on the scene and portends to further restrict crop yields. It is clear that the global food shortage crisis will not be addressed by simply producing more food as happened during the "Green Revolution." Even with the most advanced food production technologies there will be a significant shortage of food. One third of the food that is currently produced globally is lost annually between harvesting and consumption, which is enough to feed two billion people. Therefore, it is apparent that more of the food that is produced must be saved to avoid escalating world hunger. Because few agricultural resources (5%) have been invested in the postharvest preservation of food as opposed to food production (95%), significant postharvest skills and technology gaps remain in agricultural institutions of higher learning particularly in developing countries. The World Food Preservation Center. LLC was formed to address the intellectual postharvest gaps in developing countries by: (1) promoting the education (M.S. and Ph.D.) of young student/scientists in developing countries; (2) supporting young student/scientists in developing countries conduct research on much needed new postharvest technologies adaptable to their native countries; (3) organize continent-wide postharvest congress and exhibitions; (4) publish much needed new texts/reference books on postharvest technologies and methods for developing countries.

## Use of E-learning Technologies for Advancing Horticultural Postharvest Education: Recent Experience, Challenges, and the Way Forward

**V.Y. Tokala[a*], L. Kitinoja[a] and S. Khalid[b]**
[a]*The Postharvest Education Foundation, USA*
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An e-learning platform is an effective way to reach practicing scientists and extension agents in distant places that may otherwise be difficult to reach. It has gained wide importance during the COVID-19 pandemic, as it is only possible way to disseminate knowledge, skills and education to students and learners around the globe, while following social distancing norms. The Postharvest Education Foundation (PEF) is a non-profit organization, founded in 2011, with the mission to provide informal education and mentoring through e-learning to local postharvest specialists and extension workers, who can in turn train agricultural stakeholders in rural areas of their countries

to develop skill and knowledge regarding postharvest handling. The training program is comprised of twelve assignments of reading, fieldwork and written reports. The training manual is posted online so individuals or groups can participate free-of-cost and on their own schedules. Mentoring is done through emails and various social networking sites like LinkedIn, Twitter and Facebook, while reading materials and other resources are shared through the PEF website, Google Docs, Google Drive and YouTube. Till date, the PEF e-learning graduates from more than 30 different countries around the world have been trained with improved postharvest techniques to reduce losses. E-learning is the best way to provide skills and knowledge to a wide population in innovative and cost-effective way, allowing graduates to analyze and practice at their own pace. Sharing the knowledge to farmers and traders in various countries has been made possible through PEF e-learning graduates. Challenges include access to secure internet and availability of gadgets like computers and mobile phones. E-learning graduates often face financial constraints in building technologies and implementing demonstrations for a training program. PEF will be providing 10 small grants during 2021 for training program implementation.

## Landscape Horticulture Work on Sukkur - Multan Motorway (M-5)

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Motorways play a key role in the country's economic, social and physical development. The primary purpose of the Motorways network is to provide strategic transport links between the main centres of population and employment, including key international gateways such as the main ports and airports. Sukkur - Multan Motorway, M-5(392 Km) is a major part of Peshawar – Karachi Motorway Route, which is lifeline of Pakistan's economy. While travelling for business or for pleasure, millions of people view the landscape alongside the motorway. An aesthetically pleasing and eco-friendly motorway, with innovative planting strategy, is a source of pleasure, comfort, and fond memories for the travellers. A site is landscaped to increase its usefulness, beauty and economic value. Proper landscaping should have utility, as well as beauty. Well-designed landscape provides an attractive environment. A successful landscape is the sensitive balancing of many elements such as the site climate, plant material, outdoor landscape structures, utilities and roadside. In this project Shady trees (150,000), Ornamental trees (230,000) and Ornamental Shrubs (40,000) have been already planted. 800Km (both side) grass is planted on the embankment alongside the Motorway which is controlling the soil erosion and giving the soothing effect.

## Horticulture in the Northern Territory of Australia - Opportunities for R&D Collaboration with Pakistan

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The Australian Northern Territory (NT), based on climatic conditions, is divided into three distinct growing regions viz., Monsoonal Tropics, Tropical Savannah, and Semi-Arid. In edaphic terms, the NT has 12 categories of soils spread across the growing regions. Accordingly, a range of horticultural crops are grown across the territory. Mango is the major fruit produced in NT and exceeds 50% of the national production. Melons and pumpkins are the next crops of economic significance. Other horticultural crops commercially grown in the NT include Asian vegetables, banana, coconut, dates, durian, grapefruit, grapes, jackfruit, lemon, lime, papaya, passionfruit, dragon fruit, star fruit, rambutan and ornamentals. The gross value of horticultural production in the territory increased from < $100 million in 2009 to > $300 million in 2019, where averages of value created from land and water used to grow horticultural crops were $ 29,200 $ha^{-1}$ and $3,760 $ML^{-1}$, respectively. Among the comparative advantages, which make NT horticulture profitable, are research-driven advanced and climate-smart production systems; diversification; application of evolving technologies for the crop and varietal screening, yield forecasting, and quality prediction; postharvest handling systems including cool chain infrastructure; and market intelligence. Collaboration for research and development (R&D) beyond geographical boundaries is necessary for dealing with evolving challenges for sustainable agriculture worldwide. The NT Government, represented by the Department of Industry, Tourism and Trade, has signed a letter of intent with The University of Agriculture Faisalabad Pakistan for collaboration on R&D areas of mutual interest including the exchange of expertise and accessible germplasm. This relationship will benefit the horticulture industry of both the NT and Pakistan.

## New Zealand Kiwifruit Industry; Status, Technology, Role of Zespri - Learnings for Pakistan

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Kiwifruit industry of New Zealand is one of the world's leading Horticulture industry. Kiwifruit contributes 33% of the total export's revenue of New Zealand Horticulture products, with around 2600 growers growing kiwifruit over approx. 12,700 hectares in New Zealand. New Zealand grown kiwifruit is marketed as per single-desk sale and marketing strategy by a global kiwifruit company Zespri International Limited. Zespri exports kiwifruit to over 50 countries across the globe with main markets being China, Japan, Spain, Taiwan, Germany and South Korea. Strategic

management and implementation of fruit quality systems throughout the supply chain primarily focus on delivery of premium quality kiwifruit to consumers and eventually results in maximum orchard gate returns for kiwifruit growers. Success of New Zealand kiwifruit industry heavily relies on technology and sustainable R&D innovation throughout the fruit production systems and supply chain to ensure maximum of global competitive advantage for the industry. New Zealand kiwifruit industry could be regarded as role model of 'world class' fruit branding with the learnings reflected as leading-edge innovation in growing practices, optimization of supply chain to minimize losses and leading-edge consumer focused marketing strategies. High profit incentive program for growers creates a strong drive to consistently produce prime quality fruit. There are significant learnings for Pakistan Horticulture especially fruit export industry like Mango and Kinnow Mandarin. Topic will further address the key aspects of New Zealand kiwifruit industry and learnings for Pakistan fruit export sector.

## Innovative Soilless Substrate for the Future of Container Plant Production

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Soilless substrates are as ever-changing as most all other areas of horticulture production systems. Efficiency, Economics, and Environmental awareness are the three big drivers behind a lot of current research efforts. Innovations in organic material (bark, wood, peat, etc.) processing and handling as well as introductions of new materials and mix formulations have led to new product offerings and new opportunities for growers to trial new materials. The expectations by growers for their substrates to be more durable, forgiving, functional, and timeless are as high as ever. This presentation will highlight some of those changes and challenges that face the growing media industry (and growers) in the future.

## Worldwide Occurrence and Phylogeography of Watermelon Chlorotic Stunt Virus Infecting Cucurbits

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Gemini viruses (family *Geminiviridae*) are economically most important arthropod-borne plant pathogens infecting vegetable crops with a near global distribution. These phytopathogenic viruses have a wide host range in the tropical to temperate regions. Watermelon chlorotic stunt virus (WmCSV), a bipartite begomovirus (genus *Begomovirus*, family *Geminiviridae*) was reported from Yemen in 1988. During the subsequent years, WmCSV was rapidly spread into most of the

Middle Eastern countries and Northern parts of Africa. Until now, it has been reported from Israel, Jordan, Lebanon, Oman, Palestine and Saudi Arabia infecting muskmelon, pumpkin, squash, watermelon and zucchini. Recently, the cross-continent spread of WmCSV has also been reported from Mexico. Apart from the predictive global epidemic spread of WmCSV, no detailed study is available on investigating the potential factors promoting its spread. The global trade of infected fruits and vegetables and/or exchange of viruliferous whitefly vectors can be the major causes of such abrupt phylogeography of WmCSV across the continents. It can be speculated from its spread in Middle East, Africa and Mexico, that it can pose a serious threat to global cucurbit production in near future.

## Current Status, Challenges and Way Forward to Improve Export of Fruits and Vegetables

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Presently, Horticulture Industry of Pakistan is facing various challenges with respect to export of fresh fruits and vegetables to global high-end markets such as lower yield, infestation of various pre- and postharvest diseases, quality improvement, negative impact of global warming, water stress, improvement in R&D and proper use of latest technologies etc. This talk will highlight the statistical outlook of Horticulture Industry of Pakistan with reference to challenges faced by this sector. There is need to remove various barriers with realistic solutions to enhance export of fresh horticulture commodities. Role of R&D institution including Agriculture Universities is also very significant to provide solutions for various issues. The Horticulture Vision - 2030 has emphasized on various short-, medium- and long-term measures to uplift Horticulture Industry of Pakistan.

# SESSION TRACK

# A. Nursery Management

## Impact of Bio Fertilizers and Growing Media on Growth, Yield and Quality of Zinnia Flower

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Zinnia is a summer annual popular for its variety of colourful flowers. The present work was conducted at UAF Sub campus Burewala to increase the growth, yield and quality of Zinnia flowers. Initially, ten (10) different composite growing mixtures (made from different proportions of Baggas, Silt, and Sand, Coconut coir, leaf manure and Farmyard Manure) were tested in three replications for most suited medium for Zinnia production. To further boost the productivity of the flower, seeds of Zinnia were treated with Nitrogen fixing bio-fertilizers (Azotobacter and Azospirillum) and were sown in optimized growing media. Both experiments were conducted in pots in nursery under CRD layout with three replications. Parameters regarding seed quality (emergence percentage, speed of emergence), plant vegetative (number of leaves, number of branches, plant height, root length, Fresh and dry weight), and reproductive (days to flowering and blooming period) growth were recorded. Results showed that combination of sand, silt and coconut coir in 2:1:2 proportion was best for boosting vegetative growth of Zinnia plant. Seed mixing with 500 mg coconut coir treated with 10mL Azotobacter before sowing was found best for boosting almost all vegetative as well reproductive attributes of the plant.

## Compost as a Soil Media Increased Germination and Improved Growth of Ber (*Ziziphus mauritiana*) Seedlings

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Ber is important minor fruit of Pakistan which can be grown successfully in marginal lands. The cultivation of this fruit plant is increasing day by day due to its awareness among the farmers for information related to its fast growth, sustainable production, and nutritional value of fruits. Therefore, it is important that required true to type plants should be available in market at reason able prices. Suitable planting medias are considered basic requirements to get the maximum survival and growth due to their direct and significant impact on seedlings quality and productivity of trees later. So, this experiment was carried out to investigate to identify the most suitable media for ber seedlings. Seedling of 20 days old were transplanted in four different soil medias i.e., simple soil, compost, silt, and silt + compost + FYM (1:1:1). The results obtained from this study showed that the maximum survival percentage, number of leaves/seedlings, stem diameter, root length, leaf fresh, and dry weight were recorded when seedlings were transplanted in compost. It could be concluded that planting seedlings of in growing media contains compost is best for maximum survival and growth of subsequent seedlings.

# Mango Seed Germination as Affected by Growing Media, Orientations and Physical Properties

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Mango is the most celebrated fruit crop of Pakistan owing to its delicious taste, aroma, and commercial value. Mango nursery business is highly rewarding, but the quality of nursery plants has not been satisfactory in Pakistan. Further, the germination of recalcitrant seeds of mango has been very poor in various nursery conditions along with wide range of variation in seedling statutes. This study was aimed to design the best sowing conditions to achieve the maximum seed germination in mango rootstocks. Mango seeds collected from different sources were sown in different orientations to analyze the root and shoot germination patterns in baggas, silt, peat moss and coconut coir at UAF Sub-campus Burewala, Vehari. Success rate of transplanted seeds was studied for both the group sowings in the germination pots as well as in the seed beds in the lath house. Parameters like germination %, plant height, stem girth, root length, root girth, number of root branches, number of leaves, number of flushes, leaf length and leaf breadth were taken. Maximum plant height, root length, root girth, number of leaves was observed in silt and baggas at 1:2 ratio; whereas maximum plant height, stem girth, root length, root girth was obtain in seeds sown with dorsal side downwards. Conclusively, media composition and seed orientation were helpful in improving physical growth mango seedlings.

# SESSION TRACK

# B. Biodiversity & Conservation

## Physicochemical Characterization of Guava (*Psidium guajava* L.) Germplasm of Sindh

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Seventeen accessions of two guava cultivars *i.e.*, Round (Gola) and Pyriform (Surahi) were collected from Sindh province to evaluate the extent of diversity for physicochemical attributes. Maximum fruit weight (138 g) and fruit size (length 77.21 mm and diameter 65.83 mm, respectively) were found in strains collected from Hyderabad whereas, maximum fruit ratio, TSS (12.90 °Brix) and less no. of seeds were found in strains collected from Larkana. Among Pyriform accessions, maximum fruit weight (251.70 g), fruit size (length 101.33 mm and diameter 63.00 mm), minimum acidity (0.53%) and no seeds were found in $S_1$ (LSLr). Moreover, maximum TSS (14.73 °Brix) was found in $S_8$ (KSTJ), anthocyanins (0.50 mg/100 ml) in $S_6$ (BNSLr) and total sugars (8.56%) in $S_{10}$ (RSTJ). Likewise, among Round (Gola) accessions, maximum fruit weight (226.92 g) was found in $G_5$ (ABGTJ1) and fruit size (length 97.33 mm and diameter 91.33 mm) in $G_4$ (ShGTJ2). Less number of seeds/fruits 57.51 were found in $G_3$ (PGLr). Maximum TSS (17.44 °Brix) and total sugars (8.58%) were found in $G_1$ (RSGLr), anthocyanins (2.49 mg/100 ml) in $G_2$ (ShGLr) whereas, minimum TA% (0.43%) was noted in $G_4$ (ShGTJ3). These findings highlight the extent of available germplasm diversity in field. The promising selections could be useful as candidate varieties and parental material for future breeding programs.

## Physicochemical Diversity in White Flesh Guava Germplasm of Punjab and KPK Regions

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Guava (Psidium guajava L.) is a nutraceutically important commercial fruit crop of Pakistan. Thirty-seven accessions of white flesh Round (Gola) and Pyriform (Pear) shape guava cultivars were characterized for seventeen different physical and chemical traits to estimate variability. Accessions collected from Punjab had greater genotypic diversity and wider genetic base compared with KPK accessions. Several accessions of both cultivars were found better for important fruit traits including fruit weight (FW), fruit size (FS), total soluble solids (TSS), ratio TSS to titratable acidity (TA) and total sugars (TS). Among accessions, most of physical traits were strongly positively corelated whereas chemical traits were negatively correlated. Accessions with greater fruit size and a smaller number of seeds had lower TSS. Low temperature in both areas enhanced fruit size and decreased total sugars. The selected accessions could be multiplied as candidate varieties and used for genetic association studies.

## Relationships Among Elite Jujube Germplasm of Khyber Pakhtunkhwa Based on Morpho-Biochemical Traits

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Plant genetic resources are vigorously used in tree fruit improvement programs. Although Pakistan is rich in jujube (*Ziziphus mauritiana* Lamk.) genetic resources, yet it is a minor fruit crop in the country. Keeping in view the breeding objectives, morpho-biochemical diversity was estimated in 10 jujube accessions by using 32 morphological traits linked to tree, leaves, fruits and stones. Fruit weight and its dimensions were highly diverse and positively correlated with each other in all investigated accessions. The measured quantitative traits like leaf length ranged from 1.9-7.2 cm, leaf width varied from 1.4-6.5 cm, fruit weight diverged from 5.63-38.45 g, stone weight varied between 0.74-1.38 g, fruit firmness ranged from 0.14-1.88 kg, TSS dispersed between 8.5 to 17.23 %, while vitamin-C contents lies between 101.34-150.5 mg/100g. Vast morphological differences were also recorded for qualitative traits like tree shape, branching habit, leaf shape, leaf margins, leaf veins, fruit shape, fruit apex, fruit base, stone shape and for stone apex. Many of these traits are economically very important and can be helpful to boost fruit yield and quality. The PCA plot showed high phenotypic diversity and indicated that measured traits can be useful for developing jujube plant descriptor at country level and for improving taxonomy. Finally, findings of present studies are promising for managing jujube genetic resources, in cultivar improvement and for future successful breeding programmes.

## Genetic Diversity and Population Structure of Date Palm Male Accessions by Using SSR Markers

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Date palm is an evergreen, mono-cotyledonous and dioecious (2n=36) fruit plant. Naturally, date palm is a dioecious fruit tree in which male and female reproductive organs are positioned on dissimilar trees. A significant, attention driven but ignored fact i.e., “metaxenia” exists in date palm which is effect of pollen grain from diverse males on the maternal tissues of fruit. Date palm male plants of diverse origin exhibit genetic variations. Genetic diversity in any germplasm is of prime importance for utilization in crop improvement. Molecular characterization is ideal for the determination of diversity as genetic associations and inheritable variations can be determined only

through molecular characterization. Twenty-five SSR primers were used to determine genetic diversity in 32 date palm male accessions. Molecular diversity was documented by using Power marker, GenAlEx, STRUCTURE and PAST software. Studied SSR primers proved effective for detecting polymorphism among selected date palm male accessions. In this study, genetic diversity ranged from 0.3535 to 0.5208, heterozygosity deviated from 0.3438 to 0.5313 and polymorphic information content lied from 0.3093 to 0.4575. The analysis of molecular variance (AMOVA) disclosed that genetic diversity came off from within population variation (51%), whereas among population it was 49%. The results demonstrated that selected SSR markers were appropriate for studying genetic analysis in date palm male accessions.

## Role of Diversity in Improving Peach (*Prunus persica*) Genotypes and Germplasm Conservation

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Biodiversity is a record of variability between species that helps to sustain species and maintain the ecosystem. The available information on diversity helps to improve and develop new varieties having better traits and production. Among stone fruits, peach has its value due to its nutrition and is famous as the queen of fruits due to a delicious taste and attractive fragrance. Peach is the most important fruit species and has a diversity of germplasm throughout the world with the largest number of commercial genotypes. It has huge variations in skin color, fruit shape, fruit size, and pubescence on fruits that varies from cultivar to cultivar. Moreover, it has a huge variation in biochemical attributes concerning its cultivars and the environment. In Pakistan, there is a huge diversity of genetic resources of peaches including commercial cultivars, landraces, and wild species, and some genotypes have the potential to be utilized directly as rootstock cultivars, while others could be utilized in breeding programs to develop new superior cultivars with novel traits. Therefore, it is of utmost importance to collect the information of available peach genotypes for the conservation of the species.

## Gene Flow and Domestication of Potatoes in Southwestern Province of China

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Potato is non-native to China but it is the world's leading country for potato production. Historically potatoes were imported from the International potato centre (CIP) and the other European countries to China which were domesticated and evolved as the landraces. To improve the available gene pool for future potato breeding programs, a diverse population containing a mini core collection of potato (including foreign elite lines, local landraces and cultivars) was selected and genotyped by SSR markers covering the entire potato genome. A total of 174 alleles were detected with an average of 5.5 alleles per locus. Whole population could be discriminated into two main groups and seven subgroups. One sub-group (P1) revealed less genetic diversity and earlier maturity than other (P2) and contained a higher number of commercial cultivars possibly indicating a slight reduction in diversity due to selection in breeding programs. The P2 sub-group showed a wider range of genetic diversity and later maturity with more new and unique alleles attained from wild relatives. It was proposed that the potato genotypes clustered in sub-population P1 may be derived from historical population imported from ancient European and International Potato Centre genotypes while sub-population P2 may be derived from modern populations from International Potato Centre and European genotypes. It is suggested that the potato genotypes were introduced from Europe to China, domesticated as landraces, and then hybridized for modern cultivars.

## Potato Germplasm Characterization for Phenotypic Diversity and Tuber Yield

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Potato germplasm comprising 52 indigenous and exotic cultivars was evaluated for plant growth and yield related attributes. Maximum number of stems (8.33) were recorded in varieties NARC, Sadaf, Ruby and SL-24-29, respectively. Maximum tuber yield per plant was recorded in Fortus, SL-15-10 and Hermosa (1.70 kg and 1.39 kg, respectively). Correlation analysis revealed that plant height, width and length of the leaf had a positive correlation with the tuber weight and yield per plant. Principle component analysis (PCA) of 12 quantitative traits in both exotic and indigenous cultivars revealed significant morphological diversity and maximum variability (88%) was found in the first five factors. The phylogenetic dendrogram clustered varieties having similar morphological traits into class-1 (most of the indigenous germplasm) and class-2 (exotic cultivars).

Among indigenous varieties, FD-35-36 and SL-15-10 were found as more promising varieties for better yield and quality tuber production.

## Identification of Trait Sources for Yield, Disease and Drought Resilience in Bean (*Phaseolus vulgaris L.*) Landrace Diversity of North-Western Kashmir Himalayas

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In the present study, we evaluated 93 accessions (88 local landraces and five checks) of beans. There was a substantial variation among accessions evaluated for the seven qualitative traits, eight morphological and yield traits as well as pod and seed cooking quality. Most of the accessions (51) were bush type with predominantly green pods and red seed coat colour with varying degrees of mottling of seed coat and medium seed size. Broad range was observed for traits like range for days to 50% flowering (32.00-70.00), days to maturity (71.00-125.00), plant height (37.33-275.37), pods per plant (5.78-31.12), pod length (7.67-26.33), seeds per pod (2.60-7.56), 100-seed weight (12.60-59.94) and seed yield per plant (5.15-46.72). Higher PCV and GCV values were recorded for plant height, pods per plant, seed yield per plant, and 100-seed weight and low for days to flowering, days to maturity, and seeds per pod. Heritability ranged from 76.69 % for seed yield to 99.60 % for plant height. Seed yield was positively correlated with number of pods per plant, 100-seed weight and pod length and it was negatively correlated with days to maturity. PCA concentrated the variability in the first four components (78.40 %) of total variation with first two PC's explained 51.00 % of total variation mainly contributed by pods per plant, 100-seed weight and plant height. Out of 93 accessions 17 were found to be resistant to BCMV. Significant variation was found in root architecture, physiological and biochemical traits related to drought stress.

## Bio-diversity of Medicinal and Aromatic Plants of Juniper Tract Biosphere Reserve in Ziarat Balochistan, Pakistan

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This preliminary study provides the distribution pattern of biological diversity of medicinal and aromatic plants of Juniper tract Biosphere Reserve, Ziarat Balochistan, Pakistan. These plants are traditionally and medicinally important in the rural communities of Ziarat Juniper tract, Balochistan Pakistan. A total of 30 plots were established along the slope, ranging from 1,400 to 3,000 masl. The data was recorded in the circular sample plots of 0.05 ha (radius of 12.62 m). Frequency distribution and species richness were evaluated. Out of total recorded forty-four taxa, 51% were herbs, 39% were shrubs and 10 % were trees. Most common wildly distributed plants were of Asteraceae. Berberis baluchistanica of Berberidaceae was the most frequent record along the juniper track followed by Cotoneaster nummulari of Rosaceae, while Stipa trichoides was the most common grass. The results revealed that biodiversity distribution was relatively diverse along

different elevations and roadside. This study also revealed the species distribution pattern along with the altitudinal gradient and the impact of human activities at Juniper track. Thus, our findings provide valuable information that could help in managing biodiversity and conservation.

## CRISPR Mediated Genome Editing: An Efficient Tool for Development of Abiotic Stress Tolerant Horticultural Crops

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A wide range of crops such as fruits, berries, nuts, flowers, aromatic and medicinal plants are included in horticultural crops. These crops provide dietary, therapeutic, and aesthetic benefits to the mankind. Abiotic stresses such as drought, salinity, temperature, and presence of heavy metals in the soil substantially reduce crop yield globally and pose a major threat to the food security. The development of abiotic stress-tolerant crops is considered the most suitable and eco-friendly approach to cope with this challenge. However, labour intensive, time, and resource-consuming backcross and selection processes make it challenging to implement. In contrast, CRISPR/CAS9 and availability of genome sequence information of major horticultural crops (e.g., Cucurbitaceae crops, Solanaceous crops, Banana, Citrus, Apple, Spinach) provide opportunities for crop improvement by targeted genome engineering. Moreover, several horticultural crops have been already edited using clustered regularly interspaced short palindromic repeat (CRISPR/CAS) technology to meet a diverse array of research objectives. However, most of them were edited to achieve biotic stress resistance, but the development of abiotic stress-tolerant crops is also necessary with changing climate of the world. In this regard, selection of genes is considered critical. However, structural genes, regulatory genes, and cis-acting elements can be targeted through CRISPR/CAS, providing an efficient and practical approach for developing abiotic stress resistant crops. We are hopeful that CRISPR/CAS genome editing tools can change this scenario by developing abiotic stress tolerant crop cultivars that can boost production and quality.

## Morpho-Molecular Characterization and Phylogenetic Relationship in Jamun Germplasm of Pakistan

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Jamun (*Syzygium cumini*) a well-known evergreen plant with high nutritional and medicinal value is native to Pakistan. Information regarding jamun genetic resources is missing and its complete potential is not yet discovered therefore, it is still a minor fruit crop in Pakistan. Therefore, a

research was designed with the objective of variability analysis among jamun accessions. Fifty jamun accessions were collected and evaluated on morphological, biochemical and genetic bases. Qualitative characters (tree and fruit shape, fruit apex, base) were polymorphic and generally showed more than two phenotypes. Among accessions variation in data was also observed in case of quantitative characters like pulp content (43% to 91%), fruit length (2.20 cm - 4.17 cm), fruit width (1.40 cm - 2.97 cm) and fruit weight (2.67 g - 12.63 g). Among biochemical characters. TSS (13.7% - 25.4 %), TA (0.38 - 1.15%) and antioxidants (19.81 - 251.47 mg/g) also found diverse in between accessions. PCA biplot exhibited highest phenotypic variability in SFM-08, SFS-02, TUK-02, KDC-04. For genetic diversity assessment 10 Random Amplified Polymorphic DNA (RAPD) and 8 Inter-Simple Sequence Repeat (ISSR) markers were used and a total of 220 and 73 amplification products were scored, of which 61% and 87% were polymorphic respectively. The maximum discriminating band was obtained from Primer OPA16. Accessions collected from Toba Tek Singh (TUK-02) and Faisalabad (SPJ-05, SFM-08) were distinct with both type of markers and showed clear distinctive qualitative and quantitative features that can be helpful in future for crop improvement.

## Analysis of Genetic Diversity in Date Palm from Pakistan Using Cytochrome P450 Based Analogue Markers

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In Pakistan, date palm (*Phoenix dactylifera*) has a primary importance as a subsistence crop, cultivated in areas, where soil moisture and climatic conditions are relatively severe. The selection of superior genotypes from seed and offshoot proliferated date palm populations was dependent on morphological and physiochemical characteristics of the fruits, often influenced by environmental conditions. Regular transfer and exchange of such cultivars across the country is responsible for patchy and distributed populations especially in Khyber Pakhtunkhwa with ambiguous local names causing complications in their identities. The identities are also ambiguous due to the utilization of different identification tools, reference resources and local languages. Molecular descriptors for standardization and categorization are still non prevalent. Commercial and market potential of such date palm cultivars can only be achieved by the exact identification of superior genotypes. The present study is designed with the aim to assess genetic variations of commercially important date palms of Pakistan using Cytochrome P450 Based Analogue (PBA) markers. Genetic diversity and DNA polymorphism among 109 accession was characterized using 15 PBA markers. 13 0ut of 15 primers gave reproducible amplifications yielding 208 bands. Percentage polymorphism for the accession was 57.21% to 79.33% with a mean of 73.32%.

Analysis of Molecular Variance (AMOVA) results revealed that genetic differentiation was highest (97%) within the population's accessions as compared to among populations' accession (3%). The Un-weighted Pair Group Method with Arithmetic Mean (UPGMA) showed no prominent clustering based on geographical distribution. Results of Principle Coordinates Analysis (PCA) were also in accordance with cluster analysis. This revealed that PBA markers could be effective in measuring genetic diversity of date palm. The results indicated high genetic variations of date palm germplasm growing across Pakistan that could be utilized for the conservation and selection of good varieties.

# SESSION TRACK

# C. Breeding & Biotechnology

## Phenotypic Characterization of Colchiploid Germplasm of Eustis Limequat

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Eustis limequat (*Citrus aurantifolia* × *Fortunella japonica* Swingle) is a widely used acid lime cultivar in Pakistan due to its immense nutraceutical benefits. It is commonly known as Chinese lime. Its cultivated area, per hectare yield and demand is increasing. There is need for its varietal diversification to widen its germplasm base and develop polyploids for crop improvement. Polyploids offer higher heterozygosity, gigantism and have more climate change resilience. Colchiploids of Eustis lime were developed by treating seeds at different colchicine levels (control, 0.01, 0.05 and 0.1 %) and phenotypic variability was recorded. Seed germination was higher in control (80%) and took a smaller number of days in germination (14) compared with increased level of colchicine *i.e.*, 0.1 %, (44.67 %) was recorded and took a greater number of days (20) in germination. Higher colchicine level (0.1 %) markedly increased leaf length (3.48 cm), leaf width (2.31 cm) and number of leaves (7.20) compared with control and other colchicine levels. However, substantial decrease in shoot length (7.53 cm) and internodal distance (1.16 cm) was noted with the increasing level of colchicine. Cytological characterization using stomatal studies is ongoing for screening of putative polyploid germplasm. The selected promising plant material from the developed population will be useful for future breeding programs.

## Callus Induction and Embryogenesis Responses in Anthers of Guava (*Psidium guajava* L.) Cultivars

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Haploids have been produced in few tree crops including citrus, papaya, mulberry and apple using androgenesis, however, little is known about guava regarding androgenesis. Research was conducted to screen different $N_6$ basal media modifications for androgenesis in two guava genotypes using cold shock treatments. Anthers having uninucleate microspores developed more calli in two ($M_{10}$ and $M_{11}$) out of eleven different media formulations. Anthers of cv. Pyriform (Surahi) showed higher callus induction (69.58%) on $M_{10}$ ($N_6$ + 0.5 $mgL^{-1}$ 2,4-D) whereas anthers of cv. Round (Gola) developed more callus (66.60%) on $M_{11}$ ($N_6$ + 0.5 $mgL^{-1}$ 2,4-D + PVP) after cold shock pre-treatment. Anther browning was reduced to minimum in both cultivars after cold shock treatment on $M_{11}$. Anthers of cv. Round showed less browning compared with cv. Pyriform. The $M_{11}$ media augmented with PVP, increased sucrose levels and cold pre-treatment of anthers reduced browning in anthers and the developed calli. The proliferating calli in both cultivars showed development of embryogenic masses upon transfer in light on media devoid growth hormones. Maturation and germination of the somatic embryos developed from anther derived calli is in progress to produce haploids for future breeding programs.

## Morphological and Stomatal Diversity in Colchiploid Germplasm of 'Foster Pink' Grapefruit (*Citrus paradisi* Macf.)

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Polyploidization have played a pivotal role in the development of citrus germplasm having better plant vigor, thick and large leaves with intense color, more abiotic stress tolerance, dwarfness and to develop parental material for inducing seedlessness through interploid hybridization. A pink flesh seedy grapefruit (*Citrus paradisi* Macf.) variety 'Foster Pink' was selected for the development of colchiploid plant material. Seed treatment with colchicine solution (0.01 % - 0.1 %) for 8-10 hrs significantly arrested seed germination (%) which was reduced to (%) compared with control showing 86.67% seed germination. The plant material developed at higher doses of colchicine (0.05 % - 0.1 %) depicted more plant height (6.12 cm), greater number of leaves (5.0), higher leaf ratio (2.20), greater leaf length (3.66 cm), width (1.81 cm) and leaf area (1.61 $cm^2$) and more inter-nodal distance (0.51 cm) compared with control. Stomatal studies of the population revealed higher frequency of stomata per unit area (71.15) and decreased stomatal density (547.30 $mm^2$) in colchicine treated plants compared to control (82.45 and 634.19 $mm^2$, respectively). However, stomatal length and width was increased in colchicine treated plants (28.51 µm and 19.09 µm, respectively) and stomatal size was more (544.25 $\mu m^2$) at 0.05% colchicine treatment. Increasing levels of colchicine altered plant growth, leaf attributes, stomatal frequency and size indicating efficiency of the mutagen and a promising change towards hyperploidy. Chromosomal counting of the putative polyploid germplasm is in process for confirmation. Such studies will widen germplasm diversity and develop parental material for future breeding and biotechnology applications for grapefruit crop improvement.

## *In Vitro* Regeneration Responses in Acid Limes

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*In vitro* regeneration system was established in acid lime species and effect of different plant growth regulators was investigated for mass multiplication of the desired material. Nodal segments from the in-vitro grown plantlets were cultured on Murashige and Tucker (MT) basal medium fortified with various levels of benzyl-aminopurine (BAP) and naphthalene acetic acid (NAA). Maximum number of shoots induced per explant (4), shoot induction (80%) and plant survival (70%) were noted at higher level of BAP @ 3$mgL^{-1}$ in Mexican lime. In Eustis limequat, with increasing level of BAP, number of days taken to shoot induction (7) were reduced. The longest shoots (4.96 cm) were exhibited on media supplemented with BAP (3 $mgL^{-1}$) and NAA (1 $mgL^{-}$

$^{1}$). Best root induction (60%) was obtained at NAA @ 1 $mgL^{-1}$ in both Mexican lime and Eustis limequat. Conclusively, Mexican lime explants showed better response towards shoot and root induction compared with Eustis lime explants.

## Anatomical and Physico-Chemical Effects of Dwarfing and Vigorous Rootstocks on 'Red Fuji' Apple

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High-density plantations raise crop yields without increasing the space required for planting. The physiological and biochemical responses of various scion/rootstock combinations were investigated to elucidate possible mechanisms involved in rootstock-induced vigor control. Morphological observations demonstrated that the shoot length and root characteristics of 'Red Fuji' apple plants with 'M.9' were noticeably lower compared with M.26, Chistock-1, and Baleng rootstocks. Lower xylem vessel density and vessel diameter were found in the leaf of 'Red Fuji grafted with M.9 rootstock than vigorous rootstocks. Furthermore, xylem area and xylem/phloem ratio were also highest with 'Baleng' rootstocks, while the other three rootstocks recorded the lowest one. Preliminary correlation analysis and factor analysis showed that internodal length, scion trunk diameter (scion morphology index), number of root tips, and root volume (root system morphology) represented the main morphological indices for evaluating the dwarfing effects of rootstocks. Besides, starch content, indole-3-acetic acid, zeatin riboside, gibberellic acid, abscisic acid, phosphorous, calcium, iron, hydraulic conductance, net photosynthesis rate, intercellular $CO_2$, and stomatal conductance can be considered as main physiological and biochemical parameters influenced by different rootstocks. This study concluded that morphological parameters (lower plant height), lower hormonal ratio (IAA+$GA_3$+ZR)/ABA), lower mineral (P, K, and Mg), and higher starch content could be used as indices for the selection of dwarfing apple rootstocks. Our results provide a systemic viewpoint into the complex physiological mechanisms of rootstock-induced size control and dwarf indicators for early screening of dwarfing rootstocks.

## Genotypic and Phenotypic Correlation and Path Coefficient Analysis for Plant Yield in Potato (*Solanum tuberosum* L.)

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Potato is considered as one of the most important food crops after wheat, maize and rice due to its nutritional values. Potato crop is grown in tropical regions of the world *i.e.*, highlands of Andes and Africa, volcanic mountains of West Africa and South East Asia. The experiment was conducted under RCBD with two replications. Analysis of variance showed all observed traits had high significant variations. Plant yield had significant association with chlorophyll contents, tuber weight, relative leaf water contents and tuber length in phenotypic correlation analysis. While plant yield had negative association no. of compound leaves and positive with chlorophyll contents, no. of tubers, tuber weight, tuber girth and leaf area in genotypic correlation. No. of tubers and plant height showed high positive direct effect on plant yield. No. of tubers had positive indirect effect on plant yield through tuber girth, leaf area, no. of aerial stems and tuber moisture contents. Tuber dry matter depicted high heritability followed by tuber weight, no. of tubers and plant yield. This indicated that the plant yield in potatoes can be improved by improvement of yield associated traits.

## Association Mapping Reveals Novel Genomic Regions Controlling Some Root and Stolon Traits in Tetraploid Potato (*Solanum tuberosum* L.)

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Tuber crops have measurable biological variation in root and stolon phenotyping and thus may be utilized to identify genomic regions associated with these variations. The study is the first comprehensive association mapping study related to potato root and stolon traits. A diverse panel of 192 potato (*Solanum tuberosum* L.) genotypes were grown in aeroponics to reveal a biologically significant variation and detection of genomic regions associated with root and stolon traits. Phenotyping of root traits was performed by WinRHIZO, while SolCAP 25K potato array was used for genotyping. Significant variation was observed between the potato genotypes for root and stolon traits along with high heritability (0.80 in TNS to 0.95 in SL). For marker-trait associations, Q+K linear mixed model was implemented and 50 novel genomic regions were detected. Significantly associated SNPs with stolon traits located on Chr 4, 6, 7, 9, 11, and 12, while those linked to root traits on Chr 1, 2, 3, 9, 11, and 12. Structure and PCA analysis grouped genotypes into four sub-populations disclosing population genetic diversity. LD decay was observed at 2.316 Mbps (r2=0.29) in the population. The identified SNPs were associated with genes performing vital functions such as root signalling and signal transduction in stress environments (GT-2 factors, protein kinases SAPK2-like and protein phosphatases "StPP1"), transcriptional and post-

transcriptional gene regulation (RNA binding proteins), sucrose synthesis and transporter families (UGPase, Sus3, SuSy, StSUT1) and PVY resistance (Ry sto). The findings of our study can be employed in future breeding programs for improvement in production.

## Genome-Wide Association Studies Revealed Genetic Basis for Unique floral Traits in A Diversified Potato Panel

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Potato is the most important non-cereal staple crop serving as a source of food for large number of world population. Genome-wide association studies (GWAS) becomes a very useful tool to uncover the genetic basis of important plant traits by revealing significant association with trait of interest. Present study was aimed to explore the phenotypic diversity and to identify the genetic basis associated with important floral traits in tetraploid potato panel. A total of 237 tetraploid potato genotypes originating from different countries were used as plant material and grown at the experimental research area of Potato Research Center Niğde Ömer Halisdemir University, Turkey for two consecutive years (2016-2017). Mean data across both years resulted sufficient variation for pistil length (5.53 to 9.92 mm), stamen length (6.04 to 9.26 mm), and pistil length above stamen (1.31 to 4.47 mm) in the studied potato germplasm panel. Analysis of variance for the studied floral traits reflected highly significant genotypic effects. Pearson's correlation analysis reflected highly significant and positive correlation of stamen length with pistil length and pistil length above stamen. Principal component analysis was performed and the first two PCs were considered that accounted a total of 81.2% variations. A total of five markers were separately identified for stamen length (solcap_snp_c1_9717, solcap_snp_c1_9724, solcap_snp_c2_9035, solcap_snp_c2_9218, solcap_snp_c2_44474), pistil length (solcap_snp_c2_43285, solcap_snp_c2_42381, solcap_snp_c2_8513, solcap_snp_c2_23030, solcap_snp_c2_34608) and pistil length above stamen, respectively across both years. Identifying same markers across both years helped in the validation of the claimed marker-trait associations for the studied floral traits. This is very first study claiming marker-trait association for important floral traits and we believe that present information will be helpful to the scientific community interested in uncovering the genetic architecture of potato flower.

## Genetic Studies for Yield Related Traits in Tomato (*Solanum lycopersicum* L.)

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An experiment was conducted to identify the potential parents for the development of prominent hybrids in tomato based on combining ability evaluations using line x tester design. Eight parent and sixteen crosses were sown under field conditions replicated thrice following Randomized Complete Block Design and data collected for various traits were subjected to analysis of variance. Results showed highly significant differences among parents for flowers per cluster, clusters per plant, fruit setting percentage, fruits per cluster, fruit weight, plant height, days to first harvest, fruits per plant, fruit length and fruit yield per plant. Crosses showed significant differences for all traits except days to first flowering and days to 50% flowering. Tester CLN-2413 was good general combiner for flowers per cluster, branches per plant, plant height and fruits per plant, while BA-1079 was good general combiner for plant height, fruit weight, fruit length, fruit width and yield per plant. Among crosses BL-1174 × BA-1079 was good specific combination for days to first flowering, BL-1174 × Yaqui for flowers per cluster and clusters per plant, whilst BP-LO-017904 × 01786 for fruit weight and fruit length. These cross combinations may be used on commercial scale to exploit heterosis after further evaluation.

## Agro-Nutritional Phenotyping and Association Analysis of Okra Genotypes

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Okra (*Abelmoschus esculentus* L. Moench) is an important vegetable with essential nutritional and commercial significance that can be grown in a wide range of climatic conditions. The present study was conducted to evaluate twenty-one okra genotypes to identify better performing accessions in terms of leaf morphology, growth attributes and nutritional profile. Three male genotypes were crossed with nine distinct female genotypes using North Carolina Mating Design-I (NCM-I). All the parents and their crosses were grown in three replications using randomized complete block design (RCBD) and data for various agro-morphological and nutritional characteristics like plant height, pod length, leaf length, leaf breadth, total number of nodes, number of fruiting nodes, pod diameter, crude fat percentage, protein percentage, ash percentage, crude fibre percentage, ether extract percentage and nitrogen free extract percentage were recorded at maturity. All the characters showed significant results except for number of fruiting nodes and ether extract. For total number of nodes, the best specific combiner was OK-1307 × Sabz Pari and the maximum heterosis was shown by Durga × Perbhani Selection Karanti. Additive gene action was found for all parameters except for number of fruiting nodes. Maximum broad and narrow sense heritability was found for total number of nodes and pod length, respectively. The strongest positive correlation was computed between crude fat and protein percentage. The vigorous

genotypes were recommended for further genetic improvement for the purpose of developing high yielding okra varieties.

## Line × Tester Analysis for Some Yield Related Traits in Okra (*Abelmoschus esculentus* L. Moench)

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Okra is a traditional vegetable famous for its nutritional value. The research was carried out in the research area of the Department of Plant Breeding and Genetics, University of Agriculture Faisalabad. Cross combinations among 3 lines (Patel, Selection Super Green and 19234) and 3 testers (IQRA-III, Perbhani Karanti and Sabz Pari) were developed by using line × tester design. Crossed seeds along with parents were grown in the field under Randomized Complete Block Design (RCBD) with three replications. Data for various morphological traits were collected and analyzed statistically through analysis of variance and used to assess GCA, SCA and gene action. Correlation analysis was also performed for various plant traits to check the association of characters. Genotype "Selection Super Green" proved a good general combiner for fruit weight, fruit diameter and first flowering node, exhibiting values of 3.21, 1.191 and -0.89, respectively. Line 19234 was observed a good general combiner for crude fat (0.28), ash (5.43) and protein (0.39). Cross combination Patel × Perbhani exhibited the highest SCA for the number of fruits (7.78) hence can be exploited for heterosis breeding. Characters e.g., plant height, fruit length, fruit weight, leaf length and ADF were significantly associated with the number of fruits at the genotypic level. Line Patel proved a good general combiner for most of the yield-related traits. Based on GCA and SCA, line 19234 can be used to enhance quality traits and cross combination Patel × Perbhani Karanti can be used to increase the number of fruits per plant.

## Salt Induced Modulations on Physio-Morphological Traits in Okra (*Abelmoschus esculentus* L. Moench)

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Elevated concentration of salts in soil is causing a severe reduction in plant growth, development and yield. Okra is considered moderately tolerant to salinity. Genetics of okra genotypes was studied for NaCl tolerance (0, 10, 15 $dSm^{-1}$) by using Line × Tester analysis. Five lines *i.e.,* Pussa Swani, OK-1307, OK-1308, Okra-RM and Green Makhnali and three testers *i.e.,* Perbhani Karanti, Selection Super Green and Anmol along with their fifteen F1 population were observed for different morpho-physiological traits including the concentration of Na+ and K+ ions in the leaves. The study was conducted under a completely randomized design (CRD) at the research area of the Department of Plant Breeding and Genetics, University of Agriculture Faisalabad. Line OK-1308 exhibited the highest GCA (23.23) for $K^+$ concentration at 15 $dSm^{-1}$ of NaCl stress while Okra-

RM × Perbhani Karanti was observed with maximum SCA (30.89) for $K^+$ under 15 $dSm^{-1}$ of NaCl stress. Results concluded that salt tolerance in okra was controlled by both additive and dominant genes *i.e.,* at 15 $dSm^{-1}$ NaCl stress, maximum GCA variance was observed for Na+ concentration (21.65) while maximum SCA variance was found for $K^+$ concentration (884.06). The highest broad-sense heritability was estimated for dry root weight under an extreme level of salt *i.e.,* 0.93 while maximum narrow-sense heritability was found for $Na^+$ concentration (mg/L) *i.e.,* 0.12. Traits with high broad-sense heritability under the highest concentration of salt were considered valuable for further breeding programs in future and moreover, the Narrow sense heritability estimates are more desirable for a plant breeder.

## Dissection of Association Among Yield and Yield Related Traits in Tomato Germplasm

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The current research work was performed to study the dissection of association among yield and yield-related traits through correlation and path analysis in 10 tomato genotypes. This experiment was carried out in the Department of Plant Breeding and Genetics, University of Agriculture Faisalabad. The nursery was grown in a Greenhouse and after 35 days, materials were shifted in the field. The experiment was conducted in Randomized Complete Block Design (RCBD) with three replications. At maturity, data was recorded for yield and yield-related traits like; plant height, days taken to 50% flowering and fruiting, No. of branches per plant, No. of clusters per plant, No. of flowers and fruits per cluster, fruits size, single fruit weight, locules per fruit and yield per plant. High heritability and medium genetic advance indicated that environmental factors less influenced the studied traits. Correlation analysis at phenotypic and genotypic levels showed a highly significant and positive correlation between yield per plant and number of clusters per plant, plant height, days to 50% flowering. Path coefficient analysis revealed that the number of clusters per plant, number of fruits per cluster, fruit setting percentage, days to 50% maturity and single fruit weight had positive direct effects on yield per plant. While, fruit width, fruit length and plant height had direct negative effects on yield per plant. Genotypes LA-1278, LA-2662 and LA-2661 have maximum yield and may be used in the future breeding program for yield improvement.

## Characterization of Okra (*Abelmoschus esculentus* L.) Genotypes for Fruit Yield Related Traits

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Okra (*Abelmoschus esculentus* L.) is imperative vegetable crop belong to family Malvaceae and its common name is lady finger. The study was conducted for the characterization of okra for yield related traits in 30 genotypes. The study was conducted at vegetable field area of Department of Plant Breeding and Genetics, University of Agriculture Faisalabad. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Different yield and its related parameters *i.e.*, first flowering, fruiting span, plat height, number of leaves per plants, fruit length, number of fruits per plant, intermodal length, average fruit weight and hundred seed weight were measured using the standard protocol. Treatment means were compared by Least Significant Difference test at 5% probability. Analysis of variance showed significant differences for all studied traits. Highest mean values were observed for days to flowering in Nirali while minimum values were observed for 19224. Maximum fruiting span and 100 seed weight were observed for Parabhani karanti, 15382 and 19225 while maximum number of fruits per plant showed by 19225. Positive correlation was found among all traits except days to first flowering and days to first fruit setting. The genotypes Parabhani karanti and 19225 performed well as compared to Iqra-III, Nirali and Clemson spineless under the climatic conditions of Faisalabad. The study suggested that the farmers should be advised to cultivate Parabhani karanti and 19225 genotypes of okra for better crop stand and maximum yield.

## Effect of 6-Benzylaminopurine on Micropropagation of Selected Cucumber Germplasm

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The aim of current study was to establish micropropagation in cucumber plants using different explants on Murashige and Skoog (MS) media containing 6-benzylaminopurine (BAP). Significant results were revealed in three cucumber cultivars Champion, CP. 001 and Local Khera regarding micropropagation from single node, hypocotyl, shoot tip and axillary bud explants. Induction of number of shoots per explant was significantly influenced by application of BAP @ 0.5 $mgL^{-1}$. The cultivar Local Khera performed better when axillary bud, single node and shoot tip explants were cultured on BAP. However, Local Khera also showed better results for hypocotyl and shoot tip while CP .001 performed well for axillary bud and node culture. All concentrations of BAP increased root induction percentage when axillary bud, hypocotyl, shoot tip and single node were used as explants. Cultivar Local Khera showed higher percentage of roots for hypocotyl and shoot tip explants. The highest shoot induction (75.93%) was noted at higher level of BAP when shoot tips were cultured as explant followed by single node (75%) and axillary bud (62.50%).

**Brassinolide-Insensitivity Transcriptionally Inhibits Chlorophyll Synthesis and Photosynthesis Capacity in Tomato**

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Plant physiological responses are mediated through a network of molecular interactions between the BR signalosome and other plant hormones. The interactions between hormones, environmental signals, and developmental programs are so complex that the description and modelling of the whole system are very challenging. Brassinolide (BR) enhances the efficiency of photosynthetic machinery through the activation of metabolic pathways, photochemistry, and ribulose activity. In this study, we found the concealed BR-signaling mediated effects on tomato leaf morpho-physiological and biochemical traits, including chlorophyll accumulation and photosynthetic efficiency. Under controlled conditions, the altered brassinolide sensitivity1 (abs1) mutant showed decreased leaf area and biomass due to substantially reduced vascularization and epidermal cell size. abs1 mutant displayed significantly decreased chlorophyll accumulation and suppression in photosynthetic machinery components like photochemical quenching, electron transport rate, the maximal quantum yield of PSII photochemistry, and net photosynthetic rate. However, an increase in minimal fluorescence yield and non-photochemical quenching suggests that the abs1 mutant leaf has weakened abilities to harvest and transfer light energy. Moreover, the transcriptome analysis revealed differentially expressed genes involved in the chlorophyll biosynthesis and photosystem (PSI and PSII) reaction centre. The abs1 mutant depicted the decreased expression level of genes encoding light-harvesting chlorophyll a/b binding proteins and photosystem II binding protein A required for the reaction centre of the PSII complex. Besides, hormonal profiling of the abs1 mutant indicates the complexity of the BR and other phytohormones interactions. Our findings concluded that the BR signalling reduction transcriptionally impaired chlorophyll synthesis, harvesting quantum photon, and transferring light energy to PSI and PSII, leading to a decrease in overall photosynthetic capacity.

## Role of Biochemical and Molecular Markers in Horticultural Crops

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Horticultural crops are some of the main components of the human diet especially fruits and vegetables that are a particularly good source of fibre, minerals, vitamins, and antioxidants. The evaluation of fruits and vegetables is important in identifying desired traits for quality, shelf life, resistance to diseases, and stresses. Further, there are specific genes in crops against biotic and abiotic stress resistance. These resistant genes of one genotype are transferred to another genotype by interspecific or intraspecific breeding programs. To evaluate and accurate identification of the desired genes biochemical and molecular markers are used, that showed the result of crossing by telling purity of hybrid, edible quality, and adaptability of the transferred genes. Moreover, these biochemical and molecular markers are used throughout the world in breeding programs for crop improvement.

## Genome Wide Identification and Characterization of Plant Specific Dof Transcription Factor Gene Family in Cashew (*Anacardium occidentale*)

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DNA binding with one finger (Dof) proteins are one of the ubiquitous plant-specific transcription factors (PSTFs) gene family that take part in various biological processes including fruit ripening and organogenesis. The genome mining of cashew identified 67 potential *Dof* genes using variours bioinformatics tools. *Dof* proteins in cashew clustered into 8 subgroups named as A, B1, B2, C1, C2, D, E1, E2. The prevalence of segmental duplication was observed as compared to tandem duplication and this is the main reason of vast *Dof* gene family in cashew. The cis-regulatory elements (CREs) analysis disclosed the presence of elements that are specifically responsive to light, circadian, ethylene and ABA hormone, seed and meristem. In addition, a comparative analysis between *Dof* genes in cashew, lettuce and Arabidopsis is done to determine the evolutionary relationship. The extensive genome evaluation of *Dof* gene family in cashew presents reference for cloning and functional analysis of the members of this gene family.

## Screening of Various Algal Extracts for the Growth Stimulation of Brinjal Seedlings

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Brinjal is an important vegetable crop enrich with vitamins and minerals and cultivated on an area of 8325 ha per year in Pakistan. Extracts of micro and macro algae contains plant nutrients, growth hormones, amino acids and many other useful compounds. Owing to these constituents' algae are reported to increase various crop growth and yield parameters. In the present study several local freshwater algae were investigated for their possible stimulatory effect on growth of brinjal seedlings. Fourteen algal strains were collected from various water bodies of Punjab, Pakistan and algal extracts were prepared by boiling in water. The extracts were applied to Brinjal seedlings as foliar spray or root dip at 0, 10, 20, 40 and 100% of fresh weight of algae. One month after transplantation, the seedlings were harvested and parameters like root and shoot lengths, root and shoot fresh weight, and total dry weight were estimated. Out of fourteen, three algal species with tag name NP1, NP2 and NAR2 significantly improved root and shoot length and biomass of Brinjal seedlings. However, MIR6, MIR2, AR05, NAR1 and NAR3 algae increased root or shoot length, but did not affect overall biomass of seedlings. The effect of algae with tag name NAR5, NAR7, NAR4, M5 and AR08 was non-significant on length and weight of Brinjal seedlings. Regarding brinjal seedling length and weight, the effective dose of the extracts varied from 10 to 100% depending upon either applied as foliar spray or root dip. It is concluded from the results that selected algal strains can be used as growth stimulant of Brinjal plants.

# SESSION TRACK

# D. Organic & Protected Horticulture

## Health Benefits of Broccoli Sprouts: A Natural Remedy Against Various Diseases

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Broccoli is an edible Cole crop belongs to the species of cabbage considered as rich source of ascorbic acid, dietary fibres, glucosinolates, sulforaphane, selenium, and isothiocyanates respectively. It also had rich contents of indole-3-methanol, well the presence of all these components makes it a valuable vegetable possessing anti-cancer properties. Thus, it is widely used in the treatment of a variety of cancers along with neurological diseases. Moreover, broccoli is also known to have high levels of flavonoids, vitamins and minerals. World cancer research fund (WCRF) has reported about 11 million new cancers patients each year while studies have concluded improving diet particularly inclusion of vegetables *i.e.,* broccoli in regular diet could prevent 50% occurrence of breast cancer and 75% of stomach cancer. Ascorbic acid contents recognized as good substitute for iron therapy, but it can alter the metabolism of certain drugs and antitumor drugs. One of the therapeutic effects of broccoli is to treat skin diseases by using leaves juice to treat warts. Presence of sulforaphane in broccoli buds may also cure neurological diseases such as Alzheimer's and Parkinson's disease. It is also used to treat people with asthma and diabetes. Flavonoids have a role in reducing the risk of diabetes. Conclusively, presence of several phytochemicals in broccoli have shown to reduce the risk of several major diseases therefore its regular consumption in diet should be made compulsory for nourishing a healthy body.

## Effect of Organic Growing Mixes on Growth, Productivity and Quality of Eggplant (*Solanum melongena* L.)

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Sustainable vegetable cultivation is majorly dependent on raising of healthy seedling which is usually achieved by employing different growing media. Recently, the use of organic growing medium is much emphasized. Current research trial was carried out in Univ. of Agriculture Faisalabad to evaluate the impact of different organic growing media *i.e.,* sand, silt, wheat straw, rice husk, cotton ginning material and garden soil in combination on quality and productivity of two cultivars of eggplant (*Solanum melongena* L.). Different physical and chemical properties of growing mixes, seedling growth behaviour, vegetative and reproductive parameters, in addition with biochemical contents of fruits were evaluated. The research trial was conducted following randomized complete block design (RCBD) while statistical analysis was done following two-factor factorial analysis. Results depicts that Silt + Sand + Wheat straw + Rice husk combination have expressed maximum pH (6.3), EC (3.24 $dsm^{-1}$), N (0.16%), P (20.05 ppm) and K (1535 ppm). Whereas seedlings growth behaviour expressed that maximum germination (93%), shoot length

(8.74 cm), root length (5.90 cm), fresh weight (1.16 g), dry weight (0.10 g) was observed in Silt + Sand + Wheat straw + Rice husk combination. However, in vegetative growth parameters, Silt + sand+ cotton ginning material exhibited highest leaves per plant (86.99) and leaf length (15.83 cm) while maximum plant height (48.55 cm), root length (22.59 cm), minimum days taken to first harvest (103.66) and prolonged fruit harvest duration (169.33) in Silt + Sand + Wheat straw + Rice husk combination grown egg plants. Reproductive behaviour of egg plant was also enhanced under Silt + Sand + Wheat straw + Rice husk combination and exhibited highest number of fruits per plant (15.67) and yield per plant (3.86 kg). Alike outcomes were expressed from biochemical analysis of egg plant fruits where maximum TSS (2.03 °Brix) and Vit-C (2.7 mg 100/g) were observed in Silt + Sand + Wheat straw + Rice husk combination. Conclusively, outcomes exhibited that organic growing media (Silt + Sand + Wheat straw + Rice husk) enhances the germination index, seedling vigor, vegetative and reproductive growth and also the quality of produce thus expresses their potential to be used as commercial growing mix to manage the vegetable production.

## Effect of Moringa Leaves Extract on Growth and Yield of *Aloe vera*

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Aloe Vera, botanically known as *Aloe barbadensis Mill*, is a succulent perennial that belongs to the Liliaceae family. The use of chemical fertilizers to improve soil fertility, and hence, crop yield, have been reported to have adverse effects on agricultural products and environment. Moringa leaf extracts as a potential cultivator offer a relatively environmentally friendly, readily available and affordable way to increase yields to meet the growing global demand for food. Experiment was performed at UAF. Moringa leaves extract applied in five treatment application and at four different time point on Aloe Vera plants to know the effect of moringa leaf extract on growth and yield of Aloe Vera. Control treatment showed lowest growth in all parameters studied except moisture content%. Control showed highest largest leaf moisture content (89.77%). It showed lowest plant height (50.19 cm), total leaves length (28.73cm), total leaves plant breadth (5.5 cm), total leaf area (95.5 $cm^2$), total leaves fresh weight (1395.4 g), total leaves dry weight (94,99 g), largest leaf length (48.23 cm), largest leaf breadth (9.06 cm), largest leaf area (158$cm^2$), leaf fresh weight (318.8 g) and largest leaf dry weight (32.63 cm). T5 sprayed applied for 3 weeks after emergence showed statistically significant result showing highest plant height (55.91cm), leaves length (33.98 cm), leaves plant breadth (8.45 cm), leaf area (100.01 $cm^2$), leaf fresh weight (1402.7 g), leaf dry weight (98,62g), leaf length (53.82 cm), largest leaf breadth (12.53cm), largest leaf area (165.13 $cm^2$), leaf fresh weight (325.53 g) and leaf dry weight (37 cm).

## Role of Urban Horticulture in Global Food Security

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Globally, food production is of great concern due to rapid urbanization, decreasing arable land, and weather extremes due to climate change. It is expected that by 2050, the world population will be 9.6 billion and urbanization will be increase to 70% more in 2030. Due to this land scarcity and population increase, worldwide people will not get enough food and proper nourishment. Under this scenario, urban horticulture is of utmost importance as it provides a fresh food supply to urban dwellings and contributes to food security. Current urban cropping systems, such as home gardening, community gardens, edible landscape, and indoor planting systems play their essential role in the global food supply. However, the equipment of these systems with new techniques, such as vertical gardening, hydroponics, aeroponics, aquaponics, and rooftop gardening will enhance more food production as these modern techniques are eco-friendly, energy-saving, and promise food security through steady supplies of fresh fruits and vegetables to urban neighbourhoods. Therefore, in the future urban horticulture could play a really important role in strengthening local food security and in providing fresh and nutritious food to urban residents.

## Trends, Challenges and Solutions of Herbal Crops Cultivation: A Case study in Tehsil Jhumra District Faisalabad

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Herbs usually refer to the leafy plants or flowering portions of a plant. In primary health care, herbal medicine still accounts for approximately 75-80% of the world's residents (mainly in emerging countries), which is the main pillar. However herbal products are effective for curing of different disease especially in rural areas. The study was conducted in tehsil chak Jhumra district Faisalabad. The main objectives of the study were to identify current trends, challenges faced by herbal crop growers and its solutions. Interview schedule was used for data collection as research instrument. The data were analyzed through statistical package for social sciences SPSS. Vast majority 85.6% farmers belonged to crop farming and livestock farming, while 7.7% respondents had only crop. It was found that farmers' awareness about herbal crops is ranked 1stwith mean value 3.50 and standard deviation 1.02. Healing properties of herbal crops (3.43), herbal farming (3.42), and herbal products (3.23), usage of herbal crops (3.09), herbal oils (3.06) and benefits of herbal crops (3.05) were ranked as 2nd to 7th, respectively. Similarly, Improper training about herbal growing technology (4.03) and low demand in local market (4.02) were ranked as 2nd to

3rd, respectively. It was found that farmer's knowledge about herbal products is ranked first with mean value 3.53 and standard deviation 1.02 and means value was fell in between the high and medium categories but was more included toward high category. Majority of respondents were argued that they faced shortage of canal water and lack of labour for herbal crop cultivation. Small farmers cannot adopt the innovation due to financial problems. Vast majority 90% of respondents recommended that Govt should provide the modern market facilities for herbal crops. High cost of inputs was another big issue for the herbal growers. About 60% respondents recommended for the provision of subsidy on inputs.

## Effect of Bio-fertilizer and Biochar on Growth and Yield of Pak Choi (*Brassica rapa* Var. Chinensis)

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A field experiment "Effect of Biofertilizer (BF) and Biochar (BC) on growth and yield of Pak choi" was conducted at Horticulture Research Nursery, Department of Horticulture, The University of Agriculture Peshawar, during 2019-2020. The research was carried out in Randomized Complete Block Design (RCBD) with two factors replicated three times. Factor "A" consist of different Biochar levels (control, 1, 2, 3 $kgm^{-2}$), while Factor "B" consist of different Biofertilizer (BF) levels (0, 20, 30,40g) were used to determine its effect on growth and yield of Pak choi. The Biofertilizer produced in the National Agricultural Research Centre (NARC), Islamabad, was used. According to the analysis of data the maximum leaf length (19.84 cm), leaf area (197.07 $cm^2$), leaf chlorophyll content (51.64 SPAD), basal diameter (79.40 mm), numbers of leaves per plant (13.91), plant weight (0.88 kg), root length (14.70 cm) and yield ton $ha^{-1}$ (32.62) were recorded with the application of 2 kg $m^{-2}$ of Biochar. Whereas maximum plant dry weight (91.11 g) was recorded with the application of 1 kg $m^{-2}$ of Biochar. While Biofertilizer the maximum leaf length (19.58 cm), leaf area (185.85 $cm^2$), leaf chlorophyll content (50.5 SPAD), Basal diameter (80.39 mm), plant weight (0.89 kg), plant dry weight (90.95 g) and yield ton $ha^{-1}$ (33.88) were recorded in plant treated with 20g of Biofertilizer. The interaction of 2 kg $m^{-2}$ of Biochar and 20g of Biofertilizer positively improved, leaf length (24.01 cm), leaf area (272.83 $cm^2$), leaf chlorophyll content (57.37 SPAD), basal diameter (94.66 mm), plant weight (1.2 kg), plant dry weight (113.93 g) and maximum yield ton $ha^{-1}$ (42.27). The result of the research concluded that the application of 2 kg $m^{-2}$ of Biochar level and 20g of Biofertilizer can increase the growth and yield of Pak Choi under the agro-climatic condition of Peshawar.

# SESSION TRACK

# E. Production Management

## Effect of Different Soil Amendments on Growth and Flowering of Ranunculus Flower under Agro-Climatic Conditions of Faisalabad

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Ranunculus is a perennial plant from the family Ranunculaceae. *Ranunculus asiticus* L., also known as the Turban buttercup. The objectives of this study were to assess soil amendments, their application, and their impact on the growth of Ranunculus asiaticus flower and consider growing media changed to provide physical and chemical properties required to grow plants. Different growth media were used for soil amendments including the silt, farmyard manure (FYM) + silt, leaf compost (LC) + silt, poultry manure (PM) + silt, and coconut coir + silt was used for quality growth and development of Ranunculus. Each treatment was replicated three times, having five plants each. Farmyard manure + silt showed the maximum values for plant height (22.7 cm), number of leaves (9.5), number of flowers (4), stem fresh weight (34.4 g), stem dry weight (13.1 g), stem diameter (6.1 mm), leaf area (9.4 $cm^2$), total leaf chlorophyll content (20.4), flower diameter (7.4 mm) and flower vase life (8 days) respectively. The correlation of vegetative and reproductive attributes of Ranunculus demonstrated that among all treatments, farmyard manure and leaf compost improved soil conditions, which brought about better plant growth.

## Response of Humic Acid Foliar Application on Two Cultivars of Snapdragon (*Antirrhinum majus* L.)

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Present study was carried out to cheek the response of humic acid foliar application on two cultivars of Antirrhinum "Liberty" and "Sonnet". For this purpose, different concentration of humic acid like, (0, 4, 6, 8 and 10 ml humic acid per litre) were sprayed on the plants. First foliar application of humic acid was done after 30 days of plants transplanting followed by two subsequent sprays at the interval of 15±1 day. Completely randomized block design having three replications and five treatments were used in this experiment. The results showed that T5 (10ml/L humic acid) significantly increased plant height (58.67 cm) of snapdragon flowers, gives highest number of leaves (75.67), increased leaf area (6.42 $cm^2$), diameter of stem (7.74 mm) and maximum leaf chlorophyll contents (72.42, SAPD Value) and significantly took minimum days to first floral bud formation (60.33 d) and opening (68.67 d), longest spike length (17.87 cm), more number of florets per spike (27.67) , longer vase life (11.98 d) , best flower quality, significantly highest leaf nitrogen (3.14 %), phosphorus (0.50 %) and potassium contents (2.48 %) were noted in T5 as compared to all other treatments. Comparison of cultivar indicated that 'Liberty' showed best performance in response of humic acid foliar application as compared to 'Sonnet' in all

studied parameters. So, the use of 10 ml/L humic acid is recommended for better quality of snapdragon.

## Biostimulants Affect Growth, Yield and Quality of *Gladiolus hybrida* L.

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Biostimulants are among the natural products used to improve plant growth, yield and quality along with protection against various stresses. A study was conducted to evaluate impact of various concentrations of different biostimulants on growth, yield and quality characteristics of *Gladiolus hybrida* L. Experiment was set up in a completely randomized block design (RCBD) having three biostimulants, viz., Isabion, Ticamin Mix and SRS American on two gladiolus cultivars, viz., 'Rose Supreme' and 'White Prosperity'. Biostimulants were applied at 1, 3 or 5 mL $L^{-1}$ as foliar sprays after 30, 45 or 60 days of planting. Results revealed that plants supplied with 3 mL $L^{-1}$ Isabian had tallest stems (86.0 cm) and highest number of florets (10). While highest spike length (36.4 cm) was recorded in plants sprayed with 5 m L $L^{-1}$ SRS American with 3 sprays at 15 days interval. Overall, tallest stems (98.8 cm), corm diameter (58.46 mm) and flower quality of (8.4) were recorded in plants sprayed with 5 mL $L^{-1}$ Ticamin Mix at 15 days interval. Among cultivars, 'Rose Supreme' responded better when supplied with 5 mL $L^{-1}$ Isabion with greatest plant height (97.2 cm), corm diameter (60.45 mm) and highest flower quality (8.9) when sprayed three times at 15 days interval. The results revealed that the use of Isabion followed by Ticamin mix proved more effective in both cultivars with comparative better response recorded for 'Rose Supreme'. Therefore, application of biostimulants could be considered as good production strategy for obtaining higher yields of better quality with lower impact on the environment.

## Effect of Different Nutrient Level on the Growth of Cut Flower (*Matthiola incana* L.)

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The study was carried out at Floriculture research Area¸ University of Agriculture Faisalabad during the year 2019-2020. The aim of the study was to find result of foliar application of zinc and NPK on growth of Stock (*Matthiola incana* L). The experiment was arranged in randomized complete block design (RCBD) with three replications. There were twelve treatment combinations including four levels of NPK (0, 1%, 1.5% and 2%) and three level of Zn (0%, 1% and 1.5%,) which was applied on Stock. The treatments containing both zinc and NPK as T11 (1% Zn + 1.5% NPK) were better and enhanced plant height (95.69 cm), number of leaves per plant (69.35 leaves/plant) and leaf chlorophyll contents (86.56 spad). T7 (2% Zn + 1.5% NPK) was first position in leaf area (39.10 $cm^2$) and minimum days to flowering were find in T11 (1% Zn + 1.5%

NPK), 40.60 days. T11 (1% Zn + 1.5% NPK) got the first ranked in stem length (89.63 cm) and floret diameter (4.95 mm). Foliar application of zinc and NPK enhanced nutrient gathering in leaves of stock. The nitrogen contents (6.50 %) phosphorus contents (0.46 ppm) and potassium contents (40.10 ppm) increased in response to treatment containing both zinc and NPK.

## Foliar Application of Various Biostimulants Enhanced Yield and Quality of Stock (*Matthiola incana* L.)

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Stock (*Matthiola incana* L.), a member of family Brassicaceae, is a popular annual specialty cut flower. A study was conducted to evaluate the efficacy of various biostimulants on yield and quality of stock cultivars. Three different experiments were conducted using different biostimulants, viz. Isabion, Tecamin Max and SRS with three different concentrations, viz. 1, 3 and 5 mL $L^{-1}$ and different number of sprays, viz. 1, 2 or 3 sprays with three replications on three stock cultivars, viz. 'Cheerful White', 'Iron Rose' and 'Iron White'. Nursery was raised in 128-cell plastic plug trays containing UAF-Gro as substrate during 3rd week of October, 2019. When seedling reached at 2-4 true leaf stage, were transplanted in thoroughly prepared and levelled flat beds. First spray of biostimulants was applied after one month of transplanting while other two sprays were applied at fortnight intervals after first spray. Data were collected on production time (d), plant height (cm), stem length (cm), stem diameter (mm), floret diameter (mm), leaf total chlorophyll contents (SPAD), raceme length (cm), number of florets per raceme (no.), leaf area (cm2), stem fresh and dry weight (g), vase life (d) and flower quality (1-5). Experiments were laid out in randomized complete block design (RCBD) with factorial arrangements for individual cultivars. Data were analyzed using Fisher's Analysis of variance technique and treatment means were compared using LSD test at 5% significance level. In Expt.1, plants had vigorous growth, better flower yield and quality when Isabion was applied at 3 mL $L^{-1}$ as 3 sprays followed by 5 mL $L^{-1}$ as 3 sprays for all tested cultivars. In Expt. 2, plants treated with 5 mL $L^{-1}$ Tecamin Max as 2 sprays produced best growth and yield along with flower quality. While in Expt. 3, 5 mL $L^{-1}$ SRS irrespective of number of sprays had better flower yield and quality compared to other application. Among biostimulants, Tecamin Max performed best compared to Isabion and SRS for enhancing growth and flower production of stock and may be used by growers for better quality cut stock production.

## Efficacy of Various Planting Time on Yield and Quality of Cut Sunflower (*Helianthus annuus* L.)

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Sunflower (*Helianthus annuus* L.), a member of family Asteraceae, is commercially grown as annual specialty cut flower. A study was conducted to optimize planting time for year-round production of sunflower in agro-climatic conditions of Faisalabad. The cultivar 'Vincent's 2 Choice' was used in the study and seeds were sown from January 01 to December 15, 2019 at fortnight intervals for 24 times. Data were collected on production time (d), plant height (cm), stem length (cm), stem diameter (mm), flower diameter (mm), leaf total chlorophyll contents (SPAD), stem fresh and dry weight (g), vase life (d) and flower quality (1-5). Experiment was laid out according to randomized complete block design (RCBD) with three replications. Data were analyzed using Fisher's Analysis of variance technique and treatment means were compared by using LSD test at 5% significance level. Results depicted that plants sown from March to May produced best quality marketable stems along with bigger flower diameter and tallest stems outdoors, when the day temperature was 30°C - 39°C and sunshine was >10 hrs. For rest of sowing times, either stems had shorter stem length or poor unmarketable quality outdoors. However, with protection, this season may further be increased. Therefore, March to May is optimal planting time for quality production of cut stems of sunflower in agro-climatic conditions of Faisalabad, Punjab, Pakistan.

## Evaluation of Freesia Cultivars for Production and Postharvest Quality in Punjab

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Freesia is a popular cut flower, which has high demand all over the world cut flower industry. This study was conducted to evaluate the best responding cultivar in subtropical region of Punjab, Pakistan. Four different freesia cultivars were selected on phenotypic basis named as Red River, Orlando, Pink Fountain and Bicolor. The effect of time to 50% sprouting, sprouting percentage (%), plant height (cm), number of leaves per plant, leaf area ($cm^2$), leaf total chlorophyll contents (SPAD), days to spike emergence, production time, number of florets per spike, stem length (cm), spike length (cm), spike diameter (cm), fresh and dry weight of a stem (g), diameter of open floret (cm), flower quality, vase life, number of corms per clump, diameter of corm (cm), weight of corms per clump (g) and weight of a single corm (g) were investigated under Rosa Project Research Area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad. Result showed that the Red river variety showed maximum performance in terms of time to 50% sprouts in days leaf area plant height, spike diameter, number of corms per plant (9.17, 40.43 $cm^2$, 34.30 cm, 3.47 cm, 8.40 respectively), as well as in weight of single corm (12.82 g). whereas Pink Fountain showed

maximum performance in number of leaves per plant (15.59), chlorophyll content (74.96%), stem length (40.22 cm), fresh and dry weight of stem (11.68 g and 1.84 g, respectively). Orlando showed maximum vase life of flowers (8.30 days). In conclusion, it was examined that Red River, Orlando and Pink Fountain cultivars of freesia flower performed better while Bicolor showed poor performance when compared to other three genotypes.

## The Effect of Fruit Position and Direction in Canopy of Tree on Physical and Chemical Quality Related Parameters of Kinnow Mandarin

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The intention of this study was to evaluate the effect of fruit position and direction in canopy of tree on physical, biochemical, and organoleptic quality of Kinnow mandarin fruit. Two Experiments were performed. In first experiment, each tree was categorized into four parts according to height *i.e.,* control, top, periphery, bottom and inside. In second experiment, each tree was divided into four parts according to direction *i.e.*, control, north, east, south, and west. In first experiment, physical attributes of fruits were significantly affected by tree position; fruits of bottom and inside showed increase in weight and size. Chemical attributes of fruits from top and periphery showed increase fashion in terms of TSS, TA, Vit-C and sugar contents. Like chemical attributes, organoleptic attributes also showed increasing trend for the acceptance of these fruits. Physical parameters and organoleptic attributes of fruits from east direction showed significant difference followed by south direction in second experiment. The reason of these effect is mainly related to amount of sunlight received by these fruits because of their position and direction in tree's canopy.

## Perspectives of Avocado Production in Pakistan, Current Status, Challenges and Opportunities

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The Avocado (*Persea americana*) is one of the ancient stone fruits which is originated from south-central Mexico between 7000 and 5000 B.C. Now it has become one of the world's trendiest foods due to its nutritious value. Avocado has unique nutritious profile containing fibers, vitamins, carbohydrates, protein, mono-saturated fatty acids, carotenoids, minerals, potassium, and copper. Avocado flowers are botanically known as "synchronous dichogamy". In Pakistan, avocado grafted varieties Hass and Lula have successfully been grown in Sargodha, Lahore, Sukkur and Charsada. It is also called Makhan Phal or Magar Nashpati. But in Pakistan, there are no concentrated efforts to improve avocado production for export, the local production ends up rotting in avocado fruit stands. The government of Pakistan is selecting an area for avocado production. The farmers are getting trained and helped to increased plantation. The government is setting post-

harvest standards according to export standards. Since the avocado is such an expensive and in-demand fruit, a number of companies are taking keen interest to get new supplies. Drip irrigation system is suitable for the good quality production of Avocado. Avocado plants should be protected from hot winds, frost, anthracnose, scab, and mealy bug. In this way, Pakistan can increase its exports and introduce new agriculture and food sorting technologies and then local farmers can earn handsome income from this 'green gold'.

## Effect of Pruning on Plant Growth, Reproductive Behaviour and Fruit Production in Guava Varieties

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Guava (*Psidium guajava* L.) is an evergreen tropical fruit crop which bears on fresh vegetative growth. It also responds well to pruning which could help to regulate the flower induction, enhance fruit production and could rejuvenate the old and less productive orchards. Selected strains of guava cultivars Round (Gola) and Pyriform (Surahi) growing in guava germplasm unit (GPU) were subjected to pruning. The effect of pruning on flower induction and fruit quality were noted. Maximum days (15.93) taken for vegetative bud emergence were noticed in SBG while minimum days were found in AWG (11.67) strains. Flower buds were visible after 66 days of pruning in SN and 63 days in ABG strains. Maximum fruit setting started after 97 days in CS. Change in fruit skin color started in SNBAO after 140 days while in SBS in 132 days. Fruit weight was maximum in SBS (95 g) and number of seeds were minimum in SBG (120). Maximum TSS was noted in SNBAO (12.23 °Brix). It is concluded that light pruning of shoots upto 30 cm could enhance flower induction, increase fruit productivity and help to regulate guava fruit crop.

## Influences of Transplanting Time on Plant Growth and Runners Production of Different Strawberry Cultivars Grown in Azad Jammu and Kashmir

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Strawberry is a well-known aggregate fruit. It has an exceptional mouth feel taste with high nutritional characteristics. Transplanting time of strawberry runners mainly affects plant growth, yield and fruit quality. But transplantation time for different cultivars of strawberries is not yet standardized in Azad Kashmir. The objective of present study was to evaluate the field performance of three strawberry cultivars viz. Chandler, Seascape and Tribute on three different transplanting dates *i.e.,* 15th March, 30th March and 15th April. Plant vegetative growth, fruit yield and antioxidant characteristics were determined. Transplantation time significantly influenced most of the parameters under study. Runners transplanted on 30th March showed the

highest survival percentage (90.0%), number of leaves per plant (9.97) in cv. Chandler followed by cv. Seascape and cv. Tribute. Runner production per plant was high in the runners transplanted on 15th March in all the cultivars under observation. Total soluble solids, sugars, vitamin C, anthocyanin and antioxidant activity was significantly enhanced in the fruit of plants transplanted on 30th March. Overall, results suggested that transplantation of strawberry runners from 15th March to 30th March is ideal for obtaining high yield and nutritious strawberry fruit in the area of Azad Kashmir.

## Shoot Types Influenced Flowering, Fruit Bearing and Quality of Pomegranate

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Pomegranate has three types of shoots (normal, sucker and water shoot) which bears fruit that varies in quality. Therefore, this study was planned to evaluate the quality, flowering and fruiting behavior of different shoot types (Normal, sucker and water shoot) of pomegranate. Our results showed that highest no. of male (719), female flowers (857.92) and total flowers (1507) were recorded on normal shoot. Maximum fruit set (16.91%), fruit weight (201.38 g) and fruit length (66.96 cm) were observed on normal shoot compared to others. As far as biochemical parameters were concerned, total soluble solids (15.56%), titratable acidity (0.52%) and antioxidative enzymes including peroxidase (4.69 µmg-1 protein) and catalase (5.01 µmg-1 protein) were found to be more in fruits harvested from normal shoot compared to sucker and water shoot. While superoxide dismutase (18.39 $\mu mg^{-1}$ protein) was highest in fruit of sucker shoot. Phytochemicals including carotenoid (0.33 $\mu g\ g^{-1}$ β-carotene), anthocyanin (0.52 $\Delta Ag^{-I}$ FW), antioxidant (89.46 % inhibition) and total phenolics contents (375 mg $100g^{-1}$ GAE) were recorded maximum in fruits harvested from normal than sucker and water shoot. So, it is concluded that the yield as well as the fruit quality was found better in fruits obtained from normal shoot in pomegranate.

## Impact of Runners Harvest Date and Delayed Transplanting on Growth and Productivity of Strawberry cv. "Chandler"

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Runner harvest dates and delayed transplantation have a major impact on the overall productivity of strawberry plants. Thus, this study was planned to evaluate the impact of runner harvest dates and delayed transplantation on growth and development, yield and fruit quality of strawberry cv. "Chandler". Fresh and healthy runners were harvested from District Dir (KPK) at three different dates ($19^{th}$ Sept, $4^{th}$ Oct, $19^{th}$ Oct) of 15 days' interval and transplanted three time *i.e.* $3^{rd}$, $5^{th}$ and $7^{th}$ day after harvesting. Result indicated that survival was more (80.0%) in $4^{th}$ Oct harvested runners and transplanted on 3rd day. Highest number of leaves/plants (17.5) were recorded in

runners harvested on 4th October and transplanted on 3rd day while leaf area (76.72 $cm^2$) was found to be more in 19th September harvested runner and transplanted after 3rd days. However, minimum days to first flower (81) and first fruit (89) were recorded from the runner harvest on 19th October and transplanted on 7th day of harvest. Highest average number of flowers (28) were obtained in plants harvested on 19th September transplanted 3 days after harvest than other. Additionally, highest yield (395.5 g) and fruit diameter (37.76 mm) was documented on 19th September harvest and transplantation on 3rd day after harvest. Conclusively, runner harvested on 19th September and transplanted on 3rd day perform well and improve the growth and yield of cv. "Chandler" under South Punjab climatic condition.

## Influence the Growth and Yield of *Curcuma longa* L. by Organic and Inorganic Mulches

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Field research was carried out during (2018-2019) in Horticulture area, University of Agriculture, Faisalabad to estimate the effect of organic and inorganic mulches on growth and yield of *Curcuma longa* L. *Curcuma longa* L. contains curcumin compound which give yellow color has following benefits in medicines act as anti-oxidant, anti-inflammation, anticancer, dying industries and ingredients of food flavor. Mulches conserve the soil moisture and act as weed suppresser. The trial was performed in Randomized complete block design, three replications and four treatments such as T1 Wheat straw, T2 Black polyethylene, T3 Dry grasses and T0 Control. There were following parameters of the research plant height, No. of tillers, stem girth, leaf size, leaf no./ plant, dry biomass, yield g/plant, average no. of fingers, average no. of mother rhizome, finger weight, mother weight, finger size, fresh yield and dry weight. Among all these treatments T2 Black polyethylene showed maximum plant height (70.30 cm) and maximum yield per plant (223.44 g) followed by T1 Wheat straw. T0 (control) showed minimum plant height (33.65 cm) and minimum yield/plant (119.20 g). In all these parameters T2 Black polyethylene mulch showed maximum results compared with T0 Control.

## Effect of NPK Fertilizer on the Growth and Yield of Turmeric (*Curcuma longa* L.)

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Turmeric (*Curcuma longa* L) is commonly pronounced as Haldi in Pakistan and India. It is a herbaceous crop and it is from the family of Zingiberaceae. Turmeric commonly used as a spice and medicinal for curing and healing wounds. It used for the treatment of cancer and used for skin products as well. It is useful for the arthritis and diabetes as well. Turmeric is an important vegetable crop having great culinary and medicinal importance, Fertilizer play an important role in increasing quality and quantity of vegetable crops. Turmeric grows well and give better quality yield and crop by the diverse effect of NPK by giving through fertilizer (Urea, DAP, MOP). This

experiment was conduct to evaluate the efficient growth and yield of turmeric in response to the given treatments. This study was done in Horticulture zone, University of Agriculture, Faisalabad. The experiment was laid according to RCBD (Randomized Complete Block Design) with four treatments and three replications. Four number of treatments were given T0: Control treatment. T1: N:P:K (80:30:60 kg/ha), T2: N:P:K (100:40:70 kg/ha), T3: N:P:K (120:50:80 kg/ha), T4: N:P:K (140: 60: 90 kg/ha). Results of the study suggested that NPK application at T3 followed by T2 gave best results for plant height (88.60 cm), stem height of (35.80 cm), number of leaves per plant (17.33), leaf area (79.46 $cm^2$), dry biomass (64.51 g), fresh yield (197.80 g/plant), number of tillers (4.13), and curcumin content (8.30 %) as compared to the treatment T0. Stem girth showed non-significant results in response to these treatments.

## Effect of Plant Spacing and Rhizomes Size on Growth, Yield and Quality Attributes of Turmeric (*Curcuma longa* L)

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Turmeric is a perennial crop that belongs to the ginger family Zingiberaceae. An experiment was conducted at Vegetable Research Area, Institute of Horticultural Sciences (IHS), University of Agriculture, Faisalabad (UAF) during 2019-20 to check the effect of rhizome size on growth, yield and quality attributes of turmeric. This experiment was laid out in Randomized complete block design (RCBD). The treatments consisted of three mother rhizome sizes (T1 5-25 g, T2 25-35 g and T3 35-45 g) and three finger rhizome sizes (T4 <10 g, T5 15-25 g and T6 25-35 g) which were replicated three times. Rhizome size significantly affects the growth, yield and quality parameters of turmeric. Results revealed that T3 treatment gave maximum plant height (82.57 cm), number of leaves per plant (16.03), leaf area (73.20 $cm^2$), number of tillers (10.30), stem length (34.78 cm), stem diameter (17.39 mm), number of primary rhizomes per plant (11.69), number of secondary rhizomes per plant (21.44), total number of rhizomes (28.01), fresh weight of rhizomes (345.06 g/plant), dry weight of rhizomes (64.78 g/plant), rhizome length (25.92 mm) and rhizome diameter (22.53 mm) as compared to other treatments. Curcumin is an important biochemical component of turmeric with was highest (8.11 %) in T3 treatment. It is concluded that rhizome seed weight (35-45 g mother rhizome) should be planted for getting high growth, yield and quality production of turmeric.

## Effect of Black Polyethylene Mulch on the Yield of Turmeric (*Curcuma longa* L.)

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A field experiment was conducted to check the effect of inorganic mulch Black polyethylene on the yield of turmeric at Horticulture research area, University of Agriculture Faisalabad, Pakistan. Mulches conserve the moisture, enhance the soil temperature, lessen the evaporation rate and suppress weed growth. In this experiment Randomized block design was used with three replications. There was a one T1 Black polyethylene treatment and other was T0 control condition. Turmeric was significantly influenced under the Black polyethylene mulch. Plant revealed maximum plant height (84.43 cm) under the black polyethylene mulch as compared to the control (36.76 cm) condition. Early germination was also observed under the Black polyethylene mulch as compared to the control condition. Yield per plant (289.22 g) revealed significant result under the Black polyethylene mulch and control showed non-significant result for yield per plant (111.23 g).

## Effect of Crop Geometry on Growth, Yield and Chemical Constituent of Turmeric Under Faisalabad Climatic Conditions

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*Curcuma longa* L. (Turmeric) is a perennial herbaceous crop and is being used for medicinal as well as culinary purposes. A field experiment was executed to check the effect of crop geometry on growth, yield and biochemical parameters of turmeric. The experiment was laid out in Randomized complete block design (RCBD) with four treatments (plant spacing) *i.e.*, 60 cm × 10 cm, 60 cm × 20 cm, 60 cm × 30 cm, 60 cm × 40 cm) and each treatment was replicated thrice. Rhizomes were transplanted at the start of April according to treatments. Results obtained indicated that 60 cm x 40 cm was significant almost for the parameters, plant height (73.30 cm), number of leaves per plant (20.1), leaf length (40.36 cm), leaf width (22.43 cm), number of tillers per plant (6.40), stem diameter (20.80 mm), number of primary rhizomes per plant (8.10), number of secondary rhizomes per plant (17.94), total number of rhizomes per plant (26.41), weight of primary rhizomes per plant (138.6 g), weight of secondary rhizomes per plant (123.53 g), yield per plant (282.16 g/plant), dry weight of rhizomes per plant (50.85 g/plant), rhizome length (49.26 mm), rhizome diameter (19.08 mm) and total soluble solids (10.79 °Brix). Highest moisture content (58.48 %) was obtained in 60 cm × 10 cm plant spacing while maximum curcumin contents (3.62 %) was noted in 60 cm × 30 cm plant spacing. From this experiment, it is recommended that 60 cm × 30 cm plant spacing should be used for the curcumin production under Faisalabad climatic conditions.

## Effect of Different Potting Media on the Growth of Tomato

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Tomato (*Solanum lycopersicum* L.) is native to South America and belongs to family Solanaceae. It is perennial but it is grown as an annual crop in Pakistan. Tomatoes are commonly classified as determinate or indeterminate types. Among agricultural products, tomato and chili after onion are most common vegetables in Pakistan. The experiment was carried out at the experimental field of Vegetable Corp Research Program, Horticulture Research Institute (HRI), National Agricultural Research Council (NARC). The Experimental site is located at longitude 73.08° east and latitude 33.42° north on the global scale. Elevation of site was 63 msl (Mean Sea Level). The aim of this experiment was to study the effect of media on growth of tomato plant for kitchen gardening. There were 7 treatments used which were replicated 3 time and each replication contained 3 plants. The Experiment was carried out in plastic tunnel. Medium size pots were used. Treatment 2 (FYM + Compost + soil) and Treatment 7 (FYM + Compost) gave better results. The maximum plant height of tomato plant was 9.5 cm in (Soil + FYM + Compost) whereas the minimum plant height in soil (6.2 cm) and in compost (7.3 cm). The lowest plant height recorded in T5 may be due to low nutrition value and poor aeration.

## Effect of Pot Size and Growing Mixture on the Growth and Yield of Okra and Carrot

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Kitchen gardening is very helpful in acquiring contamination free vegetables with nominal cost of production. Growth of container grown vegetables is highly dependent upon size of the container and type of media used. A comprehensive study was conducted to optimize pot size and growing mixture for major crop Okra and Carrot. Two different experiments (1st on Carrot and 2nd on Okra) were laid out at UAF Sub-campus Burewala during winter and summer months (depending upon type of vegetable). In both experiments, effect of three different container sizes (4, 8 and12 inches diameter) along with three different proportions of sand, silt and farmyard manure (1:1:1, 1:2:1 and 1:1:2) as a growing media was studied under CRD two factor factorial layout replicated thrice. Different parameters regarding vegetative growth (seed germination, seedling vigor, number of leaves, plant height etc.), reproductive (number of flowers, days taken to flowering etc.) and fruit quality and yield (number of fruits per plant, yield per plant, fruit size, fruit weight etc.) was recorded and analyzed using standard statistical procedures. Results revealed that 12 inches pot was highly effective in improving carrot root growth as well as okra yield. Among growing mixtures, one part sand along with one part silt mixed with two parts of farmyard manure was highly effective in improving almost all crop growth parameters for carrot as well as okra.

## Characterization of Exotic Genotypes of Turnip Based on Morphological and Biochemical Analysis

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Turnip is an important vegetable crop in Pakistan. It has low yield due to lack of tolerance to heat stress, less disease and pest resistance. Therefore, some exotic genotypes shall be introduced which can bear high temperature and have disease resistance. This study was conducted at Vegetable Research Area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad, in which twenty-four promising turnip exotic genotypes and two local genotypes were characterized for different morphological and biochemical traits. A wide range of variation was observed among 13 physio-morphological and 11 biochemical characters in the study. Every genotype showed one or more distinct characters which could be used to identify the same. In twenty-six different genotypes 8 genotypes performed better towards morpho and biochemical characters. Furthermore, biochemical analysis showed significance difference between local and exotic genotypes. The results showed that out of twenty-eight genotypes, five showed batter bulb size shape and taste as compared to local cultivars. Some of genotypes showed early bolting due to which they cannot produce bulbs. On the other hand, two such genotypes were screened which have the ability to bear high temperature and diseases and will be ultimately beneficial for local farmers.

## Boron Application Modulates the Plant Growth, Reduces Buttoning Behaviour and Inhibits the Hollow Stem Disorder of Broccoli Florets

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Fresh broccoli florets are prone to various physiological disorders which reduces the yield, downgrades quality and marketability. It has been proved that deficiency of micronutrients resulted in poor germination and production of inferior quality of broccoli heads. Boron plays imperative role in colour related metabolism, responsible for chlorophyll pigmentation and strengthen the stem girth and reduces hollow stem disorder. Therefore, current study was conducted to evaluate the effect of boric acid foliar sprays on two stage of plant growth. Broccoli plants were sprayed with boric acid (0, 0.1, 0.2, 0.3, and 0.4%) two times; before and after heading stage. Plants sprayed with 0.3% boric acid markedly increased yield, curd weight, size, leaf area, stem length and stem diameter. Similarly, the plants applied with boric acid 0.3% followed 0.4% sprays significantly reduced buttoning and hollow stem disorders. However, there was no impact was observed on biochemical quality of broccoli juice extracted from sprayed plants. On the other hand, total

antioxidants, ascorbic acid and phenolic contents were found upregulated in florets sprayed with 0.3% boric acid. In conclusion, the foliar application of 0.3% boric acid spray at two stages of heads development along with recommended fertilizer plan could be the better strategy to reduce these disorders, improve yield per acre and quality of broccoli florets.

## Determining Set Production Potential of Three Cultivars and Comparison of Phosphatic Fertilizers in Onion

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Onion is an important vegetable, used daily as culinary item. Its prices are usually low during April-June, the time when Sindh and Punjab crops are available in the market, due to which the growers cannot get a good return from their seasonal crop (April-May). However, market demand and therefore price is high during the months of November and December. Production and availability of kharif onion crop through sets during this period can pay a good profit. Therefore, this study was carried out at Vegetable Research Area, University of Agriculture Faisalabad; with the aim to determine i) the set production potential of three onion cultivars viz. Red Bone, TI-172 and Phulkara from two different sources; Magnus Kahl Seeds (MKS) and Government (Govt); and ii) the effect of two phosphatic fertilizers, diammonium phosphate (DAP) and nitrophos (NP), applied five times at two-week interval. The experiment was replicated three times. Results showed that Phulkara (MKS) produced the highest number of sets (1807) while Red Bone produced the lowest number (119) per unit area. Also, the Phulkara (MKS) had the largest individual (1.9 g) and total (2761.5 g) set weights than that of any experimental cultivars. The application of DAP produced highest number of sets (1187.3) and individual set weight (1.46 g), followed by NP and then control. Our results indicate that the Phulkara (MKS) showed a strong potential in terms of producing a good number and healthier sets. While DAP applied Phulkara (Govt) produced the highest number of sets having the greatest mean set weight.

## Effect of Different Nitrogen Levels Spray on Growth Attributes and Oil Contents of Tulsi Plant

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Tulsi is an ornamental plant which is also being used for medical purposes. Besides of its valuable products and health benefits, cultivation of Tulsi is not so common in Pakistan. Therefore, a pot experiment was conducted at University of Agriculture Faisalabad to identify the N requirement of Tusli for enhanced growth and oil contents. Elaborating the importance of N spray in promoting the production of Tulsi in the country was also the objective of this research plan. Experiment included three levels of N (50 kg, 100 kg and 150 kg N $ha^{-1}$) which were applied as foliar spray. Data for different parameters was taken with equal days interval and analysis of that recorded data was done by using HSD test at 5% probability level. Data analysis showed that higher N application produced maximum leaves per plant (10.66), root length (10.93 cm), shoot length (11.06 cm), plant height (22.00 cm) plant fresh weight (1.38 g), plant dry weight (0.90 g), chlorophyll contents (16.80), leaf area (9.96), leaf area index (4.98) and oil contents (0.75). In conclusion, all the levels of N spray produced significant results when compared to controlled pot. It is clear from the data that Tulsi plant needs higher amount of N to produce more growth and oil contents.

## Effect of Plant Growth Regulator on Growth, Development and Yield of Fennel (*Foeniculum vulgare*)

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Fennel (*Foeniculum vulgare* Mill. L) belongs to the Apiaceae family. Fennel is one of the important medicinal and spice plants of the world. It is a high value medicinal and essential oil-bearing crop used in pharmaceutical, food and cosmetic industries, however abnormal agro-management practices reduce fennel production. Therefore, field trial was conducted to analyse the effect of $GA_3$ on growth of fennel and its production. Randomized complete block design under split design having three replications were used for this trail. Only one variety of fennel (Desi sownf) was sown and $GA_3$ was applied at different doses. At reproductive stage, the plants were sprayed with different doses of $GA_3$. Among the treatments, foliar spray of $GA_3$ significantly promoted the values for most of the growth, physiological and biochemical attributes as well as for essential oil composition and yield attributes. Data regarding morpho-physiological growth and yield parameters were collected. Fisher's analysis applied on collected data and treatment means were compared by using least significant difference test at 5% probability level. It was

concluded that a spray of $GA_3$ might be highly effective for increased productivity and essential oil composition of fennel and its showed significant effect on quality of seeds.

## Creasing in Sweet Orange: The Role of Putrescine, Aminoethoxyvinylglycine or Cobalt Sulphate

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The sweet orange fruit rind or peel is multi-layered and formed by the combination of flavedo (exocarp) and albedo (mesocarp) tissues. The albedo white tissue of the citrus fruit rind is prone to fracturing and leads to rind disorders such as creasing (albedo breakdown) in sweet oranges and puffiness in mandarins. Albedo breakdown is a drastic physiological disorder in orange being faced by many orange producing countries. This study investigated how the exogenous treatment of putrescine (PUT), aminoethoxyvinylglycine (AVG) and cobalt sulphate ($CoSO_4$) reduces the incidence of albedo breakdown in navel orange fruit. Effect of exogenous application of PUT, AVG and $CoSO_4$ on total, water-soluble and water-insoluble pectins as well as on biosynthesis of pectin esterase (PE), exo-polygalacturonase (exo-PG), endo-polygalacturonase (endo-PG) and EGase in albedo and flavedo tissues of the fruit at golf ball and ripe stages were also discussed in sweet orange cvs. Washington Navel and Lane Late.

## Role of PGRs in Preharvest Fruit Drop Reduction and Enhancement of Fruit Quality Attributes in Date Palm

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Date palm (*Phoenix dactylifera* L.) is a major fruit crop grown in subtropical and tropical areas of Pakistan. Now a days, the most crucial problem in date palm is fruit drop in Pakistan. Fruit drop occurs due to physiological, environmental, genetic and pre-mature ethylene production in plants. The present study was conducted to examine the impact of plant growth regulators on fruit drop reduction and quality enhancement of date palm cultivars. The exogenous application of various concentrations of 2,4-D (25 ppm, 50 ppm, 75 ppm) and gibberellic acid (75 ppm, 150 ppm, 225 ppm) were applied on date palm cultivar (Hillavi and Khudravi) at kimri stage. The aim of this study was to determine the influence of plant growth regulators on fruit drop reduction and quality enhancement of different date palm cultivars. Among cultivars "Khudravi" variety showed maximum bunch weight (11.50 kg), pulp weight (12.42 g), fruit width (23.90 mm), fruit weight

(11.19 g), total sugar content (28.90), moisture percentage (73.07) when treated with gibberellic acid ($GA_3$) 150 ppm concentration while fruit length (40.52 mm), TSS content (6.60), reducing sugar (19.95), non-reducing sugar (10.34), ascorbic acid content (1.60), and lower fruit drop (33.00%) was observed in "Hillavi" cultivar. Results revealed that the exogenously application of gibberellic acid ($GA_3$) 150 ppm concentration performed better in reduction of fruit drop and enhance the fruit quality of date palm cultivars as compare to 2,4-D. The experiment was conducted under Randomized Complete Block Design (RCBD) with three replications.

## Rise and Fall of Pomegranate Industry in South Punjab, Pakistan

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Pomegranate is an ancient fruit crop and known as a super fruit in Europe due to its excellent medicinal properties. In Pakistan pomegranate is classified as minor fruit despite its high demand, nutritional and economic value compared to other fruits. It is cultivated on an area of 7330 hectares with a production of 37613 tons. Review of historical data revealed rise and fall in pomegranate area and production in a cyclic fashion. In Punjab, pomegranate was mainly grown in Alipur (Muzaffargarh) but during late 90's and onwards decline in tree hygiene and production, forcefully shifted its cultivation to new areas like Allahabad, Liaqatpur (Rahim Yar Khan). It thrived well there initially but with ever increasing challenges and decline in production. Among other factors, inappropriate nursery plants, poor irrigation management, malnutrition, lack of canopy management, sunscald, fruit cracking, various pest and diseases are believed to the major culprits. Limited number of commercial cultivars (Sawa, Sandhura and Kalehar) is attributed as another important factor for poor production. Present paper will explain in detail the causes and their possible solutions of cyclic rise and fall in an area and production of pomegranate for a sustainable industry in South Punjab.

## Evaluation of Rootstocks for Better Growth and Productivity of Kinnow Mandarin

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Citrus holds the position of top ranked fruit crop of Pakistan in terms of area and production. Kinnow is considered as the trademark of Pakistan's citriculture industry. Kinnow occupies the share of 95% out of total citrus production in Pakistan. But there is an alarming problem of single rootstock culture. Rough lemon has monopolized the citrus industry of Pakistan. There is an

absolute need for substitute rootstock for higher yield and long productive life of Kinnow. A trial was conducted to evaluate and select the reliable rootstock for Kinnow at Postgraduate Agricultural Research Station (PARS), University of Agriculture Faisalabad. Kinnow was grafted on eight rootstocks. Vegetative and reproductive behavior of five to six years old Kinnow plants was recorded during 2017-18 and 2018-19. Vegetative performance of Kinnow was evaluated on the basis of stem girth (rootstock and scion), tree height and canopy volume, while reproductive performance of Kinnow was evaluated on the basis of blooming intensity, fruit set percentage, and average yield of a tree. Results revealed the significant effect of rootstock on all vegetative and reproductive traits of Kinnow mandarin. Maximum girth measurements, tree height and canopy volume of Kinnow mandarin was recorded on *Poncirus trifoliata*. Likewise, Kinnow plants grafted on *Poncirus trifoliata* gave maximum blooming intensity and fruit set percentage. Similarly, higher yield of Kinnow was obtained on *Poncirus trifoliata* followed by Fraser Hybrid. However, Fraser Hybrid rootstock gave average yield, but fruits were of good quality and marketable size. So, it was concluded that *Poncirus trifoliata* and Fraser hybrid rootstocks can be used as reliable rootstocks for citrus industry of Pakistan as an alternate to traditionally using rootstocks.

# SESSION TRACK

# F. Climate Change

## Salicylic Acid Moderated Drought Stress by Managing Plant Characteristic in Pansy (*Viola tricolor*) Under Cholistan Desert Conditions

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Salicylic acid (SA) is a phytohormone that plays major role to modulate the impacts of different abiotic stresses especially drought. Current pot experiment was conducted to find out the possible drought stress mitigation by SA in pansy flower in Cholistan desert conditions of Bahawalpur, Pakistan. For this purpose, plants were grown under four different drought levels *i.e.*, 100%, 80%, 60% and 40% field capacity (FC). For the control of drought stress, three different concentrations of salicylic acid (0.5, 1.0 and 1.5 mmol $L^{-1}$) were used and compared with non SA application. The experiment was conducted at research area of Department of Horticultural Sciences, The Islamia University of Bahawalpur. The pots were arranged according to completely randomized design (CRD) with two factor factorial arrangement which were replicated thrice. The results showed that lowest drought level *i.e.*, 100% and 60 % FC produced maximum vegetative and reproductive growth. Plant height, flower diameter, root length, number of leaves and root fresh weight were produced under 80% FC. SA concentration of 0.5 to 1.0 mmol $L^{-1}$ proved to be satisfactory level for the mitigation of drought stress whereas 1.5mmol $L^{-1}$ SA and maximum drought level (40%FC) reduces the plant morphological characteristics. All parameters were reduced tremendously with 40% FC which indicated the susceptibility of pansy flower under severe drought successfully under medium drought conditions and 0.5-1.0 mmol $L^{-1}$ SA are ideal dose for successful plant growth under hot and harsh climatic conditions of Cholistan desert.

## Trends Evaluation of Climate Warming Impact on Production and Management of Kinnow Fruit (*Citrus nobilis* Lour x *Citrus deliciosa* Tenora) in Pakistan

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Environmental change-induced disasters show maximum risk for sustainable agriculture, growth, and development of horticultural crops highly vulnerable to extreme weather and climatic variables. The present review study evaluated the impact of climate factors of Kinnow fruit (*Citrus*

*nobilis* Lour x *Citrus deliciosa* Tenora) in Punjab province, Pakistan. Fruit quality of citrus associated with phenological growth stages linked with orchard cultural management but slight variation in temperature and moisture negatively affected fruit quality, physicochemical properties, and fruit-bearing habit of trees. Results quantification showed that the maximum days were taken between the fruit-setting-fruit ripening phase at hot environmental conditions. The phenological stages also resulted in more quality indemnities due to extreme weather conditions. The districts (Toba Tek Singh and Vehari) that received extreme temperature were reported minimum fruit-setting and maximum premature drop compared with the other districts (Sargodha, Faisalabad) comparatively less hot. Sudden fluctuation in temperature also resulted in poor fruit color development, firmness, peel thickness, size index, volume, diameter, and weight. Overall research estimation stated that the fruit quality and yield is highly vulnerable to climate variables and maximum affected at the time of fruit growth and development stages. Fluctuating climatic variables were observed at warm conditions, which adversely affected Kinnow fruit growth and development and delayed color development. In the future climate change scenario, GCM-models simulate an increase in global temperature between 2.9 to 5.5°C till 2060, and crop production is highly vulnerable to climate warming trends. The downscaled results of RCP4.5 (25 km) showed a 0.04°C increase in temperature year-1 in the country. There will be a 3-5°C increase in the mean temperature under the central global (RCP 4.5, 8.5) temperature scenario by the end of this century. Consequences showed an increasing tendency in the yearly mean surface temperature all over Pakistan, which may extremely affect Kinnow production. The study also provided an understanding of the adaptation method (PA/PQNK) of smart and better citrus production by improving agrotechnological services.

## Green Revolution: A Possible Solution to Environmental Pollution in Changing Climate of World

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Urbanization, agriculture, industrial work, and the greenhouse effect are the leading causes of climatic changes all over the world. The impacts of climate change include biodiversity losses, rise in sea level, shifts in the weather pattern, changes in freshwater supply and an increase in extreme weather events such as floods and droughts as well as glaciers melting and various health impacts. It is a key concern that has been impacting human health, plants as well as animals. The concept of the green revolution is based on plantation activities, increasing afforestation, decreasing deforestation, overgrazing, etc. and such processes enable to protect and benefit the economy, habitat, people and planet. Plants use $CO_2$ and other toxic materials which can persist in the environment. It is a strategic pathway to build a sustainable future the principles of the green revolution involve the development of green belts and use of non-toxic reagents. The findings of this study showed that plantation activities should be considered on large scale for environmental quality monitoring and modelling. As plants act as natural lungs of the Universe and release

oxygen providing good quality of air. As every nation aspires to provide its citizens with the highest quality of life, including freedom from environmental pollution and the ravages that will result from a widely unpredictable, destabilized climate. In order to mitigate problems regarding climatic changes, we need to minimize the different types of environmental pollutants and to maximize the plantation activities to overcome the climatic changes.

## Ecological Adaptive Features in Few Members of Sedges from Various Regions of Punjab, Pakistan

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Family Cyperaceae is found not only in various ecological regions of Pakistan as well as in various regions of the world. Present study is based on some ecological adaptive features in root and stem anatomy of some members of sedges from Cyperaceae. Members of family Cyperaceae are adapted to a variety of habitats in Pakistan, such as arid and semi-arid regions (*Cyperus arenarius*, *C. rotundus*), waterlogged saline areas (Schoenoplectus spp.), industrial-polluted habitats (*C. alopecuroides*), aquatic wetlands (Scripus spp., Kyllinga spp., Fimbristylis spp. and Cyperus spp.) and sub-mountainous cooler regions salt range (Carex spp.). Cyperus alternifolia is the widely cultivated species in Pakistan. All the species studied showed some specific structural adaptations to withstand environmental hazards. Drought-hardy species (*Cyperus conglomeratus*) showed intensive sclerification in the cortical region, as well as in the vascular region. Tightly-packed cortical parenchyma is a characteristic feature of this species. These modifications are important not only form minimizing water loss through roots but also for water conservation. Halophytic/salt tolerant species (Schoenoplectus spp.) are equipped with intensive aerenchyma and cortical region with well-developed sclerenchyma. In addition, stellate cell is recorded in these species. These help in water conservation, salt dilution and salt transport. Aquatic species have distinctive aerenchyma in the root, which is critical in gaseous exchange under anaerobic conditions.

## Climate Change Impact on Horticultural Crop Production: A Review

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Horticultural crops have importance economically, aesthetically, and environmentally. Horticultural crop production directly depends upon the temperature, soil moisture, sunlight, and soil fertility. Climate change imposing a great impact on horticultural crops directly and indirectly. Because of climate change, the weather all around the world is changing. Extreme environmental changes affecting the morphological, physiological, biochemical, and developmental stages of the

plants. Plants survival is at risk because of these changing weather conditions. Plants became stressed because the temperature is increasing, which speed up the potential evaporation for the plants. Carbon dioxide concentrations have elevated, and they directly influenced the yields. Rainfall has been significantly declined, which is leading to water scarcity, droughts are the most severely affecting production. Climate change mitigation and maintaining the crop yield under such circumstances become a global challenge. To minimize the effect, various approaches are under development. Development of genetically resistant varieties which resilient to the adverse weather. Modification of root systems of plants by grafting over-strong rootstock. Use of water-efficient irrigation system and reuse of treated wastewater. This review enlightens the effects of climate-change on horticulture crop production, future questions, and actions that are required to overcome the effects on crop production.

## Algae (Cyanobacteria) Treated Wastewater for Irrigation in Horticultural Crops

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Climate has been influenced by human intervention, and that also leads to pollution. The different organic and inorganic chemicals have been used in many domestic and non-domestic areas that boost up water pollution. Water pollution causing different effects in every aspect of life, like in water supplies, food chains, agriculture, and down striking the economy. Wastewater treatment is essential to keep the health of many ecosystems. Algae (cyanobacteria) use in the biological treatment of wastewater, which is eco-friendly with nutrient recycling, no secondary pollution, and produced biomass which can be used in fuel production. Cyanobacteria provide valuable treatment to the contaminated water for its growth and development, it uses nitrogen and phosphorus from the water and has the capacity to remove nitrates, phosphates, sulphates, and coliforms. Treated water can be ideal for horticultural crops like vegetables and landscapes. Reusing the water can mitigate climate change and can be a good option because of water scarcity, nutrient-enriched water. Treated wastewater increases food production, increases income, and improves the livelihood of farmers. It opens the new research fields to genetically improve the cyanobacteria to remove more pollutants from the water for making is far good for the irrigation purpose.

**Assessment of Atmospheric Quality and Perception of Urban Female Community in Relation to Urban Trees in Faisalabad City**

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Atmospheric pollution is considered as the most hazardous form of environmental pollution throughout the world. Among air pollutants, particulate matter is the most concerning air pollutant in urban areas due to its negative effects on atmospheric quality. Urban trees play a major role in mitigating the air pollutants and ameliorating the atmospheric quality of urban environments. So, it is important to assess the role of urban trees in improving the atmospheric quality and understand the public opinion, especially women, towards the urban trees. In this study, Faisalabad city was divided into 20 parts and sampling intensity was 10 quadrates from each part. So, a total of 200 quadrates (100m x 100m each) were randomly selected for measuring atmospheric quality. Atmospheric gases (CO, $CO_2$ and $O_2$), particulate matter (PM0.5, PM1.0, and PM2.5), noise intensity, soil compaction, temperature, and relative humidity were measured thrice in each quadrate. Female community was addressed in determining their perception towards urban trees in Faisalabad city. Volunteer female respondents were searched at urban parks. The respondents' perception of urban trees was obtained through structured questionnaire. A five-point Likert-type scale was used by respondents to rate the statements. It was found that particulate matter concentrations were above the environmental standards. The density of urban trees was inversely correlated with atmospheric quality. The women of Faisalabad city generally have positive perception of urban trees but specifically they are not satisfied and are less aware of the multiple benefits of urban trees in the city.

# SESSION TRACK

# G. Innovative Technologies / Vertical Gardening

## Progress of Vegetable Grafting in Pakistan

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Cucurbitaceae and Solanaceace vegetables are grown on a commercial scale in Pakistan. Vegetable grafting related research work has been started in Pakistan during the last few years at some public and private sector organizations. We have conducted research trials at Department of Horticulture, College of Agriculture, University of Sargodha to optimize the grafting method for the preparation of grafted transplants of cucumber and muskmelon. According to our results, hole insertion grafting method proved better compared with tongue grafting and cleft grafting method. In another experiment, the use of pumpkin and bottle gourd as a rootstock improved the plant growth and yield of watermelon and cucumber compared with self-grafted or self-rooted watermelon and cucumber plants. Vegetable grafting is gaining popularity in Pakistan because the use of rootstocks for vegetable crops can help improve the biotic and abiotic stress tolerance of scion cultivars leading towards better nutrient use efficiency and yield and economic returns.

## Agriculture 5.0: Future of Farming through Machine Learning Technologies

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Agriculture is an important source in the economic development of India. About 70% of Indian economy relies on agriculture. As per UN projections by year 2050 human population will be nearly 10 billion. Which means we need to double the amount of food what we now produce., there will be more pressure on land as there will be only an extra 4% of land, which will come under cultivation by 2050. This means that farmers will have to do more with less. According to the same survey, the food production will have to increase by 60% to feed an additional two billion people. However, traditional methods are not enough to handle this huge demand. This is driving farmers and agro companies to find newer ways to increase production and reduce waste. As a result, Machine Learning cloud computing technology is emerging as part of the agriculture industry's technological evolution. Machine learning powered solutions will not only enable farmers to improve efficiencies, but they will also improve quantity, quality and ensure faster go-to-market for crops. This aid for farmers in the form of digital solutions combines forces with robotics and artificial intelligence to launch the imminent idea of Agriculture 5.0. However, in order to take the most advantages from Agriculture 5.0, deep training needs to be delivered to users, ideally young farmers eager to learn and apply modern technologies to agriculture and

granting a generational renewal still to come. It seems to be the right time to move forward towards a modern and sustainable agriculture that can show the full power of data-driven management to face the challenges posed to food production in the 21st Century. Data-driven agriculture, with the help of robotic solutions incorporating artificial intelligent techniques, sets the grounds for the sustainable agriculture of the future. This study explained the future advanced farm management systems through Machine learning techniques by revisiting each crucial step, from data acquisition in crop fields to variable rate applications, so that growers can make optimized decisions to save money while protecting the environment and transforming how food will be produced to sustainably match the forthcoming population growth.

# SESSION TRACK

# H. Plant Nutrient & Water Management

## Efficacy of Planting Seasons and Nutritional Levels on Growth, Yield and Vase Life of Carnation *Dianthus caryophyllous* L.

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The present research was conducted to elucidate the effect of various planting seasons and macro nutritional (NPK) levels on vegetative, reproductive and vase life of carnation viz. Chaubad Mixed. There were two planting seasons (16th Nov. and 15th Feb.) and seven treatments (NPK combinations) were used. Planting season S1 (16th Nov.) showed better results for indices like plant height, number of branches per plant, length of branches, number of leaves per plant, NPK contents, flower diameter, fresh weight of flower, fresh and dry weight ratio and flower quality as compared to planting season S2 (15th Feb.). However, regarding treatments, T2 (5:10:10 g pot-1 NPK) showed positive correlation for morpho-physiological and bio-chemical traits like plant height, number of branches per plant, length of branches, number of leaves per plant, chlorophyll contents, NPK estimation and bud diameter by showing maximum values for the attributes with comparison to other treatments.

## Response of Foliar Application of (Zn, B and Fe) to Improve Morpho-Physiological, Yield and Quality Spike Production of Gladiolus

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Gladiolus (*Gladiolus grandiflorus* L.) is a popular cut flower in local and international markets. It is a high demanding cut flower in Pakistan due to it delicate appearance, variety of colors and longer vase life. However, quality of cut spike is still low to meet the international standards due to multiple reasons. Growers are using nitrogen, phosphorus and potassium. However, majority of them do not use micronutrients which are deficient in our soil due to high alkalinity. Therefore, a study was initiated to assess the response of (Zn, B and Fe) as foliar spray to improve morpho-physiological, yield and quality attributes of Gladiolus. Experiment was performed during 2019-2020 at Floriculture Research Area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad. The treatments were comprised of 0.4% Zn, 0.2% B and 0.2% Fe alone and in combinations. These nutrients were applied two times as foliar spray, viz. at 3rd and 6th leaf stage. Randomized complete block design (RCBD) was followed for the layout of experiment having seven treatments and a control (T0) with three replications. Two gladiolus cultivars, viz., "White Prosperity" (V1) and 'Rose Supreme'(V2) was selected for this experiment. The treatment Zn + B + Fe (T7) significantly increased the plant height (97.46 cm), number of leaves per plant (9.76), leaf area (99.31 $cm^2$), leaf chlorophyll content (67.65), spike length (39.16 cm), spike diameter (9.17 mm), fresh weight of spike (77.19 g), dry weight of spike (6.40 g), flower initiation time (111.63 d), flower diameter (106.67 mm), flower quality (9.00), vase life of flowers (12.6 d), corms

diameter (29.08 mm), corms weight (17.28 g) and number of corms plant$^{-1}$ (3.98) as compared to all the treatments except for number of flowers spike$^{-1}$ which was maximum (10.81) in the plants which received foliar application of B + Fe (T6). As far as response of cultivar is concerned, cultivar Rose supreme performed best as compared to the cultivar white prosperity.

## Effect of Different Growing Media to Get Optimum or Maximum Growth of Stock in Plastic Pots

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Stock (*Matthiola incana* L.) is flowering plant belonging to family Brassicaceae. This beautiful plant is used as ornamental plant and also creates its importance as cut flowers. Stock has diversity of colors and is also a fragrant flower. But this plant is used as bedding plant mostly and for its growth it requires proper media. The study was performed in Bagh e Jinnah directorate of floriculture. The stock looks very beautiful in landscaping and used as decoration in houses. This experiment/results showed the type of growing media best for stock in plastic pots. To check the effect of different growing medias 18 plastic pots with six treatments were used and three replicates were repeated for each treatment. Different parameters including plant height, no. of leaves, days to bud development, days to bud opening, no. of buds, no. of flowers & foliage width were used to check effect of different medias on the plant growth, height and vigor. The result shows that different media has different effect on the plants growth. T1 [Silt (50%) +leaf compost (50%)] and T3 [Leaf compost (30%) +peat moss (30%) + coco coir (30%) + rice husk (10%)] showed better response *i.e.,* more sprouting of leaf, plants height and it showed optimum growth. Statistix 8.1 software was used to analyze the data. Based on the media composition contents we concluded that leaf compost was a better source for nutrients and better growth of landscape plant.

## Effect of Foliar Application of Calcium and Amino Acids on Vegetative, Reproductive and Biochemical Attribute of Tomato (*Solanum lycopersicum*)

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Tomato is a popular vegetable crop in Pakistan as well as many parts of the world. It is a heavy feeder for macro and micronutrients particularly at the later part of its life. This study was conducted at Vegetable Research Area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad during 2019-20 under randomized complete block design (RCBD). Two promising tomato varieties (V1 Sandal and V2 beef) and seven treatments (T0 control, T1 Ca 1%, T2 amino acid 1%, T3 Ca 2%, T4 amino acid 2%, T5 Ca 1% + amino acid 1% and T6 Ca 2% + amino acid 2%) were used. Maximum plant height, number of flower cluster/plant, number of

fruits/plant was obtained in treatment T6. Highest number of flowers/plant was noted in T4 and maximum fruit weight in T5. Maximum ascorbic acid was found in V1 when treated with T5 and in V2 when treated with T2. In V1 variety, maximum total soluble solids (TSS), pH, reducing sugar, non-reducing sugar and total sugars were noted when treated with T3. However, in V2 variety, maximum TSS, EC, reducing sugar, non-reducing sugar and total sugars were observed in T5 while maximum pH was noted in T4. Overall, treatments T6 was found best followed by T5. Sandal variety showed better performance as compared to Beef variety which can be recommended to the farmers to increase their profit and yield.

## Combating Blossom End Rot in Tomato Through Nutritional Management

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Blossom End Rot (BER) is an irreversible physiological disorder. It appears as water-soaked, black scar at the base of tomato fruit. It causes significant commercial losses. BER is due to number of problems like water stress, Ca deficiency, excess N or combination of all three. It occurs mostly at fruit expansion stage because most of the Ca is deposited in early fruit growth. NH4 application after fruit set will further enhance it. Saline and waterlogged soils are more susceptible. Soils need to have a percentage base saturation of Ca of 55-70% with balanced K (>150 ppm) /Ca. Less than 0.2 percent Ca in the fruit can increase the incidence. $Ca(NO_3^-)^2$ is used as Ca source in the soil. Most effectively it is controlled by adequate irrigation and fertilization. Uniform soil moisture is preferably maintained. Other factors that impair roots ability for water uptake are also considered. Foliar application can correct Ca, Mg, B, and K requirement, during highest demand and where soil fertility is low.

## Iron Sulphate Modulates Physiological Behaviour and Inhibits the Chlorophyll Degradation of Broccoli Florets

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Broccoli (*Brassica oleracea* var. *italica*) is a scrumptious vegetable crop in the cabbage family. Heads of fresh broccoli are being consumed as salad as well as culinary. During production, broccoli crop has been facing the issue of pre-mature yellowing which downgrades the cosmetic quality and limits marketability. Among the various reasons, the deficiency of micro-nutrients markedly influences on the quality production. Iron plays imperative role in colour related metabolism and responsible for chlorophyll pigmentation. Therefore, current study was planned

and conducted to evaluate the effect of iron sulphate foliar sprays on two stage of plant growth. Broccoli plants were sprayed with iron sulphate (0, 8, 12, 16mM) two times; before and after heading stage. Plants sprayed with 12 mM iron sulphate significantly increased yield, curd weight, size, leaf area, stem length and stem diameter. Likewise, the plants subjected to iron sulphate 12 mM followed 16 mM sprays exhibited higher score for colour displayed 100% green heads thereby associated with higher accumulation of chlorophyll contents. Phytochemical quality profile was also induced with the application of iron sulphate. Conclusively, the foliar application of 12 mM iron sulphate supplemented with usual fertilizer program (soil application) could be a great remedy against pre-mature yellowing in broccoli florets.

**Effect of Foliar Application of Different Levels of Zinc on the Growth and Yield of Pumpkin**

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Pumpkin is an important annual plant that belongs to the Cucurbitaceae family. Pumpkin is not just only used as vegetable, but the seeds of pumpkin contain medicinal raw materials that are used for producing pharmaceutical products such as peponen, pepostrin and gronfing to overcome prostatic hypertrophy and urinary tract irritation. Zinc (Zn) is an essential trace element for every living organism. About 200 enzymes and transcription factors require Zn as a functional component. Zinc is known to have an important role, either as a metal component of enzymes or as a functional, structural or regulatory cofactor of a large number of enzymes. Application of microelements fertilizers can enhance plants resistance to environmental stresses. Foliar fertilization is an effective practice for the application of some micronutrients, since it uses low rates and the micronutrient does not directly contact the soil, avoiding losses through fixation. The study was carried out to determine the response of pumpkin to zinc fertilizers at Department of Horticulture College of Agriculture University of Sargodha during 2020. The experimental design was randomized complete blocks with four replications. Treatments was comprised of four foliar application levels ($T_1$= control, $T_2$= 0.2%, $T_3$= 0.4%, $T_4$=0.6% Zn as $ZnSO_4$ was applied) of micronutrients at flowering stage. The results of foliar application of zinc showed that the maximum shoot length, root length, fresh weight, dry weight of root and shoot was recorded where Zn was applied at the rate of 0.4%. Number of seed and fruit weight of pumpkin showed significant response to foliar spray ($P<0.01$). The highest seed yield was obtained from foliar spray of Zn at rate of 0.4% minimum yield was produced by control. Hence, foliar spray of Zn at rate of 0.4% should be practiced to obtain maximum yield, seed number from pumpkin.

## Metals Toxicity in Wastewater Irrigated Vegetables: A Case Study of Underdeveloped Region

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Use of untreated wastewater for irrigation of vegetables has become a common practice in underdeveloped countries particularly in Pakistan due to scarcity of good quality fresh water. Wastewater irrigation led to accumulation of toxic elements in soil which could be accumulated in vegetables, contaminating the food chain and pose serious threat to human health. Therefore, present study was conducted in areas of Punjab where wastewater irrigation is common practice. Total 1200 vegetable samples were collected and analyzed for lead (Pb), cadmium (Cd) and nickel (Ni). The concentration of potentially toxic elements was analyzed by atomic absorption spectrophotometer. Results revealed that 71% vegetable samples were contaminated with Cd while 32% samples were contaminated with Ni. Results also showed that leafy vegetables found more contaminated with heavy metals as compared to other vegetables. Overall, the metal concentration in most of vegetables of wastewater irrigated areas of Punjab exceeded their respective threshold limits set by the Food and Agriculture Organization/World Health Organization. Therefore, irrigation of vegetables with untreated wastewater must be avoided to minimize the adverse impacts on human health and environment.

## Interactive Effect of Organic Manure and N, P, K Nutrition on Bulb Yield and Nutritional Quality of Onion

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Onion is very important vegetable crop of Pakistan and this vegetable is integral part of each cooking dish in Pakistan. Use of organic manures with inorganic fertilizers to meet the nutrient requirement of onion crop would be an inevitable practice in the coming years for sustainable agriculture since they improve plant growth and nutritional quality. A study was carried out at field area of Soil Chemistry Section, Ayub Agricultural Research Institute, Faisalabad to assess the interactive effect of organic manure and inorganic fertilizer on bulb yield and nutritional composition of onion. The experiment was consisted of eight treatments with three replications. Recommended dose of different inorganic fertilizers (nitrogen, phosphorus and potassium) was applied alone and in combination with and without organic manure using split plot design. Urea, single super phosphate and sulphate of potassium were used as inorganic fertilizers while well rotten farmyard manure (FYM) was applied as organic source. The results showed that interactive effect of organic and inorganic fertilizers not only increased the bulb yield but also improved the nutritional quality of onion. The highest bulb yield (21.5 tons per hectare) was observed where

combined application of organic and inorganic fertilizers was done. Furthermore, zinc content in onion bulb (42.8 mg/kg) was also improved by the combined application organic and inorganic fertilizers. Therefore, this research suggested that planting of onion with integration of organic and inorganic fertilizers not only contributed to productivity but also enhanced the nutritional composition.

## Identification for Irrigation Farming Systems of Balochistan of Promising Horticulture Crops and Water Efficient Cropping Pattern

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Horticulture despite arid to semi-arid climate has a prominent role in the economy of Balochistan. Groundwater is the essential natural resource of irrigated farming system in Balochistan. However, it was mined mercilessly especially in the highland river basins namely Pishin, Nari and partially Zhob the major deciduous growing areas. Continuous dry spell from 1997 to 2006 aggravated the situation further which resulted in complete drying of tube wells, karezes and springs. Groundwater depletion was an issue of great concern for the Government of Balochistan. The present study was undertaken by the author under Asian Development Bank financed Project for the Provincial Government. The study recommended that development of horticulture will be entirely dependent on the utilization of flood water. The available water from flood and run off is 12.76 MAF and at present only 0.5 MAF is used, the rest goes to sea. In the present paper the cropping pattern is proposed according to potential water productivity ranking under different irrigation systems. Ranking was computed using the potential water productivity in Rs. /$m^3$. Farm prices are taken and 50% of the whole sale price in the nearby markets. However, the water available has to be managed properly and growing of low delta crops in different ecologic zones coupled with high efficiency irrigation system for horticulture crops should be given priority. The irrigation and Power Department has completed construction of 46 dams mostly in over drawn basins under 100 dam schemes. The remaining will be completed by the end of 2021.

## Effects of Macronutrients (NPK) on Quality, Growth and Yield of Sponge Gourd (*Luffa cylindrica* L.)

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Sponge gourd is an important cucurbit crop extensively cultivated in Pakistan which belongs to Cucurbitaceae family and has its own value among all the cucurbitaceous vegetables. This experiment was executed to determine the effects of foliar application of macronutrients such as

NPK on quality, growth and yield of sponge gourd at Vegetable Research Area, Institute of Horticultural Sciences, University of Agriculture Faisalabad. The research was accompanied by subsequent Randomized Complete Block Design (RCBD) with 3 replications. Five treatments [0% NPK (Control), 0.5% NPK, 1.0% NPK, 1.5% NPK and 2% NPK] of standard NPK fertilizer (20:20:20) were applied. Foliar application of 2% NPK treatment was found best for vegetative and biochemical parameters. Maximum values of vegetative parameters such as stem thickness (66.40 mm), petiole length (104.83 mm), peduncle length (200.96 mm), fruit length (32.33 cm), fruit width (15.27 cm), fruits per plant (24), fruit weight (175.09 g), fruit yield per plant (1836.66 g/plant), seeds per fruit (215.15), seed length (51.26 mm), seed width (10.59 mm), 100-seed weight (9.68 g), mature fruit weight (245.89 g), mature fruit width (21.95 cm) and mature fruit length (37.31 cm) were obtained in foliar application of 2% NPK. Biochemical traits such as chlorophyll contents (29.27), NPK percentage (5.03 %) were highest in 2% NPK treatment while maximum vitamin C (71.33 mg/100g). Taken together, results obtained from this study, Foliar application of 2% NPK is the recommended dose for the maximum yield and quality production of sponge gourd.

**Response of Gravel-Sand Mulch Thickness on Temperature and Moisture Retention of Soil**

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Reducing ineffective evaporation is a feasible means to improve water use efficiency in agriculture. Mulch thickness is one of the important factors affecting soil moisture and temperature. This experiment was conducted in greenhouse at Institute of Vegetables and Flowers, (CAAS), Beijing, China. Cocopeat was used as a basic layer (30 cm) in troughs (made up from bricks) covered by a plastic film treated as control treatment while other 5 treatments were cocopeat with different thickness of sand having top layer of 0 cm, 5 cm, 10 cm, 15 cm and 20 cm respectively. Moisture and temperature of substrate was recorded regularly with an interval of 3 hours. Results showed that control treatment was too high in temperature. Whereas the treatment (T5) was not economically feasible to use due to its large quantities of sand. So, recommendations were made for the best treatment were T3 (cocopeat+10 cm sand layer) with temperature conservation and moisture retention.

# SESSION TRACK

# I. Plant Protection

## Landscape Pest Control by Entomopathogenic Fungi. A Review

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Landscape proposes aesthetics, tranquillity, and escapism to individuals. Many insects cause damage to the landscape plants, and biological control is being proposed by many researchers because of the negative impact of chemical control. Among biological control agents, entomopathogenic fungi are eco-friendly, an effective biocontrol agent with a huge host range, and a great alternative to chemical pesticides. Insect pathogenic fungi have a high potential to control various life stages of insect pests. This review will emphasize recent research trends of insect pathogenic fungi in the landscape. And the aspects of these fungi for commercial use are the following: Isolation of new species or strains, enhancement of sporulation, the formation of the new formulation, new methods of application in landscapes, and using biotechnology for increasing their efficacy. Most potential fungi are *Metarhizium anisopliae*, *Beauveria bassiana*, *Isaria fumosorosea*, *I. javanica*, and *Nomurea rileyi*. Locally isolation and formulation increase the ability of these fungi to control the insects of the landscape.

## To Record Disease Incidence of Grey Mold of Strawberry in Central Balochistan

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This study was carried out to record disease incidence of grey mold (*Botrytis cinerea*) of strawberry in Central Balochistan. Different locations were selected, viz., Killi Kanak, Killi Kadkucha, Killi Kardighap, Killi Dashath, Killi Mangochare and Killi Babari in district Mastung. The result of study showed that the disease incidence from different locations of District Mastung had highly significant difference as (40, 22, 17, 13, 5 and 3%) in Killi Kanak, Killi Kadkucha, Killi Kardighap, Killi Dashath, Killi Mangochare and Killi Babari, respectively.

## Prevalence, Frequency of Associated Fungi and Pathogenicity Test of Fruit Rot Disease of Pomegranate

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Survey of fruit rot of pomegranate was carried out from 6 different locations of district Lorlai, Balochistan. The results showed that the disease incidence from different locations of Loralai was observed as 25, 16, 55, 11, 35 and 20% in Moza Dargi, Moza Zangiwal, Moza Oryagi, Moza

Lashti, Moza Murtath and Moza Pathankot, respectively. Maximum disease incidence was recorded in Moza Oryagi followed by Moza Murtath, Moza Dargi, Moza Pathankot and Moza Zangiwal. Minimum disease incidence was recorded in Moza Lashti. The disease incidence in different varieties of pomegranate was observed as 40, 25, 20 and 15% in Red Kandhari, Zalari, Bedana and Khata Anar, respectively. The disease severity from different locations of district Loralai was observed as 2 (11-25%) in Moza Dargi, 3 (26-50%) in Moza Zangiwal, 2 (11-25%) in Moza Oryagi, 2 (11-25%) in Moza Lashti, 1 (1-10) in Moza Murtath and 1 (1-10%) in Moza Pathankot, respectively. The disease severity from different pomegranate varieties were observed as 3 (26-50) in Red Kandhari, 2 (11-25%) in Zalari, 1 (1-10%) in Bedana and Khata Anar, respectively. Among all the isolated fungi, *Aspergillus niger* (52%) remained most frequent, pre-dominant fungus and identified because of their morphological characteristics with the help of microscope, *Botrytis cincerea* (25%), *Penicillium spp.* (15%). and *Rhizopus spp* (8%). Pathogenicity test of *A. niger* was performed on pomegranate fruits. It was observed that cut method of inoculation showed higher percentage (78.01%) of rotting as compared to injection method of inoculation (67.56%).

## Mitigating Citrus Huanglongbing Pathogen Through Core Functional Endophytes: Focused on Model Citrus Pathosystem and Inhibition of Quorum Sensing Signals

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Citrus huanglongbing (HLB) is one of the irrepressible citrus tree diseases resulting in devastating loses to citrus industry. The increasing incidence caused by phloem colonizing and exotic infectious pathogen *Candidatus Liberibacter* asiaticus (Clas) are causing worldwide concern and frustration. The native microbiomes of citrus trees play important role in plant health, with good communication between the native microbiome and the host plant. Much remains unknown about the core microbiome function and importance for plant health. Core microbiomes from citrus host was studied from different provinces of China. However, it is still unknown donor beneficial microbiota from the healthy citrus plants could minimize the disease incidence in citrus. In the present study, citrus healthy bacterial microbiota (named as citrus Biome) was used to rescue the citrus plants from HLB through restructuring microbiomes. A novel half-leaf method was developed to test the efficacy of Bacillus subtilis L1-21 against Clas. A concentration of B. subtilis L1-21 at 104 CFU $mL^{-1}$ resulted in a 1000-fold reduction in Clas copy densities per gram of leaf midrib (107 to 104) by 4 d after treatment. Diseased citrus groves with disease incidence were reduced to <3% and Clas copy density was reduced from 109 to 104 pathogen $g^{-1}$ of diseased leaf midrib after using endophytes. Molecular pathways involving pathogen resistance genes and metabolic changes in healthy and diseased citrus host were regulated in citrus through B. subtilis L1-21 application. Here, citrus-derived quorum sensing inhibitors that can disrupt the pathogen communication network and ultimately reduce its colonization is under way. This study highlighted new insights to use indigenous endophytes and suggested key citrus microbiomes to mitigate citrus HLB on large scale.

## Entomopathogenic Fungi, An Eco-Friendly Bio-control Agent for the Integrated Management of Mango Fruit fly *Bactrocera zonata* (Tephritidae; Diptera)

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Mango, *Mangifera indica* L. (Anacardiaceae) is native to multiple tropical and subtropical regions including south and Southeast Asian countries. India enjoys top position by producing 18 M tonnes mangoes, which accounts for 40.48% of total world's mango production. Pakistan is among the top five producers and contributes 4.6% in world's production. Pakistani mangoes are destined for West Asia, Europe and United Arab Emirates. Mango is a rich source of foreign exchange and plays a vital role to stabilize the Country's economy. To meet the requirements of WTO an effective and eco-friendly management strategy is required. Mango is susceptible to almost 400 insect pest species and *Bactrocera zonata* is one of the notorious pests of mango orchards causes huge losses. Traditional Insecticidal control tactics render hazardous effects like environmental pollution, insecticide resistance and contamination of products causes hindrance in exporting the commodity. Entomopathogenic fungi are promising bio-control agents which have revolutionized the field of IPM. *Beauveria bassiana* and *Metarhizium anisopliae* have multiple fungal isolates which are highly pathogenic against different developmental stages of fruit fly. These endophytic fungi produce mycotoxins including bassianin, beauvericin, bassianolide, beauveriolide, bassiacridin, oosporein, and tenellin. As a major component of IPM programs, least mammalian toxicity and healthy alternative to chemicals, biopesticides are gaining importance. Currently, biopesticides comprise a small share of the total crop protection. In Pakistan work should be done to commercialize these beneficial products because of their broad future perspectives.

## Genetic Potential of Potato (*Solanum tuberosum* L.) Genotypes for Resistance Against Common Scab Disease

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Potato (*Solanum tuberosum* L.) is considered as the most important vegetable crop across the globe. Nutrients composition of potato, *i.e.,* carbohydrates, proteins, vitamins, antioxidants, etc., make it a complete diet crop. Potato conferees many biotic and abiotic stresses during whole season *i.e.,* insects, diseases, frost, heat stress etc. Potato common scab caused by Streptomyces scabies was declared as one of the deadliest diseases of potato by the famers of USA. It reduced marketability and yield of potato crop. Streptomyces scabies created superficial lesions while to deep pitted lesions over tubers under severe attack. The casual organisms were isolated from infected tubers and inoculum was prepared. Thirty-three potato genotypes were acquired from Potato Research Institute. The experiment was conducted at Plant Pathology Research Institute, AARI, Faisalabad. Potato was sown in common scab sick soil created by application of common

scab inoculum. The experiment was laid out under Randomized Complete Block Design. Scab index was measured according to scale provided by Bjor and Roer (1980). The results indicated that four genotypes viz., Sayada, FD 71-1, FD 77-4, and SH-5 rendered high resistance to common scab incidence with Sayada depicting least scab index. These genotypes would be utilized as parents for development of common scab resistant varieties.

## Varietal Preference and Population Dynamics of Onion Thrips, *Thrips tabaci* L. (Thysanoptera: Thripidae)

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Onion (*Allium cepa*) is one of the most important horticultural crops and is commonly used due to its flavor, aroma, and unique taste, and the medicinal properties. Different factors are responsible to affect the onion crop and the most important are insect pests. In the current study, varietal preference and population dynamics of thrips (*Thrips tabaci* L.) was investigated. For this purpose, five varieties (NARC Onion-1, NARC Onion 2005, NARC Onion-1, Swat-1 and Phulkara) were sown under randomized complete block design at research farm of MNS- University of Agriculture Multan, Pakistan. The results revealed low infestation of thrips on NARC Onion 2005 as compared to other four varieties. Maximum population of adult thrips (6.58 per plant) and nymph (52 per plant) were recorded during the 4th week of March on NARC Onion-1. While on onion variety Swat 1, the population of adult and nymphs was 6.13 per plant and 50.71 per plant respectively during 1st week of April. The thrips population was decreased during April on all varieties due to maturity of the crop. NARC Onion 2005 variety was resistant to thrips compared to all other varieties. The results will be helpful in the management of onion thrips.

## Entomopathogenic Fungi Promising Agent to Control Insect Pest of *Manihot esculenta*

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Cassava (*Manihot esculenta*) is one of the most popular crops, which is the fifth most produced staple food also used in medicine, ethanol production, and as a biofuel crop. Also, Cassava is an alternate source of gluten-free starch which prevents many celiac diseases. It is grown by the farmers of tropical and subtropical regions of the world for edible starch. It is drought tolerant, can grow in poor soils, and give reasonable yields, but the vulnerable factor affecting it is the arthropod pests which can cause maximum yield loss. Cassava yield is affected by mites, whiteflies, mealybugs, hornworms, thrips, lace bugs, and burrower bugs. Because of the negative impact of

chemical control, the use of insect natural enemies is in trend. There are many parasitoids, predators that have been identified, but the use of entomopathogenic fungi can be a great potential agent against these pests. *Beauveria bassiana, Lecanicillium lecanii, Metarhizium anisopliae,* and *Isaria fumosorosea* have the ability of an excellent agent. Insect-infested cassava plant emanates volatiles that triggers the sporulation of some isolates of entomopathogenic fungi. Insect pathogenic fungi to control these pests could be a promising agent.

## Identification, Host Range and Host Preferences of Cuscuta Species of Karak, Kohat and Bannu Districts

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*Cuscuta* species and their host range was studied in districts Bannu, Kohat and Karak. Two *Cuscuta* species were recorded viz., *Cuscuta reflexa* and *C. campestris*. *Cuscuta* species are widely distributed in Bannu, however, these are also found in scattered patches in district Karak, while these were noted to parasitize least number of hosts in Kohat. There was no overlap among host species at the primary level. Although *Cuscuta reflexa* is a generalist species, 74% of the total records were from the primary (*Ziziphus spina-christi*, Rhamnaceae) and secondary (*Ziziphus nummularia,* Rhamnaceae) hosts, but 10 host taxa (nine genera in nine families) were recorded overall. *Cuscuta campestris* is also a generalist species, parasitising 12 taxa (twelve genera in nine families) respectively. For *C. campestris* the primary and secondary hosts, represent 42% of the total records. *Typha latifolia* (Typhaceae) is the primary host (23% of records), whereas *Persicaria glabra* (Polygonaceae) is secondary host. A total of 22 plants species belonging to 15 families and 21 genera were observed as the host plants of the *Cuscuta* species in the three districts. Asteraceae was the preferred family parasitised by *C. campestris* while Rhamnaceae was the preferred family parasitised by *C. reflexa*.

# SESSION TRACK

# J. Stress Management

## Impact of Foliar Chitosan Application on Morphological and Physiological Processes of Calendula under Drought Stress

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Unpredictable climatic conditions pose serious threat to floriculture industry in arid and semi-arid regions of Pakistan. Identification of effective mitigation strategies is essential to increase the productivity of horticultural plants. The present study was conducted to evaluate the effects of exogenously applied chitosan on growth and physiological processes of calendula under limited water conditions. The plants were exposed to two drought stress (60% and 100% field capacity) and five chitosan (0, 2.5, 5 7.5 and 10 mg $L^{-1}$) treatments. The seedlings were transplanted at two leaf stage and drought stress was applied after 15 days of transplantation. Data regarding growth and physiological attributes were recorded. Drought stress significantly reduced biomass (number of leaves, leaf area, shoot length, shoot fresh weight, shoot dry weight, root length, shoot fresh weight, shoot dry weight), water status (relative water contents and excised leaf water contents) and pigments (chlorophyll and carotenoid content). Foliar spray of chitosan markedly improved the biomass production that was associated with increased water status and pigments under drought stress conditions. We conclude that chitosan application is an effective approach to reduce negative effects of drought stress in flowering plants like calendula. Keeping in view the current climate change scenarios and limited water availability, future studies should consider this aspect in other annual crops under extreme environmental conditions.

## Physiological and Biochemical Determinants of Cadmium (Cd) Stress in Citrus Rootstocks

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Citrus groves face several biotic and abiotic constraints during their life span. Different abiotic stresses such as salinity, drought, flood, heavy metals etc. adversely affect the growth and yield of citrus plants. Cadmium (Cd) stress influences the fundamental functions of plants. In this pot experiment, four citrus rootstocks, viz., Rough Lemon, Rangpur Lime, Sour Orange and Volkamer Lemon were subjected to three level of Cd stress, viz. T0= 0 µM, T1=2 µM and T2= 4 µM for 80 days. Different physiological parameters, viz., photosynthesis, stomatal conductance, transpiration, non-photochemical quenching and Quantum yield of photosystem II were measured in leaves. Further, various biochemical parameters, viz., SOD, POD, CAT and total soluble protein

were measured in leaves and roots. Moreover cadmium, calcium and magnesium were also measured in leaves and roots. Results demonstrated that, Cd stress severely restricted the different physiological parameters of leaves and different biochemical parameters were also affected by the high concentration of cadmium. Among different rootstocks rough lemon and Volkamer Lemon presented more tolerance towards the Cd stress when compared to Sour Orange and Rangpur Lime. Calcium, magnesium and were also found in higher amounts in leaves as compared to roots. Cd was more in roots as compared to leaves in all four rootstocks. It is concluded that presence of Cd in roots negatively impacts different processes of citrus plants.

## Evaluation of Citrus Rootstocks for Salinity Tolerance Under Varied Salt Concentrations

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Citrus species are classified as very sensitive to salinity compared to other horticultural crop plants. One of the practices to increase salinity tolerance in citrus fruits is commercial grafting and salinity sensitive varieties onto salinity resistant rootstocks and evaluating the effect of intermediate stock. For this, a pot study was carried out to evaluate the salinity tolerance for citrus rootstocks at seedling stage. Selected rootstocks for this study were Rough lemon (*Citrus jambheri* L.), Rangpur lime (*C. limonia*), Cleopatra mandarin (*C. reshni*) and Volkameriana (*C. volkameriana*). These selected rootstocks were tested against four different salinity levels (*i.e.*, control, 4.0, 6.0 and 8.0 dS $m^{-1}$) using complete randomized design (CRD) with two factors factorial. Plant growth attributes like number of leaves per plant, number of branches per plant, plant height, stem thickness, plant fresh weight, plant dry weight, root fresh weight, root dry weight, root length, root diameter, leaf area and chlorophyll content varied significantly ($p \leq 0.05$) depending upon these rootstocks. It was observed that among all these rootstocks, Rough lemon (*C. jambheri* L.) had shown more promising results in comparison to the other rootstocks of citrus when tested against different concentrations of salts. In addition, more efforts should be made to support the level of salts tolerance with physiological and biochemical analysis of citrus rootstocks.

## Effect of Salicylic Acid on Okra Sown at Different Intervals Under Heat Stress Conditions

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Okra falls in the category of major vegetable crops of summer season and belongs to Malvaceae family. It is an annual herbaceous plant, growing in both tropical and subtropical regions of the

world. Heat stress is major issue that affects okra production because temperature of world increases day by day due to climate change. Its yield is low in Pakistan due to different climatic variations and high temperature. The present experiment was performed to investigate the effect of different sowing times and application of salicylic acid on okra under heat stress. Research was conducted in growth room of Vegetable Stress Lab, (IHS). Seeds (var Sabzpari) were sown in pots with three different sowing intervals. After 50 days heat stress was given, and the foliar application of 1.5 mM salicylic acid was applied during stress. After the application of salicylic acid, data related to different parameters was collected like number of leaves, shoot length (cm), root length (cm), seedling fresh weight (g), seedling dry weight (g), stem diameter (mm), chlorophyll contents (SPAD), transpiration rate (m mol $m^{-2}$ $s^{-1}$), stomatal conductance (vpm), photosynthetic rate (u mol $m^{-2}$ $s^{-1}$) and water use efficiency (Pn/E). The results showed that application of salicylic acid responded better under heat stress conditions and significantly increased growth-related parameters. Foliar application of salicylic acid also increased chlorophyll contents and water use efficiency of plants. The experiment was conducted according to CRD under controlled conditions.

## Growth Response of Okra to Various Chemicals Under Heat Stress Condition

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Okra is an important plant of the Malvaceae family, which is grown worldwide in summer. It is also known as "Bhindi" in the subcontinent. Abiotic stresses are responsible for the reduction in plant growth and yield. Each 1℃ rise in temperature can cause a 10-15% loss in production. The current experiment was performed to check the effect of different chemicals, viz., salicylic acid, chitosan and proline and to mitigate the heat stress effect in okra. Seeds of okra var. Sabzpari was sown in 4-inch plastic pots, filled with sand. Heat stress was given after 50 days of sowing and chemicals was applied exogenously with different concentrations, viz., salicylic acid 200 ppm, chitosan 100 ppm, proline 175 ppm and their combinations salicylic acid 200 ppm + chitosan 100 ppm, salicylic acid 200ppm + proline 175 ppm, chitosan 100 ppm + proline 175 ppm and salicylic acid 200 ppm + chitosan 100 ppm + proline 175 ppm during this stressful period. After one week of the stress, plants were harvested, and data was collected. Each treatment was replicated three times under CRD. The effect of these chemicals was evaluated by recording different growth and physiological parameters (Number of leaves, shoot length, root length, stem diameter, seedling weight both fresh and dry, chlorophyll contents, transpiration rate, stomatal conductance, photosynthetic rate and water use efficiency. The results of this study show that all parameters were significantly affected by combined application of salicylic acid, chitosan and proline under heat stress.

## Genetic Variability for Drought Tolerance in Tomato at Seedling Stage

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Tomato is commonly used as vegetable alongside potato worldwide. It is a key source of antioxidants and minerals. The major limiting factor that affects physiological and morphological parameters of tomato is drought stress that causes a drastic decrease in total yield. Twenty tomato genotypes were sown in a completely randomized design (CRD) with three replications. The percentages of field capacity were kept as 40, 70 and 100. The parameters under study included number of leaves per plant, root length, shoot length, leaf area, number of lateral roots and number of branches. Recorded data of different traits were analyzed statistically using Analysis of Variance (ANOVA) and Tukey's test. Furthermore, multivariate analysis was used to identify the best performing genotypes under drought stress conditions. Shoot length, number of lateral roots, root fresh weight, shoot fresh weight, root dry weight and plant height showed significant interaction of genotypes and water levels while other characters showed non-significant interaction. Drought stress at 70% field capacity showed better performance in comparison to 40% field capacity. Among all genotypes PB-7909 considered as best genotype because it performed well in control condition. Yellow and CLN-3241-Q found to be non-efficient genotypes under control condition. LO-3691 and CLN-3241-Q were considered as drought tolerant and susceptible genotypes under 70% drought condition, respectively. Under 40% field capacity, PB-2366 and yellow were considered as drought tolerant genotypes while CLN-3241-Q considered as drought susceptible genotype. These genotypes can be grown under drought conditions for high tomato production and for future breeding purposes.

## Effect of Zinc Nanoparticles Seed Priming and Foliar Application on the Growth of Spinach (*Spinacia oleracea* L.) Under Salt Stress

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The experiment was performed to explore the effect of zinc nanoparticles (ZnNPs) to ameliorate the harmful influences of NaCl stress (salt) on the growth and development of spinach (*Spinacia oleracea* L.). Seed priming (Pre-sowing seed treatment) and foliar application of 0.1%, 0.2% & 0.3% zinc nanoparticles (ZnNPs) were applied to spinach, grown under normal and salt stress conditions. Growth and biochemical attributes were recorded at seedling stage under control and stress conditions. The application of ZnNPs increased biomass, shoot and root length chlorophyll contents, total free amino acids and total soluble proteins. However, foliar application of 0.3% ZnNPs was the most effective treatment in maintaining carotenoid contents, total anthocyanin, antioxidants, total phenolics and flavonoid contents under normal and saline conditions.

## Mitigation of Tomato Water Stress via Seed Priming and Foliar Application of Osmoprotectants

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Several biotic and abiotic factors are affecting the plant growth and development. Being highly perishable (containing 90% water) in nature, a tomato plant requires abundant supply of water for proper food development. Application of osmo-protectants ameliorates the stress. A research was conducted at UAF Sub Campus Burewala to evaluate the effect of seed priming and foliar application of osmo-protectants (Proline, Ascorbic acid and Glycine betaine) to mitigate water stress in tomato crop. Seeds of a promising tomato variety were obtained from a reliable source. Two studies were carried out. In 1st study, three laboratory trials were conducted to optimize doses and duration for priming of tomato seeds with osmo-protectants (Proline, Ascorbic acid and Glycine betaine). Initial plants were subjected to PEG (10%) induced water stress. Seed priming with osmo-protectants, especially proline (0.1 mM) was found highly effective in improving seed and seedling quality attributes. After doses and duration optimization, a field experiment was performed to evaluate the effect of foliar application of osmo-protectants (Proline, Ascorbic acid and Glycine betaine) at two-leaf, four-leaf and flowering stage (individually as well as in all possible combinations) to mitigate late-stage water stress. Only the most effective doses of each osmo-protectant (based on the results of first study) were used. Tomato seeds were primed before sowing. After seeds emergence, osmo-protectants were foliar applied as per experimental treatments. Seedlings were transplanted in the field at four-leaf stage and 50% water stress was applied throughout the growing season. Foliar application of proline (0.1 mM) at all three growth stages of tomato (two-leaf, four-leaf and flowering) was found highly effective in improving all morphological, reproductive, yield and fruit quality attributes. Significant results were observed in all treatments over control (plants grown without any seed priming and foliar application) to mitigate water stress.

## Enhancing the Salt Tolerance in Radish by Exogenous Application of Glutamic Acid

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Saline toxicity in soil is one of the major constraints for the radish (*Raphanus sativus* L.) production. One of the best ways to overcome this problem is the use of plant growth regulators to induce plant stress tolerance. Exogenously applied growth regulator, glutamic acid, response with combination of salt was examined in radish grown in soil under four levels of salt (0, 4, 8 and 12 dS $m^{-1}$) with two levels of glutamic acid (0 and 750 ppm). Results showed that salt stress reduced the growth and development of the plant when the concentration of salt was increased by 12 dS $m^{-1}$ from 4 dS $m^{-1}$. Significant decreases were more pronounced in photosynthetic

parameters by the salt addition alone. Plant growth and chlorophyll content in the leaves under salt stressed plants ameliorated with application of glutamic acid. Exogenously treatment of glutamic acid improved chlorophyll a, b and biochemical activity of plants with salt addition. Glutamic acid also decreased the salt contents in roots or leaves, and addition of reactive oxygen species (ROS) which were elevated by high concentrations of salt. Results indicated that gradual increase the salt application in soil the growth and development of the plant reduce, while the application of combined or alone plant perform better in all aspects.

## Proline Foliar Application Induces Salt Tolerance in Chilli Genotypes by Regulating their Photosynthetic Apparatus, Ionic Contents and Antioxidant Mechanisms

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Globally soil salinity is a serious threat to horticultural crop's productivity. Chilli is a major spice horticultural crop. Its growth and production are severely affected by salt stress. To address this problem, a sand culture experiment was conducted in which two chilli genotypes 'Plahi' and 'A-120' were grown under salt stress (50 mM NaCl) with foliar application of proline (0.8 mM). Proline application enhanced the salt tolerance in both genotypes by osmoregulation of sodium and potassium. It enhanced chilli growth and fruit yield by improving the plant water relations and gaseous exchange attributes under salt stress. Malondialdehyde concentration was reduced while antioxidants were increased with proline application under salt stress. There was also a significant positive correlation found among glycine betaine and proline contents. Conclusively, proline applied chilli plants performed better than non-treated plants as their photosynthetic machinery and antioxidant mechanisms showed proper working under salt stress.

## Effect of Heat Stress on Morpho-Physiological and Biochemical Attributes of Heat Sensitive and Heat Tolerant Chili Genotypes

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High temperature during summer in central Punjab-Pakistan had major problem in chili production. To mitigate its adverse effects, an experiment was designed to evaluate the effect of

heat stress on four selected chili genotypes (C-37, UK-101, H-13 and Jawala) selected from series of experiments for further investigations. Plants were grown at normal temperature 20/18°C (day/night temperature) and then after four weeks after emergence 40/32°C (day/night temperature) was given by gradually enhancing 2°C per day. After the plants exposed to heat stress, were harvested for studying the following morpho-physiological and biochemical attributes. The significant difference was observed in water-related attributes, antioxidant activities, osmo-protectants and lipid peroxidation in leaves of tolerant (L3466 and Desi) and sensitive (Suyo Long and Poinsett) genotypes under heat stress (40°C/32°C). Further studied regarding water related attributes, viz. osmotic potential, water potential, turgor potential, relative water contents and activity of antioxidants in leaves *i.e.*, superoxide dismutase (SOD) (U $mg^{-1}$ Protein), peroxidase (POD) (U $mg^{-1}$ Protein), catalase (CAT) (U $mg^{-1}$ Protein) and protein (mg $mL^{-1}$) revealed that heat tolerant chili genotypes (C-37 and UK-101) showed better than sensitive ones (H-13 and Jawala) under high temperature.

## Heat Stress Alleviation in Muskmelon by Use of Salicylic Acid and Chitosan

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Heat stress had harmful effects on morpho-physiological and growth attributes of muskmelon plants. To alleviate heat stress in muskmelon, seeds were sown in plastic pots kept at growth chamber. Plants were grown at normal temperature 20/18°C (day/night temperature) and then after four weeks after emergence 40/32°C (day/night temperature) was given by gradually enhancing 2°C per day. One week after heat stress, foliar application of chitosan (CHT) (2 $mgL^{-1}$), salicylic acid (SA) (2 $mgL^{-1}$) and its combined treatment (2 $mgL^{-1}$ CHT + 2 $mgL^{-1}$ SA) were proven to recover the heat stress induced adverse effects. One week after its applications, chitosan, salicylic acid and its combined effect improved the morpho-physiological and growth attributes such as number of leaves per plant count manually, height of seedling (cm), leaf area (cm), petiole length (cm), stem diameter (cm), chlorophyll pigment by chlorophyll meter, fresh shoot weight (g), dry shoot weight (g), fresh root weight (g), dry root weight (g), electrolyte leakage of muskmelon plants. It was proved that combined effect of chitosan (2 $mgL^{-1}$) and salicylic acid (2 $mgL^{-1}$) improved the morphological and physiological attributes against heat stress.

## Sustaining Water Balance and Various Physiological Traits in *Cucumis sativus* L. by Foliar Application of Chitosan in Three Sowing Dates Grown Under Hot Environment

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Heat stress is a major issue in tropical and subtropical regions of the world where vegetable crops are grown. Utilizing genetic diversity, two tolerant (L3466 and Desi-cucumber) and two susceptible (Suyo Long and Poinsett) were grown under field conditions in three sowing times (15th March, 1st April, and 15th April). Chitosan (200 ppm) was exogenously applied on foliage at 30 days' post sow (DPS) and then twice more in one-week intervals. During present research, the maximum summer temperature recorded in May was 47.8°C, 48.0°C in June, and 46.1°C in July, respectively. Chitosan had a greater effect on heat tolerant genotypes than heat sensitive genotypes. In the first sowing date, the heat tolerant genotypes treated with chitosan had lower water loss; Desi-cucumber had the lowest water loss with a transpiration rate of 2.97 mmol $m^{-2}$ $s^{-1}$ followed by L3466, transpiration rate of 3.07 mmol $m^{-2}$ $s^{-1}$, respectively. During the third sowing date, non-treated Poinsett had the highest transpiration rate of 4.38 mmol $m^{-2}$ $s^{-1}$ followed by Suyo Long with 4.18 mmol $m^{-2}$ $s^{-1}$, respectively. Heat sensitive genotypes had higher transpiration rates, lost more water at high temperature which led to wilting of plants in the 3rd sowing date. In this study, chitosan treatment increased the yield potential by improving the heat tolerance in cucumber plants under field conditions.

## Morphological and Biochemical Responses of Lettuce Sprout under Light Emitting Diode

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Sprout are plants first tender stem after seeds have germinated. They push tiny leaves towards the light. Almost any seed can be sprouted. Though we are most familiar with sprouted grains and legumes. Among vegetables, the most common sprout are in the cabbage (broccoli cress mustard, and radish) they have a range of flavor. The light qualities set by LED systems were monochromic red light (R), monochromic blue light (B) monochromic white light (w) as compare to Tube light control. Sprout play an important role in natural nutrients in this connection lettuce and pea sprout was selected and determined the effect of monochromatic RED and Blue led as compared to control tube light on two different sprouts. The goal of this present study is to examine the impact of light emitting diodes (LED) light on morphological and biochemical parameter of lettuce sprout.

Dry weight of plant grown increased in blue light. That is why Blue light was used. In conclusion the result showed the (LEDs) Red and blue light have positive effect on growth and development of sprout as compare to tube light (control). The final goal of our study is to improve lighting apparatus for plant factories to spread them widely.

## Physiological and Biochemical Responses of *Pisum Sativum* L. to Plant- Derived Smoke Solution under Salt Stress

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Salt stress is known to affect the seed germination, growth, water deficit, ion imbalance and cause several biochemical lesions in various plants. Approximately, 1125 Mha of world is affected by salinity. Pea (*Pisum sativum* L.) is the staple food of the world population. It is therefore necessary to evaluate methods that enhance the genetic potential for pea growth and yield under salt stress. Plant derived smoke has been determined as potential plant product in improving seed germination and plant growth. The present study was conducted to investigate the effect of *Cymbopogon jwaracusa* smoke extract (1:500) on physiological and biochemical aspects of pea under salt stress (50, 100, 150 and 200 mM). Results showed that seed germination percentage was improved with smoke as compared to control, while seedling vigor in term of root and shoot fresh weights and dry weights were also significantly increased in seeds primed with smoke extracts. Similarly, in case of alleviating solutions, there occurred a significant alleviation in the adverse effects of salt solutions when mixed smoke in all studied end points. Application of smoke solution has also increased the level of total soluble sugar and protein while reduced the level of cell injury content in pea. It can be concluded that plant-derived smoke solution has the potential to alleviate the phytotoxic effects of saline condition and can increased the productivity in plants.

## Nanotechnology: A Potential Tool to Induce Abiotic-Stress Tolerance in Plants

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Abiotic stress is a multi-facet field, encompasses different abiotic factors/stressors occur in the environment that generally impose stress on a wide variety of plant species. Plants often face multiple abiotic stresses during its life cycle that substantially affect their growth and development. Crop productivities would perhaps the most vulnerable to these abiotic stresses in agricultural production systems, thus studies about the responses of crop plants to different abiotic stress are of ecologically important under changing climate scenario. Nanotechnology is well recognized as an emerging strategy and being employed successfully to improve the crop growth, productivity, quality, nutrient use efficiency as well as to improve the abiotic stress tolerance in plants.

Application of nano-scale fertilizers is one of the possible practices of precision farming that make the crop production systems more efficient, sustainable and environmentally safe by reducing wastage of resources, input, cost and energy. Targeted delivery of nano-scale micronutrients could substantially improve the crop yields, nutrient uptake and recovery and/or fertilizer use efficiency and crop performance under stressful conditions. NPs are transported within plants through vascular bundles (xylem and phloem), however excess accumulation of NPs in the root and shoot system could induce oxidative stress due to overproduction of reactive oxygen species (ROS) in plants. Application of NPs improves abiotic-stress tolerance in plants by regulating plant physiological processes such as redox regulation, osmotic adjustment and/or activation of antioxidant enzymes. No doubt, application of NPs induces abiotic stress tolerance in plants, however their excess application causes detrimental effects on morphological, physiological, anatomical and genetic traits in crop plants which largely depends on concentration, size and chemistry of NPs. Overall, application of nanotechnology in agriculture and/or plant science is an emerging field, having both positive and negative effects on plants, however, there is a need to find ways to enhance the adaptation potential of cultivated crops agronomic and/or horticultural with the use of nano-preparations under stressful conditions.

## Response of P-doped Biochar on Spinach Grown under Cd Stress

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Spinach is well thought-out to be most important staple crop having great vulnerability to accumulate cadmium (Cd), even little increase in Cd content in grain cause harmful effects on consumer's health. A pot experiment was conducted to evaluate the effect of P-doped biochar on spinach grown in cadmium contaminated soil, harvested at germination stage. The bitter gourd waste was used for biochar synthesis. Four treatments were used to evaluate the Cd toxicity in plants: $T_1$=control; $T_2$= dried Bitter Gourd; $T_3$= biochar (Bitter Gourd); $T_4$= P-doped biochar (Bitter Gourd). The 40 mg/kg Cd contaminated soil @ 5 kg $pot^{-1}$ along with the designed treatments in their respective pots were filled and placed in the glass house. Maximum germination percentage (90.3%) and dried matter (15.62 g) was observed with $T_4$, while minimum dried biomass (6.41 g) recorded in $T_1$. The highest Cd concentration was observed in T1 (6.68 mg/kg) as compared to amended treatments. The designed study could be practically applicable to reduce the Cd toxicity in cereals crops and achieve higher yields.

# SESSION TRACK

# K. Mushroom Technology

## Effect of Iron and Nitrogen Rich Additives on the Growth, Yield and Nutritional Composition of *P. pulmonarius* on Wheat Straw

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In the present studies, *Pleurotus pulmonarius* was grown on wheat straw with iron and nitrogen rich three supplementary material. This study was conducted to evaluate the most suitable substrate to produce Oyster mushroom. As for the time taken to completion of spawn running, the treatment emended with cottonseed cake (T5) took minimum number of days (19.33). As for the time taken for emergence of primordial, cottonseed cake (T5) took minimum number of days (24.38). The time taken for harvesting stage, cottonseed cake (T5) took minimum number of days (27.28). The number of fruit bodies cottonseed cake (T5) took maximum number of fruit bodies (5.56) while wheat straw (T1) took minimum number of fruit bodies (4.00). Regarding total yield of mushroom, cottonseed cake (T5) produced maximum yield (315 g). Proximate analysis of *P. Pulmonarius* grown on cottonseed cake emended T5 showed maximum moisture content (88.67%), while dry matter percentage was maximum (13.33%) in T5 treatment. Crude protein was higher in T5 treatment (28.33%). Fibre content showed the best results in both T5 and T6 treatment (13.67%) and (13.33%) respectively. Ash content was maximum in T5 (14%). Fat content was maximum in T5 treatment emended with cottonseed cake (4.33%) while the carbohydrate maximum content (31%) was in cottonseed cake emended substrate. Mineral analysis show N (4.32%), P (1.3), and K (1.31%) in T5 treatment, while calcium (33.56) mg/100g, manganese (20.85) mg/100g, iron (41.57) mg/100g, zinc was 28.16 mg per 100 g maximum recorded in cottonseed cake emended substrate.

## Evaluation of Locally Available Substrates (Peanut shell, Soyabean straw, Office scrap paper) for Yield Production of *Pleurotus sajor-caju*

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Mushroom cultivation is a high suitable way to produce high nutritious food by utilizing the agriculture and lignocellulosic wastes. This experiment was conducted for the evaluation of various agriculture and lignocellulosic wastes such as peanut shell, soybean and office scrap paper in various proportions for yield production of *Pleurotus sajor-caju*. The experiment was planned with five replications and seven different treatments in such a ways T1 (100% Peanut shell), T2 (100% Soybean straw), T3 (100% office scrap paper), T4 (50% soybean straw + 50% peanut shell), T5 (50% soybean straw + 50% office scrap paper), T6 (50% peanut shell + 50% office scrap paper) and T7 (33.3% peanut shell + 33.3% soybean straw + 33.3% office scrap paper) to check the yield

and biological efficiency. It was found the highest yield of mushroom was gained in the treatment T7 was 633 grams and the lowest yield was recorded in T1 was 275 grams compared with other treatments T5, T6, T4, T2, and T3 604, 521, 473, 368 and 355 subsequently . It was concluded that the combination of all these agricultures and lignocellulosic wastes gave the maximum yield production in early days and observed the treatment T7 is the best for the cultivation of Oyster mushroom. However, peanuts shells recommended as best substrate for production of high quality mushrooms and farmers are advised to use to cultivate mushroom with combination of agriculture waste material for bumpy production.

## Production and Yield of Oyster mushroom (*Pleurotus djamor*) on Cotton Waste and Rice Cellulosic Waste Material on the Basis of Various Spawn Rates

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*Pleurotus djamor* as an important edible mushroom in diet because of having high protein content. Oyster mushroom cultivation is important in managing organic wastes which cannot be disposed easily. Mushroom use woody structure and convert it into healthful natural product. The main aim of this study was to check the efficacy of the different spawn rates on the growth and yield parameters of the oyster mushroom available at local scale for the local farmers. To check the efficacy of the different growth media including cotton waste and rice cellulose waste were used for the spawning of Oyster mushroom. The spawning was done on different concentrations as 15, 25, 35, 45 and 55 spawns per bag per (500 g) dry weight. Data for pinhead formation, maturation of the fruiting bodies, number of flushes/bag, number of bunches/bag, number of fruiting bodies/bunch and period between flushes was counted before harvest. However, total soluble solids, protein content and biological efficiency were calculated after harvest. Moreover, fresh and dry yield in terms of percentage was also noted. This study contained (5 treatments replicated four times) and there were total (20) bags in this experiment. As far as the treatments are concerned it was observed that the (55) spawns per bag was the best treatment while there were better results of growth and yield of Oyster mushroom grown on cotton waste compared with rice cellulose waste. In conclusion, major observations were listed that (55) spawn rate in cotton waste may be used for the better-quality mushroom. It will be an economically effective using cotton waste substrate due to highest yield and abundantly used throughout the year.

## Compost Physico-chemical Factors that Impact on Yield in Button Mushrooms (*Agaricus bisporus*) at Commercial Level in Pakistan

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Button mushrooms, *Agaricus* sp., are secondary decomposers that require nutritious and very selective composts for their growth. The conventional method of preparing button mushroom composts is to use a wheat straw crushed from a combined harvester of 1-2 inches size. In this study different size of straw was used in compost preparation for button mushroom cultivation. The objective was to find the suitable size of straw for composting which enhances yield at the commercial level. Button mushroom was planted in three different straw size composts. The nitrogen content of each compost was calculated, moisture content and temperature were recorded throughout composting and during the conditioning period. Yields of mushrooms were taken in three different flushes results of the mean yields of mushroom grown indicated that the three composts were significantly different; the compost prepared from 6-inch straw size gave significantly superior yields of mushrooms of 2781 g/bag of compost compared to the conventional straw size compost which gave 1650 g/bag and other sized compost. Though many factors contribute to the yield of button mushrooms, the superiority of the straw size and quality may be attributed to the main factor. Thus, it can be concluded that straw size during compost preparation has a strong impact on the yield of button mushroom.

## Efficiency of Hardwood Trees (Sheesham, Siris) Sawdust for Yield Production of (*Pleurotus djamor*) with Cornflour as a Supplementary Material

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Mushroom cultivation is very useful business to produce protein enriched food by decomposing lignin containing substances. To investigate effectiveness of saw dusts of hard wood trees (Sheesham and Siris) along with supplement (corn flour) research was carried out in mushroom house, Department of Plant Pathology, UAF. The local strain of Oyster mushroom (*Pleurotus djamor*) was studied for evaluation of mycelia growth, formation of pinhead, formation of fruiting bodies, quantity of fruiting bodies, yield production from 1st, 2nd and 3rd flushes, total yield and biological efficiency. Results concerning to 25%, 50%,75% and 100% mycelia growth substrate contained 8% corn flour + 92% saw dusts proved to be significantly effective, followed by substrate contained 4% corn flour + 96% saw dusts, and lowest was substrate contained 16% corn flour + 84% saw dusts. Data related to number of fruiting bodies, quantity of fruiting and duration of time for primordial initiation again substrate contained 8% corn flour + 92% saw dusts showed

significant results. Pinhead formation completed in maximum days by substrate contained 0% supplement. Highest yield production (445.1 g) was achieved by treatment (T4) on substrate composed of 8% corn flour + 92% saw dusts followed by treatment 3 (381.2 g) and 2 (280.7 g) on 4% corn flour + 96% saw dusts and 2% corn flour + 98% saw dusts correspondingly. Lowest yield production was obtained from treatment 6 on 16% corn flour + 84% saw dusts. Utmost biological efficiency was observed (110.2 %) on 8% corn flour + 92% saw dusts and least biological efficiency (56.7%) was examined in treatment 6 on 16% corn flour + 84% saw dusts. Saw dusts of hard wood trees along with limited quantity of additive (corn flour) are effective for the cultivation of *P. djamor*.

# SESSION TRACK

# L. Landscape/Turfgrasses

## Display Characteristics of Different Varieties of Gladiolus (*Gladiolus grandiflorus* L.) In Landscape

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In present study, four different gladiolus cultivars were evaluated on the basis of various morphological and flower quality attributes to identify the most suitable and attractive gladiolus cultivar in landscape. Experiment was carried out following randomized completely block design (RCBD) with three replications. Data were analyzed by using Software "Statistic 8.1" and treatment means were compared by using Tukey's test at 5% significance level. The statistical analysis based on different morphological traits of the evaluated cultivars revealed that the cultivar named "White Prosperity" showed the best performance based on flower quality and other growth attributes. The cultivar named "Purple Flora" was observed to be least effective; while the remaining cultivars including "Red Balance" and "Rose Supreme" were observed to be intermediate in performance as compared to the white prosperity and purple flora cultivars. Moreover, a population-based survey was carried out to assess the efficacy of gladiolus as a bedding plant in the landscape. A survey comprised of a questionnaire form which was distributed among 200 local visitors randomly chosen from the society. The conducted survey revealed that the respondents with age less than 30 years were the most frequent as compared to the other age groups. A significant amount of the respondents encouraged the utilization of gladiolus as a bedding plot in the landscape. The present study identified "white Prosperity" as a best performing gladiolus cultivar under Faisalabad agro-ecological conditions and a promising candidate to be utilized in the landscape as a bedding plot. Moreover, based on the analysis of the public survey conducted, it has been concluded that the inclusion of gladiolus as a bedding plant in the landscape could create new vistas in landscape horticulture.

## Effect of Different Potting Media on Growth and Development of Dahlia Cultivars Under Agro-Climatic Condition of Faisalabad

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Dahlia is a high valuable and herbaceous plant in the landscape. It is c commonly used to beautify the gardens, lawns, and environment as the winter annual flowering plant. For the growth of the flowering plant in the pot, the growing media is very important. The research was conducted at Lalazaar nursery, Estate management department, the University of Agriculture Faisalabad. To analyze the effect of different potting media on the growth and development of different varieties

of dahlia under agro-climatic conditions of Faisalabad. This study was analyzed that different potting media have a different impact on the dahlia plant. Potting media including the soil, farmyard manure (FYM) + sand, poultry manure + sand, leaf compost + sand, coco coir + sand, press mud + sand, farmyard manure (FYM) + poultry manure + sand, poultry manure + leaf compost + sand, leaf compost + coco coir + sand, coco coir + press mud + sand. Each treatment was replicated three times, having 5 plants each. The experiment was designed under the CRD (complete randomized design). The data were collected on various morphological parameters. Chemical analysis of potting media showed that pH was in the required range for the best growth of Dahlia. The maximum plant height (76.66 cm), number of leaves (58.33), leaf area (11.66 $cm^2$), stem diameter (10.0 mm), number of branches (60), number of flowers (8), flower diameter (11.33 cm) was observed in treatment which was coconut + press mud + sand. Nitrogen and potassium were best taken up coconut coir + press mud + sand, plants which responsible for the vigorous growth and flowering of plant grown exhibited high pH values for these treatments, which plant grown in poultry manure (PM) + sand and FYM + poultry manure (PM) + sand, from these media does not allow nutrient uptake to cause slow growth of Dahlia pinnata. It was observed that coconut coir + press mud + sand fulfils the proper nutrient (N, P, and K) optimum range of pH as well as soil structure required in the container of Dahlia. Thus, it is suggested that growing media (sand + coconut coir + press mud) is best for the plant growth in the container.

## Impact of Different Potting Media on Growth and Flowering of Zinnia

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Zinnia (*Z. elegan*s) is popular and delightful annual flower of summer season, very popular due to diverse colorful flowers and respond to potting media. Biochar is important for water retention, nutrient balance, pH, support beneficial microbial development, such as accomplish by peat. This study was performed in nursery area of MNSUAM to evaluate the impact of potting media on vegetative growth and flowering of zinnia. Two zinnia varieties (Dreamland and Profusion) were collected from Chanan Din seed store, Lahore, and their nursery was developed in the university. Different levels of silt, biochar and peat moss were used as potting media. Data of different morphological, physiological and reproductive parameters was collected to evaluate the efficiency of local and commercial media for growth of Overall low concentration of biochar and high concentration of peat moss significantly influenced the morphological and physiological attributes of Dreamland and Profusion. Thus, it is suggested that used the low concentration of biochar increases the growth and flowering attributes in both cultivar of zinnia.

## Impact of Paclobutrazol and Maleic Hydrazide on Growth and Quality of Warm Season Turf Grasses

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Warm season turf grasses are fast growing and require frequent mowing that increases maintenance cost of lawns. However, range of different plant growth retardants are available including Paclobutrazol (PBZ) and Maleic Hydrazide (M.H) for controlling growth and mowing of these grasses. Therefore, present study was planned to explore the impact of PBZ and M.H on visual quality along with growth of warm season turf grasses. Fine Dacca, Korean, Tifway and Khabal were collected from Hassan nursery, Multan. Paclobutrazol PBZ and Maleic Hydrazide were applied through foliar application using CRD arrangement. Data of different morphological, physiological and anatomical parameters were recorded. It was observed that foliar application of plant growth retardants significantly reduced growth and mowing in warm season turf grasses by decreasing different morphological, physiological and anatomical attributes. It is concluded that 0.04% level of PBZ reduced the number of mowing in warm season turfgrasses that will decrease the cost of lawn maintenance and support the landscape industry.

## Effect of Foliar Application of Micronutrients on Performance of Three Flowering Annuals

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Present experiment was conducted to observe the effect of foliar application of micronutrients on growth of three annuals, viz. Snapdragon (*Antirrhinum majus*), Stock (*Matthiola incana*) and Aster (*Callistephus chinensis*). Solutions of four different micronutrients viz. Manganese (Mn), Zinc (Zn), Boron (B) and Iron (Fe) were applied thrice either individually @ 1% and 2% or in collaborative combinations @ 1% and 2% at fortnightly intervals. Solutions were applied before flower bud initiation when the plants had attained full growth. Results depicted that antirrhinum and stock plants attained maximum plant height of 92.3 cm and 89.0 cm, respectively, in 2% mixed solution of Mn + Zn + B + Fe, whereas aster plants attained maximum plant height of 67.3 cm in 1% mixed solution of Mn + Zn + B + Fe. Maximum number of flowers (37.6) and branches (17.0) in aster were found in 1% mixed solution of Mn + Zn + B + Fe. However, maximum number of florets (69.6) in antirrhinum were found in 2% mixed solution of Mn + Zn + B + Fe. Thus, the results showed that a combination of micronutrients in the form of foliar spray @ 1% or 2% was better than applying singly in improving the plant growth of antirrhinum, stock and aster plants.

## Impact of Fertilizers and Weedicide Applications on Growth and Density of Different Turf Species

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Maintain good quality of turf grasses is considered an important key point in turf grass industry. Fertilization and weedicides applications is a possible way to increase the plant growth of turf species. In field experiment, we studied the impact of N, P, K 15:15:15, Ammonium sulphate and 2-4D, MCPA on plant growth of *Cynodon dactylon* and *Zoysia japonica*. The Experiment was conducted in plots. To increase the plant growth, we applied both fertilizers 50 kg/acre in randomly 4 splits every 15 days after plugging of grass. Data were collected every week according to leaf size, color and density of grass. The results showed that *Cynodon dactylon* plant growth and density increases rapidly instead of *Zoysia japonica*. Fertilizers whereas increase the growth of plant and increase the weeds. We have also applied weedicides to control weeds in plots because weeds have a lot of impact on growth. The results were interpreted that *Cynodon dactylon* have 15 -20 days earlier high-density green cover other than *Zoysia japonica* and control weedicides have also impact on plant growth.

## Phytoremediation for Landscape Irrigation with Treated Wastewater

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The overpopulation, urbanization, and economic race increase the pressure on the freshwater resources, resulted in water scarcity challenges around the globe. The generation of wastewater also enhancing the scarcity threats for the freshwater resources. Currently, Pakistan generates about 6.414 billion $m^3$ of wastewater annually. The best way to deal with this wastewater is to recycle it and use it for irrigation in urban landscapes. Currently, phytoremediation using constructed wetlands is an eco-friendly and cost-effective technology for developing countries like Pakistan to remove metal and non-metal pollutants from the contaminated water. Using treated wastewater for landscape irrigation reduces the amount of water that needs to be extracted from natural water sources and reducing the discharge of wastewater to the environment. This is a powerful means of water conservation and nutrient recycling, reducing the demands of freshwater and mitigating pollution of surface and groundwater. Thus, treated wastewater an alternative resource in the irrigation of parks and recreation sites, sports sites, school gardens, roadsides, and refuges. Treated wastewater is a valuable source for recycling and reuses in Pakistan and other arid and semi-arid regions that are confronting increasing water shortages.

# SESSION TRACK

# M. Postharvest Management

## Comparative Study of Different Preservative Solutions for Extending Flower Quality and Market Acceptability of *Rosa hybrida* cv. Freedom

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Rose is one of the most important floricultural crops both economically as well as aesthetically whose beauty must be enjoyed for a longer period of life. The current experiment was performed to explore the comparative effect of different vase solutions to enhance the post-harvest attributes and extend the vase life of *Rosa hybrida* cv. Freedom. The experiment was conducted in the research area of the Department of Horticultural Sciences, The Islamia University of Bahawalpur. There were 11 treatments comprising of honey (T1), sugar (T2), salicylic acid (T3), acetic acid (T4), indole acetic acid (IAA) (T5), and a combination of all solutions with sugar. These treatments were compared with tap water (T0). There were four plants in each treatment with three replications which were arranged according to a completely randomized design (CRD) under room temperature. The results showed that maximum fresh weight (g) was measured in T4 (acetic acid), flower head diameter (mm), and flower color was ideal under T3 (salicylic acid). Maximum dry weight (g), highest flower freshness on 1$^{st}$ and 3$^{rd}$ day, minimum petal discoloration which leads to productive market acceptability, and highest vase life were recorded in T2 (sugar). It is worth noting that the lowest market acceptability of flower and minimum vase life was observed when sugar is combined with any other vase solution. It means sugar reduces its effectiveness when combined with growth regulators. From this experiment, it can be concluded that sugar provides an ideal medium for vase life extension and enhancing the post-harvest attributes of *R. hybrida* cv. Freedom.

## Optimal Postharvest Procedures for Extending Longevity of China Aster (*Callistephus chinensis* L.)

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China aster (*Callistephus chinensis* L.) a member of family Asteraceae, is an emerging specialty cut species. To ensure consumer satisfaction, postharvest procedures for extending its longevity need to be optimized. Therefore, a study was conducted to optimize harvest stage, storage method and duration, and pulsing and vase preservatives for extending postharvest longevity and maintaining quality of cut stems. Stems were harvested from a commercial flower farm at Kasur, Punjab, Pakistan, before 10:00 AM and transported to postharvest floriculture laboratory of the Institute in a refrigerated vehicle within six hours of harvest. On arrival, stems were rehydrated for two hours at ambient temperature and relative humidity, sorted, trimmed to uniform stem length of 45 cm, and labelled accordingly. In Expt. I, stems were harvested at closed bud (when started showing color), half open and fully open stage. In Expt. II, two storage methods at 4±1°C temperature, viz. wet and dry along with three storage durations, viz. 2, 4 and 6 days were compared. In Expt. III, sucrose @ 2%, 5% and 10%, citric acid @ 150, 300 and 450 mg $L^{-1}$ or

salicylic acid @ 100, 200 and 300 mg $L^{-1}$ were used as pulsing solution for 24 h followed by shifting in distilled water. In Expt. IV, sucrose @ 0.5%, 1% and 2%, citric acid @ 100, 200 and 300 mg $L^{-1}$ or salicylic acid @ 50, 100 and 200 mg $L^{-1}$ along with control (water) were used continuously till termination. All experiments were laid out individually in completely randomized design with factorial arrangement where required, with five replications of three stems each and evaluated in a vase life evaluation room. Among harvest stages, stems harvested at tight bud stage had longest vase life (5.9 d), greatest stem fresh weight (69.2 g), dry weight (6.7 g), and water uptake (300 mL). Whereas ion leakage (69.0%) was highest for stems harvested at fully open stage. Among storage methods, wet stored stems demonstrated longest vase life (5.8 d) and greatest water uptake (503 mL). Whereas stems stored dry in floral cardboard boxes had highest ion leakage (107.3%). Pulsing with citric acid at 450 mg $L^{-1}$ had longest vase life (5.9 d) and highest water uptake (320 mL). Vase solutions significantly extended longevity (6.2 d) compared to stems placed in water (3.7 d) but was at par with pulsed stems. Vase solution containing sucrose improved fresh weight (56.2 g), and dry weight (16.8 g). In summary, China aster stems should be harvested at tight bud stage when petals just start showing color for longest vase life, however, fully opened flowers had better visual quality. Among storage methods, stems stored in water (wet) had longest vase life, while increase in storage duration reduced longevity. Pulsing significantly maintained the stem quality for longer duration, while vase solution containing sucrose significantly extended the postharvest longevity.

## Effect of Citric Acid and Ascorbic Acid on Vase life of Gladiolus cv. Red Fortunate

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Gladiolus is the most cultivated cut flower in Pakistan and millions of spikes sell each year, but the spike has short vase life which reduce the market value and today main challenge for florists is to extend the longevity of cut flowers in vase. Apart from external quality of flower, vase life of cut flower is one of the most important factors for consumers so in this study we check Ascorbic acid and citric acid as a vase solution product, T0 Control (only distilled water was added) T1: 600 mg/L A.A.+ 600 mg/L C.A., T2: 900 mg/L C.A. T3: 900 mg/L A.A., T4: 350 mg/L Citric Acid+ 350 mg/L Ascorbic Acid with 3% sucrose for each treatment except control. The experiment was conducted according to Completely Randomized Design (CRD) having 5 replications of each treatment and 5 plants in each replication. Data collected were statistically analyzed by using Statistix 8.1 software computer package with Tukey's HSD of Variance at a 5% level of probability to compare the treatment mean. The result shows that T1 increased the vase life 15.6 days, enhanced flower opening percentage 91.59%, and maximum solution uptake 64 ml with T1 and minimum weight loss 2.5 g compared with T2. It is concluded that vase life, flower opening percentage and solution uptake increased by using Citric acid and Ascorbic acid as a vase solution.

## Evaluation of Different Holding Solutions for Prolonging Vase Life and Keeping Quality of Cut Gerbera (*Gerbera jamesonii* L. cv. 'Navy') Flower

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Gerbera is fourth most popular cut flower in the world's cut flower trade and gaining popularity in local florist market in Pakistan. Stem bending, bacterial and fungal contamination and vascular occlusion are the main reasons for the short life of gerbera flower in a vase. Keeping in view high market demand in local flower markets and role of various biodegradable compounds to improve the postharvest life of cut flowers, present study was conducted with an aim to extend the postharvest life of cut gerbera flowers cv. 'Navy'. For this purpose, four levels of ethanol (2, 4, 6, 8% ethanol + 2% sucrose) and four level of salicylic acid (25, 50, 75, 100 mg $L^{-1}$ SA + sucrose) were used. Experiment was executed according to Completely Randomized Design (CRD) with nine treatments and six replications at the Postharvest and Floricultural Lab. of the Institute in March 2020. Results revealed that treatments with 6% ethanol + 2% sucrose (T3) and 50 mg $L^{-1}$ SA + 2% sucrose (T6) showed significantly better results than all other treatments, viz., increased flowers vase life, relative fresh weight, dry weight %age, flower diameter, stem length and water uptake. More specifically T3 increased the vase life 64.25%, flower diameter 26.31%, stem length 5.94%, relative fresh weight 29.21%, dry weight 68.96%, solution uptake 45.06% and decreased ion leakage of florets 16.46% while treatment T6 increase the flower vase life 64.10%, flower diameter 29.62%, stem length 5.88%, relative fresh weight 20.15%, dry weight 84.94%, solution uptake 31.39% and decreased ion leakage of florets 12.38% as compared to control treatment. Therefore, both treatments *i.e.,* T3 and T6 are recommended to prolong vase life and maintain the quality of cut flowers of Gerbera cv. 'Navy'.

## Optimization of Aluminum Sulphate and Calcium Chloride for Maximum Vase Life of Gladiolus cv. White Prosperity

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Gladiolus is the top ranked cut flower sold globally as well as in Pakistan. Maintaining good quality of cut flowers and extending the vase life, is considered important and practical for having acceptable products for the markets, so to increase the vase life we used chemical aluminum sulphate and calcium chloride. T0 Control (distilled water) T1: 350 mg/L calcium chloride T2: 900 mg/L, T3: 350 mg/L aluminum sulphate, T4: 900 mg/L aluminum sulphate with 2% sucrose in all Treatments except control. The experiment was conducted according to Completely Randomized Design (CRD) having 5 replications of each treatment and 5 plants in each replication. Data collected were statistically analyzed by using Statistix 8.1 software computer package with Tukey's HSD of Variance at a 5% level of probability to compare the treatment mean. The results showed that T4 increase the vase life 15.52 days, enhanced flower opening

percentage 96.87%, and maximum solution uptake 67.2 ml and minimum weight loss 1.15 g with T4. It is concluded that both citric acid and ascorbic acid extended the vase life, flower opening percentage and solution uptake.

## Lanthanum Enhanced Postharvest of Cut Tulip Flowers by Increasing Water Consumption and Concentrations of Sugars, Proteins and Chlorophylls

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The experiment was conducted in Postharvest Floriculture Lab., of the Institute in Feb. 2019. We observed the effect of separately adding two sources of lanthanum (La), $LaCl_3$ and La $(NO_3)_3 \times 6H_2O$ at a concentration of 45 µM each, to the chemical solution of 10 cut tulip flower varieties. Ascorbic acid (AsA; 0.2 g $L^{-1}$) was used as a reference solution, as distilled water was used as control. The variety Laura Fygi observed the longest postharvest life with 14 days. The highest water intake per gram of stem fresh biomass weight (FBW) (2.5 mL) was observed in the variety Violet Beauty, whereas the lowest (1.09 mL) was observed in Pink Impression. At the end of the postharvest life period, high concentrations of total soluble sugars in petals and total soluble proteins in leaves were observed in La-treated stems, compared to the treatment and the control. Moreover, La $(NO_3)_3 \times 6H_2O$ supply enhanced the fresh weight of stems in vase and extended vase life. Moreover, this treatment resulted in the highest foliar concentration of chlorophylls at the end of postharvest life. Therefore, La increases tulip flower postharvest life as a consequence of increasing the concentrations of some vital biomolecules.

## Effect of Salicylic acid and Some other Chemical on Keeping Quality and Vase Life of Cut Chrysanthemum Flowers

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Chrysanthemum is one of the most common cut flowers and has the highest commercial status in the floriculture industry. Vase life varies among various species. It is one of the most valuable characteristics for determining flower quality, satisfying consumer likings and extending its commercial value. Maintenance of optimal water status is the most important factor for prolong vase life period. This study was conducted at Floriculture Postharvest Lab. of the Institute. Preservative solutions at different concentrations on three cultivars of cut chrysanthemum. Results showed that many aspects of postharvest life such as longevity, loss of water, uptake rates, relative fresh weight and flower head diameters were significantly influenced by different types of preservative solutions. These treatments in the first experiment were salicylic acid (SA) at 5 mg/l as a holding solution + sucrose (15 g/l), SA (10 mg/l) as a holding solution + sucrose (15 g/l), SA

(20 mg/l) as a holding solution + sucrose (15 g/l), (5 mg/l) as spray + SA (5 mg/l) as holding solution + sucrose (15 g/l), (10 mg/l) as spray + SA (5 mg/l) as holding solution + sucrose (15 g/l), (5 mg/l) as spray + SA (20 mg/l) as holding solution + sucrose (15 g/l) in the first experiment, while in the second experiment they comprise glycerol at 10 g/l + citric acid at 0.2 g/l + sucrose at 15 g/l and 40 g/l + citric acid at 0.2 g/l + sucrose at 15 g/l, ethanol at 2%+ citric acid at 0.2 g/l + sucrose at 15 g/l and 5% + citric acid at 0.2 g/l + sucrose at 15 g/l, tap water + 7-HQC at 0.2 g/l + citric acid at 0.2 g/l + sucrose at 15 g/l and tap water. In the first experiment, salicylic acid influenced post-harvest Life suggesting a potential application of salicylic acid as a substitute for chemicals commonly used in preservative solutions. In the second experiment, the best treatment was ethanol at 2% as it increased vase life, decreased water loss, increased relative fresh weight and diameter of flower heads.

## Folk Floral Recipes for Extending Postharvest Longevity of Cut Flowers

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Floral preservatives are widely used for handling cut stems to extend their longevity and maintain quality by improving water uptake, controlling microbial growth, and providing carbohydrates necessary to carry on metabolic activities after harvest. However, commercial preservatives are neither available all-around the world nor suitable for handling organically produced cut flowers. Therefore, studies were conducted to evaluate the effect of different homemade folk recipes on postharvest performance of selected cut flower species. Stems were grown outdoors using standard practices, were harvested at commercial maturity before 10:00 AM and transported to the postharvest laboratory within 1-6 h of harvest. Treatments included different folk homemade floral recipes, which were applied either as 24-48 hr holding or continuous vase application and compared on selected cut flower species. Among tested recipes, use of citric acid along with sucrose and aluminum sulphate proved best folk recipe for growers and wholesalers, while for consumers and florists, use of lemon/lime soda or citric acid along with sugar and a biocide were effective for extending vase life of tested species. Use of bleach or vinegar in recipes had detrimental effect on vase life, pH and EC of vase solution and bacterial population in the solution. Moreover, continuous use of these recipes had greater effect than short term use for 24-48 hr. In summary, some of above-mentioned cost-effective homemade recipes may extend vase life of cut species and may be used instead of chemical preservatives to keep organically grown cut flowers safe during postharvest handling.

## Optimal Postharvest Protocols for Handling of Cut *Dendranthema grandiflorum* Stems

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Chrysanthemum (*Dendranthema grandiflorum*) is a leading cut flower worldwide on account of novel flower colors and shapes, plant architectures, flowering times, postharvest quality and biotic and abiotic stress tolerance. Studies were conducted at Floriculture Laboratory, Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan, during 2018-2020, to evaluate the optimal harvest stages, pulsing solutions and storage and duration. In study I, chrysanthemum cut cultivar 'Podolsk' stems were harvested at three different stages viz., petals just showed color, partially/half opened flowers and fully opened flowers. Fully opened flowers had highest initial & final fresh weight and dry weight (31.5 g, 16.2 g and 7.2 g, respectively) and lowest fresh weight change (-15.2 g), while partially opened flowers had highest flower quality (9.4), flower diameter (54.8 mm), change in flower diameter (30.7 mm), ion leakage (110.8%), vase life (22 days) and the lowest change in flower quality. This study concluded that cut chrysanthemum stems harvested at partially/half opened stage proved best stage for distant markets and storage. Stems which were harvested at fully opened stage were best for local markets. Study II was conducted on different pulsing solutions for 24 hours on cut chrysanthemum 'Antonov' and 'Euro' cultivars. This experiment included ten treatments, viz., control (no pulsing), sucrose @ 2%, sucrose @ 5%, sucrose @ 10%, citric acid @ 150 mg $L^{-1}$, citric acid @ 300 mg $L^{-1}$, citric acid @ 450 mg $L^{-1}$, salicylic acid @ 100 mg $L^{-1}$, salicylic acid @ 200 mg $L^{-1}$ and salicylic acid @ 300 mg $L^{-1}$ with five replicates. Results showed that citric acid @ 150 mg $L^{-1}$ had highest flower quality (8.7), vase life (23 days) and lowest petal wilting (51.4%), petal necrosis (43.6%), leaf wilting (73.7%) and leaf chlorosis (71.6%). Study III was conducted to optimize storage methods and duration for exotic cut chrysanthemum cultivar 'Podolsk'. Treatments included control (unstored), wet and dry storage for 3, 6 and 9 days at 4±2$^{o}$C using standard packaging protocols. Results revealed that wet storage for 6 days had highest vase life (21.2 days), water uptake (71.8 mL), solution pH (6.7), solution EC (116.0 µS $cm^{-1}$) and had lowest petal necrosis (3.0%) and bent neck (2.6%). Overall, partially opened flowers had best harvest stage for longest vase life of cut chrysanthemum. Similarly, citric acid @ 150 mg $L^{-1}$ for 24 hours pulsing proved best solution for prolonging vase life and maintain flower quality of cut stems. Harvested stems of cut chrysanthemum placed in wet storage for 6 days at 4±2$^{o}$C had longest vase life and may be used for optimal postharvest handling of cut chrysanthemum stems.

## Pre-harvest Application of Nitric Oxide Inducing Antioxidant Activities and Delaying Biochemical Changes in Banana Fruit During Storage

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Banana is an economically important fruit for local and export markets worldwide. Banana fruit is a good source of nutrients including bioactive phenols, antioxidants and potassium. However, it is

a highly perishable fruit and deteriorates rapidly after harvesting due to adverse physiological changes. Banana is a climacteric fruit and after harvesting it exhibits a respiratory peak during natural ripening. The aim of this study was to investigate the pre-harvest effect of nitric oxide (NO) on qualitative and biochemical responses of banana fruit. Banana fruit were treated in the field with 25, 50 and 100 µM NO at three stages 2, 5 and 10 weeks after bunch emergence. Banana fruit were harvested after 15 weeks of bunch emergence and stored at 25 °C for 15 days for physico-chemical analysis. Banana fruit treated with 100 µM NO treatment significantly maintained total antioxidant activity, ascorbic acid, and phenolic contents. The same treatment reduced weight loss, total soluble solids, and decay incidence. In addition, NO treatment inhibited rapid changes in colour, firmness and titratable acidity. The pre-harvest application of NO could be a promising approach to maintain the postharvest quality and postpone the physico-chemical changes in banana fruit.

## Peach Cultivars Exhibit Variation in Fruit Quality During Ripening at Ambient Conditions

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Peach is an emerging industry and popular summer fruit grown in temperate to cool subtropical regions of Pakistan. High perishability limits its postharvest life with reduced fruit quality and market window. Hence, the present study was carried out to analyze the ripening behavior of early- and late-season maturing peach cultivars with respect to their physical and biochemical fruit quality. Fruity of peach cultivars 'Florida King', 'Early Grand' and '6-A' (early-season maturing) and '5-A' and '8-A' (late-season maturing) were kept at ambient condition up to 5 days to evaluate changes in their physiological, physical, and biochemical fruit quality characteristics. Early-season maturing cultivar '6A' showed highest ethylene production (15.81 mL $kg^{-1}$ $h^{-1}$), and respiration rate (4.38 mg $CO_2$ $kg^{-1}$ $h^{-1}$). At ripe stage lowest fruit weight loss (4.5%), titratable acidity (TA; 0.28%) and highest soluble solid contents (SSC;13.8%), SSC:TA ratio (49), total sugars (32%) and total carotenoid (0.41 mg $g^{-1}$ FW) were recorded in '8-A' peach fruit. Whereas, highest total phenolic contents (34 mg GAE $100g^{-1}$ FW), total antioxidant (4.1 µmol Trolox $100g^{-1}$ FW) and ascorbic acid content (20 mg 100 $g^{-1}$ FW) were observed in '5-A' fruit. Conclusively, compared to early-season maturing cultivars fruits of late-season maturing peach cultivars '8-A' and '5A' exhibited the better fruit quality during ripening at ambient condition.

## Postharvest Quality Dynamics of Wild Black Raspberry (*Rubus occidentalis* L.) Fruits Stored at Different Temperatures

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Black raspberry is an important minor fruit of temperate region. Due to the ideal conditions for its growth, black raspberry plants have been found under natural conditions of Rawalakot. Currently they are only found in wild, therefore, no studies have been conducted to enhance their cultural practices, postharvest quality, and storage life. However, the proposed study was done with the objective to check the effect of different storage temperatures on postharvest quality and shelf life of wild black raspberry fruits. In this regard, wildly grown black raspberry fruits were harvested at full ripe stage and stored at different cold temperatures (0, 4, and 8ºC) along with storage at room temperature (20 ± 2ºC) as control. Data was recorded at different intervals (day 1, day 3, day 5, and day 7) during storage. Data regarding physical, biochemical, and sensory characteristics during storage at different temperatures was collected. Obtained results were statistically analysed and means were compared by using LSD test at ($P \leq 0.05$). Results obtained showed that maximum fruit weight loss (49.70%) and fruit spoilage (64.75%) was observed in fruits stored at T4 (20ºC), while the minimum fruit weight loss (14.97%) and fruit spoilage (4.00%) was observed in fruits stored at T2 (4ºC). Similarly, total soluble solids (11.83%) and pH (4.24) were recorded maximum in fruits stored at T4 (20ºC), while the minimum total soluble solids (9.05%) and pH (3.53) was observed in fruits stored at T2 (4ºC). In case of titratable acidity (0.09%), vitamin C (0.14 mg 100g-1 FW), antioxidants (1.90 mg $100g^{-1}$), total phenols (0.36 µg$100g^{-1}$ FW), total anthocyanins (11.07 mg$100g^{-1}$ FW) and total flavonoids (2.23 mg $100g^{-1}$) maximum values were recorded in T2 (4ºC), while minimum titratable acidity (0.03%), vitamin C (0.11 mg 100 $g^{-1}$ FW), antioxidants (1.31 mg $100g^{-1}$), total phenols (0.28 µg $100g^{-1}$ FW), total anthocyanins (6.79 mg $100g^{-1}$ FW) and total flavonoids (1.69 mg $100g^{-1}$) were recorded in T4 (20ºC). Sensory attributes like taste (6.16), texture (6.41), aroma (6.25) and overall acceptability (6.83) were also maximum in fruits stored at T2 (4ºC). It is concluded from this study that black raspberry fruits stored at T2 (4ºC) had maximum physical, biochemical, antioxidant and sensory characteristics. Moreover, during storage, it was observed that quality of fruits deteriorated with the passage of time. However, fruits stored at lower temperature such as 4ºC gave better results in terms of shelf life as the fruits maintained their quality for 5 days at this temperature.

## Effect of Edible Coatings on Postharvest Quality of Persimmon Fruit

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Persimmon (*Diospyros kaki* L.) is a climacteric fruit and has relatively short postharvest life. Application of edible coatings is one of the viable options to extend the postharvest life of persimmon fruit without compromising its quality. In this study, efficacy of 1% chitosan, 2% Aloe

vera gel, and 1 mM salicylic acid to delay deterioration in fruit quality of persimmon cv. Fuyu during 5 days under ambient storage was evaluated. Persimmon fruits coated with chitosan exhibited least fungal decay during storage period followed fruit coated with Aloe vera gel. Edible coating of 1% chitosan significantly delayed development in peel colour, accumulatio of pulp lycopene and carotenoids and hindered loss in fresh weight, dry matter, total soluble solids, and membrane permeability in permission fruit. Until the end of storage study, fruit firmness (53.3 N), titratable acids (0.16%), ascorbic acid (26.64 mg $100^{-1}$), total antioxidants (44.2%), total phenolics (48.4 GAE $g^{-1}$) and total anthocyanins (0.13 $\Delta A g^{-1}$) also remained higher in chitosan-coated fruits. In conclusion, persimmon fruit coated with 1% chitosan received highest organoleptic score and remained fresh for at least 3 more days as compared to control.

## Postharvest Oxalic Acid Dip Alone and with Sanitation Attenuate Ethylene Production and Maintain Fruit Quality of 'Red Lady' Papaya Fruit at Ambient Conditions

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Papaya is highly nutritive fruit crop having low shelf life. This research was aimed to check the effect of oxalic acid (OA) on shelf life and quality of papaya fruit cv. 'Red Lady' at shelf under ambient conditions (25±2ºC & 55-65% RH). The study consisted of two experiments, 1st experiment executed to optimize dose of postharvest oxalic acid concentration on unripe physiological mature papaya fruit, while 2nd experiment dealt with the effect of optimized OA dose alone and in combination with sanitation on ripe papaya fruit quality and shelf life of ripe papaya at ambient conditions. Physiological mature unripe papaya fruit were treated with various doses of OA (control, 2.5, 5 and 10 mM), the 5 mM-OA treated fruit exhibited lower weight loss, ethylene production and respiration rate. The optimized dose of OA (5mM) was applied as postharvest dips in another experiment along with sanitation (Untreated (control), 5% Chlorine alone, 5 mM-OA alone and 5% Chlorine + 5 mM-OA) on ripe papaya fruit. The treated fruit were kept at ambient conditions for 8-days, various physiological, physico-chemical and antioxidative attributes were evaluated. The experimental design was Completely Randomized Design (CRD) with factorial arrangement replicated thrice. Papaya fruit treated with 5 mM-OA alone exhibited significant lower ethylene production, respiration rate, fruit weight loss and significant higher fruit firmness than untreated and other treated fruit. However, various biochemical parameter including ripening index, total anthocyanin contents, total antioxidants and activities of catalase, peroxidase and superoxide dismutase was observed in the papaya fruit treated with 5 mM-OA combined with 5% chlorine in comparison to other treatments.

## Use of Nano-Emulsion as an Edible Coating to Maintain the Quality of Mango Fruit Under Storage Conditions

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Mango is an important fruit crop in tropical and subtropical regions of the world. It is widely consumed due to due its delicious taste, colour, aroma and rich nutritional value. 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 mango fruit. Nano-emulsion was prepared by using 3% Acacia oil, 18% tween 20. Coated and non-coated (control) fruits were stored at 18±2° C and 80 ±5 % relative humidity for 20 days. 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 colour, taste, aroma, disease incidence and overall acceptability.

## Slowing the Deterioration of Jaman Fruit by Postharvest Quinic Acid Application

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Jaman is highly perishable fruit having short shelf life. Significance of organic acids have been well documented for improving quality of fruits through slowing down their deterioration rate. Therefore, the potential of quinic acid (QA) in relation to fruit quality of Jaman fruit will be explored in this research. Physiological mature fruits were harvested and dipped in various QA treatments (0, 0.5, 1 and 2 mM) using tween 20 (1 mL $L^{-1}$) as surfactant and kept at ambient conditions (25 ± 2 ºC & 55-60% RH) for physicochemical analysis. Fruits treated with 2 mM QA showed lower respiration rate (6.27 mmol $CO_2$ $kg^{-1}$ $hour^{-1}$) and ethylene production (22.09 mmol $C_2H_4$ $kg^{-1}$ $hour^{-1}$) compared to control. Minimum shriveling, disease incidence with lowest fruit weight loss was recorded in fruit treated with 2 mM QA as compared to control and other QA concentrations. Postharvest QA application @ 1 mM exhibited the highest soluble solid contents (17.13°Brix) and ripening index (17.13) with lower (0.15%) titratable acidity in Jaman fruit. The highest pH (3.41) and ascorbic acid contents (35.37 mg/100g) was recorded in 2 mM and 1 mM QA concentration respectively as compared to control and other QA doses. Conclusively, postharvest dipping of QA (2 mM) could be a promising method to suppress deterioration with improvement of Jaman fruit quality, possibly due to a combination of its physiological effect in

delaying the ripening process, coupled with an inhibition of the diseases and shriveling development.

## Effect of Almond Gum Coating on Storage Life Extension and Quality Conservation of Guava Fruits

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Guava (*Psidium guajava* L.), a member of family Myrtaceae, is one of the most commonly grown fruits in Punjab and has been widely used for its nutritional significance. Guava is a climacteric fruit and needs proper postharvest care and handling. The use of plant-based edible coatings has emerged as a new, efficient, and eco-friendly approach to extend the shelf life of many fresh agricultural commodities including fresh fruits, fresh cuts and vegetables. In this experiment, fruits were coated with almond gum and stored at 14 ± 2°C. There were four treatments: Control, 5% almond gum, 10% almond gum and 15% almond gum. It was assessed that all the coating treatments gave better results as compared to the control fruits; although 10% almond gum showed the best results as compared to all other treatments. Coated fruits exhibited substantially higher superoxide dismutase, peroxidase, ascorbate peroxidase, and catalase activities. Moreover, these showed markedly higher total phenolics, ascorbic acid, antioxidant activity, and titratable acidity, but reduced total carotenoids, total soluble solids, and ripening index throughout the storage. In contrast, non-coated fruits showed very rapid decay and colour degradation. Thus, it was concluded that almond gum significantly increased the shelf life and maintained the quality of guava fruits.

## Application of Hydrocolloid Gum as an Edible Coating for Maintaining the Persimmon Fruit Quality Aspects Under Storage Conditions

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Persimmon fruit is gaining economic importance due to its taste and nutritive profile. Being as a climacteric fruit, it has high respiration activity and low shelf life. Current study was developed by using a hydrocolloid gum (tragacanth gum) as an edible coating. Commercially mature persimmon fruits were coated with different concentrations of tragacanth gum (0, 0.5, 1 and 1.5% w/v) and stored at 20 ± 1°C and 80 ± 2% relative humidity for 20 days. Application of edible coatings reduced the weight loss percentage, membrane leakage and malondialdehyde content. Moreover, coated fruit showed higher amount of ascorbic acid, titratable acidity and total phenolic contents. Coated fruits showed the minimum change in total soluble solids, pH and ripening index. Tragacanth gum application inhibited the elevation in activities of polygalacturonase, pectin methylesterase and cellulase enzymes. Additionally, coated fruits showed higher activities of

ascorbate peroxidase, catalase, superoxide dismutase and peroxidase and antioxidant capacity. Furthermore, coating added positively and significantly affected sensory attributes such as taste, colour, aroma, texture and overall acceptability. Regarding the effect of coatings concentration, statistical data showed that 1% tragacanth gum coating was the best for increasing the storage life of persimmon fruit with minimum change in qualitative and quantitative aspects.

## Exposure to Aqueous Ozone Retained Nutritional Quality of Strawberries During Cold Storage

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Improper sanitizing methods to control decay and decontaminate fresh fruits and vegetables may pose serious threats to human health. The purpose of this study was to evaluate the impact of ozone on physical, biochemical, and phytochemical properties of strawberries cv. Chandler. Strawberry fruits were exposed to aqueous ozone (flow rate ≥ 3.3 mg min−1 for 125 g strawberry $L^{-1}$ water) for 0, 3, 6 and 9 min. followed by storage at 2±0.5°C and 95% relative humidity for 12 days. Changes in fruit quality were recorded at 0, 2, 4, 6, 8, 10 and 12 days after cold storage. Ozone-treated fruits had lower pesticide residues and higher microbial disinfection compared to untreated strawberries. Moreover, strawberry fruits treated with ozone for 3 min. exhibited higher fresh weight retention and 4 days delay in fungal decay under cold storage. Results indicated that ozone treatment for 3 min maintained high level of membrane permeability and total soluble solids in strawberry fruit during storage. The ozone treatment for 3 min. also induced higher peroxidase, catalase, and superoxide dismutase enzyme activities. The ozone application resulted in retention of higher anthocyanins contents throughout the storage period. Conclusively, ozone application for 3 min was best treatment for enhancing marketable life (6 more days), reduce fungal decay and retain higher phytochemical contents in strawberry fruits. In conclusion, results suggested that postharvest ozone treatment for 3 min. was effective in retaining fruit quality and enhancing storage life of strawberries.

## Postharvest Hot Water Treatment (HWT) Suppressed the Fruit Rot and Enhanced the Quality of Papaya Fruit Cultivar "Red lady" during Cold Storage

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Papaya (*Carica papaya*) fruit has climacteric, rapid ripening and perishable nature, which makes it susceptible to postharvest fruit rotting resulting in less shelf life and severe postharvest losses. This experiment was carried out to investigate the effectiveness of hot water treatment on papaya fruit for minimizing the rotting and increasing the storage life. For this purpose, mature unripe papaya fruit were treated with hot water at different temperatures (50°C, 52°C, or 54°C) for 5

minutes and stored at 12 °C temperature and 85-90% RH for 28 days. Different attributes including weight loss, firmness, fruit decay, total soluble solids, titratable acidity, ripening index, ascorbic acid, total phenolics, total antioxidants and the activities of antioxidative enzymes were evaluated on fortnightly interval. After completion of storage period, less fruit weight loss (4.63%) and decay (5.1%); higher firmness (12.92 N) was recorded in papaya fruit treated with 54 °C as compared to the control. While the minimum total soluble solids (6.91 °Brix), maximum titratable acidity (0.056%) was observed in HWT 52°C treatment. Similarly, ascorbic acid (33.33 mg $100g^{-1}$), total phenolic contents (34.75), total antioxidants (47.50), and antioxidative enzyme activities were also maximum in case of papaya fruit treated with HWT 52°C. It was shown by the present study, that papaya fruit treated with HWT 52°C preserve the quality of fruit throughout storage, however HWT 54°C treated papaya fruit showed less decaying. Overall, papaya fruit treatment with HWT @ 52-54°C proved successful for suppressing the fruit rot and increasing the shelf life.

## Enhancement of Shelf Life of *Diospyros kaki* by Postharvest Application of Salicylic Acid

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Improvement of shelf life of Persimmon (*Diospyros kaki*) is a major challenge in marketing and export due soft and delicate nature of its fruit which leads to low storage life and high insect and disease incidence. Salicylic acid application after harvest can maintain the fruit quality and reduces the chance of disease incidence. This study was aimed to assess the role of different levels of salicylic acid (SA) on the storage life of persimmon fruit. Four levels of were *i.e.*, 0, 1, 3, and 5 mm of salicylic acid were applied. Fruits were dipped into the solutions for 30 min and then stored at 4°C. Fruits were examined after one month of storage. TSS was maximum at control and minimum at 3 ppm. pH of fruits that treated with 5 ppm was higher as compare to others. The decaying index was higher at 5 ppm followed by 2 ppm and minimum at 3 ppm. Shrivelling observed was maximum at 5 ppm and minimum at 3 ppm. Among all levels of SA concentration 3 ppm appears to be more efficient in the maintenance of long shelf life but showed less total soluble solid contents and pH.

## Gum Arabic as Novel Edible Coating for Conservation of Postharvest Quality and Shelf Life Extension of Fruits and Vegetables: An Overview

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Gum arabic is also known as gum acacia which is viscous and one of the soluble hydrocolloids derived from dried exudates of stems and branches of Acacia species. It is widely used as stabilizer, thickener and emulsifier in different industries related to food, textile, lithography, cosmetics and pharmaceuticals globally. In last decade, it became famous in food industries due to plant derived organically safe nature, antimicrobial properties, and its imperative impact on quality of products. It urges the research scientists to evaluate its potential in maintaining quality of fresh fruits and vegetables. Edible film coating of gum arabic has been reported for extending the shelf life of fresh produce by developing internal modified atmosphere, inhibiting microbial growth, and creating barrier against ethylene, respiration, and moisture loss during storage. Fruits and vegetables coated with gum arabic markedly retained higher ascorbic acid contents, phenolic concentrations, antioxidants, flavonoids, carotenoids, and antioxidant enzymes, and maintained best eating quality during storage. Gum arabic could be employed as a novel and potential edible coating to substitute the synthetic preservatives being used for the extension of shelf life of fruits and vegetables in the supply chain.

## Postharvest Physiological and Biochemical Fruit Quality of Pomegranate Cultivars as Influenced By Transportation Method

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The study was conducted to investigate the postharvest storage life of pomegranate whole fruit of two pomegranate cultivars (‘Sawa’ and ‘Sandhora’) transported directly and indirectly. For this purpose, one lot of harvested fruit of both cultivars was transported directly to the Postharvest science and Technology lab and the second lot was transported indirectly to the laboratory (Farm to Wholesaler to Retailer to laboratory). Whole fruit of both cultivars were investigated at ambient conditions (25 ± 2$^{o}$C, 60-65% RH) at shelf. The experimental design was completely randomized design (CRD) with factorial arrangement. Different parameters were studied during the study including physiological parameter (weight loss, ethylene production, respiration rate) and biochemical parameter (juice pH, total soluble solids, titratable acidity, ascorbic acid). Regardless of cultivars, higher fruit transit loss was observed in pomegranate fruit transported indirectly as compared to direct transported fruit. During shelf at ambient conditions, the fruit transported indirectly exhibited higher ethylene production, fruit weight loss, soluble solid contents, and

titratable acidity as compared in direct transportation in both pomegranate cultivars. Regardless to transport method, on day-5 of shelf, higher ethylene production, weight loss, higher soluble solid contents and lower ascorbic acid were observed in fruit of cv. 'Sawa' as compared to cv. 'Sandhora'. Overall pomegranate cv. 'Sandhora' transported directly to lab exhibited better physiological and biochemical attributes than cv. 'Sawa' transported indirectly.

## Comparative Performance of Ethylene Releasing Sachets on Fruit Ripening of Mango cv. Late Sindhri

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Mango is known as King of fruits, a highly valued crop traded worldwide. Regarding postharvest, the local industry is facing many challenges to maintain its quality during the supply chain. However, mangoes are generally exposed to calcium carbide after fruit harvest for fruit ripening. This chemical has been banned and being substituted with different imported ethylene releasing agents. However, the efficiency of locally developed ripener was not known. The purpose of this study was to evaluate the potential of a locally sourced ethylene releasing sachets. Mango fruits cv. Late Sindhri were harvested at green mature stage and desapped using both physical and lime water methods and transported to the laboratory at MNS- University of Agriculture Multan. The fruits were weighed and placed in export sized cardboard boxes with newspaper lining. As per manufacturer recommendations, the ripening sachets were put into water for two-three minutes and then placed in the boxes in which fruit was packed. After two days the ethylene releasing sachets were removed from the boxes. Different physical and biochemical attributes were studied at two days' interval until the ripening of mango at ambient condition (24±2°C) for 8 days. Comparable results were recorded for both local and imported sachets in weight loss, fruit skin color, visual quality, skin shrivelling, firmness, antioxidants, anthocyanins, and enzyme activities. The fruit treated with local ethylene sachets has good and comparable results showing more ethylene production and fruit respiration compared with imported ethylene sachets and minimum production of ethylene and respirations was observed in control fruit.

## Post Storage Temperature Conditioning Delays Enzymatic Browning and Maintains Quality of Litchi Fruits during Ambient Storage

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Effect of post-storage temperature conditioning (PSC) was studied on litchi fruit browning, antioxidative status and biochemical quality. Fruits were stored under cold-storage at 5±1ºC for 28 days. After removal from cold-storage at 7 days interval, fruits were subjected to three PSC-treatments at 12ºC (i = no PSC, ii = one-day PSC and iii = two-days PSC) before placing them at 20ºC shelf-conditions. Among these treatments, one-day PSC delayed surface browning, maintained total anthocyanins; exhibited reduced weight loss and fruit decay. One-day PSC suppressed membrane leakage, malondialdehyde contents and showed reduced peroxidase and polyphenol oxidase enzymes activities. One-day PSC-treated fruits showed conserved soluble solids, ascorbic acid, titratable acidity, phenolic contents and DPPH (2, 2–diphenyl–1–picrylhydrazyl–radical) scavenging activity with higher activities of catalase and superoxide dismutase enzymes having maintained sensory quality. In conclusion, one-day PSC following cold storage delayed enzymatic browning and maintained overall quality of litchi fruits.

## Pre-Storage *Aloe vera* Gel dipping Maintained Physico-Chemicals Fruit Quality Attributes of Guava (*Psidium guajava* L.) cv. Gola during Storage under Ambient Conditions

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Guava is an important fruit crop of different tropical and subtropical areas. Guava is 4$^{th}$ leading fruit of Pakistan and area under cultivation is rapidly increasing throughout Pakistan. Due to climacteric fruit thus deteriorates quickly under ambient conditions. Various types of edible coatings and natural plant extracts are being used for shelf-life enhancement and quality maintenance of fruits. The objective of present study was to enhance the shelf life of guava by applying edible coating of Aloe vera gel. Guava fruit were treated with different coating of AVG along with untreated fruit and keep at ambient conditions for 12 days. Data were collected and analyzed after 3 days' interval for different physico-chemical parameters (weight loss, vitamin C, sugars, pH, TSS, TA) and enzymatic activities. *Aloe vera* gel treated fruits showed a positive impact on quality maintenance and shelf life enhancement of guava fruit up to 12 days during ambient conditions. Postharvest treatment of guava fruit with *aloe vera* gel coating retained good

fruit quality as well as significantly enhanced the enzyme activities. Therefore, application of *Aloe vera* could be suggested for commercial use on guava fruits during storage.

## Response of 1-MCP Smart Card Technology in Delaying Postharvest Senescence and Maintaining Overall Quality of Green Chilies

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Green chilies are one of the highly perishable crops having limited marketable life due to quick moisture loss, respiration, shrivelling and susceptible to microbial spoilage. The present study was aimed to extend shelf life and evaluate the potential of 1-MCP smart card technology in fresh green chilies at ambient conditions. Green chilies cvs. Ghotki and Talhari were harvested from district Hyderabad, Sindh province and transported to Postharvest Research and Training Centre (PRTC) for these experiments. Chilies were resorted into fresh, defect and blemish free and weighed in plastic crates. Each crate contains 2 Kg of fresh chilies covered with paper and there were two treatments; control without card and with 1-MCP card, respectively. Chilies were assessed for its quality on 2-day interval till 8th day of ambient storage (26±2 ºC). Chilies treated with 1-MCP cards exhibited significantly reduced respiration, weight loss, wrinkling, decay, ion leakage and change in red chili percentage, maintained visual quality with higher ascorbic acid contents, total phenolic concentrations and total antioxidant activities, than control. 1-MCP card treated chilies also showed higher retention of chlorophyll contents and antioxidant enzymes (superoxidase dismutase, peroxidase, catalase and ascorbate peroxidase) during storage. However, non-significant results were observed for biochemical quality attributes (SSC, acidity, sugar acid ratio and pH) in green chilies. In conclusion, 1-MCP smart card technology could be used as a promising technique as an alternative of synthetic preservatives, eliminate the processing methods (*i.e.,* dipping, spraying) and assist in extending shelf life of green chilies which make the supply chain more sustainable.

## Improving Market Opportunities for Small Land Holding Tomato Growers by Addressing Postharvest Value Chain Issues: A Case Study of Punjab-Pakistan

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Pakistan is an agriculture-based country predominantly consisting of small holders especially in case of horticultural crops. Vegetable industry is coming into limelight due to its imperative role in food security. Among vegetables, tomato is the second most grown crop all over the country.

However, due to multiple factors including traditional methods of postharvest handling and marketing result in low returns to tomato growers. Therefore, considering this gap, ACIAR launched the vegetable value chain project (2017-2021) to help assist community by improving value chain issues of four leading vegetable crops *i.e.*, potato, tomato, onion and chilies. During last three years (2017-2020), significant postharvest value chain R&D work has been conducted. Initially, a baseline survey was conducted to document the conventional supply chains to assess the key issues needed to be resolved with possible R&D work. During "Walk the value chain" activity, it was observed that there are no defined quality criteria and branding used for fresh tomatoes at wholesale markets. Growers harvest, pack and sell tomatoes without considering market demand for quality standards which results in lower market return. After baseline survey, quality standards have been defined by working with market actors including wholesalers and retailers and built capacity of growers to practice /implement these quality standards for getting high price of their produce. Moreover, local tomato consignments were tracked to the distant market and their auction process was observed. Well graded product clearly showed high price as compared to other consignment with no grading from same area. The storage potential of commercial tomato cultivars was also evaluated, and details shared with target community. Likewise, the concept of harvest time, maturity indices, pre-harvest pesticide interval, sorting, grading, packaging, storage and transportation was also observed lacking. Project team presented the pictorial illustration that how can they reduce food waste and postharvest losses by resolving these problems. Capacity building of growers was also strengthened through participatory farmer training sessions (PFTS) including, men and women, during season. In conclusion, the postharvest value chain R&D approach markedly enhanced the produce quality and showed better market returns to the growers.

## Combined Application of Methyl Salicylate and Arginine Alleviates Chilling Injury and Extends Storability of Bell Pepper (*Capsicum annuum* L.)

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Bell pepper is a highly perishable vegetable crop that requires proper handling and suitable care to extend its shelf life. Loss of water due to high transpiration rate causes reduction in fruit firmness, cosmetic appearance and weight loss, therefore, affect the marketability of the bell pepper. Chilling injury is most critical issue in bell pepper under low temperature storage. The objective of this experiment was to reduce the chilling injury and enhance the storage life of bell pepper. Methyl salicylate (MS) and arginine (Arg) were tested following different treatments such as T1=Control, T2= 0.01 mM MS, T3= 0.05 mM MS, T4 = 1 mM Arg, T5 = 1.5 mM Arg and T6 = 0.01 mM MS +1.5 mM Arg and treated bell pepper were stored at 5±1ºC. Physical, biochemical and phytochemical parameters were studied at 7 days interval followed by two days of shelf life at ambient condition. In this experiment, on last removal (28+2 days), MS and Arg treatments for 10 min showed highly significant results with lower weight loss, maintained fruit color and firmness,

and reduced wrinkling, decay, disease incidence and alleviated chilling injury. It also maintained higher chlorophyll contents, ascorbic acid, total antioxidants and total phenolic contents as compared to control. In conclusion, combine application of MS and Arg treatment could be possibly used to reduce chilling injury and improve storage life of bell pepper under cold storage conditions.

## Impact of Ozone and Ultrasound Application on Microbial Decontamination and Quality of Lettuce (*Lactuca sativa*)

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Lettuce crop (*Lactuca sativa*) has been recognized as a nutritive and commonly recommended by nutritionist. As it is usually consumed as raw or in unprocessed form salad's leaves have been associated with different diseases due to bacterial contamination. Ozone and ultrasound in aqueous medium were used individually and in combined form for different time durations (5, 10 and 15 minutes) to sanitize salad leaves. Parameters like microbial count (*Escherichia coli*, *Salmonella* and total plate count) and organoleptic characters (taste, color texture etc.) were analyzed at 0, 5 and 10 day after treatment. Significant reduction in microbial count was observed in treated samples as compared to control. After treatment (0 day) *E. coli*, *Salmonella* and total plate count on lettuce surface were minimum i.e., 3.3, 2.0 and 3.3 Log10 CFU $g^{-1}$, respectively, in salad treated with ozone + ultrasound in aqueous media for 15 min. On day 5 after treatment, *E. coli* and total plate count showed minimum bacterial spreading (3.0 and 1.3 Log10 $CFUg^{-1}$) in case of ozone + ultrasound for 15 min, while least number of salmonella count was observed in ozone + ultrasound treatment for 10 min. On 10 day, these microbes were again least in count under combined application of ozone and ultrasound for 15 min. Non-significant difference was observed in biochemical quality parameters of lettuce as compared to control. In conclusion salad leaves treated with aqueous ozone and ultrasound for 15 min. markedly reduce microbial spoilage and maintained overall quality with better consumer acceptability.

## Assessment of Sono-ozonation as a Sanitizing Practice in Grapes (*Vitis vinifera*) at Household level and its impact on Quality under Refrigerated storage: A Consumer Perspective

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Grapes are the rich source of nutrients, used without peeling and processing, and tend to pose potential risks of microbial contamination, considering unregulated pre and postharvest practices in supply chains The objective of current study was to test efficacy of an eco-friendly sanitizing technique, to be introduced at consumer level. Two studies were conducted to evaluate the efficacy

of sono-ozonation ($O_3$/US) application for 3, 6 and 9 minutes on grapes: i) its impact on inoculated berries with *E. coli* and *Salmonella*; ii) its impact on microbial status, physical quality, biochemical and, biocidal compounds and cosmetic attributes of berries up to 14 days under a household refrigerator (5±2 °C). Outcomes obtained by inoculated samples explored that with each increment in treatment duration *E. coli* and *Salmonella* gradually reduced up to >99 %. Similarly, when market samples of grapes were subjected to similar treatments, the largest reduction in total plate count was observed 1.48 $Log_{10}$.CFU/g at 6 minutes $O_3$/US treatment, and the reduction was 2 $Log_{10}$.CFU/g, when evaluated after 2 weeks of refrigerated storage. $O_3$/US application at 6 minutes did not have any negative impact on grapes quality, rather showed slight increase in Total phenolic contents and flavonoids and retained Vit-C content and TSS. However, some detrimental impacts related to decay index was observed in 9 minutes $O_3$/US treatment after two weeks storage. On the basis of overall quality and microbial analysis it was concluded that sono-ozonation application for 6 minutes can be successfully employed as a sanitizing practice to remove microbial contaminants from grapes at household level, which also maintained grapes quality under refrigerator storage up to two weeks.

# SESSION TRACK

# I. Processing & Value Addition

## Microwave Oven Drying as A Rapid Moisture Content Determination Method for Plants: A Review of Its Developments Within the Last Decade

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Microwave oven drying is an energy-efficient method of drying due to faster drying rate through selective heating. This drying method works by the application of microwaves which selectively target the polar constituents of the material being dried. Microwaves are non-ionizing electromagnetic waves that heat up a material by two simultaneous mechanisms: 1) dipole rotation and 2) ionic conduction. These two mechanisms result in a turbulence among molecules and ions within the material's polar groups, thereby, generating heat. Consequently, the heat produced evaporates the moisture present within the material. Due to this reaction, several researchers investigated whether this drying method can be a potential alternative to the conventional oven drying method in moisture content determination by applying it to a wide variety of materials, including plants. Although the pioneer research on this application date back to as early as the 1960's, interest on this topic continues to develop even to this day. Within the last ten years, microwave drying has been applied to peanut hull pellets, yerba mate, paddy, apple, and Indian wheat to determine their moisture contents. Results from these continue to prove that microwave oven drying can certainly be an alternative to conventional oven drying.

## Spectrum of Medicinal Properties of Cinchona

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Cinchona belongs to family Rubiaceae, because of its antimalarial activity it becomes very popular and got more importance from centuries. Many Alkaloids are present in this tree including Chichonine, Quinidine, Quinine, and Cinchonidine are the main among all of them, but percentage varying from species to species. The combinatorial effects of more than twenty alkaloids are more effective of its medicinal property as compared to one of them. Since the early 17$^{th}$ century cinchona bark was used as an antimalarial drug to solve and cure several health problems associated with malaria. Cinchona can also be used to cure several other diseases because its alkaloids have, anti-oxidant, anti-cancer, anti-obesity, anti-inflammatory and anti-microbial activity. This Article reviews the medicinal and aromatic activities of cinchona.

## Microwave-Assisted Extraction: A Novel Technique to Extract the Phytochemicals

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Recently, functional foods have been gaining popularity as a natural approach to combatting various ailments with the help of significant plant-derived bioactive compounds. These phytochemicals are separated from plants through a technique called "extraction" for convenient usability as active ingredients in the food and pharmaceutical industries. Among these, microwave-assisted extraction (MAE) is non-ionizing electromagnetic waves having frequencies of 300 MHz to 300 GHz that heat the food material through dipole rotation and ionic conduction of its polar constituents. The review focused on the factors that affect the yield of microwave assisted extraction. In this method of extraction, factors that determined its success were found to be the microwave power level, microwave frequency, irradiation time, amount of moisture in the sample, surface area and/or thickness of the sample, composition and structure of the sample, solvent concentration, sample-to-solvent ratio, temperature and/or pressure applied, and number of cycles required for extraction. Moreover, the solvent was one of the most significant factors for MAE because it directly interacted with the plant material and helped in the breaking down of its structure as an external force. In the absence of solvent, MAE can still be used in that the microwaves target the microscopic moisture naturally present in the plant material. As the moisture evaporates due to increased internal temperature, it applies pressure on the cell wall, thus, stretching it until it is eventually ruptured. As a result, phytochemicals are leached out of the plant material. In this study, results confirm the effectiveness of MAE as a "Clean and Green" method in which essential oils are extracted 9 times faster than the conventional method, the quality of which is better in sensory and antioxidant properties when incorporated into functional food.

## Fruits and Vegetables Waste Valorization in Industry and Its Health Benefits: A Review

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The cultivation, transportation, refining as well as disposal of food, waste is produced at various levels. Deposit, incineration, and composting include the first-generation methods used for the treatment of food waste. However, these techniques are not suitable for food waste because they

emit harmful methane gas and bad odor, and they have sluggish kinetics of the reaction, which can be tackled to a certain degree by implementing alternate strategies for food waste recovery by waste conversion to value-added goods such as fuels and substances. Approximately one-third of the foods produced for human consumption is lost or unused globally, according to the Food and Agriculture Organization study. The primary commodities used for all horticultural crops are fruit and vegetables. Their nutrients and health-promoting compounds are raw, minimally refined, and processed. The FAO reports that loss and residues of fruit and vegetables are the largest of all food categories and could exceed up to 60%. The United Nations Food and Agriculture Organization (FAO). Fruit and vegetable manufacturing activities contain essential by-product waste, which is about 25 to 30% of the total crop category. The waste consists predominantly of sow, skin, rind, and pomace, which contain strong sources of potentially valued bioactive compounds, including carotenoids, polyphenols, dietary fibres. They are an excellent source of a variety of useful additives, known as bioactive compounds (carotenoids, polyphenols, etc.). These bio compounds have a good effect on health and are known to modulate their metabolism processes and affect their cellular functions in human health, based on their route and bioavailability in the body, due to antioxidants, anti-cancer, anti-inflammatory, anti-allergenic and anti-atherogenic. This can also be used for the design of practical or enriched food, for the medical and pharmaceutical health industry, and for garment industries, among others in a number of industries, including the food industry.

# SESSION TRACK

# J. Extension & Commercialization

# Effect of Commercial Biostimulants on Growth and Productivity of Petunia (*Petunia hybrida* L.)

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Petunias typically needs high degree of chemical fertilizers for high quality bloom and prolonged flowering period. While excessive fertilizer application often results in soil salinity and other pollution issues. Biostimulants are environment friendly nutritive compounds containing bioactives and phytochemicals that affect the crop growth and productivity. Current research trial was conducted in Floriculture Research area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan to evaluate the efficacy of commercial biostimulants viz Seamaxx, Quantis, Isabion and Planofix foliar application on growth and development of *Petunia hybrida*. The research trial was conducted following complete randomized design (CRD) while statistical analysis was done following ANOVA technique and treatment mean was compared using least significance test (LSD) at 5% probability level. Results conclude that Planofix application @ 300 µL $L^{-1}$ exhibited the highest vegetative growth in terms of maximum plant height, no. of branches per plant, no. of leaves, leaf length and width. While the similar trend was observed regarding reproductive growth as expressed by highest flower number, flower fresh and dry weight, blooming period and minimum days to flowering. Comparatively, following Planofix, Petunia growth and productivity was significantly influenced by other biostimulants in decreasing order as Isabion > Quantis > Seamax, respectively. The outcomes of study expressed that potential of commercial biostimulants and these findings could be applied on other flower crops and with basic research support these can be suggested to local farming community.

# SESSION TRACK

# K. Marketing, Export & e-Business

## Estimating Florist Perceptions for Cut Flowers

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Cut flowers are flowers or flower buds that have been cut from the plant bearing it. It is usually removed from the plant for decorative use. Typical uses of cut flowers are in decors such as vase display, wreaths and garlands. To estimate the florist perceptions about cut flower market a survey was conducted in Lahore city. Survey participants were self-selected and asked to answer questions evaluating their preferences. Florist participants also evaluated cut flowers based on demand, flower-color harmony and price on a scale of 1 to 7 (1 = very unlikely to purchase, 7 = very likely to purchase). Price was found to be the most important factor, accounting for 43.1% of the decision to purchase by consumer. Color harmony was the next most important factor, accounting for 34.9%. When asked what they would pay, on average, for the containers on display, consumer participants responded with a price of PKR 15000/-. A majority of grower participants (75.0%) had produced annual planters in the past. Retailer participants also indicated that they would charge their customers an average retail price 14% less than the growers' suggested average retail price.

## Consumer Perceptions for Cut Flower Tulip (*Tulipa gesneriana* L.)

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Tulip is an ornamental bulbiferous geophyte belonging to family Liliaceae. A perennial herbaceous plant cultivated worldwide for its elite properties such as flower color, quality and other alluring traits. The festive and occasional features like royalty and love with respect to its color attracts people. Tulip is grown as a cut flower and is marketed throughout the world. The Dilder's tulip is fancied by most people, yet few are unsatisfied by the price. Globally the marketing index decreased due to climatic factors and expenses. Awareness was needed to be developed among people for identifying tulip and its value. A survey was conducted in Lahore city in three florist shops at different locations to check the response of customers towards tulip and its price. The florist consumer relationship to understand the marketing value of tulip. In this report a questionnaire was generated containing questions of sorts and was answered by the clients. The answers were mostly based on their likes, dislikes and the prices with respect to the cut flower quality. A positive response majorly from female consumers was obtained. Though the issue of the flower price is still a dispute. The customers mostly preferred red-, orange- and pink-colored flowers (cv. Lalibela, Baree Alata, Denmark). The interested emptor was then further interviewed and the response for marketing of tulip was efficacious. Data were analyzed by SPSS software, obtaining the mean values and their frequencies so that data could be interpreted in the simplest form. The question responses were encoded in numeric form for better analysis. The results were segregated by age, gender and preferences.