4th BRI Sino-Pakistan Agriculture FORUM

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Abstract Book

Abstracts

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Technical Session I

Biotechnology & Functional Genomics in Agriculture

Oral Presentations

Nanobiotechnology and Sustainable Development of Crop Production

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Sustainable agricultural development is highly dependent on efficient crop production. As an interdisciplinary discipline, nanobiotechnology has shown great potential in crop production. Nano-pesticides, nano-fertilizers, nano-regulators, and nano-sensors are known to improve crop stress tolerance. Cerium oxide nanoparticles and manganese oxide nanoparticles showed good effects on improving salt tolerance and drought resistance of crops. Silver nanoparticles and copper-based nanomaterials have been reported to improve crop disease resistance. Recently, we found that MXene quantum dots can improve cotton Verticillium wilt resistance. Nano sensors such as carbon nanotubes have been widely used to detect crop stress signalling molecules such as hydrogen peroxide. Overall, nanobiotechnology has great potential in improving crop production to facilitate the sustainable development of agriculture.

Plant Viruses, Their Impact and Genome Editing Based Strategies to Control

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Phytopathogenic viruses are a major biotic constraint to agricultural productivity and, throughout the warmer parts of the world, many of the most important diseases of crops are caused by arthropod-borne viruses of the family Geminiviridae. The symptoms caused by these viruses include enations, leaf curling and stunting, which resemble developmental abnormalities. Family Geminiviridae has recently been expanded from nine genera (Curtovirus, Mastrevirus, Turncurtovirus, Becurtovirus, Grablovirus, Eragrovirus, Capulavirus, Topocuvirus and Begomovirus) to 14 genera by the addition of the genera Citlodavirus, Maldovirus, Mulcrilevirus, Opunvirus and Topilevirus. Whitefly-transmitted begomoviruses, the biggest genera of this family are a major limiting factor to produce numerous dicotyledonous crops worldwide. With the increasing concerns over the use of insecticides as well as the adoption of agricultural practices that favour the build-up of both vector and virus populations including, for example, widespread monoculture and overlapping cropping seasons, as well as the lack of suitable sources of natural resistance (so-called host-plant resistance) in many crop species the problems due to these viruses are increasing. Transgenic approaches paved the way to a virtually unlimited source of virus resistance for application in agriculturally important plant species. Several transgenic approaches have been used to develop resistance against geminiviruses including pathogen-derived approaches e.g., RNA interference. The recent advancements in targeted genome engineering via Clustered regularly interspaced short palindromic repeats (CRISPR) and CRISPR-associated Cas (CRISPR/Cas) have unprecedented potential to develop virus resistance and crop improvement. In this talk, I will discuss various strategies that have been used for the development of virus resistance in our lab.

Genetic Analysis of Drought Resistance and Innovation of Drought Resistant Germplasm Resources in Cotton

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Cotton is an important strategic material of our country and an important raw material of cotton spinning industry, which concerns the strategic adjustment of our agricultural structure and the safety of textile industry. Drought is the main adverse factor affecting the high yield and quality of cotton in the main producing areas of China. Water-saving and drought-resistant measures are significant requirements for the green development of cotton industry. Understanding the molecular mechanism of the interaction between cotton and drought stress and improving drought resistance and water use efficiency cotton are the main ways for the green and sustainable development of cotton industry. In this study, we established a Cotton Phenomic Platform to achieve high-throughput identification of drought resistance (DR) traits, developed 10 new indicators for DR, and mapped 179 QTL related to DR based on multi-digital traits and conventional phenotypic traits. We cloned 28 DR related genes in cotton and analysed the functions and regulatory mechanisms of 10 important genes such as GhCIPK6 and GhMKK16. A total of 22 SNP-based DR markers were developed. A total of 15 drought-resistant resources were obtained by high-throughput phenotypic identification, greenhouse potting, PEG simulated infiltration treatment, drought chambers, and water control in Xinjiang field. A total of 55 drought-resistant cotton resources were innovated by molecular marker-assisted introduction, genetic modification, and gene editing. Additionally, 55 innovative DR cotton resources have been created using techniques such as molecular marker-assisted introgression, transgenics, and gene editing.

Utilizing High-Throughput Phenotype and GWAS to Explore Cotton Drought Resistance QTN

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As the largest cotton production base in China, Xinjiang plays a crucial role in national agricultural production. However, Xinjiang is located in an arid and semi-arid region, with scarce water resources. In recent years, the frequent occurrence of extreme weather has seriously constrained the development of China's cotton industry. Cultivating drought resistant new varieties through molecular marker assisted selection is an effective way to address drought hazards and promote sustainable development of cotton in Xinjiang. In the past, researchers have identified many QTLs and candidate genes in analysing the genetic mechanism of cotton drought resistance, but major molecular markers/genes have not yet been explored and applied. Currently, combining high-throughput multispectral phenotypes with GWAS is a novel and effective method for analysing the genetic structure of complex drought resistance traits and cloning key genes. Therefore, this study aims to conduct field dynamic and reliable high-throughput phenotypic investigations on 300 upland cotton resources from different genetic backgrounds and geographical sources based on a low altitude drone monitoring platform, equipped with multispectral cameras. Combined with whole genome resequencing data, GWAS and the summary of previous QTL Meta analysis results will be used to co

locate cotton drought resistance quantitative trait nucleotides (QTN)/excellent alleles, and develop markers, to further analyse the molecular mechanism of cotton drought resistance and lay the foundation for creating new cotton drought resistant varieties with the help of MAS.

Genome-Wide Association of The Metabolic Shifts Underpinning Dark-Induced Senescence in *Arabidopsis*

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Dark-induced senescence provokes profound metabolic shifts to recycle nutrients and to guarantee plant survival. To date, research on these processes has largely focused on characterizing mutants deficient in individual pathways. Here, we adopted a time-resolved genome-wide association-based approach to characterize dark-induced senescence by evaluating the photochemical efficiency and content of primary and lipid metabolites at the beginning, or after 3 or 6 days in darkness. We discovered six patterns of metabolic shifts and identified 215 associations with 81 candidate genes being involved in this process. Among these associations, we validated the roles of four genes associated with glycine, galactinol, threonine, and ornithine levels. We also demonstrated the function of threonine and galactinol catabolism during dark-induced senescence. Intriguingly, we determined that the association between tyrosine contents and TYROSINE AMINOTRANSFERASE 1 influences enzyme activity of the encoded protein and transcriptional activity of the gene under normal and dark conditions, respectively. Moreover, the single-nucleotide polymorphisms affecting the expression of THREONINE ALDOLASE 1 and the amino acid transporter gene AVT1B, respectively, only underlie the variation in threonine and glycine levels in the dark. Taken together, these results allow us to present a very detailed model of the metabolic aspects of dark-induced senescence, as well as the process itself.

Applications of Plant Genomics: Improving Crop Production for Sustainable Agriculture

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Extreme climatic conditions are distressing intimidation for the accessibility of food for the growing population in Pakistan. Sustainable growth of the agriculture sector stands vital for food security and rural development in Pakistan. Crop production regarding quality and yield are affected due to climatic changes. Adaptation, as well as mitigation strategies, is required to moderate the climatic effects on food crops to sustain production and improve the quality as well as the availability of food to the growing population in Pakistan. Several methods are available for crop production and improvement to preserve the quality yield. Previously conventional breeding methods have introduced several crop varieties with improved traits. But now conventional plant breeding techniques and conventional methods for plant protection are not sufficient due to limitations of germplasm, time limits etc. to introduce new and improved varieties to perform well in adverse weather conditions. Plant metabolic pathways are required to be explored which may unravel the mysteries of crop plants' performance

under the present scenario of global warming. Plant genomic strategies along with molecular biology approaches are making progress in improving plant protection and production policies. These approaches with improved technologies may find the solution to identify and characterize the new genes to be allowed to introduce new crop varieties. The newly developed transgenic plants may have better performance in severe weather conditions and produce higher yields and improved quality of crops.

The microRNA-7322-5p/p38/Hsp19 Axis Modulates *Chilo suppressalis* Cell-Defenses Against Cry1Ca

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Bacillus thuringiensis (*Bt*)-secreted crystal (Cry) toxins form oligomeric pores in host cell membranes and is a common element in generating insect-resistant transgenic crops. Although Cry toxin function has been well documented, cellular defenses against pore-formation have not been as well developed. Elucidation of the processes underlying this defense, however, could contribute to the development of enhanced *Bt* crops. Here, we demonstrate that Cry1Ca-mediated downregulation of microRNA-7322-5p (miR-7322-5p), which binds to the 3' untranslated region of *p38,* negatively regulates the susceptibility of *Chilo suppressalis* to Cry1Ca. Moreover, Cry1Ca exposure enhanced phosphorylation of Hsp19, and *hsp19* downregulation increased susceptibility to Cry1Ca. Further, Hsp19 phosphorylation occurs downstream of p38, and pull-down assays confirmed the interactions between Hsp19 and Cry1Ca, suggesting that activation of Hsp19 by the miR-7322-5p/p38/Hsp19 pathway promotes Cry1Ca sequestration. These findings provide new insights into invertebrate epithelium cellular defenses.

Diverse Role of Mycoviruses and Potential Applications for Sustainable Agriculture

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Mycoviruses ubiquitously infect all major fungal taxonomic groups. It has been almost six decades since the discovery of the first mycovirus and several new families of mycoviruses are reported to date. Recently, deep sequencing technologies have become a powerful tool to enhance our understanding of mycovirus diversity and its evolution. Mycoviruses can have cryptic, hypervirulent, or hypovirulent effects on host fitness. Hypovirulent mycoviruses harbouring phytopathogenic fungi can be used as biocontrol agents in fungal disease management. Fungal pathogens harbouring mixed infection of mycoviruses have been known to overcome host silencing machinery and alter phenotype, and expression of host genes. They can convert pathogenic fungi into non-pathogenic endophytes that can be exploited to enhance the health of economically important crops. Whilst endophytic fungi harbouring mycoviruses enhance plant tolerance to biotic and abiotic stress and thus, can be used as biological priming agents to mitigate climate changes. In conclusion, mycoviruses interaction with

fungi makes them an important tool in sustainable agriculture, and further research into engineering mycoviruses and understanding the molecular mechanism underlying mycovirus-host interaction holds the potential to revolutionize agriculture.

Accurate Identification of Cold Tolerance in Rice Germplasm Resources and Gene Mining of Cold-Related Genes

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Rice holds significant global importance as a staple food for over half of the world's population. A decline in rice yield can be attributed to cold stress. Therefore, it is very important to screen and identify cold-tolerant germplasm resources for the development of cold-tolerant rice varieties. In our previous work, we precisely evaluated the cold tolerance of rice germplasm during its vegetative growth phase by principal component analysis (PCA), using various morphological, physiological, and biochemical indicators. Furthermore, we performed a genome-wide association study (GWAS) on phenotypic traits and found some candidate genes associated with cold tolerance. Furthermore, we did haplotype analysis. These findings offer novel perspectives on comprehending the mechanisms underlying cold tolerance. In subsequent investigations, we will focus on the molecular mechanisms of these recently identified cold tolerance genes, aiming to provide additional support for the breeding of cold-tolerant rice varieties.

Deep Learning-Based Mining of Plant Regulatory Elements

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Machine learning techniques have been extensively used in genomics research. With new technologies enabling the investigation of biology at an unprecedented scale and in a multitude of dimensions, deep learning has been widely applied in many areas of large-scale data analysis to resolve complex biological. In the field of agriculture, the construction of deep learning models combined with high-throughput genome editing techniques hold the promise to replace traditional breeding practices by rationally combining beneficial variants genome-wide and creating new varieties with unprecedented efficiency. Deep learning-based modelling of gene expression is the first step to achieve this ambitious goal. This talk will cover: 1) the basics of gene expression regulation, its impact on development and abiotic stress response; 2) recent progress in modelling gene expression using machine learning approaches; 3) deep-learning based modelling of gene expression and identification of known and novel plant cis-regulatory elements and 4) use cases of deep learning models to predict and guide precise editing and smart design of crop regulatory elements.

Genomics of Plant Root Adaptation to Environmental Stresses

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Roots are pivotal for the anchorage of land plants in the soil and for the efficient uptake of water and mineral nutrients, thus playing a crucial role in plant fitness. Plants experience a wide range of edaphic stresses, including drought, flooding, salinity, and nutrient deficiencies that negatively impact their productivity. Therefore, understanding the genetics underlying plant root adaptation to these stresses has become a key area of research, with implications for sustainable agriculture and ecosystem resilience. Here I will discuss our recent discoveries in genomics research on the mechanisms underlying plant root physiological and developmental responses to various soil-borne abiotic stresses (1, 2, 3, 4). Specifically, I will discuss the use of high-throughput sequencing techniques, including next-generation sequencing, transcriptomics, and genome-wide association studies, to unravel the intricate gene networks involved in root stress responses in model plant species and crops. The role of key genetic determinants such as kinases and transcription factors in stress perception and signalling will be highlighted, providing insight into their role in shaping root adaptation strategies. These studies can enable the development of stress-tolerant crop varieties and sustainable farming systems in the face of a changing climate and growing global food demand.

Technical Session I

Biotechnology & Functional Genomics in Agriculture

Poster Presentations

Development of Surrogate Bulls: Technical Difficulties and Future Perspective

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In livestock breeding, the concept of surrogate bulls has emerged as a revolutionary breakthrough with the potential to transform cattle farming. Surrogate bulls, also known as "bull clones," are genetically identical replicas of exceptional breeding bulls. This cutting-edge technology promises to enhance the efficiency, productivity, and genetic diversity of cattle breeding programs. Utilizing advanced cloning techniques, the genetic material of superior bulls can be replicated to produce identical offspring. This ensures that desirable traits such as high milk production, disease resistance and robust growth are maintained. Emerging gene-editing technologies like CRISPR-Cas9 enable the precise modification of cattle genomes, allowing for the introduction or removal of specific traits. The development of surrogate bulls, often involving cloning or advanced genetic engineering techniques, presents several technical difficulties and challenges like low cloning efficiency, maintaining genetic stability, reduced longevity and productivity, low pregnancy rates, reduced genetic diversity, prohibitively expensive requiring skilled scientists, laboratory equipment, and facilities and questionable sustainability. Addressing these technical difficulties requires ongoing research, advancements in cloning and genetic engineering techniques, and a commitment to ethical and responsible use. The potential benefits for enhanced breeding programs, biodiversity preservation, and global food security make surrogate bulls a subject of great importance and fascination in the agricultural landscape. As the research and technology evolve, the surrogate bulls should be introduced into breeding programs.

Identification and Characterization of Dieback Disease Resistance Linked SSR Markers in Shisham Dieback

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Shisham (*Dalbergia sissoo*) is one of the most important tree species found in the Indo-Pak subcontinent. Shisham population is highly threatened due to its dieback disease that is dispersed throughout its habitat. Our group has collected healthy germplasm from across Punjab province. This germplasm was later challenged with *Botrydiplodia theobromae.* In another survey the diseased samples were collected. Among many pathogens, *Botrydiplodia theobromae* was the most prevalent. Transcriptomic data was generated from healthy and diseased plants. Subsequently, transcriptome-wide identification of PR (Pathogenesis Related) genes *EST-SSRs* from this data and publicly available online data was performed. When the ESTs were applied on the pathologically characterized material

a *DsBSR* (Biotic stress resistance) transcription factor was identified to be linked with the dieback resistance. The marker-screened plants were also further validated and confirmed by the in-vitro fungal leaf assay. Marker fragments were isolated and sequenced for further analysis. The downstream in-silico analyses showed that the amplified fragment was closely related to the same family member of *Abrus pectorius*. When the fragments were analysed for the protein interaction the fragment had interactions with acquired immunity factors (ICS1, and SARD1) and induced resistance factors (GH3.12). The RT-PCR also reported increase of the transcripts with the inoculation of the *Botryodiplodia theobromae* indicating a strong correlation of the factor with the dieback resistance. This *DsBSR* member has not yet been reported to have its role in dieback resistance. This study would improve our understanding of biotic stress resistance in woody tree species.

Genomic Insights into Faba Bean Defense: Identifying Key SNPs for Enhanced Ascochyta Blight Resistance

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Climate warming poses challenges and opportunities for plant breeders, particularly in Germany, where spring faba beans dominate cultivation. However, improved winter hardiness in faba beans aligns with milder German winters, introducing winter-sown varieties as a novelty. Faba bean genetic defense against Ascochyta blight, caused by *Ascochyta fabae*, is crucial for its integration into crop rotations. Traditional breeding for resistance is demanding due to complex inheritance and low heritability. Therefore, current study was conducted to screen 224 homozygous faba bean lines for Ascochyta resistance traits. Prospective heritability values from the first two replicates suggested 12 replicates were needed to achieve h^2>70% (realized h^2=87%). Genetic variation for Ascochyta resistance traits was detected with strong genetic correlations among traits. Five lines outperformed the resistant line 29H, while three were highly susceptible. A genome-wide association study (GWAS) with 188 inbred lines and 2058 markers, including 17 guide SNP markers, identified 12 markers associated with various resistance traits, potentially representing new resistance genes. One guide marker (Vf-Mt1g014230-001) on chromosome III validated a known QTL. The guided marker approach successfully complemented the GWAS. Marker-assisted selection for Ascochyta resistance hinges on transferring genetic results among faba bean populations and saturating QTL-bearing regions. The Göttingen Winter Bean Population may serve as a valuable source for resistance breeding against Ascochyta blight. This research contributes to climate change resilience in agriculture by enhancing faba bean crops' resistance to Ascochyta blight.

Morphological and Bioinformatic Analysis for Improving Resistant Starch in Wheat (*Triticum aestivum*)

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Starch is the major storage polysaccharide in wheat endosperm and the ratio of amylose and amylopectin content in it accounts for the quality of wheat grain. Resistant starch, having high amylose content has potential implications on human health overcoming the various non-communicable diseases including diabetes, obesity, and cancer. In order to identify the target genes involved in starch synthesis, genome wide analysis of *TaSS* gene family in wheat was done which resulted in the identification of 12genes in wheat genome present on chromosome 1, 6 and 7. On the basis of phylogenetic analysis, *TaSS* genes were classified into 4 sub-families i.e., *SSI, SSII, SIII and SSIV*. Gene structure analysis showed that these genes have conserved no. of exons within a sub-family. Moreover, the motif analysis indicated that identified motifs were conserved across all the *TaSS* genes in wheat and recognized as components of the starch synthase catalytic domain. In order to increase RS content in different wheat genotypes, *SSIIa* gene was selected as a potential target of CRISPR/Cas9 mediated genome editing. Screening of 60 local genotypes was done to identify the amylose content in them which resulted in the selection of 4 genotypes i.e., Inqlab-91, Watan, Gold and Sehar for targeted genome editing. Furthermore, tissue culture protocol was optimized, and regeneration efficiency was evaluated in 4 genotypes i.e., Gold 2016, Watan, Sehar and Inqlab. Three factors i.e., genotype, media composition and embryo harvest stage were assessed for their potential in tissue culture. Among these protocols, protocol 2 was found to show higher efficiency at each stage of tissue culture as compared to the protocol 1 for each genotype. Among the 4 genotypes, regeneration efficiency rate with immature embryos was found to be highest in Gold 2016 i.e., 15% as compared to the 13%, 12.5% and 12% in Inqlab, Watan and Sehar, respectively.

Study of Salt Exclusion Mechanism in *Triticum aestivum* Genotypes Under Salinity Stress

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Salt stress affects both agricultural productivity and quality. Elevated levels of salts e.g., Na^{+}, Cl^{-} and Mg^{+2} in the soil can cause water shortage issue as well as can disturb physiological activities of a plant. Wheat, a staple food of Pakistan and many more countries is also pruned to soil salinity. It's the need of the time to enhance salt tolerance in the bread wheat genotypes and to study the salt tolerant mechanism in the wheat plant. Hence the main goal of this research will be the study of salt exclusion mechanism in *Triticum aestivum* genotypes under salinity stress. Four wheat genotypes were used to elaborate salt exclusion mechanism. All these genotypes were sown in pots with 3 salt treatments (100, 150, 200 mM NaCl) and one check (Normal) and with 3 replications under completely randomized

factorial design. Morphological indices e.g., root length, shoot length, root-shoot length ratio, physiological indices e.g., root fresh weight, shoot fresh weight, root dry weight, shoot dry weight, root-shoot fresh weight ratio and root-shoot dry weight ratio and biochemical indices e.g., proline content and N^+/ K^+ ratio were calculated of each and every experimental unit. The data was further analysed under statistical designs (Analysis of variance, mean analysis, and bar graphs) to check the significance of both factors for each trait and to estimate the least difference. Moreover, to interrelate the morphological, physiological, and biochemical behaviour of plant while doing salt exclusion, correlation was applied on the data collected from all indices. For molecular analysis the relative expression pattern of *Triticum aestivum* salt tolerant gene (*TaSTG*) was analysed through RT-PCR. The outcomes came up with the conclusion that germination count after 7 days of sowing can help as an earliest screening tool for salt tolerance. While presence of high strength of association between shoot related morphological traits (length, fresh weight, and dry weight), concentration of proline in per gram fresh sample and Na^+/K^+ ratio declared that these traits could aid to differentiate the tolerant wheat plant from the sensitive, after four weeks of sowing. Also, a tolerant genotype under salt stress down-regulate its *TaSTG* gene to gear up exclusion mechanism. Moreover, the genotypes LU-26, accession no. 10125 and Sehar-2006 were salt tolerant.

Genetic Engineering: A Promising Tool to Control Arthropod-borne Diseases

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Arthropod-borne diseases (ABDs) are highly significant at the human-animal interface, concerning high morbidity and mortality. These diseases spread via arthropod vectors, including Insects (flies, fleas, bugs, and lice) and arachnids (ticks and mites). ABDs are accountable for about 17% of infectious diseases and more than 0.7 million deaths annually. These ABDs occur in higher tropical and subtropical regions of the developing world. Most ABDs are parasitic infections, including malaria, trypanosomiasis, schistosomiasis, chagas disease, leishmaniasis, and babesiosis. The outbreak and re-emergence of highly lethal infectious diseases have increased in the last decades because of climatic variabilities, genetic mutation-based evolution of variant pathogenic and drug-resistant species of existing pathogens, and migration of the human population to novel ecological niches. Horizontal gene transfer is one of the leading causes of new species' development. Various control measures were found insufficient, except genetic engineering, which has been advancing for the last 15 years and involves gene manipulation, recombination, gene silencing, and gene modifications. The endonuclease-containing copies are produced to augment the inheritance of desired traits among the targeted population. The genetic manipulation of arthropods is expanding due to the application of CRISPR/Cas9 technology. Such technology equally applies to the genetic manipulation of vectors and parasites to control them. Various strategies based on CRISPR/Cas9 for interfering with parasite development or damaging the reproductive system of arthropod vectors help block their transmission. Further studies need to be conducted to explore their application at a large scale, ethical concerns, and cost- effectiveness measurement.

Prevalence and Pathology of Marek's Disease in Layers and Layer Breeders in Faisalabad

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The poultry industry is continuously decreasing the gap between demand and supply of meat in Pakistan. There is distinct increase in poultry production; quantity and quality wise by shifting towards environmentally controlled poultry production houses. There are multiple barriers in the way of sector's development including neoplastic diseases, encounters with severe economic losses in poultry industry. Among neoplastic diseases, Marek's disease is a major viral neoplastic disease that affects all age groups of birds and is present throughout the world. Present study was designed to investigate the prevalence and pathology of MD in layer and layer breeder in Faisalabad. Molecular diagnosis of MD virus and its correlation with gross microscopic pathology by using Polymerase Chain Reaction (PCR). Total 951 samples were collected from different sheds of Faisalabad Division through simple random sampling technique. Gross lesions of Marek's disease were enlargement of spleen, liver, and kidney. Diffused and nodular lesions were found on liver spleen, kidney. Enlarged and discoloured sciatic nerve was found in some cases. For histopathology liver, spleen, kidney, and sciatic nerve were collected in 10% neutral buffered formalin and processed. Histopathology showed T-cell lymphoma in PCR positive samples. The DNA was extracted using DNA Purification Kit and PCR performed by targeting the meq gene (314 BP). Based on PCR performed, out of 951 samples 18.93% were found positive. Out of 951 samples 20%, 16% and 12% prevalence were recorded in district Faisalabad, Jhang and Toba Tek Singh respectively. Highest prevalence was found in tehsil Chak Jhumra (25%), while lowest was found in Gojra (11%). Based on shed type, 23% prevalence was found in open type of housing. Based on flock size, 26% prevalence was found in 20001-30000 group. Highest prevalence 27% was found at 11-20 and 31-40 week of age. Based on type of birds, 34% prevalence was found in non-descript birds. In winter, 26% prevalence was recorded.

Salivary Glands of Tick are Capable of Inducing Extracellular Vesicles but Contain Fewer Proteins than Salivary Vesicles

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Saliva enhances the feeding of ticks, thereby playing an important role in transmission of pathogens by ticks. Saliva of ticks has been studied extensively in recent past to analyse its inner contents. In addition to pathogens, miRNAs and proteins, extracellular vesicles have also been identified in tick saliva. In our previous study, proteomics as well as transcriptomic analysis of tick salivary vesicles was carried out. As saliva is the chief product of salivary glands, therefore, it is quite interesting to check whether the salivary glands of tick are capable of secreting extracellular vesicles too? This study was

therefore, carried out to examine the salivary glands of ticks for the secretion of vesicles. Moreover, a comparative analysis was generated between proteins identified in vesicles isolated from saliva as well as salivary glands. Interestingly, it was observed that the salivary glands of tick, *Haemaphysalis longicornis* are capable of inducing vesicles. Proteomic analysis revealed a total of 287 proteins in salivary glands induced vesicles. Salivary glands induced vesicles were rich in skeletal proteins, heme proteins, and structural proteins. Comparative analysis revealed that tick salivary vesicles are much more abundant in proteins as compared to salivary glands induced vesicles. The findings are preliminary and suggest further investigation to gain insight into the role of tick-derived vesicles in pathogen transmission and biology of ticks.

Detection of Bacterial Biofilms Thriving on Plastic Waste for Degradation

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Plastics are ubiquitous in our natural environment. They are becoming part of the Earth's fossil record. Plastic bags produced are not decomposed and remain for centuries in soil that results in reduction of productivity of farmland. With increase in plastic consumption, demand elevated and is negatively impacting the Earth. Despite extensive research on plastic degradation, little attention has been given to the dumping sites on terrestrial land which contains microbial biofilms involved in plastic degradation. This research investigated the bacterial biofilms of plastic dumping sites between twin cities by collecting ten samples from various locations, yielding 8 isolates that were subjected to biochemical and morphological testing. Isolates were further analysed for their biochemical, anti-biofilm activity, and plastic degrading activity and later 16s RNA sequencing was performed. Biochemical tests revealed that these isolates as oxidase, catalase, gram positive and negative cocci. Molecular tests revealed that among these biofilms contains strains of *Pseudomonas*, *Acinetobacter baumanni* and *Acinetobacter guillouiae*. These strains involved in biofilm formation that degrade plastic. These strains are bacterial biofilms possess plastic degrading genes, making them potential candidates for genetic engineering in plants, particularly for addressing plastic pollution issues in the environment. In addition to this, by manipulating these bacterial communities, the rate and extent of plastic degradation can be enhanced. Further research may explore the changes in plastic associates with specific bacterial taxa, degrading capacity, and detection of degradation products, microbial strains, and enzyme responsible for degradation and associated genes.

Using Nano and Genomics-Based Technologies to Combat Post-Harvest Pathogens of Fruits and Vegetables

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Microbial infections in fruits and vegetables are the main cause of post-harvest losses resulting in significant economic damages in Pakistan. Substantial advancements have been made at nanoscale in synthesizing nano-based packaging materials that can enhance the shelf life of fruits and vegetables by protecting them against bacterial and fungal infections. Genomics tools can also be applied on bacterial genomes for investigating the molecular mechanism(s) of pathogenicity. Through genome sequencing technologies biosynthetic gene clusters can also be identified in bacterial genomes that encode antibacterial and antifungal metabolites. Thus, the strategies based on nanotechnology and genome sequencing can be integrated for controlling post-harvest losses of fruits and vegetables caused by microbial infections.

Technical Session II

Sustainable Horticulture for Food Security

Oral Presentations

Genetic Basis of Agronomically Important Traits in Tomato and Its Applications in Breeding

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Tomato is the main vegetable crop in the world and the largest vegetable crop in protected cultivation in China. Tomato is also a model plant for botanical research and fruit biology. The genetic basis of important traits of tomato was deciphered, and the genetic variation of important traits was also identified. For example, the 3-bp Findel in the promoter of the *ALMT9* gene is the causal variation for tomato fruit malate. Based on genetic variation and genomic information, molecular markers and genomic markers were developed and applied to tomato molecular breeding. The Presentation will include genetic analysis of several important traits, molecular breeding technology and new variety breeding. And the future of breeding by genome design in tomato will be discussed.

Integrating Precision Agriculture Technologies to Increase Sustainability of Valuable Horticultural Crops

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Precision agricultural technologies (PAT) are well recognized as novel tools to enhance sustainability, profitability, and productivity of high value horticultural crops. High-value horticultural crops are suitable targets to implement PAT due to high economic return rates. PA interventions can responsibly reduce the cost of production without compromising quality and yield potential. High-value horticultural crops play a critical role in global food security due to their nutritional and economic significance. However, their production is often constrained by resource limitations, environmental concerns, and fluctuating market demands. The conventional use of agricultural inputs results in ineffective functioning and uneconomic output. PA involves the precise application of agricultural inputs, such as water, fertilizers, and pesticides, in response to spatial variability within a field. Yield variability is caused by the spatial distribution of different soil properties. Identification and characterization of growth parameters and yield limiting factors due to soil variability is an important aspect of employing PAT. Variable rate fertilization and irrigation involve applying nutrients and water to crops in a site-specific manner. These techniques utilize data-driven insights to adapt the distribution of fertilizers and water, optimizing resource use and promoting healthier plant growth. Variable rate fertilization and irrigation contributes to increased yields, reduced environmental impact, and more sustainable agricultural practices by addressing spatial variability within fields. VRT holds the promise of not only meeting the nutritional needs of a growing population but also ensuring the resilience and adaptability of farming practices in the face of changing climates and resource constraints. The application of PAT within the field of horticulture showcases a potentially effective strategy for achieving enhanced production and farm profitability, it emphasizes on the significance of achieving an ideal balance among these elements to promote sustainability. Sections of this paper comprehend a review on the utilization of PAT in diverse horticultural contexts specifically for fruit and vegetable crops under rainfed conditions.

Key Technologies for The Sustainable and Healthy Development of Citrus Industry

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Citrus is the largest fruit crop in the world, and the nutrients it provides play an important role in keeping human beings healthy. However, the development of the citrus industry is currently faced with some problems such as disease prevalent, different quality, and a decline in orchard profit. From a comprehensive analysis, the lack of labour leading to inadequate management is the main reason for the various problems in the current industry. For this reason, we have developed some simplified and high-quality cultivation techniques from the establishment of the orchard, soil management, water and fertilizer management, tree blossom and fruit management, pest management, etc., to ensure that the orchard managements can be completely implemented in the case of insufficient labour force, then to reduce costs and improve the fruit quality, which will promote the sustainable and healthy development of the industry, and in the end meet the people's demand for citrus.

Near Freezing Temperature Alleviate Peach Chilling Injury and Improve Aroma Quality During Postharvest Storage

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To alleviate the chilling injury (CI) of peach fruit, the effects of near-freezing temperature (NFT) (-1.2 ± 0.1 ℃) on reducing the CI and aroma loss were evaluated. NFT significantly inhibited the flesh internal browning (IB), maintaining the ability of normal ripening during the shelf-life after cold storage. Meanwhile, NFT decreased the MDA content and accumulated high content of AsA and GSH by increasing antioxidant enzyme activities and transcription of key genes of AsA-GSH cycle. In addition, the transcription of several *PpPPOs, PpPODs* were inhibited by NFT, conversely compared with the induction of *PpSODs*. The content of C6 compounds, esters and lactones derived from fatty acids were elevated dramatically than fruits kept at 0℃ and 5℃. Correspondingly, the transcript levels of *PpLOX1, PpHPL1, PpADH1* and *PpAAT1* were induced significantly. NFT increased the chilling tolerance and kept aroma quality in peach fruit by keeping the ROS metabolic balance via regulating activities of related enzymes and expression level of genes.

Role of *BrSDG8* on bolting in Chinese cabbage (*Brassica rapa*)

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Bolting is an important event in Chinese cabbage to transition from vegetative growth to reproductive growth and is regulated by a complex gene network and epigenetics (e.g., histone methylation), and flowering transition targeting *FLC* is closely associated with epigenetic modifications. Unripe bolting can seriously affect the formation of leafy head in Chinese cabbage leading to low yield and quality, therefore, it is of great significance to find out the molecular mechanism of bolting, and then to intervene in the unripe bolting. Two early bolting mutants *ebm5-1* and *ebm5-2* were created and screened in previous work, and further studies showed that the mutation of histone methyltransferase gene *BrSDG8* was responsible for the trait of early bolting. Transcriptomic sequencing, Western blot and ChIP-PCR will be used to identify the downstream target genes and decipher their biological processes, as well as the effect of histone modification on bolting. The research results will help to reveal the epigenetic regulation mechanisms of Chinese cabbage bolting and flowering and provide new genetic resources for the cultivation of Chinese cabbage varieties.

Innovative Technologies for Sustainable Urban landscape

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Landscape was based on cultural and spiritual trends. It is shifting from spiritual foundations to contemporary designs. Historically, in the developed world, aesthetic gratification remained a dominant consideration. Prioritizing the functional capacities of physical features in landscape design is a result of the rise in popularity of global environmental issues. Incorporating eco-friendly practices, such as landscaping in a way that conserves natural resources, is at the core of contemporary trends in landscape design that focus on sustainability and conservation. There are initiatives underway to encourage local flora and discourage exotics. Examples shown include conserving water, adding drought-tolerant plant species, and even use of organic pot instead of plastic or clay pot. Additionally, these projects have received encouragement from global initiatives like "Mix it Up" and "Edible Landscape," which encourage cultivating edibles alongside ornamentals to preserve biodiversity and increase urban productivity. Traditions and culture have always had an impact on how decisions are made about designing a landscape, but as environmental concerns have become more prevalent, modern trends like vertical, green wall, layered landscaping, green roofs, and diverse land use for things like spiritual, cultural, and functional gardens by use of organic products in landscape design have been a success.

Establishing Horticulture Value Chains: Key Learnings from Case Studies of Pakistan

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Worldwide, horticultural crops offer manifold opportunities and benefits compared to other crops, due to their intensive nature requiring more inputs, labour but providing high returns. It is an excellent choice for small holders with limited resources, but there are numerous challenges in establishing value chains from crop production to marketing. Over the last 15 years, through various internationally funded projects, there has been lot of work done in Pakistan, to understand and overcome various challenges including socio-economic and technical in developing and demonstrating horticulture value chains for small and medium growers of fruits and vegetables. These projects included Australian (ACIAR) funded mango, citrus, and vegetables value chains, along with EU/UNIDO funded Codes of Practice. This presentation explains the approach used for value chains development including team building, R&D backup, involving small holders, walk the chain activities, cluster development, monitoring supply chains, market linkages, capacity building, pilot demonstrations and sustainability etc. Few examples are given as how growers learned to establish their enterprises and commercial value chains of horticultural crops, which would be a good source of learning and inspiration for stakeholders especially in developing countries.

Preservation, Domestication, and Value Addition of High-Value Medicinal Plants in Gilgit Baltistan, Northern Pakistan

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The pristine region of Gilgit Baltistan, located in Northern Pakistan, is widely recognized for its diverse collection of approximately 600 medicinal herbs and shrubs, many of which are currently facing the threat of extinction. The presentation during the Forum will highlight the critical importance of preserving and cultivating these valuable medicinal plants while actively involving local farmers in their cultivation. Gilgit Baltistan is home to a rich variety of medicinal plants, which have been valued for their healing properties in both traditional and modern medicine. These plants hold significant economic potential. For example, the indigenous wild garlic can fetch high price in national markets. Furthermore, species like Sea Buckthorn, Buckwheat, Black Goji Berry, and the Rhodiola plant exemplify untapped economic opportunities. This presentation explores strategies to protect endangered species and promote their domestication. This involves conserving their natural habitats and adopting responsible cultivation practices to meet the growing demand. Engaging local farmers in the cultivation of these endangered species is of utmost importance. The aesthetic aspect of these plants, especially their blossoms, is a compelling incentive for cultivation. Additionally, the significance of educating farmers on cultivation techniques and value addition will be discussed. Drawing from China's success in producing over 150 products from Sea Buckthorn, this abstract will share valuable insights on economic viability. This presentation will emphasize the transition from unstructured harvesting methods to a professional approach, ensuring the preservation and improved utilization of precious, rare, and valuable plant species in Gilgit Baltistan. The presentation will discuss the urgent

need to preserve and cultivate the valuable medicinal flora of Gilgit Baltistan. The potential economic and environmental benefits are substantial. Professional harvesting and cultivation may ensure sustainable utilization of these species for future generations.

Breeding and Industrial Development of Tree Peony and Peony in China

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Tree peony is a famous traditional flower with high ornamental, edible and medicinal values. In addition to its cultural attributes, it also has a very high economic value. Tree peony industry is developing rapidly in China, especially the cut flower of peony, which is popular these years. However, short flower period and flowering only in spring, and lack of novel cultivars with special flower structure and colours dramatically limited the development of peony industry. Based on this, we collected resources of wild and cultivated germplasms, cultivated new varieties with special colours such as yellow and orange using distant hybridization. We also established an accurate flowering regulation technique to make the tree peony bloom in any time of a year. We have realized a complete set of industrial processes, from resources evaluation, cultivation, breeding, postharvest, product and also application in rural revitalization.

New Horizons in Modernizing Agriculture of Pakistan under BRI

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The history of trade between China and Indo-Pak goes back to ancient times through the silk route. During the era of modern Chinese civilization Belt and Road Initiative (BRI) is making new development and creating tremendous opportunities for the world to come together. Under BRI the revival of the old silk road as China Pakistan Economic Corridor (CPEC) has its own importance by linking China with Gwadar port and beyond. The trade between China and Pakistan has always remained in a negative balance favouring China. Accordingly, it's a dire need of time that relevant institutions of Pakistan must rise to the occasion particularly professional universities to make certain advancements in R & D and to develop products surpassing the standards of Chinese consumers to reduce the trade deficit among the two countries. Competing China in industrial products development will not be easy for any developing countries so do with Pakistan. However, exporting non-competing agricultural products from Pakistan to China could be a relatively an easy equation to boost exports. Opportunities in agricultural sector collaboration are vastly available to work synergistically, especially in tropical and temperate crops. The prime objective of this initiative will be to develop four CPEC Regional Centres of Excellence in Agricultural Development (RCEAD) in all four provinces of Pakistan under CATAS (Chinese Academy of Tropical Agricultural Science) and CAAS (Chinese Academy of Agricultural Sciences) to modernize agriculture and to ensure the availability of

agricultural/horticultural produce in both China and Pakistan markets round the year. CPEC-RCEAD will provide infrastructure, scientific exchange of human resource, germplasm sharing, technology sharing for R & D activities and expansion of agriculture/horticulture sector of both countries in times to come.

Revitalizing Grape Production: Opportunities and Challenges in Pakistan

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Grapevine (*Vitis vinifera* L.) is among the top fruit crops and China leads in terms of production worldwide. Most of the commonly cultivated varieties in Pakistan belong to *V. vinifera* but *V. jacquemontii* and *V. parvifolia* are also available. However, most of the cultivated varieties have been imported from the USA, Italy, Turkey, and Iran. There are no locally developed varieties in Pakistan. As far as the recent reports, Pakistan lacks research advances related to breeding new germplasm. Production of grapes in Pakistan is following a declining trend due to multiple aspects, for example, production technology, processing, storage, and marketing. The lack of improved commercial varieties is the most important factor directly affecting grape production in Pakistan. After the exchange of exotic species and genera, this issue can be resolved by developing locally adaptable grape cultivars. Regarding this, China is rich in grape germplasm resources; more than 35 Vitis and 40 wild species have their origin in China. The exchange of germplasm and joint breeding programs can uplift the viticulture industry of Pakistan.

Technical Session II

Sustainable Horticulture for Food Security

Poster Presentations

Effect of Bio-stimulant Preservatives on Shelf Life and Quality of Gladiolus Cut Flower cv. Red Magma

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Gladiolus (*Gladiolus grandifloras* L.) belongs to the family Iridaceae and is one of the important cut flowers. It is used for adornment and decoration in the by floriculture industry. In the cut flower industry, one of the most pivotal factors for customer satisfaction is the vase life and quality of flower. Many chemical preservatives have been used to extend the vase life, but they are not environment friendly. This study was conducted to compare different concentrations of neem leaf extracts as bio stimulant and calcium chloride as a chemical preservative to check the vase life of Gladiolus cv. Red Magma. Two concentrations of neem leaf extract (NLE), and $CaCl_2$ solution were used 2%, 4%, and 50 mgL^{-1},75 mg L^{-1}, respectively. While 4% sucrose was added in each treatment including control. The experiment was comprised of 5 treatments having three replications. The result revealed that neem leaf extract 4% + sucrose 4% showed significant results among all treatments. The maximum vase life (9 days), high number of open florets (4.6), lower number of closed florets (-6.3), maximum weight gain (69 g), maximum water uptake (147.6 ml), extended flower quality (7.6), least termination symptoms(0), maximum change in EC (0.06 mS cm^{-1}), maximum change in pH (2.6) of vase solutions, delayed petal abscission (6.64 days), high dry weight (4.36 g), least bacterial count (0.63 CFU), high change in spike diameter (0.56 cm), maximum change in spike length (3.8 cm) and high blooming percentage (82.2%) were observed in vase solution containing neem leaf extract 4% + sucrose 4%. While control (distilled water + 4% sucrose) gives minimum values in all cases. Thus, it can be concluded that neem leaf extract can be used as an alternative floral preservative as it enhances the postharvest longevity of cut gladiolus spikes.

Mitigation Effect of Heavy Metal on Growth and Physiological Attributes of African Marigold

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African marigold (*Tagetes erecta* L.) is an annual flower crop produced globally for its aesthetic and landscaping industry value. The present study investigated the mitigation effect of heavy metals on growth and physiological attributes of selected medicinal plant. The effect of different concentration of copper and cadmium on the growth and the physiological parameters such as plant height, shoot and root dry weight, photosynthetic rate, transpiration rate and stomatal conductance of African marigold were examined in this study. The pot experiment was performed at Lalazar Nursery of the University. Seven treatments along with control and various concentration of $CdCl_2$ (30 ppm, 50 ppm), $CuSO_4$ (40 ppm, 80 ppm) and two combinations of both metals were applied after four weeks of seed germination. The experiment was conducted in Completely Randomized Design with three replications per treatment. Plants were harvested after six weeks of treatments. The findings indicated

that negative results were obtained by applied copper and cadmium that decreased the content of dry matter in the roots and shoots and physiological parameters compared with the control. The combination of both metals had severe effect on the growth and physiological parameters of plants as compared to applied single metal in soil.

Effect of Biochar on Growth and Development of Money Plant

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Money plant (*Epipremnum aureum* L.) is a popular decorative foliage indoor plant. Soilless substrates, which are often made of a combination of organic and inorganic materials, are crucial for encouraging optimal growth and for providing structural support to increase the effectiveness of growing indoor plants. Small amount of biochar can be added to soilless substrates to improve fertility, increase plant nutrients, improve water retention, balance pH levels, and lessen nitrogen leaching. Experiment was carried out according to Completely Randomized Design (CRD) with six treatments having three replications and there are five plants in each treatment. Treatment concentrations of biochar viz garden soil (100%), garden soil 49.75% + leaf manure 49.75% + biochar 0.5%, garden soil 49.50% + leaf manure 49.50% + biochar 1%, garden soil 49.25% + leaf manure 49.25% + biochar 1.5%, garden oil 49% + leaf manure 49% + biochar 2.0% and garden soil 48.75% + leaf manure 48.75% + biochar 2.5% were used. Silt was used as a control. ANOVA was performed at 95% level of significance and Least Significant Difference (LSD) test was carried out for mean comparison. The results showed the highest mean value of leaf area (36.6 cm), number of shoots (5), plant height (35.48 cm), number of leaves (34.33), stem diameter (5.75 mm), leaf fresh weight (52.66 g), root length (15.33 cm), number of lateral branches (4.33), plant quality (9.16), chlorophyll contents (0.56 $\mu molm^{-2}$), water holding capacity (62%), bulk density (1.92 gcm^{-3}), pH (6.4), electrical conductivity (3.9 $Ms\ cm^{-1}$), porosity (70%), total available nitrogen (7.12%), total available phosphorus (3.38%), total available potassium (4.75%) and organic matter content (39.52%) in garden oil 49% + leaf manure 49% + biochar 2.0% treatment.

Effect of Exogenous Application of Thiamine as Foliar Spray on Carrot under Drought Stress Conditions

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Carrots (*Daucus carota* L.), among the most important root vegetables in the Apiaceae family, are cultivated worldwide. Thiamine participates in the processes underlying plant adaptations to certain types of abiotic and biotic stress, mainly oxidative stress. A pot experiment was carried out in the Old Botanical Garden at University of Agriculture, Faisalabad to analyse the influence of exogenously applied thiamine as a foliar spray on growth and yield in relation with different physio-biochemical

parameters, antioxidant activities, and osmolyte accumulation in carrot plants grown under control (100% field capacity) and water stress (60% field capacity) conditions. Drought stress markedly decreased plant growth, grain yield, leaf photosynthetic pigments, total phenolic content, total soluble proteins, leaf water potential (Ψ_w), leaf turgor potential (Ψ_p), osmotic potential (Ψ_s), and leaf relative water content, while it increased the activities of enzymatic antioxidants and the accumulation of leaf ascorbic acid, proline, glycine betaine, malondialdehyde, and H_2O_2. However, foliar spray with thiamine mitigated the deleterious effects of water stress on growth and yield by improving the Ψ_w, Ψ_s, Ψ_p, photosynthetic pigments, osmolytes accumulation and the antioxidative defense mechanism. The results revealed that exogenous application of thiamine was effective in increasing the tolerance of carrot plants under drought stress in terms of growth and grain yield by regulating plant-water relations, the antioxidative defense mechanism, and accumulation of osmolytes, and by reducing the membrane lipid peroxidation.

Comparison of Essential Oil Extraction Techniques in *Rosa centifolia*

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The woody perennial blooming plant *Rosa centifolia* belongs to family Rosacea and is considered as the queen of flowers. In current investigation, essential oil was extracted by using two different methods as treatments viz. Hydro and steam distillation, respectively. The experiment was laid out using a Completely Randomized Design (CRD) and each treatment was replicated three times. Each sample (replication) contains 10 kg petals of *Rosa centifolia* in Hydro and steam distillation. The quantity (yield) of extracted essential oil for both extraction methods was recorded. The results showed the quantity of concrete oil 2.67 gm and 1.45 gm and quantity of absolute oil 1.43 gm and 0.73 gm through hydro and steam distillation, respectively. The extracted essential oil was analysed through gas chromatography for its characterization and chemical constituents. Both methods (treatments) were compared on the basis of oil yield and quality in terms of its various constituents. It is concluded that Hydro distillation gives better yield as compared to steam distillation method. However, the quality of essential oil of *Rosa centifolia* was better when extracted through steam distillation method compared with hydro distillation.

Effect of Different Growing Substrates on the Growth and Flowering of Carnation cv. Clove Pink

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Carnation (*Dianthus carophyllus* L.) belongs to the family *Caryophyllaceaae*. It is herbaceous plant that is native to the Mediterranean region. Potting media plays a vital part in the growth and flowering of carnations. Optimal growing medium gives the plant stability and serves as a reservoir for nutrients and water. Hence, the aim of the study was to evaluate the quality of Carnation cv. 'Clove Pink' grown in different potting substrates. Four treatments as T_0: silt (100%-control), T_1: press mud + silt (50:50), T_2: peat moss + silt (50:50), T_3: coco coir + silt (50:50), and T_4: leaf manure + silt (50:50) were used. According to results, the T_2treatment showed best result in term of maximum plant height (39.62 cm), number of leaves per plant (223), number of branches per plant (16.34), stem diameter (10.28 mm), bud diameter (10.71 mm), plant fresh weight (59.62 g), plant dry weight (14.54 g), days to 1st flowering (171.96 days), number of flowers per plant (12.96), fresh weight of flower (0.97 g), dry weight of flower (0.39 g), flower diameter (39.12 mm), flower quality (6.48), leaf temperature (32.52°C), leaf photosynthetic rate (23.21 μmol m^{-2} s^{-1}), stomatal conductance (0.17 mmol $m^{-2}s^{-1}$) and leaf transpiration rate (0.44 mmol m^{-2} s^{-1}) compared with other treatments. Minimum values of all parameters were noted in control media due to poor chemical properties and less availability of nutrients.

Integrating Phenology, Physiology and Fruit Quality Approaches for Sustainable Viticulture Production Systems

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Climatic variability has affected the sustainability of global grapes production systems as it adversely affects grapevines phenology, physiology, and fruit quality. This implies that many of the traditional viticulture zones would not remain suitable for superior quality grape production. The aim of this study was to explore an integrated approach coupled with crop growth models to quantify the effect of environmental variability on vine development and fruit quality. Four commercial grapevine cultivars; Perlette, Sugraone, King's Ruby and NARC Black were selected after a detailed survey of vineyards in Pothwar region of Pakistan. Data regarding key growth stages (budburst, 5 leaf, bloom, berry set, veraison/colour change, and harvest), vine physiological activities (photosynthesis and water use efficiency) and sugars percentage were recorded at Islamabad and Chakwal vineyards 2019 and 2020 vintages. The results indicated that vine developmental stages were attained earlier with

higher sugar (up to 8%), lesser photosynthetic activity (up to 31%) and WUE (up to 29%) for the hotter site Chakwal than Islamabad. The length of growth period; budburst to harvest was longer (up to 21 days) for the relatively colder vintage of 2020 with higher photosynthetic activity (up to 12%) and WUE (up to 13%). Variability among grapevine cultivars e.g., early ripening for cv Perlette (up to 19 days), higher photosynthetic activity (up to 30%) with more sugars (up to 7%) for cv Sugaraone under the varying environmental conditions necessitates site specific vineyard management. The applied crop growth model STICS was able to simulate vine development with good efficiency ranging from 0.73 to 0.94, thus providing an efficient decision support tool for viticulture. The presented integrated approach would help in timely planning vineyard management strategy to avoid abiotic stress and devise adaptation strategies for climate smart and sustainable viticulture.

Comparative Effects of Varieties and Rootstock Age on Success and Survival Rate of Epicotyl Grafting in Mango

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

Zinc Application for Improved Grapes Production in Zhob District, Balochistan: Mitigating Water Scarcity Challenge

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Balochistan, known as the "fruit basket" of Pakistan, particularly for its grape production in Zhob district, faces a significant challenge due to water scarcity. Zinc is a crucial micronutrient for grapes, impacting various growth processes. This research work was carried out at Directorate of Agriculture Research, Zhob to examine the potential of zinc application to alleviate water scarcity while enhancing grape yield. The application of four different zinc levels (control, 10, 20, and 40g Zn per grape vine) yielded promising and statistically significant results. The 40 g Zn treatment exhibited the highest vine yield (25.3 kg), cluster weight (327.23 g), and berry weight (21.3g) while the control treatment had the lowest values (16.2 kg, 202.8 g, and 11.2g, respectively). Moreover, 40 g Zn treatment induced the highest titratable acidity (3.4%) and total soluble solids (TSS) values with the lowest pH (3.75). In contrast, the control treatment had the lowest titratable acidity (2.35%) and TSS value and soluble sugars (1.14 mg g^{-1} FW), while 40 Zn treatment had the highest soluble sugar content (1.81 mg g^{-1} FW). It is recommended that application of zinc in grape cultivation offers promising solution to combat the effects of drought by enhancing grapevine growth and resilience through zinc supplementation for sustainable agriculture and thriving grape industry in this region.

Establishing Nursery for Strawberry Cultivars at Poonch District

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Strawberry is a well-known aggregate fruit. It has an exceptional mouth feel taste with high nutritional characteristics. The quality and vitality of strawberry nursery are primarily contingent upon the climatic conditions prevailing in the area where the runners are produced. The climate in Azad Jammu and Kashmir is conducive to the nursery production of strawberries, yielding high-quality runners of various strawberry cultivars. However, there is currently a lack of standardized guidelines for selecting the transplantation area and cultivating different strawberry cultivars in Azad Kashmir. The present work has been designed to evaluate the runner health of three strawberry cultivars cvs. Chandler, Sea Scape and Tribute in different areas of Poonch district. The experiment was laid out in randomized complete block design (RCBD) with three strawberry cultivars at three different locations (Chotta Galla, Khai Galla, Hajira). Current study revealed that runner production was higher in the areas where temperature was low, and flower and fruit production was more in the areas where temperature was higher. It was reported that in some strawberry cultivars, flower and fruit production is source limited and fruit production is directly proportional to fruit/leaf ratio. However, it was

observed that flowering and runner production depends on the temperature of the cropping year. The findings of this study indicate that strawberry plants transplanted in cooler locations exhibit a higher capacity for producing abundant and robust runners. On the other hand, plants transplanted in slightly warmer locations demonstrated superior performance in terms of yield and fruit quality.

Taxonomic and Nutritional Evaluation of *Rubus* Species from Muzaffarabad Division of Azad Jammu and Kashmir

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Genetic diversity of fruit crop species in general and Rubus species in particular are threatened by commercialization which demands to preserve these genetic resources as soon as possible, not only for the long-term survival of these species but also to ensure enough variability for breeding programs. Rubus species are widely distributed throughout the region of Azad Jammu and Kashmir, however, no attempts have been made so far to determine how Rubus species tackle the climate change and adapt successfully under the unfavourable climatic conditions. Therefore, this study was designed to evaluate the taxonomic and nutritional characteristics of Rubus accessions collected from Muzaffarabad Division of Azad Jammu and Kashmir. A total of 530 Rubus accessions were collected from 106 sites. Collected specimens were processed for identification using herbarium sheets. Based on taxonomic studies, a total of four Rubus species were identified i.e., *R. ellipticus*, *R. occidentalis*, *R. niveus* and *R. macilentus*. Results regarding leaf traits of studied species exhibited variation in leaf area, number of leaves per shoot, leaf shape, number of leaf lobes, shape of leaf base, petiole length and petiole thickness, whereas all the species possessed uniform leaf margin (serrate), leaf venation (arcuate) and leaf colour (green). Data pertaining fruit traits exhibited variation in fruit shape, fruit diameter, fruit colour, nature of fruiting, date of fruit setting and number of fruits per shoot. The results regarding nutritional traits of different Rubus species showed variation in total soluble solids, titratable acidity, vitamin C content, total sugars, total phenolic content, total flavonoid content, antioxidant activity and total anthocyanin content. Promising Rubus species, screened out by morphological and biochemical characterization will be further investigated through SSR markers to confirm the genetic variations.

Fruit Quality Attributes in White and Pink Flesh Grapefruit Germplasm

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Varietal screening for fruit quality attributes is the pre-requisite for selection of elite genotypes for diversification and their utilization in citrus breeding programs. Fruit of pink and white flesh

genotypes were collected from the experimental fruit gardens of the institute. Fruit of all genotypes showed spheroid shape with truncate type base shape. Regarding fruit physical attributes, fruit weight and fruit size (FL, FD) were more in S3 (367 g, 89.34 mm, 107.35 mm) followed by 'MJ' while fruit ratio (FL:FD) was more in 'RM'. Grapefruit 'OB' showed seedlessness having 1.60 developed seeds followed by 'FS'. Among biochemical traits, the highest total soluble solids (TSS) contents were recorded in 'R' (8.70°Brix) and RM' (8.63°Brix) while titratable acidity percentage was more in 'SR3'. Sugar acid ratio (TSS:TA) was higher in 'OB' (7.43) followed by 'PR'. Ascorbic acid content was more in 'RB3' (75.34 mg 100 mL^{-1}) and 'FF'. Anthocyanins were markedly higher in 'RM' (0.74 mg 100 mL^{-1}) whereas total sugars were more in 'S3' (8.23%) followed by 'R'. Conclusively, among 18 different genotypes RB3, SR and RM (pink flesh), 'R' 'FF' and 'OB' (white flesh) genotypes were found as potential candidates having better fruit quality attributes. Further screening of these genotypes is suggested for fruit quality attributes across multiple seasons. Moreover, molecular marker assisted screening of the germplasm will be helpful to identify genetically distinct genotypes for future breeding programs.

Aloe Vera Gel as an Innovative Palatable Coating for Preservation of Postharvest Quality and Storage Life Extension of Fruits and Vegetables: An Overview

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Aloe vera, belonging to the Aloe genus, is considered as one of the oldest plant species. The term *Aloe* is believed to have originated from the Arabic word *Alloeh* or the Hebrew word *Halal* both of which refer to a material that has a shiny appearance. The Aloe vera (ALV) gel formulation has a total of 75 constituents, including a diverse range of substances such as vitamins, enzymes, minerals, carbohydrates, lignin, saponins, salicylic acid and amino acids. It has gained significant recognition for its remarkable medicinal properties. ALV gel is used in the cosmetic industry, for the cure of burns and wound healing. Furthermore, it has beneficial properties such as antifungal, anticancer, and anti-inflammatory capabilities. In the past few years, the global demand of ALV gel as a palatable coating for postharvest preservation of fruits and vegetables during storage has significantly increased. The evaluation of its potential use as an eatable film coating for preserving the freshness of fruits and vegetables has become significant in the scientific research. Eatable coatings of ALV gel act as a barrier against external pathogens and enhance the storage life by minimising the gaseous exchange, loss of water, flavours, aroma, and solute passage to the outer layer (cuticle) of fruit and vegetables. The use of ALV gel in postharvest conditions has shown significant outcomes in preserving the physiochemical, phytochemical, and enzymatic attributes and extending the storage life of various fruits and vegetables. It effectively delays the production of ethylene, respiration rate, enzymatic browning, chilling injury, microbiological spoilage, disease incidence and decay. Additionally, ALV gel contributes to improve marketability and eating quality throughout the storage and transportation processes. Thus, the use of ALV as an innovative and promising palatable coating exhibits a feasible alternative to the current practice of synthetic preservatives or chemicals to extend the shelf and storage life of fruits and vegetables by preserving overall quality throughout the postharvest storage and supply chain.

Physical and Nutritional Diversity Among Commercial Grapefruit Varieties in Pakistan

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Grapefruit (*Citrus paradisi*) is a familiar specie of genus citrus, and its name was given due to bearing habit in the cluster just like grapes. Grapefruit is the most widely used species, including pigmented and non-pigmented varieties. Because of their absence of pigmentation, non-pigmented grapefruit was also known as a white group. Grapefruit juice is one of the relatively low-calorie fruit juices. 100 ml of grapefruit juice contains an average of 39 kcal. Like other citrus juices, it is rich in organic acids, the main of which is citric acid (0.8-2 g 100 mL^{-1}). The aim of this work was to determine fruit quality parameters of grapefruit like as fruit weight, peel weight, seed number, fruit firmness, total titratable acidity, ascorbic acid, total soluble solids, pH as well as its phytochemicals. There was a need to compare the nutritional value of commercially grown grapefruit varieties to assess the variation of bioactive compounds in locally available genotypes (Flame, Frost Marsh, Marsh Seedless, Rio Red, Shamber, Ruby Red, Star Ruby, Pink Ruby, and Red Blush). Fruit weight and peel thickness were higher in Marsh Seedless respectively, (382.78 g) and (4.72 mm) while fruit firmness was higher in Red Blush (11.34 N). Immature seeds were maximum (2.1) in Red Blush. Ratio TSS:TA was higher in Ruby Red (8.52) and pH was higher in Shamber (3.23). Antioxidants were recorded higher in rag of Flame (40.4%), seed of Red Blush (37.4%), peel of Ruby Red (35.6%), and juice of Frost Marsh (36.5%). Carotenoids were recorded higher in the peel of Star Ruby (36.2%). The percentage distribution of glutathione in juice was higher in Rio Red (28.1%). It was concluded that comparative analysis of pigmented and non-pigmented varieties of grapefruits have much higher genotypic diversification.

Effect of Moringa and Neem Extract on the Shelf Life of Ber at Ambient Temperature

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Jujube (*Ziziphus mauritiana* L.) stands amongst the world's highest-quality fruits, but its short shelf life poses significant challenges due to its perishable nature. The reasons behind postharvest losses in Jujube fruit encompass physical, physiological, and pathological factors. Therefore, an experiment was conducted to assess the potential of moringa leaf extract and neem oil coatings on the quality of ber cv. 'Umran' stored at room temperature. The ber fruits selected for study were healthy, uniform, and mature, harvested from Square No. 32, Institute of Horticultural Sciences, University of Agriculture, Faisalabad. These fruits were subjected to various treatments involving dipping them in aqueous solutions of Neem oil (1% and 2%), moringa leaf extract (1% and 2%) and various combinations such as 1+1% Moringa Leaf Extract + Neem oil and 2+2% Moringa Leaf Extract + Neem oil. The treated fruits

were then stored at ambient temperature conditions (25±2°C with 30±5% relative humidity) for 12 days and fruit quality was compared to control. All treated ber fruits lasted at ambient temperature for 12 days, however untreated ber fruits began to deteriorate after 7 days. Data on parameters regarding fruit length (cm), fruit width (cm), weight (g), weight loss (%), visual quality, disease incidence, decay percentage, marketability, colour, aroma, overall acceptance, total soluble solids (TSS), titratable acidity (TA), ascorbic acid content, TSS:TA ratio and phytochemical content was recorded. Among all the treatments, ber fruits treated with 2+2% Moringa Leaf Extract + Neem oil exhibited similar performance to the untreated fruits. Notably, the 1% and 2% Neem oil treatments outperformed the other treatments in terms of extending shelf life and maintaining fruit quality.

Efficiency of Exogenous Application of Triacontanol on Kinnow Mandarin and China Lemon under Drought Stress

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Abiotic stress factors including temperature changes, salinity, and drought exert a significant impact on plant growth. Among these stressors, drought is a particularly critical global limitation for crop production. Drought stress typically reduces crop yields during vegetative and initial reproductive growth stages by diminishing quantity, size, and quality. Triacontanol, a promising plant growth regulator, holds the potential to increase crop yields and enhance plant resilience to environmental stressors. The current study aims to investigate the effects of triacontanol application under drought conditions on the growth of Kinnow mandarin and China lemon plants in a controlled environment at the Citrus Project, University of Agriculture, Faisalabad. The plants in the study were subjected to three treatments: a control group (no drought stress and no TRIA application), T_1 (0.75 mg L^{-1} TRIA application) and T_2 (1.50 mg L^{-1} TRIA application). Data on several morphological parameters (plant height, plant weight, root length, root weight, leaf count per plant and leaf weight) and biochemical parameters (total antioxidants, superoxide dismutase, peroxidase, and catalase) were assessed to evaluate the role of triacontanol in mitigating the detrimental effects of drought stress. The results revealed that the application of triacontanol had significant effects on all the selected parameters. Specifically, the application of 0.75 mg L^{-1} of triacontanol improved all the morphological and biochemical parameters of Kinnow Mandarin. However, in the case of China Lemon, triacontanol showed less pronounced results with minimal improvements in all parameters.

Triacontanol's Role in Mitigating Drought Stress Effects on Guava

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Guava, commonly known as *Psidium guajava* is a tropical fruit-bearing tree native to Central America and extensively grown in tropical and subtropical regions across the globe. The fruit is renowned for its sweet taste and nutritional value. The scarcity of water is expected to become increasingly crucial in the future and it will have a significant impact on the fruit crops. To address this challenge, researchers have explored the use of Plant Growth Regulators (PGRs) that regulate different aspects of plant growth and development. Triacontanol, a natural PGR present in plant cuticles has demonstrated its ability to enhance plant growth and yield in a range of crops by promoting essential physiological processes. Drought, characterized by prolonged periods of abnormally low rainfall leading to water shortages can severely impede plant growth, development, and productivity. Studies have provided evidence that the application of triacontanol can enhance the resilience of guava plants to drought stress by stimulating root development, reducing water loss through transpiration, and improving key physiological functions like photosynthesis and antioxidant activity. The study conducted aimed to investigate the impact of drought stress on two-year-old guava plants. Data on several morphological parameters (plant height, plant weight, root length, root weight, leaf count per plant and leaf weight) and biochemical parameters (total antioxidants, superoxide dismutase, peroxidase, and catalase) was collected to evaluate the role of triacontanol in mitigating the detrimental effects of drought stress. Among the various treatments, exogeneous application of triacontanol at 1.5 mg L^{-1} exhibited the most promising results in terms of enhancing the plant's resistance to drought and promoting overall growth and productivity.

Mango Nutritional and Biochemical Profiling: Unravelling the Role of Climate and Soil

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Mango (*Mangifera indica* L.) is a tropical fruit that belongs to the family Anacardiaceae. It is widely known for its nutritional value and bioactive compounds notably carotenoids, provitamin A, vitamin C and phenolics. Climatic conditions, such as temperature, rainfall and sunlight exposure can impact the nutritional and biochemical composition of mangoes. Mangoes grown in soil rich in organic matter have higher antioxidant levels. These soil-related factors have a significant impact on the nutritional composition of mangoes. A study was conducted to check the impact of climatic conditions and soil on the buildup of nutritional and biochemical profiles in mango cv. Dusehri and Sindhari collected from Punjab and Sindh. The research aimed to evaluate soil parameters (soil texture, pH, organic matter content and nutrient levels) as well as nutritional (carbohydrates, protein, minerals, fatty acids, lipids, and vitamins) and biochemical (total soluble solids, ascorbic acid content, total sugars, reducing sugars, non-reducing sugars, phenolic compounds, flavonoids, and the DPPH scavenging assay)

profiles of mangoes. The results revealed that different mango cultivars exhibited varying responses to different attributes across different locations. The Dusehri variety performed exceptionally well in Multan, followed by Mirpur Khas (Sindh), whereas the Sindhari variety displayed poor nutritional as well as biochemical profile in Faisalabad. The research highlights the influence of soil and climatic conditions on the nutritional and biochemical profiles of mangoes, with specific varieties showing varying adaptability and performance in different regions.

Deciphering Genetic Variability among Jamun (*Syzygium cumini*) Genotypes of Four Countries (Pakistan, Indonesia, Philippines, and United States)

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Jamun (*Syzygium cumini*) is an evergreen fruit-bearing tree and is native to the Indo-Malayan region. It was introduced to different parts of the world, including the United States of America and Australia, in the early 20th century. Its enormous diversity is evident which needs proper evaluation, documentation, and confirmation. The present study investigated the PCR-based DNA amplification profile of Jamun (*Syzygium cumini*) germplasm from Pakistan and evaluated its relationship with genotypes of United States, Indonesia, and Philippines, by using RAPD and ISSR markers. Cumulatively, 175 bands (100 -2600 bp) were scored, of which 134 were polymorphic corresponding to almost 76% polymorphism among collected Jamun genotypes. When the germplasm of four countries was compared in relation to genetic markers, almost 81% of genetic variability was attributed to differences among accessions while 19% of variation was due to differences between collections. Accessions of Pakistan revealed a maximum polymorphism percentage (92.71%, 73.31%) followed by the United States (89.62%, 68.18%) and the Philippines 67.66%, 71.42%). High PIC (0.389, 0.457) values were observed in Pakistan's Jamun germplasm in comparison to the United States (0.370, 0.387) and the Philippines (0.313, 0.296). Nei's Genetic distance matrix-based cluster analysis and STRUCTURE analysis also confirmed the high diversity of germplasm. The findings of this study confirmed the genetic distinctness of Pakistan's germplasm from other countries with high genetic diversity. The outcome of this study will aid breeders in molecular marker-assisted breeding and better utilization of Jamun germplasm.

Introduction of Elite Exotic Horticultural Crops for Germplasm Diversification and Mitigating Climate Change

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The fruit industry of Punjab is facing many challenges including climate change, stagnant production, declining produce quality, biotic and abiotic stress, narrow genetic diversity, and monoculture. Imports of fruit crops in Pakistan are increasing while exports sharply declined by more than 40 thousand tons during the last decade with 40% less earning of foreign exchange during 2021-2023. These facts highlight a dire need to diversify the existing pool of cultivated fruit crops by introducing potential exotic fruit crops, testing their adaptability under local agroclimatic conditions, and providing potential varieties to the progressive growers. Keeping in view these challenges, the Institute of Horticultural Sciences, UAF took the lead and started a Punjab Agriculture Research Board (PARB) funded project in collaboration with national and international research organizations of China, Australia, and the USA for germplasm diversification in fruit crops along with the introduction of suitable medicinal crops. Under this project, the germplasm of selected fruit crops including citrus, mango, guava, strawberry, longan, jack fruit, dragon fruit, avocado, passion fruit, blackberry, and medicinal crops (black pepper, clove, cumin, caraway etc.) is being imported from renowned international resources, collaborating organizations and is being tested for their adaptability. Under this project germplasm of selected fruit crops has been collected, planted at the experimental fruit gardens as a germplasm unit and multiplied for distribution to the collaborating partners. Awareness seminars and workshops are conducted, and extension articles are being published to enhance public awareness about the potential new fruit and medicinal crops and their production technology. Collectively these efforts will be helpful to widen the gene pool and enhance productivity. The selected elite germplasm may also be useful as parental material for future breeding programs for crop improvement.

Estimation of Phenotypic Variability in Gamma Irradiated Germplasm of Acid Lime Cultivars

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Mutation breeding has favoured crop improvement programs by developing genetically improved germplasm with desired traits like seedlessness, dwarfism, and precocious flowering in major fruit crops. Therefore, the current study aimed to develop irradiated germplasm of acid lime varieties viz. Mexican lime and Eustis limequat grafted on Rough Lemon rootstock to develop genetically diverse

germplasm for future breeding programs. Significant phenotypic diversity was found in the developed gamma-irradiated germplasm. With the increase in the dose of gamma rays (140 Gy), morphological parameters like bud sprouting (35.33%), plant survival (38%), and the number of branches (2.30) were decreased. Similarly, among foliage parameters, the minimum number of leaves (8.80), reduced leaf size (3.86 cm, 2.14 cm), and leaf area (2.07 cm^2) were also noted at higher gamma dose (140 Gy) compared with non-treated control plants. However, leaf thickness increased with the increase in gamma dose and the maximum leaf blade thickness was noted at 140 Gy (0.70 mm). Furthermore, among irradiated germplasm of both varieties, Mexican lime showed better sprouting and growth towards various doses of gamma rays compared with Eustis limequat. Further screening of the developed irradiated germplasm based on physiological and biochemical responses is in process to estimate variability.

Combining Ability Analysis in Hot Pepper (*Capsicum annuum* L.) under Water Deficit Conditions at Seedling Stage

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Hot pepper (*Capsicum annuum* L.) holds significant agricultural importance globally and is cultivated worldwide. In Pakistan, its productivity faces substantial challenges due to various edaphic factors, including temperature fluctuations and drought etc. Consequently, there is a growing need to prioritize the breeding of drought-tolerant and genetically stable genotypes in hot pepper cultivation. This study aimed to investigate general and specific combining ability parameters among genotypes exposed to varying levels of drought stress at seedling stage. Twelve hybrid combinations, comprised of four female lines and three male testers, were subjected to two levels of drought stress, 70% and 40% field capacity, at seedling stage in a greenhouse during the Rabi 2022-23. The experiment was conducted using a triplicated complete randomized design. Data were collected for various seedling parameters, including root and shoot length ratios, root, and shoot dry weight ratios, root and shoot fresh weight ratios, number of leaves per seedling, stem diameter, leaf area, and chlorophyll content. Drought stress significantly reduced seedling traits in all genotypes. CH-321-3 emerged as the most promising general combiner female parent for seedling length, exhibiting the highest positive and statistically significant general combining ability (GCA) values. Among the hybrid combinations, CH-132-2 × YP demonstrated the highest specific combining ability (SCA) effects (9.38) for seedling length under both 40% and 70% field capacity conditions. Regarding leaf area, all hybrids displayed significant SCA effects under normal irrigation, while 12 and 9 hybrids exhibited significant SCA effects under 70% and 40% field capacity, respectively. Notably, all the evaluated traits displayed greater SCA variance compared to GCA variance under both normal and stress conditions, highlighting the prevalence of non-additive gene action. Traits demonstrating high broad-sense heritability under drought stress conditions were identified as valuable candidates for inclusion in future breeding programs aimed at developing drought-tolerant hot pepper hybrids.

Influence of Foliar Application of Moringa Leaf Extract on Morphological Attributes of Lettuce (*Lactuca sativa* L.)

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Lettuce is one of the most important salad vegetables, being a healthy food consumed in large amounts as fresh. It has many essential components and vitamins for human health such as calcium, iron, and vitamin A. The problem of increasing production via synthetic fertilizers, i.e., urea and DAP etc. is hazardous for humans, soil, and the environment. A possible solution would be using organic fertilizer to increase lettuce production. To cope with this issue, moringa leaf extract (MLE) is used to increase the growth and yield of lettuce. The pot experiment was conducted to observe the effect of foliar application of moringa leaf extract on lettuce plants. This experiment was carried out in a completely randomized design (CRD) with five treatments and three replications, each consisting of three pots. The treatments were T_0 (control) water sprayed, T_1 (0.5% MLE), T_2 (1% MLE), T_3 (1.5% MLE), T_4 (2% MLE). The obtained results showed that the increase in MLE concentration improved the attributes. The number of leaves, chlorophyll content, shoot length, root length, fresh weight of shoot, dry weight of shoot, root fresh weight, root dry weight, leaf length, and leaf width were significantly increased with the application of 2% MLE. The results of T_1 (0.5% MLE), T_2 (1% MLE), T_3 (1.5% MLE) were also predominantly improved. The minimum results were obtained from T_0 (control). Hence, it is concluded that moringa leaf extract is a useful growth promoter, has a considerable effect on the growth and development of lettuce cultivars, and is thus recommended for production of the lettuce crop.

High Throughput Soybean Phenotyping with UAVs and Geospatial Analysis

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The crop breeders face various challenges of meeting the nutritional demands of a growing global population through improving genetic traits in crops. The cost of identifying genetic traits in potential breeding lines has been significantly decreased by emerging technologies. However, the time-consuming and resource-intensive field-based evaluation of these traits remains a significant challenge. The research explores the use of Unmanned Aerial Vehicles (UAV) in Soybean breeding programs for high-throughput phenotyping. A semi-automated method developed to generate orthomosaic images and 3D models utilizing a low-cost UAV equipped with a Near-Infrared (NIR) sensor provides a strong correlation between UAV-derived plot-level data and manual measurements. The high-resolution data enabled the development of a grain yield predicted model within the same growing season. The integration of geospatial data will reduce environmental variability and improve data accuracy. The advances enable breeders quickly identify and advance potential soybean lines for varietal improvement program.

Screening of Hot Pepper (*Capsicum annuum* L.) Hybrids for Heat Tolerance Through Morpho-Physiological Characters

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Hot pepper (*Capsicum annuum* L.) is a member of the Solanaceae family and ranks as the third most produced vegetable, following potatoes and tomatoes. Various abiotic factors exert their influence on hot pepper crop at different developmental stages, with heat stress emerging as the most detrimental factor, particularly in the context of climate change. This study primary objective was to investigate the impact of elevated temperature on the reproductive phase of hot pepper plants and identify thermotolerant hybrid. The experiment followed a randomized complete block design (RCBD) with a split-plot arrangement involving two key factors. Twenty F 1 hot pepper hybrids, alongside a standard control, were transplanted into earthen pots and were subject to heat stress. Analysis of variance revealed significant genetic variability among the hot pepper hybrids for heat stress tolerance. Temperature treatment exhibited a significant influence on fruit setting and cell membrane thermostability. Hybrids were assessed for their temperature tolerance based on morpho-physiological parameters, leading to their classification into three categories: tolerant, semi-tolerant, and susceptible. Within the tolerant group, the hybrid CH211- 4 × M1 exhibited the highest thermotolerance, followed by CH211-4 × M10. In the semi-tolerant category, hybrids CH321-3 × M10, CH132-2 × M11, Marvi558 × M15, CH132-2 × M9, CMS × M9, and CMS × M10 were identified, while the susceptible group included the hybrids Marvi558 × M12 and Marvi558 × M13. Correlation analysis conducted under normal temperature conditions revealed a positive relationship between plant height and stem width, internodal distance, fruit dry weight, and the number of fruits per plant. Conversely, under high- temperature conditions, fruit fresh weight exhibited positive correlations with fruit dry weight, the number of fruits per plant, and moisture content. Additionally, fruit dry weight showed a positive association with the number of fruits. These critical morphological and physiological traits hold promise for utilization in future breeding programs aimed at developing heat-resilient hot pepper hybrids.

Effect of Trehalose on Morphological and Biochemical Attributes of Pea Hybrids under Heavy Metal Stress

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The impact of heavy metal pollution on the environment and agricultural systems has become a subject of increasing concern worldwide. Industrial activities, mining, and urbanization have led to the release of toxic heavy metals into the soil, posing a significant threat to plant growth and crop productivity. Among potential solutions, trehalose, a non-reducing disaccharide, has shown promise in enhancing plant tolerance to heavy metal stress. In response to this environmental challenge, a pot experiment based on a completely randomized design (CRD) under factorial arrangements was carried out to investigate the positive impact of trehalose to reduce the effect of heavy metal (cd) on the growth and yield of five pea hybrids (P-13, P-29, P-91, P-97 and P-97c) grown under heavy metal (5, 10, 20 mg kg^{-1}) cd solutions and foliar application of trehalose 10mM was applied with total seven treatments T_0 (controlled), T_1 (5 mg kg^{-1}), T_2 (10 mg kg^{-1}), T_3 (20 mg kg^{-1}), T_4 (10 mM trehalose), T_5 (5 mg kg^{-1} + 10 mM trehalose), T_6 (10 mg kg^{-1} + 10 mM trehalose), T_7 (20 mg kg^{-1} + 10 mM trehalose) in three replications. Different vegetative and biochemical parameters were analysed. Results demonstrated that P-97c exhibited the most significant improvements in plant height, pod length, pod width, pod fresh weight, pod dry weight, pod yield per plant, and leaf area when treated with T_4 (10 mM trehalose). Additionally, P-29 exhibited the highest superoxide dismutase activity (SOD) and dynamic catalase activity (CAT) when subjected to T_7 (20 mg kg^{-1} Cd + 10 mM trehalose). Further analysis revealed that P-97c treated with T_5 (5 mg kg^{-1} Cd + 10 mM trehalose) displayed maximum dynamic peroxidase activity (POD), H_2O_2 content, malondialdehyde activity, nicotinamide adenine dinucleotide phosphate activity, phenolics, and protein activity. Overall, trehalose application proved effective in mitigating heavy metal stress and enhancing pea vegetative growth, offering promise for sustainable agricultural practices.

Response of Chitosan and Salicylic Acid on Fenugreek under Heat Stress Conditions

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Fenugreek is an excellent spice crop due to occurrence of pungent aromatic or distinctive mixture in seeds which give attractive taste to consumers and makes it an extremely favourite addition for the

purposes of cooking in Asia (Pakistan, India, Bangladesh). Leaves of fenugreek are used as a leafy vegetable. Because of global warming heat stress is common and alarming situation affecting agriculture. Leafy vegetables especially fenugreek is very susceptible to heat stress. Keeping in view, current research was carried out to evaluate the impact of chitosan and salicylic acid to mitigate the injurious effects of heat stress on fenugreek. Fenugreek seeds were grown in pots under controlled conditions. The plants were allowed to grow. Heat stress was applied gradually by increasing 2°C daily, finally 40°C was achieved. Foliar application of chitosan and salicylic acid was made by following treatments (T_1 = Control, T_2 =1.5 mM Salicylic acid, T_3 = 1.2 mM Chitosan, T_4 = Combination of T_2 and T_3). Data were gathered based on growth (no of leaves/plant, seedling shoot length, seedling fresh weight, seedlings dry weight and shoot/root ratio), chlorophyll contents, electrolyte leakage, photosynthetic rate, transpiration rate, stomatal conductance and water use efficiency. The experiment was performed according to CRD. This was analysed using standard statistical procedures and techniques. Results exhibited that applications of 1.5 mM salicylic acid and 1.5 mM SA + 1.2 mM CTS can mitigate heat stress in fenugreek plants while also enhancing the growth of plants.

Effect of Growth Stimulants on Plant Growth and Yield of Cauliflower

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This study was planned with the aim to investigate effect of different growth stimulants on growth and yield of cauliflower (*Brassica oleracea* var. *botrytis*). In this experiment, five different growth stimulants (control, Quantis 8 ml L^{-1}, Isabion 4 ml L^{-1}, Seamax 3.3 ml L^{-1}, Moringa leaf extract 3%) were used under RCBD design with four replications. Results showed that Seamax application 3.3 ml L^{-1} produced maximum number of leaves (27.0), leaf fresh weight (738.5 g), highest nitrogen percentage (1.62%), phosphorous percentage (0.14%) and potassium percentage (0.15%). Maximum plant height (28.8 cm), chlorophyll content (51.8 cci) and leaf dry weight (23.76 g), were noticed in Isabion (4 ml L^{-1}) treatment while, maximum leaf length (34.1 cm), maximum curd fresh weight (807.3 g) and total curd yield per acre (8.86 ton $acre^{-1}$) were noted in response to Quantis (8 ml L^{-1}) application. Minimum days to 50% curd initiation (50.0), maximum curd diameter (29.7 cm) and curd dry weight (40.93 g) were observed in Moringa leaf extract (3%). Farmers can use Quantis and Moringa leaf extract (3%) to increase the cauliflower curd yield.

Boron Alleviates Cadmium Toxicity in Watermelon Seedlings by Increasing Cadmium Chelation in Cell Wall and Triggering Antioxidant Defence System

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Cadmium (Cd) is highly toxic heavy metal and its pollution negatively affect plant growth and

development. Boron (B), an essential micronutrient, is integral part of cell wall and helps in alleviation of heavy metal stress in plants. However, little information is available regarding role of B in cadmium stress tolerance particularly in watermelon. In present study, watermelon seedlings were exposed to 0 µM and 75 µM B levels under 50 µM Cd toxicity under hydroponic conditions. Plants exposed to Cd stress showed reduced root and shoot growth, plant biomass and higher H_2O_2 and lipid peroxidation. The application of B improved plant growth and relative chlorophyll content by decreasing Cd uptake, and alleviated oxidative damage by increasing antioxidant enzymatic activity of catalase and superoxide dismutase. B application also significantly increased ionic soluble pectin in Cd affected watermelon leaves that promoted more Cd binding sites in pectin. Results of Fourier-Transform Infrared Spectroscopy (FTIR) spectral showed more pectin and cellulose content in B treated watermelon leaves that enhanced chelation of Cd in cell wall. In conclusion, B alleviates Cd toxicity by chelation of Cd into cell wall and enhancing antioxidant enzymatic activity resulting less Cd uptake and oxidative damage. These results might help in watermelon production in Cd polluted soils.

Alleviation of Abiotic Stresses during Seed Germination in Carrot by Seed Priming

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Carrot (*Daucus carota* L.) is herbaceous biennial crop in Apiaceae family that grows a delicious taproot. In Pakistan, carrot productivity is affected by factors like salinity, drought and extreme temperature which reduce seed germination and lead to uneven seedling growth. Pre-sowing treatments like seed priming can be highly beneficial for uniform germination and superior performance under abiotic stress like salt stress, water stress and elevated temperature. The objective of this study was alleviation of abiotic stresses in carrot seed during germination by seed priming. Seed treatments (Potassium phosphate 0.5%, hydro-priming) were used to prime the carrot seeds for 24 hours and unprimed seeds were taken as control. Primed and control seeds were exposed to different levels of salinity (0, 3, 9.6, 20.6 and 35 dS m^{-1}), water potential (0, -0.15, -0.3 MPa), and temperature (10, 20, 30, 40°C). Under salt stress conditions, germination and growth parameters including final germination percentage (FGP), germination index (GI), seedling fresh and dry weight, root and shoot length and vigour index gave significant results with both priming treatments, while, germination energy (GE), mean germination time (MGT) and time taken to 50% germination (T50) gave significant results with nutripriming. Under drought stress conditions, the germination and growth parameters including final germination percentage (FGP), germination index (GI), time taken to 50% germination (T50), fresh weight and root length of seedling gave significant result with hydropriming and nutripriming while, germination energy (GE), seedling dry weight, seedling shoot length and vigour index (VI) gave significant result with nutripriming and mean germination time (MGT) gave significant result with hydropriming. Under temperature stress conditions, all germination and growth parameters gave significant result with hydro and nutripriming.

Potato Farming in Baluchistan: Impact of Different Planting Methods on Yield

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Potato (*Solanum tuberosum* L.) is one of the most important crops in the world due to high nutritional value and its share in food security. This research was done to assess four alternative planting methods for table potato Kuroda to evaluate their impact on yield components at research farm of Surtal and Khanozai that faces a significant challenge of water scarcity. The efficiency of using nitrogen and water in the commercial potato production system may be improved by switching from furrow potato cultivation techniques to wide bed planting systems. Planting potatoes in wide bed decreases the need of water and nitrogen fertilizer applied through irrigation. It was observed that planting potatoes in plain wide beds may increase the effectiveness of water and nitrogen utilization due to less infiltration in the furrow, which extends beyond the potato root zone. The findings indicated notable outcomes in various aspects of potato growth. The planting of potatoes in large beds covered with soil from single side enhanced yield per hectare (13.5 t ha^{-1}), tuber growth (87.6%), average number of tubers per plant (12.2) and plant spread (46.5 cm). The tallest plants (50.5 cm) were noticed when tubers were planted on ridges. Conversely, maximum occurrence of fresh greenish (10.2) and damaged potatoes (4.2%) was noted when tubers were planted using the local farmers' practice. For greater potato yield in this area, it is advisable to plant the potato crop on levelled wide beds and cover them from one side.

Efficiency of Exogenous Application of Triacontanol on Tomato Plants under Drought Stress

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Tomato is nutrient-rich food consumed worldwide. Drought stands out as a major threat to agricultural output among abiotic stresses. Tomato cultivation is particularly vulnerable to the adverse effects of drought. Triacontanol, a promising plant growth regulator holds the potential to boost crop yields and enhance plant resilience to environmental stressors. To alleviate the detrimental effects of drought, triacontanol (TRIA) was administered to five different tomato varieties cultivated in greenhouses at the Institute of Horticultural Sciences, University of Agriculture, Faisalabad. The experiment involved subjecting plants to three different treatments: a control (no drought stress and no TRIA application), T_1 (0.75 mg L^{-1} TRIA application) and T_2 (1.50 mg L^{-1} TRIA application). Data was recorded regarding morphological parameters (plant height, plant weight, root length, root weight, leaf count per plant and leaf weight) and biochemical parameters (total antioxidants, superoxide dismutase, peroxidase, and catalase). Results revealed that the foliar application of TRIA at a concentration of 1.5 mg L^{-1} improved morphological as well as biochemical parameters. This study underscores the potential of triacontanol as a sustainable approach for enhancing drought tolerance in tomato plants, which has broader implications for sustainable agriculture and food security in the context of climate change-induced water scarcity.

Urban Agriculture and Z-farming: A solution to Sustainable Cities

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In 2050, the world population will reach 9.1 billion, 34% higher than today. Urbanization is expected to continue at an accelerated pace, and the growth rate will be higher in developing countries. Hence, significant challenges are posed, including increased food demands, global warming, and the loss of green spaces. In response to these emerging grave challenges, sustainable urban agriculture practices are a paradigm shift. Although the very idea of urban agriculture is not new, practicing it on rooftops stands out as a climate-smart solution. Rooftop gardening pitches a road towards sustainability as it is a prodigious opportunity to promote a viable microclimate and address food security issues through food production. Urbanization and drastic climate change are two inseparable issues. This study helps in bridging the knowledge gap about how rooftop agriculture contributes to curbing climate change emergencies with population growth and mitigating their effects. Rooftop gardens have multifaceted benefits, including their ability to enhance urban food production, reduce the carbon footprint of food transportation, and promote local food systems. Furthermore, green roofs act as natural insulators, contributing to energy efficiency in buildings while reducing greenhouse gas emissions. This abstract also emphasizes how community driven rooftop gardening initiatives empower residents, foster social cohesion, and address food security issues, particularly in underserved urban communities. This also encompasses the importance of innovative technologies, community engagement, and policy support in realizing the full potential of sustainable urban agriculture on rooftops. By harnessing underutilized spaces, cities can mitigate the impacts of climate change, enhance food security, and create more sustainable and resilient urban environments. In a nutshell, swift and purposeful actions are needed, and rooftop gardening is a holistic and promising strategy to cope with the challenges faced by this urbanizing world and its growing uncertainties.

Effect of Mulching Materials on Growth and Yield of *Cuminum cyminum* L.

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Cuminum cyminum L. is an annual herbaceous plant in the Apiaceae family that has traditionally been used as a medicinal plant in many countries. Cumin is native to Asia or the Eastern Mediterranean. Cumin has been used as a spice for thousands of years. According to Egyptian history, cumin has been used as a spice as well as a preservative for mummification. Spanish and Portuguese introduced cumin to Americans. Today, cumin is mostly grown in Pakistan, India, China, Mexico, and Africa. In the Indo-Pak subcontinent, cumin has been used in many recipes. Its yield is influenced by both biotic (diseases, insects, and weeds) and abiotic (temperature, rainfall, and humidity) stress factors. There are different methods of increasing cumin yield however, mulching is fast and the easiest method. Mulch provides protection from wind, soil evaporation, fog, loss of soil moisture, weeds, and helps to improve the chemical and physical properties of soil. It also helps in promoting an earlier yield of cumin. This study investigates the impact of various mulching materials on the growth and yield of cumin. The research was conducted under field conditions in a randomized complete block design with three replications.

The mulching materials tested included grass (T_1), paddy straw (T_2), corn leaves (T_3), black polythene sheet (T_4), white polythene sheet (T_5) and control (T_0) which received no mulching. The results showed that treatments T_1-T_3 had same effect on cumin growth and yield and showed better result thanT_0, while T_4 and T_5 enhanced cumin plant growth and yield under the given climatic conditions.

Effect of GA_3 and NAA on Growth and Yield of Cumin (*Cuminum cyminum* L.)

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This study aimed to investigate the effects of growth regulators on plant growth in cumin. The treatments included a control (T_0), GA_3 application at 50 ppm (T_1), GA_3 application at 75 ppm (T_2), GA_3 application at 100 ppm (T_3), NAA application at 50 ppm (T_4), NAA application at 75 ppm (T_5), and NAA application at 100 ppm (T_6). Various growth parameters, including plant height, number of branches, number of umbels per plant, number of seed umbels per plant, seed weight per plant, 1000 seed weight, plant fresh weight, and plant dry weight were measured. The results showed that increasing the concentrations of both GA_3 and NAA significantly influenced the growth of cumin plants. In terms of plant height, the highest mean value was observed in T_6 (61.29 cm) compared to control (32.18 cm). Similarly, the number of branches, number of umbels per plant, number of seed umbels per plant, seed weight per plant, 1000 seed weight, plant fresh weight, and plant dry weight showed significant improvement with increasing concentrations of growth regulators. Overall, the findings indicate that the application of growth regulators, particularly NAA at higher concentrations, led to a significant increase in cumin growth and physiological attributes. These results suggest that NAA holds great potential as a plant growth-promoting substance to enhance growth and productivity of cumin plants.

Alleviation of Abiotic Stresses during Germination in Naturally Aged Sesame (*Sesamum indicum* L.) Seeds by Seed Priming

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During storage, seeds of sesame are degraded, lose their viability, become more vulnerable to stress conditions during germination, and eventually fail to germinate. Priming is a strategy for activating seeds before planting that can speed up the rate and percentage of emergence and germination, particularly in stressful environments like salt stress, water stress, and elevated temperatures. The purpose of this study was to alleviate abiotic stresses during germination in naturally aged sesame seeds by seed priming. Seed priming treatments (KCl 1.5%, $CaCl_2$ 2%, MLE 3%, GA_3 50 ppm and hydro-priming) were used to prime the sesame seeds for 16 hours and dry (unprimed) seeds were taken as control. Primed and control seeds were exposed to different levels of water potential (0, -0.2, -0.4 MPa), salinity (0, 2.5, 5 dSm^{-1}) and temperature (10, 20, 30, 40^oC). Results showed that by increasing the levels of salinity and drought and by giving temperature above and below the optimum range, germination parameters of seeds decreased. Whereas primed seeds showed better performance under

increasing stress conditions as compared to control. During salt stress, all the germination characters including final germination percentage (FGP), germination energy (GE), germination index (GI), mean germination time (MGT), time to 50% germination (T50), seedling fresh and dry weights gave overall significant results with halopriming as compared to control. Under drought stress conditions FGP was obtained significant with halopriming ($CaCl_2$), dry weight was highest in haloprimed (KCl) and hydroprimed seeds. However, other parameters gave significant results equally with all priming treatments as compared to control. Under temperature stress conditions, all germination parameters gave highly significant results with MLE priming. Whereas MGT was significant in hydro, hormo and haloprimed (KCl) seeds and T50 was significant in haloprimed (KCl) seeds.

Nano-Stimulants Modulated Essential Oil Yield of Lemongrass by Using Hydro and Steam Distillation Methods

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Lemongrass is a fragrant grass that has significant industrial potential. It is grown for its essential oil, which has a high economic value because of its multiple medical, cosmetic, and culinary uses. The goal of this study was to improve the yield of essential oil and evaluate the effective extraction method of lemongrass essential oil yield by using nanostructured plant growth regulators loaded with silicon nanoparticles (Sodium nitrophenolate and Daminozide) to promote sustainable agriculture. In the present study, different concentrations of sodium nitrophenolate Si-NPs and daminozide Si-NPs, such as (control, 100 mg L^{-1}, 200 mg L^{-1}, and 300 mg L^{-1}) were applied. The experiment was designed using a randomized complete block design (RCBD), and the data were analysed using Fisher's analysis of variance (ANOVA). Tukey's test was used to compare treatment means at a 5% probability level. In the hydro distillation extraction method, T_4 (100 mgL^{-1} Daminozide Si-NPs) showed the maximum essential oil yield, while the minimum was found in T_0 (control). In the steam distillation extraction method, the highest value of essential oil yield was obtained by T_4 treatment, in which (100 mg L^{-1} Daminozide Si-NPs) was applied. In contrast, the lowest value of essential oil yield was observed in T_1 (100 mg L^{-1} sodium nitrophenolate Si-NPs). It is concluded that 100 mg L^{-1} Daminozide Si-NPs significantly improved the essential oil yield of lemongrass plants by using the hydro distillation extraction method.

Effect of Pre-Harvest Foliar Application of Iron Sulphate ($FeSO_4$) on the Growth and Quality Traits of Broccoli

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Broccoli (*Brassica oleracea* L. var. Italica) is an important Cole crop vegetable. The purpose of the present field experiment was to evaluate the response of pre-harvest foliar application of iron sulphate ($FeSO_4.7H_2O$) on broccoli for various growth, yield, and quality parameters. The broccoli cultivars were exposed to iron sulphate comprising of three distinct levels (8 mM, 12 mM, and 16 mM) along with control (Distilled water) in the form of pre harvest foliar spray on two different cultivars of broccoli (cv. Parasol and Marathon). First spray of iron sulphate was applied after 30th day of transplanting followed by 2nd application after 45th day of transplanting of broccoli seedlings. The experiment was carried out according to Randomized Complete Block Design (RCBD) under factorial arrangements with three replications of each treatment and statistically analysed by suitable statistical software and means were compared by LSD test. Results revealed that the exogenous application of (12 mM) was found to be best for increase significantly the plant height (cm), number of leaves, leaf area (cm^2), stem length (cm) and diameter (mm), fresh weight (g) and dry weight (g) of leaves, days to curd initiation, weight of primary (g) and secondary (g) curd, diameter of primary curd (cm), number of secondary curds, yield per plant (g), total soluble solids (°Brix), reducing sugar (%), total sugars (%), non-reducing sugars contents (%), nitrogen (%), phosphorous (%), potassium (%) in the curd of both cultivars of broccoli (parasol and marathon) while in same way the highest total acidity contents (%) was found in (control) in the curds of both cultivars (parasol and marathon). Along with this the cultivars and treatment interaction were also found to be significant. To sum up, the Marathon cultivar of Broccoli responded better against iron sulphate in terms of its physical and biochemical attributes as compared to Parasol. Based on correlation results, yield per plant was significantly positively correlated with various studied growth traits of broccoli such as number of leaves, stem length, stem diameter, leaf area, leaves fresh weight, days to curd, weight of primary and secondary curds. So, it concluded that pre harvest foliar application of iron sulphate can promisingly enhance the growth and quality traits of broccoli.

Use of Biochar Developed from Different Feedstocks at Different Temperatures for Control of Root Knot Nematode in Tomato

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Tomato (*Lycopersicon esculentum* Mill) is one of the most essential crops in our diet that often face a hidden threat below the soil, the root knot nematodes (*Meloidogyne* spp.) which develop galls on tomato roots leading to reduced yields and lower-quality fruits. Traditionally, chemical nematicides were used to control nematodes but these substances harmed the environment and human health. Hence, there is a need to find a more sustainable alternative. Biochar, a form of charcoal made from

organic materials have emerged as a promising candidate for nematode control. In this study, biochar was developed from various feedstocks (wheat straw, maize stalks, green waste, and sugarcane bagasse) at different temperatures (300°C and 500°C) and assessed at different concentrations (1%, 2% and 3% w/w) to combat root knot nematodes. These materials were applied together with nematodes in a pot experiment in a completely randomized design to evaluate their effectiveness in suppressing root-knot nematodes and promoting plant growth. These biochar treatments were also investigated for their physiochemical and elemental properties in addition to *in vitro* nematicidal activity. The results concluded that biochar extracts used in different concentrations did not have any direct nematicidal activity. Similarly, the application of biochar led to enhanced plant growth and reduced the development of the root-knot nematode. The best treatment was sugarcane bagasse biochar developed at 300°C followed by SCB500°C for both the growth enhancement and nematode management. However, it needs to be studied that by which mechanisms biochar application promoted growth and controlled nematodes. Further research is needed to optimize biochar application methods and dosage to maximize its nematode-fighting ability. Additionally, exploring its compatibility with other sustainable practices such as organic farming and crop rotation could lead to even more vigorous nematode management strategies.

Structural Modifications in *Medicago polymorpha* L. Collected from Different Regions of Faisalabad

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Fabaceae is one of the largest families, which includes 765 genera and nearly 20,000 plant species. Members of Fabaceae inhabit a diverse range of habitats like extreme arid conditions, higher altitudes, extreme saline areas, moist habitats, marshes and swamps and precipitous slopes worldwide. *Medicago polymorpha* is a species of the Fabaceae family. Medicago genus is also called medic. Hundred species of plants in the genus Medicago can be found in the Mediterranean to Central Asia. To assess the anatomical characteristics of this species, different samples of *M. polymorpha* were collected from various regions of Faisalabad. Anatomical parameters were root and stem area, epidermal thickness and cell area, cortical region thickness and cell area, vascular bundle number and its cortical region area, lamina thickness, midrib thickness adaxial and abaxial stomatal density and area. The root, stem, and leaf anatomy of a few chosen ecotypes from various habitats were also studied. Sections of the root, stem, and leaves were stained with safranin and fast green. A collection of prepared glass slides was examined under a light microscope. One-way ANOVA was applied on the data using Minitab statistical software (V. 20). Furthermore, multivariate analysis was applied to analyse data to examine the association of characters of different species. Results depicted that root, metaxylem, stem and phloem area were highest in Kaleem Shaheed Park, Edan valley and Bag-e-Jinnah ecotype. While among leaf anatomical parameters, the greatest lamina thickness and midrib thickness was found in Chenab club and Muhammdia Park ecotypes. Meta xylem area and phloem area was highest in Muhammdia Park and Nawaz Sharif Park ecotypes. More stomata were found on the abaxial surface of leaves and less in adaxial surface of leaves. To study comparative anatomy of *M. polymorpha*, the data were subjected to multivariate (cluster) analysis.

F1 Hybrid Seed of Radish Produced by Intraspecific Hybridization

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Intraspecific hybridization has enormous potential to accelerate the process of intensive crop development and improvement. This study was conducted with the aim of production of F1 hybrid seeds of radish through intraspecific hybridization and evaluation of the agro-morphological characteristics of radish germplasm. Ten radish accessions (R-44, R-47, R-50, R-51, R-55, R-61, R-63, R-68, R-80, R-85) and their potential cross-combinations were used in the study, as well as reciprocal crosses. The experiment was laid out in a Randomized Complete Block design along with three replications. The study revealed significant diversity in agro-morphological and biochemical traits among ten selected radish accessions and their hybrids. Notably, inbred line R-80 exhibited the longest days to flowering, while R-61 displayed the highest leaf count per unit and R-50 the lowest. Leaf dimensions varied, with R-47 having the longest leaves (36.00 cm) and R-61 the widest (25.33 cm). R-80 had the shortest leaves (11.33 cm). Root lengths ranged from 17.97 cm (R-55) to 39.33 cm (R-80), while root diameter ranged from 24.42 mm (R-61) to 82.51 mm (R-44). Flower colour diversity was observed, with R-80 displaying dark purple flowers. Taste varied from pungent (R-61) to sweet (R-55). Certain hybrids exhibited purple seed coats, and R47×R51 had the largest seed diameter, with R50×R44 having the highest thousand seed weight (6.52 g). Additionally, R50×R44 showed the longest siliques (7.85 cm), widest siliques (11.67 mm), and the most seeds per silique (7.00). R-68 had the highest total soluble solids (5°Brix), while R-80 had the highest titratable acidity (3.3%). In terms of vitamin C content, R-61 stood out with 0.77 mg 100 g^{-1}. Furthermore, inbred lines R-63 and R-55 had the highest levels of reducing (57.5%) and non-reducing sugars (45.4%), respectively, while R-80 had the highest pH value (6.166). Overall, this study highlights the substantial diversity within the radish accessions and their hybrids, with each excelling in different parameters. The hybridization approach employed in breeding aims to harness hybrid vigour, transfer desirable traits, and create novel phenotypes.

Standardization of Postharvest Handling Protocols for Cut *Helianthus annuus* L.

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Sunflower (*Helianthus annuus* L.) a member of Asteraceae family, is a commercially grown specialty cut flower, which is popular due to its vibrant colours, easy production, and magnificent flowering. Optimal postharvest handling protocols are needed to extend the vase life of cut stems, which are still not standardized for this emerging specialty cut flower. Therefore, a study was conducted to optimize postharvest practices for cut sunflower during 2022-23. Four experiments, viz. harvest stage, harvest time, handling procedures and water quality were conducted to find out best harvest and handling practices for cut sunflower stems. All experiments were laid out individually in completely randomized

design with five replications of two stems each. In expt. 1, stems were harvested at three different stages, viz. closed bud, partially opened and fully opened stage. Stems harvested at partially opened stage had shown longest vase life (8 d), followed by closed bud stage (7 d). Highest water uptake (394 mL) was recorded in fully opened stems. In Expt. 2, stems were harvested at three different times of the day, viz. morning (7-8 AM), noon (12-1 PM) and evening (5-6 PM). Longest vase life (8 d) was recorded in evening harvested stems, followed by morning harvested stems (7 d). In expt. 3, longest vase life (7 d) was recorded in wet-wet (stems kept in buckets containing water from harvest until evaluation in lab.) stems, followed by dry-wet (halfway dry from harvest to lab. but in buckets containing water during processing) stems (5 d). In expt. 4, among different water sources, stems placed in distilled water with 5% sucrose solution exhibited longest vase life (8 d). In summary, cut sunflower should be harvested at partially opened stage at evening for longest vase life, stems should be kept in water from harvest until marketing and may be pulsed with sucrose for enhancing longevity and maintaining quality of cut stems.

Impact of Rhizobacterial Diversity on the Vegetative and Floral Characteristics of Potted *Calendula officinalis* cv. Inca Hybrid

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Calendula officinalis L. which belongs to family Asteraceae is suitable for borders, beds, cut flower gardens, containers and in the cottage garden. Rhizobacterial strains (RBS) have the beneficial effects on growth of plants. RBS solubilized the phosphorus and make available to the plants and increase plant growth and yield. Aim of the study was to evaluate different rhizobacterial strains on potted *C. officinalis*. Eight treatments viz. T_0: Control, T_1: *Pseudomonas sp.* (MN9), T_2: *Bacillus sp.* (AS-53), T_3: *Burkholderia sp.* (PsJN), T_4: *Pseudomonas sp.* + *Bacillus sp.* (MN9 + AS-53), T_5: *Pseudomonas sp.* + *Burkholderia sp.* (MN9 + PsJN), T_6: *Bacillus sp.* + *Burkholderia sp*. (AS-53 + PsJN), T_7: *Pseudomonas sp.* + *Bacillus sp.* + *Burkholderia sp.* (MN9 + AS-53 + PsJN) were compared in this trial which was laid out according to Completely Randomized Design (CRD) with three replications and there were 10 plants in each replication. Best results were recorded in treatment T_7 having a combination of three RBS (*Pseudomonas sp.* + *Bacillus sp.* + *Burkholderia sp.*) for all parameters viz. number of leaves per plant (48.30 leaves), number of branches per plant (11.8 branches), plant height (58.60 cm), leaf area index (19.5 cm^2), stem diameter (11.03 mm), plant fresh weight (74.6 g), plant dry weight (18.35 g), days to 1st bud initiation (76.39), number of flowers per plant (10.8 flowers), flower diameter (75.62 mm), and flower weight (11.3 g) of *C. officinalis* as compared to all treatments. Results of all parameters were less in treatment T_0 in which no strains were applied (control). It is concluded that the application of different rhizobacteria strains improved the growth and flowering of Calendula and can be used by nurserymen to limit synthetic fertilizer usage.

Optimal Pulsing and Vase Preservatives for Extending Postharvest Longevity of Selected Cut Flowers

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Cut flowers are valued products in floral industry for their exceptional traits and striking beauty. However, ensuring their freshness for extended periods and maintaining quality after harvest is imperative to satisfy the discerning demands of consumers. Hence, a study was conducted to optimize the use of preservatives specifically tailored for two geophytes, viz. gladiolus (*Gladiolus* L. hybrids) and tuberose (*Polianthes tuberosa*) and two specialty cut species, viz., aster (*Callistephus chinensis)* and stock (*Matthiola incana*). Two experiments were conducted on the species individually encompassing pulsing and vase solutions. Stems were grown at Floriculture research area following standard procedures, harvested before 09:00 am and transported to Floriculture Lab. Upon arrival, stems lower 2-4 cm ends were recut, rehydrated for 2 hours, and stems were graded based on stem length and flower/inflorescence size and stage of opening and placed in respective treatments. In study I, eleven pulsing solutions were evaluated, where after processing, stems were pulsed with freshly prepared solutions for 24 hours followed by placement in distilled water in jars until termination. Study II focused on testing nine different freshly prepared vase solutions till termination of stems. The stems were placed in an evaluation room at 22±2°C with 50±10% humidity received 12 hours of light from white, fluorescent tubes. Results indicated that stems pulsed with 2% sucrose + GA 100 mgL^{-1} + BA 100 mgL^{-1} + citric acid 300 mgL^{-1} had longest vase life (20.3, 11.8, 8.6 and 7.4 days) in China aster, gladiolus, stock, and tuberose, respectively. Regarding vase solutions, distilled water + 7 UP (66:33) proved best with longest vase life (21.0, 10.5, 10.5, and 8.6 days) in in China aster, gladiolus, stock, and tuberose, respectively. In summary, the studied stems may be pulsed with 2% sucrose + GA 100 mgL^{-1} + BA 100 mgL^{-1} + citric acid 300 mgL^{-1} overnight, while distilled water + 7 UP (2:1) was the optimal vase preservatives for longest vase life and maintaining quality of cut stems of tested species.

Critical Assessment of Fertilizer Overuse in Pakistan's Horticulture Industry and Its Reverberations on Public Health

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The horticulture sector in Pakistan has witnessed substantial growth in recent years, contributing significantly to the country's economy. However, this expansion has been accompanied by a concerning trend of excessive fertilizer use, raising critical questions about its implications for public health. This paper examines the multifaceted aspects of the excessive use of fertilizers in Pakistan's horticulture sector, highlighting the potential risks it poses to human health and well-being. Through

an extensive analysis of data and empirical evidence, this research sheds light on the adverse effects of excess fertilizer application on soil and water quality, subsequently impacting food safety. The paper delves into the pathways through which harmful residues find their way into the food supply chain, posing risks such as contamination of fruits and vegetables with toxic elements. These contaminants, when consumed, may lead to health problems, including acute and chronic diseases. Furthermore, the research explores the broader implications of fertilizer misuse on public health, including the financial burden it places on the healthcare system due to increased cases of pesticide-related illnesses. The study also discusses the environmental consequences, such as water pollution and soil degradation, which indirectly affect public health through compromised access to clean water and food security. In light of these findings, the paper advocates for a comprehensive and coordinated approach involving government agencies, agricultural stakeholders, and public health institutions. It emphasizes the urgent need for stricter regulations, improved monitoring mechanisms, and farmer education programs to promote responsible fertilizer use. By mitigating the adverse effects of excessive fertilizer use in the horticulture sector, this research aims to safeguard public health, ensuring a healthier and more sustainable future for Pakistan. This research offers valuable insights for policymakers, agricultural experts, healthcare professionals, and environmentalists striving to address the intricate challenges arising from the excessive use of fertilizers in the horticulture sector, ultimately promoting a safer and more sustainable food system.

Impact of Gamma Irradiations on Morphological Characteristics and Growth of *Bougainvillea glabra* cv. "Choisy" Cuttings

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Bougainvillea is a versatile, multipurpose landscape plant that can withstand dry conditions and thrive in a variety of climates including droughts. Recently, there has been increasing interest in developing new traits through induced mutations. In this study, we investigated the effects of mutation diversification induced by gamma irradiation on *Bougainvillea glabra* cuttings. The experiment entailed exposing the cuttings to various doses of gamma irradiation to determine its significant influence and observe changes in morphological characteristics, growth, and development and survival rates. The Cesium-137 element was utilized with radiation doses of 0, 7, 14, and 21 grays. The difficult survival of plants was observed at higher dose, i.e., 21 grays and followed by 14 grays respectively. While stimulating effect was observed in 7 grays with control effect 0 gray. For this study, we utilized four treatments with Complete Randomized Design (CRD) arrangements. Fisher's analysis of variance and Tukey's Test were employed to compare the treatment means at the 5% level of probability. In irradiated plants, difference in all the growth and anatomical modification characters was observed as compared to control. The morphological abnormalities were observed in plant height which was drastically reduced as compared to control. The other growth characters such as number of branches plants^{-1}, length of sub-branch, number of leaves/branches, length of leaves, width of leaves, length of petiole, length of internodes, length of flower tube, length of bract, length of thorn and number of thorns branch^{-1} were found statistically significant as compared to control. It was also observed that the cuttings treated with higher dose of 21 grays were small and has taken more days for sprouting 64 days. Reduction in sprouting, survival of plants, plant height, number of branches, leaf number and size and different abnormalities were observed with increased exposure to gamma rays. The findings demonstrated that gamma irradiation notably influenced the morphological characteristics and growth of Bougainvillea glabra cv 'Choisy' cuttings. The irradiation doses affected

the sprouting time, with higher doses leading to a delay in sprouting. The percentage of sprouts also decreased with the increasing radiation doses. The lengths of the main and sub-branches were reduced with higher doses, along with a decrease in the number of branches per plant. The number and length of leaves were similarly negatively affected by higher radiation doses. Changes were also observed in leaf and bract colours, with higher doses leading to darker colours.

Tomato Plant Health Monitoring using Kitchen Gardening Robot

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Home-grown tomatoes strike better in taste and have plenty of nutritional value. Automated Kitchen Gardening is an advanced concept and is highly appreciated as the robot has made the whole process autonomous and more efficient. Ensuring the sound health of tomato plants by detecting all kinds of minor to acute diseases from early to advanced stages, which was nearly impossible by the naked eye. Kitchen gardening robots are equipped with highly effective RGB cameras along with a variety of sensors like (pH, temperature, and moisture). All these components are integrated with exceptionally trained deep-learning algorithms and digital image processing techniques for outstanding results in disease classification and diagnosis. Yield is increased to a dramatic level as we trained our algorithm with an open dataset. A total of 75 tomato fruits were obtained with an accuracy of 89%. Kitchen gardening has huge benefits in terms of nourishment and the organic nature of tomatoes. Chemical, toxins, and additive-free tomato plants with their vital, nutritional, dietary, and organic values are produced using robots in kitchen gardening.

Optimizing Postharvest Handling Protocols for Delphinium – A Novel Specialty Cut Flower

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Delphinium, commonly known as 'Larkspur', is herbaceous flowering species which is gaining popularity as specialty cut flower in Pakistani markets due to its vibrant colours and plant hardiness. A study was conducted to optimize postharvest handling protocols for delphinium cut stems comprising five experiments. In Expt.1, stems harvested at three different stages, viz. bud stage, 25% florets open, and fully open inflorescences were evaluated to find out best harvest stage. In Expt. 2, vase water sources, viz. distilled, tap and canal water were compared to find out best choice for handling cut delphinium stems. In Expt. 3, stems were handled with various wet and dry methods from harvest to marketing or processing as optimal handling procedures (wet-wet, wet-dry, dry-wet, and dry-dry). In Expt. 4, stems were treated with 1-MCP cards to find out ethylene sensitivity of cut stems (control, 1-MCP card-1, and 1-MCP card-2) for 24, 48 and 72 hours at 22 ± 2ºC temperature. In Expt. 5, different vase preservatives were tested to find out the best preservative for longest vase life. Treatments included distilled water (control), 1% sucrose + citric acid 150 mgL^{-1}, 1% sucrose +

salicylic acid 100 mgL^{-1}, 1% sucrose + aluminium sulphate 100 mgL^{-1}, lemon/soda (7Up) + distilled water (66:33), 1% sucrose + lemon lime juice (4 mL L^{-1}), 1% sucrose + vinegar (4 mL L^{-1}), 1% sucrose + bleach (15 mL L^{-1}) and Chrysal Clear Professional flower food. Experiments were laid out according to Completely Randomized design (CRD) with five replications individually having two stems each and evaluated in a vase life evaluation room set at 22±2˚C temperature, 50±10% relative humidity and 12 h of light from white, fluorescent tubes. Results revealed that delphiniums when harvested at 25% open florets exhibited longest vase life (5.3 days). Cut stems placed in distilled water exhibited highest water uptake (99 mL) with longest vase life (5.7 days). Wet handling of delphinium stems-maintained flower quality along with longest postharvest longevity (5.4 days) when handled in wet-dry conditions. Stems treated with 1-MCP card-1 exhibited longer vase life (3.7 days) with low respiration rate (0.01). Distilled water plus 7Up (66:33) performed best and resulted in the longest vase life (5.7 days) with least change in flower quality. It is concluded that delphiniums should be harvested when 25% florets get opened, handled in water from harvest to marketing or packing, placed in distilled water or at least tap water for handling cut stems, and vase solution containing lemon/lime soda proved beneficial to extend postharvest longevity and maintain quality of cut stems and may be used by the florists and other marketing stakeholders for handling cut delphinium stems.

Evaluation of Various Biostimulants on Improving Growth, Yield, and Quality of *Eustoma grandiflorum* L. and *Matthiola incana* L.

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Lisianthus (*Eustoma grandiflorum*), a member of family Gentianaceae, and Stock (*Matthiola incana* L.) a member of family Brassicaceae, are extensively cultivated as cut flowers in the world and are getting popularity in Pakistan as well. A study was aimed to evaluate the efficacy of various biostimulants on improving the growth, yield, and quality of lisianthus and stock at Floriculture Research Area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad, during 2022-2023. The experimental study was laid out individually to elucidate the effects of three different products, viz. Isabion (3 mL L^{-1}), Humic acid (0.4%) and Corteva xyz (3 mL L^{-1}) on lisianthus and stock. Both experiments were laid out according to randomized complete block design (RCBD) individually with three replications and 10 plants of each lisianthus and stock were used in each replication. Biostimulants were applied at 3 mL L^{-1} of isabion or Corteva xyz and 0.4% humic acid, which were sprayed four times at the interval of 15 days on each species starting after three weeks of transplantation. Results demonstrated noteworthy variations among different treatments in both *Eustoma grandiflorum* and *Matthiola incana*. Results depicted that isabion application significantly increased plant height (60.3 cm), leaf area (27.7 cm^2), flower diameter (39.8 mm), stem fresh weight (77.6 g), stem dry weight (16.9 g), number of buds (2) and vase life (9 days) of *Eustoma grandiflorum*. For *Matthiolaincana* L. application of isabion significantly increased in plant height (81.6 cm), leaf area (32.9 cm^2), flower diameter (4.3 mm), stem dry weight (22.6 g) and total chlorophyll content (80.8 SPAD). Isabion consistently yielded beneficial results across these parameters, indicating its potential as an effective biostimulant for promoting stock growth, development, and quality attributes.

Optimizing Nutritional Regimes for Quality Flower and Seed Yield of Calendula in Punjab, Pakistan

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Calendula (*Calendula officinalis* L.), family Asteraceae, commonly known as pot marigold, is a popular winter annual grown extensively to be used as bedding plant in Pakistan. Along with ornamental value, it also contains significant medicinal importance and is used in cosmetic industries. A study was conducted at IHS-UAF during 2022-23, to optimize nutritional regimes for higher flower and seed production of calendula in agro-climatic conditions of Faisalabad. There were six treatments in this experiment including control (no additional fertilizer), N @ 90 kg ha-1, NPK (90: 45: 45 kg ha^{-1}), NPK (90:45:45 kg ha^{-1} + micronutrients (1% Fe, B & Zn each), NPK (90:45:45 kg ha^{-1} + Isabion 0.4%) and NPK (90:45:45 kg ha^{-1} + Humic acid 0.4%). Experiment was laid out in a randomized complete block design (RCBD) with three replications of 30 plants each. Data were collected on plant height, plant canopy diameter, number of flowers, flower diameter, leaf area, leaf total chlorophyll contents, production time, harvest index, seed yield per plant and 1000 seed weight. Data were analysed using Fisher's analysis of variance technique and treatment means were compared using LSD test at $P<0.05$. Results revealed that the tallest plants (40.9 cm) and greatest plant canopy diameter (39.44 cm) were recorded in plants supplied with NPK+ micronutrients @ 1% Fe, B & Zn each. The greatest leaf area (39.71 cm^2) along with highest leaf total chlorophyll contents (40.38 SPAD) and longest production time (149.5 days) was recorded in plants fertilized with NPK (90:45:45 kg ha^{-1}) + Isabion (0.4%). Similarly, greatest flower diameter (40.22 mm) along with highest seed yield per plant (90.5 g) and 1000 seed weight (35.5 g) was recorded in plants supplied with NPK (90:45:45 kg ha^{-1}) + Isabion (0.4%). However, highest harvest index (19.07%) and number of flowers (50.2) were observed in plants fertilized with NPK (90:45:45 kg ha^{-1}) + Humic acid (0.4%). Shortest plant height (28.8 cm) and plant canopy diameter (27.1 cm), least leaf chlorophyll contents (31.80 SPAD) and smallest leaf area (16.18 cm^2) were recorded in plants where no additional fertilizers were applied. Likewise, smallest flower diameter (13.74 mm), least production time (142.8 days) and least harvest index (16.35%) were recorded in plants with no additional fertilizer. Moreover, least number of flowers (35.7), seed yield per plant (83.6 g) and 1000 seed weight (30.44 g) was recorded in plants supplied with N only @ 90 kg ha^{-1} followed by control where no additional fertilizer was applied. In summary, application of NPK (90:45:45 kg ha^{-1}) along with micronutrients @ 1% Fe, B and Zn each and Isabion (0.4%) may be used for higher yields of best quality calendula flowers and seed production.

Potential of Mixture of Tea Waste and Agricultural Waste for Cultivation of *Pleurotus pulmonaious*

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The waste of agriculture was used for mushroom cultivation, elimination of ecological pollution and

had better impact on environmental and friendly attitude. Mushroom comprised a filthy extent of carbohydrate, protein, lipids, and fibres. Tea waste (Lipton)latterly along by agriculture unused substantial (straw of wheat, corn meal, cotton waste and thatch grass) were applied to make compost by means of substrate for the rearing of mushroom (*Pleurotus pulmonarius*). Gypsum and wheat bran were applied to be used as auxiliary stuff estimated 5% of the substrate dehydrated mass in entire conducts. Complete randomized design (CRD) was applied to the experiment having arranged five different ratios (100% tea waste, 75% tea waste+ 25% agri. waste, 50% tea waste+ 50% agri. waste, 25% tea waste+ 75% agri. waste, 0% tea waste+ 100% agri. waste). Substrates arranged by standard strategies and put into the autoclave plastic packs, can sack immunized by 10% bring forth. Bring forth run pinhead development first gathering time, absolute yield, organic effectiveness (%) and nature of mushroom was watched. The time taken for 100% produce run were run to fluctuate between 19-36 days and time for pinhead arrangement was in the scope of (54.5 to 67.4) days. Despite there were no factually huge yield contrast related with the forced medicines, the mean most noteworthy yield was found in 50% tea waste+ 50% agri. waste (410.14 g), trailed by medications 25% tea waste+ 75% agri (379.98 g), 0% tea waste+ 100% agri. waste (338.88 g), 75% tea waste+ 25% agri. waste (291.22 g), 100% tea waste (249.46 g). The efficiencies of different blend were somewhere in the range of 83.8% and 52.08%. Conclusively, leaves of tea waste used as substrate are appropriate and new organic material for production of Oyster mushroom when mixed with waste of agriculture material. The tea waste is largely present and can be utilized in blends with Agri. waste or other cellulosic material for the mushroom development. There is need to increase awareness in farmers about proper utilization of tea waste for mushroom cultivation.

Effect of Apple Pomace, Banana Leaves and Date Palm Leaves Waste Mixture on Production of *Pleurotus ostreatus*

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Apple pomace is a by-product from apple industry and considered as horticultural waste and has the potential to support the growth of microorganisms. In this study, the effect of apple pomace on the growth rate of *Pleurotus ostreatus* was investigated. Pleurotus Spp. is an important mushroom group and extensively used in food handling industries and has pharmaceutical uses. Its capability to produce in a varied range of temperatures and to consume existing lingo cellulosic materials is reason to be reflected as an extremely fascinating mushroom for manufacture. Various substrates such as cereal straws, corncobs, coffee grounds and urea are used in greater part to create mushroom. To check the influence of various substrates such as apple pomace, date palm leaves and banana leaves proceeding the cultivation and production of Oyster mushroom, On the basis of growth of mycelia, primordial appearance time, yield of mushroom, colonization time, fresh weight and biological efficiency were analysed. Different treatments were used and significant results indicated that among all the treatments used best growth of mycelia, earlier formation of pin head, better yield and days to fruiting were observed in T_3 50:50% (date palm leaves + banana leaves) with 5% apple pomace, T_5 25:75% (date palm leaves +banana leaves) with 5% apple pomace, 50:50% (date palm leaves + banana leaves), T_2 50:50% (date palm leaves + banana leaves) with 2% apple pomace, T_4 25:75% (date palm leaves + banana leaves) with 2% apple pomace, T_1 50:50% (date palm leaves + banana leaves). Maximum yield (439.3) and maximum biological efficiency (89.1) was obtained from treatment T_3 50:50% (date palm

leaves + banana leaves) with 5% apple pomace. Above findings showed that treatment T_3 was the best substrate as compared to all others to produce mushroom.

Evaluation of Various Cultivars of Cut Sunflower for Yield and Quality Performance in Punjab, Pakistan

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Sunflower (*Helianthus annuus* L.) a member of Asteraceae family, is extensively cultivated as specialty cut flower in different parts of the world and is also getting popularity as specialty cut flower in Pakistan. Therefore, a study was conducted in 2022 to evaluate various cultivars of cut Helianthus annuus in agro-climatic conditions of Faisalabad, Punjab, Pakistan, for finding best suited cultivars for the region. Experiment was laid out according to randomized complete block design (RCBD) with four replications of 40 plants each. Data were analysed using Fisher's analysis of variance technique and treatment means were compared using LSD test at $P<0.05$. Three cultivars, viz. Tall Red Sun, Vincent Choice and Teddy Bear were compared to assess their growth and production in local conditions. Data were collected on production time, plant height, stem length, leaf area, leaf total chlorophyll contents, flower diameter, stem fresh weight, stem dry weight, stem diameter, number of leaves per stem, number of buds per stem, flower quality and vase life. Tallest plant height (137.8 cm) along with greatest flower diameter (18.9 cm) and stem fresh weight (767.6 g) was recorded in Tall Red Sun. Shortest plant height (34 cm) and longest production time (62 d) was recorded in Teddy Bear. Highest flower quality (9) and least production time (43 d) was recorded in Vincent choice, followed by tall red sun (7) (52 d). Longest vase life (7 d) was also recorded in Vincent Choice. In summary, Vincent Choice proved best cultivar for optimal plant height and flower diameter along with least production time and may be used for high quality cut sunflower production in agro-climatic conditions of Faisalabad, Punjab, Pakistan.

Optimal Planting Time for High Quality Cut Stock Production

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Stock (*Matthiola incana* L.), a member of family Brassicaceae, is a promising specialty cut flower which has gained popularity and demand in local markets during recent years. However, its optimal planting time plays a crucial role in quality stem production and to fetch higher returns. Therefore, a study was conducted to optimize planting time for cut stock production in agro-climatic conditions of Faisalabad, Pakistan. Stock 'Column Rose Pink' seeds were imported from Pan American Seeds, USA, and seeds were sown four times at 15 days interval, viz. September 15, October 01, October 15, and November 01. Nursery was raised following standard procedures and seedlings at 2-4 true leaf stage were transplanted on levelled flat beds with 15 × 15 cm spacing between plants and rows. The experiment was laid out according to randomized complete block design (RCBD) with three replications each

having 30 plants. Stock sown on November 01 took the least number of days (96.3 d) to flower followed by October 15 (110 d). While those planted on September 15 took the longest time (94 d) to produce flowers ready for harvest. The tallest plants (63.3 cm) were recorded when planted on September 15, followed by October 01 (58.3 cm). However, seeds sown on November 01 resulted in shortest plant height (41.2 cm). The greatest leaf area (42.3 cm^2) was observed when planted on September 15, followed by October 01 (39.9 cm^2). The highest leaf total chlorophyll contents (95.9 SPAD) were recorded on first sowing September 15, followed by October 01 sowing (89.9 SPAD). Least leaf total chlorophyll contents (84.8 SPAD) were recorded in the last sowing carried out on November 01. The September 15 planting time had the greatest raceme diameter (57.5 mm), followed by (52.9 mm) when sowing was done on October 01. Sowing late in the season on November 01 produced the smallest raceme diameter (45.6 mm). Tested stock cultivar had the greatest stem diameter (12.1 mm) when sowing was done on September 15, followed by October 01 (10.0 mm), while November 01 had least stem diameter (9.1 mm). Highest stem fresh weight and stem dry weight (76.3 g and 10.6 g, respectively) were resulted when planted on September 15 while, those sown on November 01 had least stem fresh weight and stem dry (53.5 g and 6.3 g, respectively). The best flower quality (9) was noted when sown on September 15 and October 01, while poor flower quality (6.9) was recorded for November 01 sowing with shorter stems and racemes. In summary, early sowing in mid-September to early October had best quality cut stem production with better quality cut stock stem production and may be used by growers in Agro-climatic conditions of Punjab, Pakistan.

Optimal Production Protocols for Cut Celosia- A New Specialty Cut Flower for Pakistani Markets

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Celosia (*Celosia argentea* L.), a member of family Amaranthaceae, is an herbaceous summer annual and a quantitative short-day plant. It is a popular specialty cut flower and getting popularity in Pakistani markets as well. Therefore, a study was conducted at Floriculture Research Area, IHS-UAF during 2022-23 to evaluate different planting methods and planting densities, nutrients along with bio-stimulants and varietal evaluation to optimize production protocols for this cut flower. In experiment I, fewest days to flowering (63.5 d) were taken by plants when planted on ridges with 15 × 15 cm spacing. While longest time to flowering (74.5 d) was recorded for plants grown on flat beds along with 22.5 × 30 cm spacing. Highest plant height (62.1 cm), widest flower diameter (67.2 mm) and stem diameter (10.2 mm), highest stem fresh weight and stem dry weight (44.4 g and 5.4 g, respectively), and highest number of marketable stems per plant (8.1) were recorded when planted on flat bed with 22.5 × 30 cm spacing. The longest vase life (19.6 days) was recorded when plants were planted on flat beds followed by ridges with 22.5 × 30 cm plant spacing. In expt. II, least production time (63.3 d), highest plant height (46.1 cm), widest leaf area (37.7 cm^2), greatest flower diameter (16.2 mm), highest stem fresh weight and stem dry weight (16.6 g and 3.2 g, respectively), best flower quality (9) and longest vase life (9.0 days) were observed when celosia were supplied with NPK @ 90:45:45 kg ha^{-1} + micronutrients @ 2 mL L^1. The highest leaf total chlorophyll contents (47.0 SPAD), greatest stem diameter (6.1 mm) and greatest number of marketable stems per plant (6.1) were recorded when plants were provided with NPK @ 90:45:45 kg ha^{-1} + Isabion @ 2 mL L^{-1}. In experiment III, least production time (64.4 d), highest plant height (62.9 cm), widest flower diameter (60.3 mm), greatest stem fresh weight (44.3 g) and stem dry weight (4.5 g), highest flower quality (9), greatest vase life (20.6 days) and greatest number of marketable stems per plant (9.3) were recorded in *Celosia cristata*,

while greatest leaf area (85.7 cm^2) and stem diameter (20.7 mm) were noted in Celosia plumosa. In summary, celosia may be grown on flat beds or ridges with 22.5 × 30 cm spacing and provided with NPK @ 90:45:45 kg ha^{-1} + micronutrients @ 2 mL L^{-1} + Isabion @ 2 mL L^{-1} for best quality cut stems and higher number of marketable stems of celosia.

Estimating Yearly Variability in Phenological Attributes of Guava Germplasm

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Different accessions of Round (G) and Pyriform (S) cultivars of guava (*Psidium guajava* L.) were evaluated for yearly variations in the phenological attributes during 2021-2023. The study was carried out at guava GPU, experimental fruit garden of the institute. Guava accessions showed well defined vegetative and reproductive phenological stages according to Flecking's coding and BBCH general scale. Early bud emergence and bud growth was found in accessions G2 and S4. The number of days for vegetative bud emergence, bud swelling, and bud growth begins were recorded as minimum in accessions G2 (8, 12, 17) and S4 (10, 14, 18), respectively. Similar trend was observed for days to 1st leaf sprouting, more leaves unfolding and leaves fully developed in G2 (23, 29, 35) and S4 (24, 30, 36). Regarding reproductive stages like 50% flowering, petal fall and fruit setting an early emergence and growth with minimum days was recorded in G2 (66, 72, 77) and S4 (67, 73, 76). Regarding fruit growth begin and 80% fruit growth was completed in G2 (126, 136) and S4 (125, 136). Early fruit colour changing, and fruit ripening was also noted in G2 (136, 162) and S4 (136, 165). Conclusively, Round accessions G2 and Pyriform accession S4 depicted early vegetative and reproductive growth initiation and completion across multiple seasons indicating their potential as early varieties. Present research provides genotypic behaviour for expression of elite accessions for various phenophases, their interaction with environmental conditions and cultural practices. Furthermore, the findings may improve management for commercial guava production under rapidly changing climatic conditions.

Technical Session III

Plant Protection & Green Control Technologies

Oral Presentations

Mechanism of U-box E3 Ubiquitin Ligase of Soybean Involved in Host Resistance to *Heterodera glycines*

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Ubiquitination modification is a post-translational modification of proteins. Plant U-box (PUB) proteins, as a class of ubiquitin proteins, play an important role in plant's response to biotic and abiotic stresses. Soybean cyst nematode (SCN) is one of the most destructive plant pathogenic nematodes, causing billions of dollars of losses in soybean production worldwide. To date, there are few reports on the response of soybean ubiquitination genes (*GmPUBs*) to nematode stress and the specific functions and mechanisms of *GmPUBs* genes in the interaction between soybean and SCN are still unclear. In this study, the molecular mechanisms of *GmPUBs*in response to SCN infection was clarified by studying the characteristics and expression patterns of*GmPUBs* genes, the specific functions, and roles of *GmPUBs*, and the regulatory mechanisms of *GmPUBs*.

The Pheromone Encoding in the Peripheral and Central Nervous System of *Helicoverpa armigera*

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The cotton bollworm *Helicoverpa armigera* (Hübner) is a worldwide pest and can cause substantial agricultural losses. Its pheromone components had been developed as a sex attractant for controlling the pest by capturing the males. The mechanism of sex pheromone perception in male *H. armigera* has been investigated extensively in order to improve the efficiency of the sex pheromone attractant. However, the neural encoding and the neural pathway from the peripheral to the central nervous system for the sex pheromone in the male *H. armigera* are mainly unknown. In the present study, we performed electrophysiological and morphological characterization of the antennal lobe neurons in *H. armigera*. By utilizing the techniques of single-sensillum recording and tracing and intracellular recording and staining, we could identify individual olfactory receptor neurons (ORNs) and projection neurons (PNs). Our results show that the major pheromone component Z11-16:Ald was detected by the ORN housed in Type A trichoid sensilla, and the information was transmitted to the glomerulus Cumulus (Cu) in the macro glomerular complex by the ORN and then sent to medial lateral horn (mLH) by the Cu-PN. The secondary pheromone components Z9-16:Ald and Z9-14:Ald were encoded by the ORN in Type C trichoid sensilla, and the information was transmitted to the dorsomedial posterior glomerulus (DMP) and then sent to lateral lateral horn (lLH) by the DMP-PN. The pheromone inhibitors Z9-14:Ald and Z11-16:OH were encoded by the ORNs in Type B and Type C sensilla, and the information was transmitted to the dorsomedial anterior glomerulus (DMA) and then sent to lateral lateral horn (lLH) by the DMA-PN. The dual roles of Z9-14:Ald, agonist, and antagonist, were mediated by DMP and DMA neurons, respectively. The results of this study revealed the mechanisms of olfactory

processing at the level of neural circuits and provided new insights into the evolution of peripheral and central olfactory pathways across related species.

Turnover of Bacteria-Derived Carbon and its Mechanisms for Soil Carbon Sequestration

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Soil organic matter (SOM) represents an important terrestrial carbon reservoir in the biosphere, and microorganisms have been recognized as significant material contributors to the formation of SOM. However, the turnover of microbial biomass residues with respect to their detailed microbial food web and the mechanism by which material from microbial sources is sequestered in soil organic matter remain elusive. Therefore, we traced the fate of Gram-negative ($Gram^-$) microbial biomass carbon through the microbial food web over time, using the concentrations and isotopic compositions of biomarker phospholipid fatty acids (PLFA) in a soil incubation with isotopically (^{13}C) labelled model bacterial cells (Escherichia coli). And we tracked ^{13}C-amino sugars (from chitin and peptidoglycan) in order to shed light onto the bacterial and fungal food web. We found that the *E. coli*-derived ^{13}C was utilized by fungi first, then the label was shifted from fungi to $Gram^-$positive ($Gram^+$) bacteria, arbuscular mycorrhizal fungi (AMF), actinomycetes, and to $Gram^-$ bacteria other than E. coli. Finally, the carbon was transferred from all consumers to the next consumer level; this is reflected in ongoing loss of ^{13}C-PLFA without a shift in the ^{13}C-PLFA pattern. During incubation, ^{13}C-amino acids decreased significantly, whereas 13C-amino sugars changed only slightly over time, suggesting that amino sugars as biomarkers are relatively stable compared to amino acids. ^{13}C-F-GluN/^{13}C-MurA significantly increased before day 14, then levelled off until the end of the experiment. This further highlighted that bacterial C was stabilized in soil by conversion to fungal biomass grown on the bacterial biomass. In summary, our study detailed the turnover process of microbial biomass residues via the microbial food web to necromass and finally to SOM and provided evidence that bacterial biomass residues were predominantly utilized by fungi; thus, at the end, the C was mainly stabilized as fungal necromass.

White And Brown Adipose Tissues: The Fuel for Hibernation

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Hibernation is the most effective energy saving strategies for small mammals. To survive the hibernation season, some hibernators store body fat as the main fuel of hibernation during fattening period. There are 2 types of adipose tissue with opposite functions, the white adipose tissue (WAT) is the energy storing organ and the brown adipose tissue (BAT) burn the lipid through thermogenesis. WAT accumulation affects the survive rate and hibernation expression. WAT dramatically increased by about 10-fold in 2-3 months fattening period with no evidence of obesity-related diseases. However, the underlying mechanism of this impressive adaptation is still unknown. The distribution of WAT is crucial for metabolic health, the visceral fat accumulation is closely related with metabolic disorders.

Our recent study shows that, Daurian ground squirrel (*Spermophilus dauricus*), a typical fat-storing hibernator, accumulate subcutaneous WAT before visceral WAT during fattening, the visceral WAT showed hyperplasia rather than hypertrophy during fattening period. This adipogenesis pattern provide the insights into metabolic health during fattening. According to our previous observation, the hibernation varies among individuals, some animals just express very shallow torpors during the whole hibernation season. Since BAT is the most important thermogenic organ and mitochondria is crucial organelle for the thermogenic capacity, we observed the morphological differences of mitochondria among hibernating, euthermia and arousal Daurian ground squirrels. We found that the euthermia squirrels showed decreased mitochondrial cristae density comparing with hibernating and arousal squirrels. Besides, the lipid droplet area is significantly smaller in euthermia squirrels' BAT. These results might be indicating the relationship between BAT mitochondrial morphology and hibernation expression. Above all, as the fuel of hibernation, the accumulation and physiological changes of adipose tissue affect the hibernation profoundly, the underling mechanisms might provide evidence of hibernation initiation and maintenance.

Key Technologies for Harmless and High-Value Conversion of Organic Solid Wastes by *Hermetia illucens* Wuhan Strain and Microbes

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Hermetia ilucens L. (Diptera: Stratiomyidae), also known as black soldier fly (BSF), can be found in decaying organic wastes, such as animal manure and food waste. Over the past several years, investigators in our group have made some research and application progress on BSF breeding and organic waste conversion by BSF larvae and microbes. We isolated some microbes that could induce BSF adults to lay eggs and used in large scale BSF breeding factory. It allows the high efficiency eggs mass production of BSF larvae to meet demand of large -scale organic waste conversion at low cost. Microbes from BSF play important roles in BSF larvae nutrition and resistance against pathogens. BSF larvae gut microbiota (e.g., *Clostridium butyricum*) also could help reduce the risk of antibiotic resistance genes in animal manure. Bacteria isolated from the BSF larvae gut and eggs can be cultured and used to promote BSF growth and shorten the time to the prepupal stage in lab and in factory. These processes greatly reduce environmental impact caused by organic waste. Application of BSF larvae and microbes for recycling animal manure is well established. The residues collected from BSF larvae conversion are subjected to secondary fermentation using nematicidal microbes to produce functional organic fertilizers and have good efficiency against root rot nematode in field. The technology combined BSF, and microbes could reach low emission and high-value utilization of organic wastes.

Sustainable Cotton Production: Challenges and Opportunities in Pakistan

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Cotton is an important cash crop and backbone of Pakistan's economy. However, since last decade, the cotton production had declined to 5.5 million bales against the potential of 15 M bales. The major causes for this decline include low quality seed, high pest pressure due to climate change, injudicious use of pesticides especially at early crop stages leading to death of natural enemies, development of insecticide and *Bt* resistance in insect pests of cotton. All these factors have made cotton a non-profitable crop and farmers have shifted to other crops like sugarcane, corn, rice, potato etc. Keeping in view this critical situation, an initiative was taken to develop an IPM strategy involving bio-friendly plant-based chemicals. Different plant-based extracts were evaluated against cotton insect pests during 2019-2021. The results revealed that extracts of bitter apple, neem, tobacco, and asafetida (hiing) were very effective. The cotton advisories regarding use of these plant extracts were developed and disseminated among farmers throughout the growing season 2021-23. Moreover, IPM plots were also established at tehsil level as a model to help Agri. Extension Department for the farming community. The IPM demonstration plots has increased from 120 to 225 throughout Punjab. To analyse impact of all these interventions, a third-party validation survey team visited 1200 cotton farmers throughout cotton zone of Punjab and collected data. According to survey, 93% respondents agreed that Agriculture Department conveyed cotton production and plant protection technology in time and farmer benefitted by the Government advisory. Seventy four percent farmers appreciated the implementation of the policy of not spraying any chemical until 60 days from the sowing of crop. About 86% farmers were aware of biopesticides and their application. About 80% respondent reflected that beneficial insect played an important role in keeping the sucking insect pests below ETL level where they did not spray insecticides in first two months of cotton sowing. Up till September 2021, approximately 57% insecticidal spray was reduced than the last year by cotton farmers, which positively reduced input cost $acre^{-1}$ of farmers. This was the first year that farmers sprayed biopesticides $plant^{-1}$ extracts as the IPM practice and got promising results. Observing successful revival of cotton through IPM and good price of cotton, the 89% respondent agreed to follow IPM model next year.

Introduction of International Standards and Integrated Pest Management (IPM) for Crops

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The desert locust plague raged in 2019-2020, causing huge losses to countries. We carried out relevant research and sorted out the standardization of pest's management in international organizations and countries. During the research process, we conceived the idea of setting up a technical committee for Integrated Pest Management (IPM) for Crops under ISO. After working with experts and researchers, we formed the final version of the proposal in April 2023. In April 2023, we formally submitted our proposal to ISO. As of July 17, the proposal finally passed the first round of voting with 23 votes of

support. During this period, we organized two global presentations, with more than 40 international experts participating in the discussions. As of August 16, the proposal received a second round of voting with 5 votes of postponing, and the final decision will be made at the TMB meeting in September. Dr. Yuanyuan Zhuang, Director General of SASR (South Asian Standardization Research Centre), will give a presentation on the introduction of International Standards and Integrated Pest Management (IPM) for Crops.

Identification of *cis*-Acting Replication Element in VP2-Encoding Region of Senecavirus A Genome

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Picornavirus possesses one positive-sense, single-stranded RNA genome, in which a cis-acting replication element (CRE) is located. The CRE is a stem-loop structure that harbours a conserved AAACA motif within its loop region. This motif functions as a template for adding two U residues to the viral VPg, therefore generating a VPg-pUpU that is required for viral RNA synthesis. Senecavirus A (SVA) is an emerging picornavirus. Its CRE has not been identified yet. In the present study, one putative CRE containing a typical AAACA motif was computationally predicted to exist within the VP2-encoding sequence of SVA. To test the role of this putative CRE, 22 SVA cDNA clones with different point mutations in their CRE-formed sequences were constructed to rescue replication-competent SVAs. A total of 11 viruses were rescued from their individual cDNA clones, implying that some mutated CREs exerted lethal impacts on SVA replication. To eliminate these impacts, an intact CRE was artificially inserted into those SVA cDNA clones without ability of recovering virus. The artificial CRE was proven to be able of compensating for some, but not all, defects caused by mutated CREs, leading to successful recovery of SVAs. These results indicated that the putative CRE of SVA was functionally like those of other picornaviruses, perhaps involved in the uridylylation of VPg.

Engineered Phage Endolysins with Extracellular Antibacterial Activity Against Gram-Negative Bacteria

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Phage-encoded endolysins are emerging antibacterial agents based on their ability to efficiently degrade peptidoglycan on Gram-positive bacteria, but the envelope characteristics of Gram-negative bacteria limit their application. Engineering modifications of endolysins can improve the optimization of their penetrative and antibacterial properties. This study constructed a screening platform to screen for engineered Artifificial-Bp7e (Art-Bp7e) endolysins with extracellular antibacterial activity against *Escherichia coli*. An oligonucleotide of 20 repeated NNK codons was inserted upstream of the endolysin gene Bp7e to construct a chimeric endolysin library in the pColdTF vector. The chimeric ArtBp7e proteins were expressed by transforming the plasmid library into *E. coli* BL21 and released by

chloroform fumigation, and the protein activities were evaluated by the spotting method and the colony-counting method to screen for promising proteins. Sequence analysis showed that all screened proteins with extracellular activities had a chimeric peptide with a positive charge and an a-helical structure. Also, a representative protein, Art-Bp7e6, was further characterized. It exhibited broad antibacterial activity against *E. coli* (7/21), *Salmonella enterica serovar Enteritidis* (4/10), *Pseudomonas aeruginosa* (3/10), and even *Staphylococcus aureus* (1/10). In the transmembrane process, the chimeric peptide of Art-Bp7e6 depolarized the host cell envelope, increased the permeability of the cell, and facilitated the movement of Art-Bp7e6 across the envelope to hydrolyze the peptidoglycan. In conclusion, the screening platform successfully screened for chimeric endolysins with extracellular antibacterial activities against Gram-negative bacteria, which provides methodological support for the further screening of engineered endolysins with high extracellular activities against Gram-negative bacteria. Also, the established platform showed broad application prospects and can be used to screen various proteins.

Protected Agriculture Matters: Year-Round Persistence of *Tuta absoluta*in China Where It Should Not Be

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Tuta absoluta (Lepidoptera: Gelechiidae) originates from the South American tropics but has become a major invasive pest of tomato and other Solanaceae crops worldwide. Agricultural protected facilities (APFs) such as greenhouses and plastic tunnels may provide thermal conditions that allow the survival of *T. absoluta* in temperate zones with cold winters. In this study, a CLIMEX model was used to investigate the dual effects of increasing use of APFs and climate warming on the potential distribution and seasonal dynamics of *T. absoluta* in China. Our model showed that the northern boundary for year-round population persistence in China, ignoring APFs, was approximately 30°N, covering about 21% of China's area suitable under current climate. The modelled suitable area increased to 31% and northern boundary for year-round population persistence shifted to 40°N in 2080 under global warming. When APF refuges are included, the potential suitable area was 78% under the current climate and 79% under global warming. This suggests that, in the future, the increasing use of APFs will increase the areas at risk of *T. absoluta* invasion significantly more than global warming because APFs effectively protect *T. absoluta* from harsh northern winters. In addition, vegetable production in surrounding open fields will be at risk of invasion during milder seasons when APFs are opened and *T. absoluta* can disperse. Therefore, the micro-climate of APFs should be considered as part of the invasion process, and Integrated Pest Management should be simultaneously implemented inside and outside APFs for the rational management *T. absoluta.*

Green Technologies for Pest Insects Control: Current Developments and Future Thrusts

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Globally, nearly one-fifth of crop yield is lost due to insect pests, and the warming climate is being foreseen to trigger more yield losses due to the increased abundance of insect pests. Traditional pest control methods often involve the use of harmful chemicals that can have adverse effects on both human health and the environment. As a result, there has been a growing demand for green technologies of pest control that are both effective in eliminating pests and environmentally friendly. Any pest control technique as a stand-alone technique may not be sufficient to control the target pest but the integration of all possible techniques commonly known as integrated pest management (IPM) can give a successful control. The Pakistan Agricultural Research Council as an apex research organization in the federal government has been undertaking R&D to develop green technologies for pest control and coordination with the provinces. The green technologies involve exploring the host plant resistance for developing pest-resistant-only varieties, biological control (both conservation and augmentative release) programme, biopesticides (botanicals, microbial and sprayable *dsRNA*), semiochemicals for manipulating the behaviour of insect pests, and area-wide integrated pest management (AW-IPM) incorporating the sterile insect technique (SIT). Host plant resistance is monitored under the Variety Evaluation Committee through the National Uniform Yield Trial (NUYT) system and by this system, 825 resistant varieties of agronomic crops and 29 varieties of horticultural crops have been released. Screening of germplasm is conducted under natural field conditions and by inducing infestation of larvae (maize stem borer, rice leaf folder) and by electrical penetration graph system; EPG (rice brown plant hopper, wheat aphids). Biological control of sugarcane borers by augmentative releases of egg parasitoid, *Trichogramma chilonis* has been implemented on more than 0.2 million acres. Microbial biopesticides are developed by isolating the microbial pathogens from the lepidopterous cadavers. Botanical biopesticides formulations are developed by the consortium of toxic compounds of various plants for targeting the sucking insect pests. The sprayable *dsRNA* targeting the genes of aphid *Schizphis graminum*, and rice brown plant hopper have been evaluated. The AW-IPM of fruit flies incorporating the male annihilation technique (MAT), bait application technique (BAT), and orchard sanitation has been applied on more than 2500 acres of fruits and vegetables, which facilitated for enhancing the horticultural exports. The simultaneous application of MAT and SIT for cost-effective management of fruit flies is on its way for implementation in the field. The IoT-based monitoring system for fruit flies has been developed.

Technical Session III

Plant Protection & Green Control Technologies

Poster Presentations

Biological Conversion of Plant Biomass in the Symbiotic System of a Fungus-Farming Termite

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Termites are eusocial arthropods that play a crucial role as decomposers, contributing to enhanced soil fertility and increased agricultural productivity. The fungus-farming termites exhibit remarkable success and efficiency in the degradation and digestion of plant materials. They establish a mutualistic association with *Termitomyces* fungus and gut microbiota, to facilitate the efficient breakdown of lignocellulose and acquire essential nutrients. However, the process of lignocellulose degradation in these termites is poorly understood. In the present study, several analytical approaches were performed on the fate of plant biomass components to examine which lignocellulose components digested throughout the decomposition process in *Odontotermes formosanus* (Shiraki). This study showed a gradual reduction of lignin, cellulose, and hemicellulose from 256.6, 513.3, and 152.5 mg g^{-1} in mulberry wood to 208.2, 456.5, and 129.6 mg g^{-1} in fresh comb; 110.6, 303.0, and 102.9 mg g^{-1} in mature comb; and 94.9, 176.9, and 71.0 mg g^{-1} in old comb, respectively. Crystallinity index (%) was also reduced in fresh (36.1%), mature (31.9%), and old comb (25.0%) compared to mulberry (38.5%). Significant changes in guaiacyl (G), syringyl (S), and p-hydroxyphenyl (H) lignin units were recorded in fresh (56.8, 41.8, and 10.6µg), mature (22.2, 15.9, and 3.8 µg), and old comb (19.0, 14.1, and 4.1 µg) compared to original wood (92.4, 46.2, and 7.2 µg, respectively). Additionally, a significantly increased diversity of monomeric sugars was recorded in the older parts of comb. The results of our study provide evidence that young workers are responsible for the initial breakdown of lignocellulose, while a significant portion of the lignin, hemicellulose, and cellulose remains in fresh comb, where most of the decomposition takes place.

Efficacy of Entomopathogenic Nematodes and Insecticides Against *Pieris brassicae* Under Lab Conditions

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Pieris brassicae, commonly known as cabbage butterfly, is an important pest of Cole crops such as cabbage, cauliflower, radish, turnip. Different techniques such as natural and synthetic chemicals have been used to control this pest. To address this challenge the experiment was conducted to check the efficacy of two entomopathogenic nematodes (EPNs) (*Hetro rhabditis bacteriophora* and *Steinernema glaseri*) and four insecticides (emamectin benzoate, lufenuron, cypermethrin and indoxacarb) against different larval instars of *P. brassicae* under laboratory conditions. Different concentrations (0, 20, 50 and 100 IJs) of EPNs alone and in combination with selected insecticides were tested against *P. brassicae*. The mortality data were recorded after 3, 5 and 7 days while the compatibility of EPNs with

insecticides was investigated daily. The results indicated that the maximum mean mortality of *P. brassicae* larvae has been caused by cypermethrin followed by lufenuron, emamectin benzoate, indoxacarb, *H. bacteriophora* and in *S. glaseri*. The combination of cypermethrin and *H. bacteriophora* demonstrated the synergistic efficacy and found to be compactable by causing highest mortality as compared to all other treatment combinations, including lufenuron paired with *S. glaseri* and *H. bacteriophora*. The findings highlighted the potential of integrated management of *P. brassicae* by EPNs with conventional insecticides to enhance overall efficacy. Moreover, this research contributes valuable understandings for the development of sustainable and environmentally friendly practices for the management of Cole crops pests.

Toxicity of *Beauveria bassiana* and Insecticides Against Insect Pests and Natural Enemies

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Cotton is one of the most important economic crops across the world. It is affected by many pests, but the most economically harmful are cotton bollworms, which affect the yield at the fruiting stage. A Lab experiment was conducted, to study the effects of *Beauveria bassiana* (1x106 CFU mL^{-1}) and insecticides (Abamectin, Imidacloprid, Abamectin + Imidacloprid) with some recommended concentrations against pink bollworm, cotton aphid and ladybird beetles under laboratory conditions. Insecticide mixture (abamectin + imidacloprid) was the most effective insecticide against cotton aphid and revealed 83.13%-99.13% mortality, while abamectin and imidacloprid showed almost same mortality 65.97%-83.90% after 3 days. *B. bassiana* was less effected and only 68.13% mortality was recorded after 3 days. The most effective insecticide against pink bollworms was imidacloprid which showed 67.19%-83.30% mortality while abamectin was least effective against pink bollworm and exhibited only 22.05%-45.06% mortality after 3 days. The mixture of abamectin and imidacloprid had significant effect and exhibited up to 99.73% mortality after 3 days, while *B. bassiana* had moderate effect against pink bollworm, only 61.79% mortality was recorded. In the case of ladybird beetle abamectin was least effective after 1 day and 15.69%-25.48% mortality was observed, while highest mortality (53.48%-80.08%) was observed with insecticide mixture (abamectin + imidacloprid) 3 days of post application. Time and concentration were found to be correlated positively. These findings would suggest that a combination of these insecticides might be efficient and useful for controlling sucking and chewing insect pests of cotton.

Comparative Bio-efficacy of *Metarhizium anisopliae* and Synergistic Interaction of Insecticide Mixture Against *Phenacoccus solenopsis* and its natural enemies

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Cotton infestation with pests causes deterioration in lint quality and high loss in crop production. Cotton mealybug (*Phenacoccus solenopsis*) causes 12 to 35% loss in Pakistan and 10 to 60% loss in the North and Central Zones of India. The present study was conducted to observe the comparative efficacy of insecticide mixture (chlorpyrifos and cypermethrin) and *Metarhizium anisopliae* on *P. solenopsis* under laboratory conditions by leaf dip method. The individual and combined treatments of insecticides revealed dose and time-dependent mortality of *P. solenopsis*. Chlorpyrifos was very effective with 30.80-45.21%, 41.76-60.78% and 65.46-79.62%, after 24h, 48h and 72h respectively. Cypermethrin was relatively less toxic with 26.94-40.28%, 33.11-50.07 and 53.07-66.29% mortality after 24h, 48h and 72h respectively. The highest morality 95.07% was recorded with the combinations of cypermethrin+ chlorpyrifos against *P. solenopsis* after 72h. The mixtures of insecticide (chlorpyrifos + cypermethrin) were significantly more toxic to *P. solenopsis* than individual treatments. Similar trend was recorded in case of toxicity against ladybird beetles. M. anisopliae showed moderate virulence against *P. solenopsis* 5.29%, 20.12% and 65.24% were recorded after 24h, 48h and 72h. In addition, the synergistic factor (SF) and co-toxicity coefficient (CTC) values indicated synergistic interactions at different time intervals. These findings suggest that application of individual and mixture of insecticides are toxic to mealy bugs in contrast they are equally toxic to natural enemy. The individual application of entomopathogenic fungus might be efficient to control insect pests but their mixture with insecticide could be efficient against insect pests.

In Vivo Assessment of Different Insecticides Against *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae)

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The fall armyworm (FAW), *Spodoptera frugiperda* (Lepidoptera: Noctuidae) is the great threat now a days to many crops, mainly maize. Synthetic insecticides proved themselves as successful chemical control agents due to their effective way to interfere with the physiological or molting process in noctuid species. In this study field efficacy of six synthetic insecticides was checked with their possible

combinations and individually. Maize crop was sown in Entomological Research Farm through Randomized Complete Block Design (RCBD) with three replications. Foliar application of each mixture and same concentrations (25:75, 75:25, 50:50) was applied after 45 days of emergence of maize crop after the attack of fall armyworm. The data on larval population density and natural enemies were recorded. The lowest mean larval population (0.01 larvae plant^{-1}) was recorded in Chlorantraniliprole: Emamectin Benzoate (75:25) at 96 hours while maximum mean larval population (1.50 larvae plant^{-1}) were observed in Spinetoram: Flubendiamide (25:75). The insecticides alone recorded lowest mortality and highest larval population of FAW in the field conditions with a less toxic effect. The maximum mean population (3.02 individuals row^{-1}) of natural enemies were observed in Lufenuron: Flubendiamide while Emamectin Benzoate with Lufenuron and Chlorfenapyr recorded lowest mean population (2.10 individuals row^{-1}) among all insecticide's mixtures. The insecticides used in this study showed a great reduction in larval incidence of fall armyworm and it's concluded that insecticides can be a strong and quick management strategy.

Assessment of Mass Trap-and-Kill Performance of Waxy Pheromone-Dispensing Device Against Tephritid Fruit Flies (Diptera: Tephritidae) In Orchards

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Fruit flies (Diptera: Tephritidae) damage vary in various fruits and vegetables depending on the species and area. The current study was conducted on Semi chemicals-based techniques against fruit flies in orchards. Bee wax, Paraffin wax, and Croda wax were used to develop slow-release formulations with methyl eugenol. The results described that combination of waxes Bee + Croda + Paraffin wax (10:90) showed maximum attractancy (56 flies week^{-1} trap^{-1}) during week 12th of observation. The results of the total number of fruits per quadrate revealed that maximum number of fruits (29 fruits quadrate^{-1}) were recorded during 8th week at 40:60 concentration of Bee + Croda + Paraffin wax and methyl eugenol while lowest number of fruits (6 fruit quadrate^{-1}) were recorded during 1st week at 20:80 concentration of Bee wax + Methyl Eugenol, respectively. The results of the infested fruit per quadrate revealed that lowest number of infested fruits (3.66 fruit quadrate^{-1}) were recorded during 1st week at 10:90 concentration of Bee + Croda + Paraffin wax +methyl while highest number of infested fruit (17 fruit quadrate^{-1}) during 8th at 50:50 concentration of Bee + Paraffin + methyl eugenol respectively. The results of fruit fly infested fruit per tree revealed that lowest number of infested fruits (4.33 fruit tree^{-1}) were recorded during 1st week at 20:80 concentration of Bee + Croda + Paraffin wax +methyl eugenol while highest number of infested fruit (24 fruit tree^{-1}) were observed during 6th week at 20:80 concentration of Bee wax+ methyl eugenol, respectively. It was concluded that pheromone + wax based slow released formulations can be a great approach for the management of fruit flies in orchards.

Evaluation of Wax Based Slow-Release Pheromone Dispensers for Mass Trapping of Tephritid Fruit Flies (Diptera: Tephritidae) In Orchards

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Fruit flies (Diptera: Tephritidae) have gained economic importance in Pakistan because of the substantial losses they cause to fruits at the agricultural farm level. In this study a semi chemical-based approach was employed to suppress the population of fruit flies in orchards. Three biodegradable waxes (candelilla wax, carnauba wax, paraffin wax) and their various combinations (10:90, 20:80, 30:70, 40:60 and 50:50) were used to develop slow-release formulations with methyl eugenol. The results of the catches per trap revealed that highest number of catches (62 flies trap^{-1}) were recorded during 3rd week at 10:90 concentration of candelilla + carnauba + paraffin wax and methyl eugenol while lowest number of fruit flies (22.5 flies trap^{-1}) were observed during 6th week at 50:50 concentration of carnauba wax+ methyl eugenol, respectively. The results of the total number fruit per quadrate revealed that maximum number of fruits (41.30 fruits quadrate^{-1}) were recorded during 3rd week at 10:90 concentration of candelilla + carnauba + paraffin wax and methyl eugenol while lowest number of fruits (31.53 fruit quadrate^{-1}) were recorded during 6th week at 50:50 concentration of carnauba wax + methyl eugenol respectively. The results of the infested fruit per quadrate revealed that lowest number of infested fruits (5.2 fruit quadrate^{-1}) were recorded during 5th week at 10:90 concentration of candelilla wax + methyl eugenol while highest number of infested fruit (10.84 fruit quadrate^{-1}) during 6th week at 50:50 concentration of carnauba wax + methyl eugenol, respectively. The results of infested fruit per tree revealed that lowest number of infested fruits (6.4 fruit tree^{-1}) were recorded during 6th week at 10:90 concentration of candelilla wax + methyl eugenol while highest number of infested fruit (11.84 fruit tree^{-1}) were observed during 1st week at 50:50 concentration of carnauba wax+ methyl eugenol respectively. This research proved that biodegradable waxes in the form of slow-release pheromone dispensers can be used as ecofriendly technique alternative to toxic insecticides for the successful management of fruit flies without causing any harmful concerns.

Efficacy of Wax-Based Attract-and-Kill Bait Stations and Liquid Formulations for Female Tephritid Fruit Flies in Orchards

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Fruit flies are a notorious pest for fruits and vegetables and are responsible for 89.50% of losses in Pakistan. In this study, experiments were carried out with wax based attract-and-kill bait stations and liquid formulation for foliar spray to control fruit flies. The wax-based attract-and-kill bait station consists of a solution of protein hydrolysate, ammonium acetate, spinetoram and sugar was made, and solution was combined with matrix 1 (carnauba wax + Tween 80), matrix 2 (candelilla wax + Tween 80) and matrix 3 (carnauba wax + candelilla wax (50:50) + Tween80). While the second experiment

consisted of the liquid formulation in which solution was combined with liquid matrix 1 (paraffin wax + Tween 80 + solution), liquid matrix 2 (glycerin + Tween 80 + solution) and liquid matrix 3 (paraffin wax + glycerin (50:50) + Tween 80 + solution). The results revealed that the catches of total killed adult female fruit flies ranged between 0-46, 0-32.33 and 0-38.67 fly-catches per week per trip in semi-spherical shape, stripe shape, and cylindrical shape attract-and-kill bait station, respectively. The results mixture of carnauba wax + candelilla wax + solution X bait station with semi spherical shape killed high number of female fruit flies. The minimum fruit infestation (846.8 no. of pupae 100 fruits^{-1}) was recorded in plots treated with Glycerin+ Paraffin + solution X. Maximum yield (109 kg plant^{-1}) was recorded in plots treated with Glycerin+ Paraffin + solution X which exhibited approximate 1.79, 1.61 and 1.45 times more yield per plant in citrus as compared to control treatment (61 kg plant^{-1}) respectively. Maximum cost benefit ratio of net return and cost per treatment 5.7 were recorded at LM3(Paraffin wax + glycerin + solution X) and the minimum cost benefit ratio of net return and cost per treatment 4.30 were recorded at LM1. The cost benefit ratio of net profit and total expenditure per treatment were greater at LM3 followed by LM2 and LM2 demonstrated the number 5.7, 5.6 and 4.30, respectively.

Isolation and Assessment of EPF Strain for Their Pathogenicity Against *Spodoptera furgiperda* (Lepidoptera: Noctuidae)

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The fall armyworm (FAW), (*Spodoptera frugiperda*) (J. E. Smith) (Lepidoptera: Noctuidae) is an important migratory polyphagous invasive insect pest. There is a strong need to develop management practices such as Entomopathogenic fungi (EPF). This study was conducted to isolate the EPF and to check their pathogenicity against *S. frugiperda* under laboratory conditions. Three strains of fungus were isolated MBC-807 (*Lecanicillium attenuatum*), MBC-076 (*Beauveria bassiana*) and MBC-P-052 (*Metarhizium anisopliae*) from collected soil samples. Two larval stages were assessed against these strains for confirmation of virulence. A total of six concentrations of each purified strain were made. The data on larval mortality was observed after 24, 48, 72, 96, and 120h of post-exposure intervals. The results depicted that mortality for 2nd instar larvae through the foliar method was highest (64.4%) at 120 hours on strain (MBC-P-52). Whereas the mortality for 3rd instar larvae through the foliar method was highest (34%) at 120 hours on strain (MBC-P-52) at concentration 1×109. The results showed that larvae were more susceptible in foliar method. The strain (MBC- P-52) exhibited higher pathogenicity with least LC50 values for 2nd instar through foliar method with the length of exposure time as compared to the other two EPF strains while the least pathogenic was found to be the strain (MBC-076). The strain (MBC-P-52) exhibited higher pathogenicity with the least LC50 values for 3rd instar ingestion with the length of exposure time as compared to other two EPF strains while the least pathogenic was found the strain (MBC-076). All the strains showed potential as a biopesticide and could be used as a biocontrol agent.

In Vitro Assessment of Different Insecticides Against *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae)

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The fall armyworm (FAW), *Spodoptera frugiperda* (Lepidoptera: Noctuidae) possess severe major losses to maize crop. This invasive pest species is being managed with synthetic insecticides to avoid feed and fodder losses of maize crop. The present study was conducted under laboratory conditions to assess the efficacy of six different insecticides (Chlorantraniliprole, Spinetoram, Chlorfenapyr, Emamectin benzoate, Lufenuron and Flubendiamide) in the form of mixtures and individually. Fall armyworm susceptible population was reared on artificial diet in small plastic jars individually. A total of fifteen different mixtures of all insecticides and three concentrations (25:75, 75:25, 50:50) of each was made and individual insecticides were checked on recommended dose. The diet dip bioassay was used for the larvae of *S. frugiperda*. Larval mortality data was observed after 24, 48, 72, 96 and 120h. LC_{50} and LT_{50} were also calculated through probit analysis. The Chlorantraniliprole: Emamectin Benzoate showed highest mortality of 83.33% followed by Chlorantraniliprole: Lufenuron (73.33%) at 120 hours while Spinetoram: Flubendiamide recorded lowest mortality 0.47% at 24 hours among all mixtures. The LC_{50} value for Chlorantraniliprole: Emamectin Benzoate (75:25) were 5.1µL followed by Chlorantraniliprole: Lufenuron (75:25) of 8.6µL at 120-hours. The Chlorantraniliprole: Emamectin Benzoate (75:25) achieved LT_{50} value of 35.6 hours followed by Chlorantraniliprole: Lufenuron (75:25) that were 54.3 hours. Chlorantraniliprole insecticide mixture with other showed higher toxicity with least LC_{50} and LT_{50} values with the length of exposure time as compared to other insecticidal mixtures while the least effective was found with Flubendiamide.

A Report on Incidence of Egg-Larval Parasitoid of *Spodoptera frugiperda* from Faisalabad, Punjab, Pakistan

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The fall armyworm (FAW), *Spodoptera frugiperda* (Lepidoptera: Noctuidae) is an invasive pest of maize crop in Pakistan mainly in Punjab. This study is on the incidence of an egg-larval endoparasitoid of *S. frugiperda* from maize field and its efficiency of parasitism on *S. frugiperda* under laboratory conditions. The *S. frugiperda* larvae were collected during the autumn season of maize crop in the months of July, August, and September in 2022. A *Chelonusformosanus* Sonan (Hymenoptera: Braconidae) was identified based on its morphology and biological characteristics. The maximum field parasitism was observed 13.55% from unsprayed maize field with maximum relative abundance (2.74%). The parasitism efficiency of *C. formosanus* was compared on 0 to 3-day-old aged eggs of *S. frugiperda* with three sex ratios (Female: Male); 1:1, 2:1 and 3:1 of *C. formosanus* adults. The results showed a significant and almost same parasitism rate (96-97%) in all pairs of 0-, 1- and 2-day-old eggs while parasitism rate in 3-day-old eggs ranged (22 to 55%). The 3-day-old aged eggs showed shorter

egg-larval development duration (9 days) as compared with the 0-day-old aged eggs (17 days). No significant differences were observed in pupation rate (77 to 84%) and emergence rate (79 to 84%) among all pairs. The results confirmed the presence of *C. formosanus* in Pakistan and has great efficiency to perform well on *S. frugiperda* and it is amenable to be reared in laboratory.

Assessment of Pathogenicity of Isolated EPF Strains Against Tephritid Fruit Flies (Diptera: Tephritidae)

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Tephritid fruit flies (Diptera: Tephritidae) are devastating and quarantine pest of different fruits, crops, and vegetables. Traditionally, fruit flies are controlled by different chemicals, but it has residual effects and hinders the trade of fruits and vegetables so as an alternate biopesticides are considered best option to manage the fruit flies. The research was conducted to isolate different entomopathogenic fungi (EPF) and to check their pathogenicity against *B. cucurbitae* under laboratory conditions. Three EPF strains *Lecanicillium attenuatum* (MBC-443), *Metarhizium anisopliae* (MBC-059) and *Beauveria bassiana* (MB-S-088) were isolated from soil collected from District Faisalabad and Sialkot. The maggots and pupae were used for the pathogenicity assessment EPF strains at the concentrations (1×10^5, 1×10^6, 1×10^7, 1×10^8, 1×10^9 spore mL^{-1}). The bioassay was done by using direct foliar application method, ingestion method and immersion method. The data was observed on mortality percentage and pathogenic potential after 24, 48, 72, 96 and 120 hours of post exposure interval (PEI). The mortality for maggots through foliar application method was found moderate (7.07%) at 24 hours for strain (MBC-443) while the highest mortality (55.28%) was at 120 hours for MB-S-088. The mortality for maggots through ingestion method was moderate (8.60%) at 24 hours and the highest mortality (55.99%) at 120 hours for the same strains. The mortality for pupae through foliar application method was moderate (8.92%) at 24 hours for MBC-443 and the highest mortality (54.27%) at 120 hours for the strain (MB-S-088). The mortality for pupae through immersion method was moderate at 24 hours was 9.40% for MBC-443 and the highest mortality at 120 hours was 58.32% for MB-S-088. The strain MB-S-088 (*Beauveria bassiana*) was found to be more lethal with LC_{50} value (2.2×10^5 and 3.4×10^5 CFU mL^{-1}) for both methods (foliar application and ingestion) on maggots and pupae. All the strains showed potential as a biopesticide and could be used as a biocontrol agent.

Vulnerability of Different Life Stages of Brinjal Shoot and Fruit Borer against Entomopathogenic Nematodes (*Steinernema feltiae*) and New Chemistry Insecticides

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Brinjal (*Solanum melongena*) is an important vegetable crop in Pakistan. It has a lot of dietary fibre, vitamins, and minerals and is known for its medical properties. However, the brinjal is attacked by different insects among them brinjal shoot and fruit borer (BSFB) is an important pest. The larvae of BSFB bore into the shoots, fruits, and stems of the plant causing significant damage and reducing crop yields. Different techniques such as chemicals and biocontrol agents such as are used to manage BSFB. Entomopathogenic nematodes (EPNs) and some novel insecticides can also be used to control BSFB. EPNs and novel insecticides are more specific in their action and vulnerability. The study was conducted to check the vulnerability of different concentrations of EPN (*Steinernema feltiae*) and new chemistry insecticides such as flubendiamide and abamectin against different life stages of BSFB. The experiment was conducted under complete randomized design (CRD) with five treatments and three replications. The data regarding mortality and multiplication of EPNs were recorded after 24, 48, and 72 hours. Results showed that after 72 hours 83.33% mortality was noted on the application of EPNs with concentration (100 IJs mL^{-1}) on 3rd instar larvae. The combination of EPN (*S. feltiae*) and abamectin (500 ppm +100 IJs mL^{-1}) stimulated highest mortality of 84.40% by using on 5th larval instar after 72 hours as compared to 83.33% by using *S. feltiae* and flubendiamide (1000 ppm +1001Js) on 4th larval instar. New chemistry insecticides abamectin and flubendiamide triggered 73.33% and 63.33% mortality with concentrations of 500 ppm and 1000 ppm respectively on the 5th larval instar after 72 hours. In conclusion, the highest mortality of BSFB was obtained when EPNs and new chemistry insecticides were used in combination.

Development and Evaluation of Nano-Formulation of Some Selected Phytoextracts Against Fall Armyworm *Spodoptera frugiperda* (Lepidoptera: Noctuidae)

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Armyworms (Lepidoptera: Noctuidae) are destructive pests of various crops, including maize, wheat, cotton, gram, and many vegetables. The fall armyworm, *Spodoptera frugiperda* (J.E. Smith), is one of the most destructive species in the genus *Spodoptera*. Numerous synthetic pesticides are employed to control these lepidopteran pests, but continuous use of these chemicals causes different non-target effects, such as insecticide resistance and human health hazards. So, rather than chemicals, adopt some new methods for the control of this pest. Nanotechnology and botanical extracts have traditionally been used as effective pest-control alternatives to modern insecticides. This study aimed to evaluate the most effective nano-formulated plant extract against 3rd instar *S. frugiperda* larvae under laboratory and field conditions. For this purpose, initially screened five plant extracts using the leaf dip bioassay method. Only the three most effective plant extracts were selected for detailed study.

Further screening of the most effective plant extracts formulated with 10 and 20% of silver nitrate ($AgNo_3$) nanoparticles showed that 20% formulations of *Nicotiana tabacum* and *Azadriachta indica* at 20% of concentration and Super Lock® at the recommended label dose proved to be most effective against *S. frugiperda* larvae. The 20% of *N. tabacum* and *A. indica* is further concentrated at the rates of (5, 10, 20, 40, and 80%). The findings revealed that after 72 hours of post-exposure, maximum mortality was observed in *N. tabacum* (84%) and *A. indica* (56%), with the highest concentration of 80%. In the field trial, a maize field infested with fall armyworm larvae was treated with four treatments. After 48 hours of post-treatment, Super Lock® was most effective at the recommended label dose, causing maximum mortality (100%), followed by *A. indica* (64%), and *N. tabacum* (60%) at 80% concentration. Conclusively, *N. tabacum* was most effective in the laboratory experiment. Under field conditions, *A. indica* was the most effective at reducing the *S. frugiperda* population. This study will assess the insecticidal potential of nano-formulated plant extracts against *S. frugiperda*.

Assessment of Berseem Crop as a Reservoir for Insectivorous Arthropods Feeding on Aphids along BRI

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Berseem (*Trifolium alexandrinum* L.) is known as the king of fodders crops due to its high nutritional content for livestock rearing to meet the common man meat and food requirements in Pakistan. Berseem is a natural enemy trap crop that attracts insectivorous arthropods. To share along BRI countries for green production, an experiment was conducted from December 7th to April 25th in the winter season (2022-2023) at the Entomological Research Area (ERA) of the University to check berseem as a reservoir for insectivorous arthropods. Five fixed plants sampling methods were used. As a result of weekly observations from the insect pest community we had different aphid densities across different sampling dates specifically, from sucking insect pests, overall highest mean of aphids (121.66 100 plants^{-1}) was recorded on 1st March. While from aphid species, green peach aphid (*Myzuspersicae*) was the dominant species on March 1st with (121.66 100 plants^{-1}) on April 19th, the spotted aphid (*Therioaphis maculate*) with (21.67 100 plants^{-1}) and the cowpea aphid (*Aphis craccivora*) on March 1st with a mean of (5 100 plants^{-1}), respectively from chewing insect pest leaf minor was highest on March 22nd with (28.33 100 plants^{-1}) and grasshopper with (1.66 100 plants^{-1}) on January 11th. The survey results showed that the highest mean number of insectivorous arthropods (25 100 plants^{-1}) was observed on April 19th. Among these insectivorous arthropods, on April 19th, the syrphids were highly abundant with a mean of (25 100 plants^{-1}), while the Asian ladybird beetle on March 29th with (8.33 100 plants^{-1}) and on December 28th, the spider with a mean of (5 100 plants^{-1}). These findings emphasize the dynamic interplay between aphid populations and insectivorous arthropods and enlighten the role of berseem as a potential reservoir for insectivorous arthropods.

Insect Community Interaction in Mung Bean Crop

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Mung bean (*Vigna radiata* L. Wilczek) crop is being introduced in Pakistan in the current cropping pattern for optimized production methods. Regarding a long-term pest management approach, it is essential to understand the present relationships between insect pests and their natural enemies by an open field survey during 2021 season at Entomological Research Area of University of Agriculture Faisalabad, Pakistan. As a result of weekly visual operation of mung bean crop as whole plant, overall, 17.02% sucking insects; 47.5% chewing insects and 35.40%. natural enemies were recorded. Peak activity of red cotton bug was recorded during 14-22 August while highest population of stinkbugs and jassid was recorded during flowering stage and pod sucking bug was recorded during pod formation stage. Among sucking insects, mean population of red cotton bug (15.66), stink bugs (17.3) and jassid (5.94) was recorded as, among chewing insects, mean population of gram blue butterfly (5.58), cutworm (23.46), sailor butterfly (23.46), hadda beetle (4.62), sugarcane pyrilla (3.66) and mixed population of grasshoppers (23.62) were recorded. Peak activity of natural enemies was recorded during flowering and maturity stage. Mean population of yellow paper wasp (23.49), tachinids (27.58), spiders (17.21) and seven spotted ladybird beetle (9) were recorded. This study will help to implement sustainable management strategies in benefitting manner of farming community and policy makers in agriculture sustainability.

Insect Community Dynamics in Alfalfa (*Medicago sativa* L.): Queen of Fodder along BRI

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Alfalfa (*Medicago sativa* L.) being Queen of fodders is a valuable perennial forage legume crop essential for the livestock sector in Pakistan. To share its insect community along BRI countries, an experimental open field survey was conducted to evaluate the population dynamics at different growth stages (vegetative, bud formation, flowering stages) in alfalfa field from December 2022 to April 2023 at Entomological Research Area in University of Agriculture Faisalabad, Pakistan. For this, data was recorded from the whole plant weekly by visual observation through five-point sampling method. As a result, among sucking insects four species of aphids as *Aphis craccivora, Acyrthosiphon pisum, Therioaphis maculate, Rhopalosiphum padi* and among chewing insects *Hyperapostica* and *Agromyza frontella* while among natural enemies *Coccinella septempunctata*, *Harmonia axyridis*, *Cheilomenes sexmaculata*, *Paederus fuscipes, Syrphus ribesii* and from Araneae (Spider) were identified. The

population density of *A. craccivora* (52.13%) was highest followed by *A. pisum* (33.04%), *T. maculate* (11.11%) and *R. padi* (3.6%) 100 plants^{-1}. Whereas the highest population of aphids was seen in April. Among chewing insect pests *H. postica* (73.4%) was highest followed by *A. frontella* (26.5%). The population densities of chewing insects were at its highest peak in March. Among predators *C. septempunctata* exhibited its highest population (50.0%), coinciding with the peak abundance of sucking and chewing insect pests in March. Whereas the maximum population densities of sucking and chewing insect pests were highest on bud formation stage while lowest was recorded on vegetative stage. These findings are useful for designing alternative effective pest management strategies of crop which are needed for agriculture agroecosystems. The sharing of long-term data recordings along BRI countries the fundamental basis of our findings in green technology offering valuable opportunities to students and researchers.

Ecological Status of Insect Pests and their Natural Enemies in Maize Field

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Maize (*Zea mays*) being a multipurpose crop offers raw material to industry, feed for livestock and use in poultry production. Therefore, Govt of Pakistan has focused on maize-soybean intercropping to increase the agronomic productivity along with economic proficiency. Therefore, it is significant to identify the insect pest relationship with natural enemies for sustainable pest management strategy among BRI countries. For this, an open field survey through five fixed point sampling method was conducted at early, middle, and late growth stages of maize crop during 2020-2021 at Entomological Research Area in University of Agriculture, Faisalabad, Pakistan. Overall insects' community comprised of 78.32% sucking (aphids, dusky cotton bug and stink bug) and 21.67% chewing insects (pyrilla, grasshoppers, red pumpkin beetle, corn borer and fall armyworm). Highest mean number of aphids (157.17) and pyrilla (61.24) was recorded at tasselling stage on 22nd October. Fall armyworm was also reported at V4-V5 stage of growth on 24th September. Among natural enemy community, tachinids (48.07%), spiders (27.63%) and coccinellids (24.28%) were recorded highest at silking stage on 29 October. For sucking insects (V12-V14 to tasselling stage) and for chewing insects (V4-V5 to R3) is most susceptible to control. The study will help to forecast, monitor, and implement control measures at appropriate times to get desirable objectives of sustainable integrated pest management in maize field.

Characterization of Insect Community in Kabuli and Desi Chickpea Varieties along BRI

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The chickpea (*Cicer arietinum* L.) a substantial grain legume crop which contributes greatly to food security and will become more crucial because of climate change. Numerous studies have shown that the Thal regions of Punjab, Khyber Pakhtunkhwa provinces, Sindh, and Baluchistan are where the chickpea crop is primarily grown but region of Faisalabad is newly introduced for the irrigated production of this crop, however, it lacks any trace of recent research on insect community in chickpea crop. An open field survey was carried out during the spring season 02-11-2022 to 14-04-2023 at the farm of Centre for Advanced Studies (CAS) University of Agriculture, Faisalabad to evaluate the population dynamics of insect pests and their natural enemies of Kabuli and desi chickpea varieties and to share this insect community with BRI countries for sustainable IPM. Through random sampling method the results of weekly visual observations of one leaf per plant revealed that cowpea aphid (*Apis craccivora*) at flowering stage posed a substantial threat, with the peak population of Kabuli (230.32 100 leaves^{-1}) and desi (230.32 100 leaves^{-1}) observed on 17th and 10th February. Pod borer (*Helicoverpa armigera*) population was highest (3.05 100 leaves^{-1}) on 4rth April in Kabuli while in desi variety (2.48 100 leaves^{-1}) on 23rd March. The leaf minor (*Liriomyza cicerina*) population was highest in Kabuli (0.61 100 leaves^{-1}) on 23rd March and in desi (0.75 100 leaves^{-1}) on 10th March. From natural enemies, 7-spotted ladybird beetle (*Coccinella septempunctata*) was highest on 3rd March (31.7 100 leaves^{-1}) in Kabuli while on 10th March (16.9 100 leaves^{-1}) in desi variety. Furthermore, syrphid fly (*Syrphidae*), roove beetle (*Staphylinidae*), Asian ladybird (*Harmonia axyridis*) and variegated ladybird beetles (*Hippodamia variegata*) were also observed as natural enemies. This study contributes to sustainable agricultural practices, aligning with BRI's commitment to environmentally friendly farming.

Potential of Five Different Botanicals Aqueous Extracts Against Some Sucking Insects and Mites in Laboratory Condition

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Botanical extracts are considered as the best alternative to conventional insecticides that are ecologically acceptable and environmentally safe. Since ancient times, humans have been utilizing certain plant materials and extracts as natural insecticides to control and repel the insect population. The current study was conducted to evaluate the toxicity of some botanical leaf aqueous extracts such as tobacco (*Nicotiana tabacum*), bakain (*Melia azedarach*), eucalyptus (*Eucalyptus globulus Labill*), moringa (*Moringa oliefera*) and peppermint (*Mentha piperita* L.) against aphid (*Rhopalosiphum padi*), two-spotted spider mite (*Tetranychus urticae Koch*) and thrips (*Thrips tabaci*) at different intervals of time such as 24, 48, 72 and 96 hours respectively. The leaf dip method was used for bioassay and this

experiment was carried out under a Complete Randomized Design (CRD). Data regarding percent mortality was corrected by Abbot's formula and was subjected to Tuckey's HSD mean comparison test. The botanical extracts were prepared at different dilutions: T_1= 10%, T_2= 5%, T_3= 2.5%, T_4= 1.25%, and T_5= control. As per findings, tobacco showed the highest toxicity (LC_{50} values of 0.15, 0.42 and 1.08 mg L^{-1}) respectively inducing mortality rates of 85% among aphids, 80% mortality for two-spotted spider mites and 82% for thrips. Bakain exhibited the second-highest mortality rates with LC_{50} values of 1.67 mg L^{-1}, 0.56 mg L^{-1} and 2.92 mg L^{-1}. Among others, the botanical extracts of eucalyptus showed higher toxicity as compared to moringa and peppermint. These findings demonstrate the strong potential of these botanicals as an effective strategy against sucking pests of different crops that are safe for the environment as well.

Integrated Pest Management in UAE Date Palm Agriculture: Challenges and Prospects

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For centuries, the date palm has held a central economic, social, and environmental role in the UAE and other date-producing regions. The cultivation of dates and other palm-derived products significantly contributes to both the national economy and the income of local farmers. Date palm plantations play a vital role in the agro ecosystem of UAE. However, the productivity and quality of date palm trees and their fruits have been steadily declining over the years. This decline can be attributed primarily to pest infestations and various environmental and social factors. Date palms and their fruit are susceptible to a range of insect pests, including borers, red palm weevil, lesser date moth, and mites. These pests have led to substantial reductions in date palm yield and fruit quality. Conventional insecticides, which have long been relied upon, are now proving ineffective in providing a satisfactory solution to combat these date palm pests. Furthermore, the use of such chemicals has raised concerns about their adverse environmental impacts and potential risks to human health. To address these challenges, an Integrated Pest Management (IPM) program has emerged as a promising strategy. This approach incorporates several key elements, including visual inspections, the management of pest behaviour using pheromones, crop and field sanitation, the removal of infested fronds and offshoots, and the elimination of concealed breeding sites for pests. This paper aims to provide an updated overview of IPM as a promising framework for effectively controlling major date palm pests, offering a more sustainable and environmentally friendly solution to the challenges facing date palm cultivation.

Seasonal Population Dynamics of Insect Community in Maize Field

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Investigating maize (*Zea mays* L.) fields for insect community in the current changing cropping pattern is essential for devising the integrated pest management packages. For this, an open field survey of maize was conducted during spring and fall season of (2022-2023) at Plant Breeding and Genetics (PBG) research area in University of Agriculture, Faisalabad, Pakistan adjacent to China Pakistan Corridor. The data was collected weekly through visual observation and random sampling methods. Among sucking insects, highest mean population of leaf hoppers (*Dalbulus maidis*) and aphid (*Rhopalosiphum maidis*) per 100 maize plants was recorded in spring season (118.55) and fall season (2394.54) on April 20th and October 13th, respectively. The fall Armyworm had a mean average of 1.74 per 100 maize plants on 30th March during spring season. Within the natural enemy guilds, coccinellids, staphylinids and araneae were recorded. The highest mean population (284.48 100 plants^{-1}) of rove beetles (*Paederus fuscipes*) was observed during the reproductive stage on May 11th, in the spring season. In the fall season, the mean population of spider reached its peak at 17.76 100 plants^{-1} on September 29th, during the vegetative growth stages. This research provides valuable insights into the current insect community population dynamics of pests and natural enemies in maize fields. This study would play vital role in the future pest management strategies for mixed cropping patterns involving soybean.

Response of *Nilaparveta lugens* to New Chemistry Insecticides and Entomopathogenic Fungi on Course and Fine Genotypes of *Oryza sativa*

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Brown plant hopper (*Nilaparvata lugens*) is the main pest of rice that causes serious reduction in yield of paddy. Plant hopper invasion reduces the number of productive tillers, growth vigour and plant height. Its heavy invasion causes drying and yellowing of the leaves. An experiment was conducted under field conditions to control this pest. Two new chemistry insecticides (flubendamide and chlorfenapyr) and microbial biopesticides of Entomopathogenic fungi, (*Beuveria bassiana* and *Metarhizium anisopilae*) were applied on leaves of rice genotypes (Super Basmati and KSK-133) to control the *N. lugens.* On Super Basmati, mortality rates of *N. lugens* against chlorfenapyr, flubendamide, *B. bassiana* and *M. anisopliae* were 80%, 86%, 40% and 50%, respectively, after three days of treatment. The mortality rates were 90%, 95%, 50% and 60% after 7 days of treatment. After 10 days, 80%, 85%, 75% and 83% mortality rates were observed against chlorfenapyr, flubendamide, *B. bassiana* and *M. anisopliae*, respectively. On KSK-133 mortality rate of *N. lugens* against chlorfenapyr, flubendamide, *B. bassiana* and *M. anisopliae* were 75%, 80%, 72% and 80%, respectively, after 3 days

of treatment. The mortality rates after 7 days were 90%, 95%, 85% and 87%, respectively, whereas after 10 days, mortality rate was 75%, 80%, 90% and 95%, respectively. Results revealed that mortality of biopesticides increased with the increase in exposure time. Efficacy of biopesticides was higher on coarse variety as compared to basmati variety.

Impact of Green Synthesized Nanoparticles of Zinc Oxide and New Chemistry Insecticides (Dinotefuran, Imidacloprid and Pymetrozine) against Rose Aphids (*Macrosiphum rosae*)

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Macrosiphum rosae (Homoptera: Aphididae) is the major pest of rose plants and many other crops. Very little work has been conducted in Pakistan on rose aphid management by using reduced risk insecticides. In this study, aphidicidal impact of novel chemistry insecticides (pymetrozine, dinotefuran and imidacloprid) on rose aphids was evaluated under laboratory and field conditions. For laboratory evaluation, six concentrations of each insecticide (50, 100, 150, 200, 250 and 300 ppm) was used using leaf dip bioassay method following completely randomized design with three replications. Mortality was observed after 24, 48 and 72 hours. For dinotefuran, the highest mortality was 94.31% at 300 ppm after 72 hours. In the case of pymetrozine, the highest mortality (92.85%) was observed at 300 ppm. By applying neem based ZnO nanoparticles, the highest mortality (95.57%) was observed after 72 hours. For field experiments, pre-treatment data was observed from rose plants grown at Rosa Farm, Horticultural Research Area, UAF. Post treatment reduction in aphid population was observed after 1, 3 and 5 days after insecticide application. According to the results, the highest mortality (60.44%) was observed against pymetrozine after 5 days which was at par with the result of dinotefuran causing highest mortality (58.57%). In the case of imidacloprid, maximum mortality was 46.7%.

Larval Feeding Behaviour of Spodoptera Frugiperda on Bt and Non-Bt Crops for Developing Integrated Management Strategies

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Spodoptera frugiperda (Fall Armyworm) is a highly destructive pest of corn on a global scale. While there has been extensive research on this pest, our understanding of its behaviour, particularly its movement and feeding patterns during the reproductive stages of corn plants compared to the

vegetative stages, remains limited. To address this gap, we conducted a preliminary study at the University of Agriculture, Faisalabad, Pakistan, using two different corn growth stages (R1 and R3) and four distinct plant zones (tassel, above ear, ear zone, and below ear). Further, laboratory experiments were conducted to investigate the impact of various corn tissues (e.g., opened tassel, closed tassel, silk, kernel, and leaf), two different feeding sequences (closed tassel-leaf-silk-kernel and leaf-silk-kernel), and an artificial diet on the survival and development of Fall Armyworm larvae. Our findings highlight that the ear zone of the corn plant significantly influences the feeding preferences and survival of Fall Armyworm larvae, regardless of the plant's reproductive stage. Preference for specific feeding sites among first-instar larvae were also observed during data collection. During the reproductive stages of corn plants, leaves did not exhibit any significant preference or suitability for the early instar larvae's development. However, silk and kernel tissues positively influenced the survival and development of Fall Armyworm larvae. The results of our study provide novel insights that are crucial for advancing sustainable insect control programs aimed at managing the Fall Armyworm in maize crops cultivated across various agroecological zones in Punjab, Pakistan.

Effect of Abiotic Factors on the Incidence of Sucking Pests in Bitter Gourd (*Momordica charantia*: Cucurbitaceae) and Sponge Gourd (*Luffa cylindrica*: Cucurbitaceae)

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The agriculture sector is facing many challenges due to adverse climatic conditions and complex pest infestation that have a considerable impact on its productivity. Bitter gourd (*Momordica charantia*) and sponge gourd (*Luffa cylindrica*) are two essential vegetables which are susceptible to pest infestation, like aphids, jassids, whiteflies, and mites, which can cause considerable damage to crops. This study was focused on the impact of abiotic factors against different pests on bitter gourd and sponge gourd. The pest infestation of aphids, jassids, whiteflies, and mites was investigated on bitter gourd (variety: Prachi) and Rama tori (hybrid variety of sponge gourd). The experiment involved investigating a simple correlation between pest populations and various abiotic factors, with four repetitions. Weekly data was collected from 15 randomly selected plants in each sub-block through visual examination. Correlation analysis revealed significant associations between pest population and meteorological factors such as (temperature, humidity, and rainfall). For sponge gourd, aphids (-0.31*) and jassids (-0.236*) were negatively correlated with maximum temperature, but whiteflies (0.225*) and mites (0.076*) were positively correlated with maximum temperature. All pests, like aphids (-0.12*), jassids (-0.1327*), whiteflies (-0.3382*), and mites (-0.1722*), were negatively correlated with minimum temperature. Aphids (-0.2892) and jassids (-0.0891) were negatively correlated with relative humidity. However, whiteflies showed a positive correlation with relative humidity (0.1398*). In terms of rainfall, aphids (-0.1712*), jassids (-0.1574*), whiteflies (-0.1027*), and mites (-0.2197*) were negatively correlated with rainfall. Similarly, for bitter gourd, aphids (-0.187*), jassids (-0.264*), and whiteflies (-0.292*) were negatively correlated with maximum temperature, while whiteflies (0.0041*) were positively correlated with relative humidity. Aphids (-0.031*) and jassids (-0.021*) were negatively correlated with minimum temperature. In terms of rainfall, aphids (-0.2125*), jassids (-0.0257*), whiteflies (-0.0157*), and mites (-0.201*) were negatively correlated with rainfall. These findings

provide valuable insights for developing effective pest management strategies, enhancing crop productivity, and ensuring sustainable vegetable cultivation in Pakistan.

Population Dynamics of Chewing Pests and their Predators on *Zea mays* L. in Relation to Different Abiotic Factors

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Maize crop is attacked by a variety of insect pest species that play an important role in reducing economic output. An experiment was laid out to describe the population dynamics of chewing pests such as fall armyworm, cob borer, stem borer and predators like (ladybird beetle, spiders, green lacewing, and predatory mites) in relation to different abiotic factors. The experiment was conducted in the Entomological Research Area, University of Agriculture, Faisalabad using a Randomized Complete Block Design. The data regarding abiotic factors like temperature, humidity, and rainfall were correlated with maize varieties and pest population. The whole data was subjected to Statistix 8.1 statistical program. Results of the study showed that maximum population of pest i.e., fall armyworm (*Spodoptera frugiperda*) 2.85±1.44, stem borer (*Chilo partellus*) 2.21±1.44, cob borer (*Helicoverpa armigera*) 2.11±1.32 while maximum population of predators like ladybird beetle (*Coccinella septempunctata*) 3.24±20.70, spiders 2.13±8.77, green lacewing (*Chrysoperla carnea*) 2.12±20.70, and predatory mites 2.34±1.44) was recorded during study period. Fall armyworm showed highly significant correlation with average, maximum and minimum temperature (0.837**, 0.784**, 0.8382**), but it revealed highly negative non-significant correlation with rainfall (-0.8036**). Stem borer indicated highly significant correlation with average, maximum and minimum temperature (0.817**, 0.7788**, 0.8139**) but showed negative correlation with rainfall (-0.4982*). Cob borer correlation matrix revealed that least specimen indicated non-significant relation with anyone. Spider revealed highly significant correlation with average temperature (0.545**) while ladybird beetle revealed a negative significant correlation with maximum and minimum temperatures (-0.6067**, -0.5408**). Green lacewing showed significant correlation with humidity (0.5201*), while predatory mites showed highly significant negative correlation with rainfall (-0.6428**). The findings indicated that abiotic factors have a significant influence on the number of pest and predator population in maize fields.

Technical Session IV

Advances in Food Science & Technology

Oral Presentations

Characteristics and Processing Technology of Surimi and Its Products Made from Freshwater Fish

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The high output but low value of freshwater fish in China has resulted in a large amount of freshwater fish resources not being fully utilized. Therefore, processing freshwater fish as raw materials into surimi is an effective way to utilize freshwater fish resources. Surimi is rich in protein, has a unique taste, is easy to store, and freshwater surimi can be used as a raw material for surimi products. In recent years, surimi products have gained consumers' love and have good development prospects, which can achieve the transformation of freshwater fish from low value to high value. This report elaborates on the research progress of freshwater surimi processing from several aspects, including the development history of freshwater fish surimi processing, selection of freshwater fish raw materials, processing techniques, and new processing technologies, providing theoretical and technical support for the processing of freshwater fish.

Biofortified Crops – An Opportunity for Ensuring Nutritious and Affordable Diet

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Malnutrition is rampant among women, children, and adolescents in Pakistan. Stunting, wasting, and micronutrients deficiencies have profound effects on immunity, growth, and mental development of children. The National Nutrition Survey 2018 confirmed that over a fifth of all women of reproductive age (22.1%) and 18.6% were found to be deficient in Zinc. The first biofortified zinc wheat variety was approved and launched in Pakistan in 2016. Biofortifying wheat with zinc is a highly effective, food systems approach to deliver more nutrients at scale to population of Pakistan. HarvestPlus has led the program which has now reached millions of vulnerable consumers. The success was driven by involving all actors in the wheat supply and value chain, from R&D institutions, extension workers, seed companies, farmers, aggregators, to food processors and retailers. HarvestPlus has created and published the supply chain delivery model. The sequence of activities includes capacity development of public and private sector, seed and grain production, and availability of foods accessible to beneficiaries through existing and new market channels and a development of a scaling model. The reach was expanded through increased investment in key delivery activities in seed, grains, and foods. The monitoring is done through regularly collecting the program data, and through annual farmers and value chain actors' surveys. The impact assessment on human health is also monitored through measuring the change in the population's zinc intake through National Nutrition Survey 2018. Additional studies are in progress to monitor household and market level use of zinc wheat and the subsequent health benefits. Nearly 4 million metric tons of wheat grain harvested in the cropping season of 2022-23. More than 2.1 million farming households are growing zinc wheat. More than 98 million people are now consuming biofortified zinc wheat and products. This includes nearly 13 million on farm with 100 percent replacement rate and 85 million off farms with minimum of 35 percent of the replacement rate of their grain with biofortified zinc wheat. More than 80,000 metric

tons certified seed produced for cropping season of 2023-24. Nearly same number of seed is estimated to be available as farm saved seed. The initial catalyst to scale was the support from the Government in early generation seed production and a high quality, competitive product developed through the CGIAR with subsequent new products added. Maintaining the scale is driven by market demand and promotion of nutritious foods to consumers in the marketplace facilitated by the use and adoption of digital technologies. Five biofortified zinc wheat varieties have been released which include Zincol 2016, Akbar 2019, Nawab 2021, Tarnab Rehbar and Tarnab Gabdum 1. Adopt and take calculated risks with digital technologies like digital extension, farmer platforms and digital marketing to rapid scale up of the biofortified crops. Ensure activities are promoted and easily accessed by women farmers and minority groups. Constant dialogue with Government and multidisciplinary support organizations for inclusion of specific steps of value chain to expand biofortified crops beyond zinc wheat. Ensure liaison with other nutrition interventions for a larger and harmonized impact. Continue increasing capacity of value chain actors to increase access and availability of nutritious foods.

Bactrian Camel Milk in China: Production, Research and Processing

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Renowned as “Ship of the Desert”, camels have performed a crucial role in the lives of desert dwellers since antiquity, and thus camel milk was only considered a staple diet belonging to nomadic communities. However, the consumption of camel milk has grown exponentially recently due to consumer’s understanding of its nutritional value inherent to its chemical composition as well as different health benefits. Bactrian camel (BC), which is mainly reared in Asian countries, its milk is far from being fully understood, and numerous questions remain to be discussed: what are the nutritional advantages of BC milk? What are the real functional properties of BC milk? How do processing methods affect its compositional structure and functionality? A better understanding of BC milk could allow us to obtain more insight into this unique food resource. Therefore, in comparison with dromedary camel milk, this review mainly highlighted the research results about compositional variations, potential functional ingredients, technological prospects as well and future research areas of BC milk.

Prospects of Non-Thermal Preservation Technologies in Pakistan to Reduce Food Security Burden

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Food security remains a critical concern in Pakistan, where a substantial portion of the population faces challenges related to the availability, access, and utilization of nutritious food. Traditional thermal processing methods, such as canning and pasteurization, have limitations in preserving the nutritional quality, sensory attributes, and energy cost. Non-thermal preservation technologies, on the other hand, offer innovative alternatives that can extend the shelf life of food products while retaining

their nutritional value. High-pressure processing (HPP), Pulsed electric field (PEF), Cold plasma, and Ultrasound assisted preservation are key promising non-thermal preservation technologies having prospects in Pakistan. HPP involves subjecting food products to high pressures without the use of heat. This process effectively destroys pathogenic microorganisms and extends the shelf life of perishable foods, such as fruits, vegetables, and meat, while preserving their taste, texture, and nutritional content. Given Pakistan's rich agricultural diversity, HPP can play a vital role in reducing post-harvest losses and ensuring a steady supply of high-quality food products. Pulsed electric field (PEF) processing is another emerging preservation technique that involves the application of short, intense electric pulses to food products, disrupting the cell membranes of microorganisms and thereby extending shelf life. By minimizing the need for chemical preservatives, PEF aligns with the growing demand for clean-label and minimally processed foods. Cold plasma and ultrasound-assisted preservation offer further possibilities for the Pakistani food industry. To harness the full potential of non-thermal preservation technologies in Pakistan, several challenges must be addressed. These include infrastructure development, research and development initiatives, and regulatory frameworks that ensure food safety and quality standards. Collaboration between government agencies, research institutions, and the private sector is essential to facilitate the adoption of these technologies and integrate them into the existing food supply chain. Conclusively, these technologies have the potential to reduce post-harvest losses, and extend shelf life, thus solving the issue of food security.

Facility Agriculture and the All-encompassing Approach to Food

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The conception of the ‘All-encompassing approach to food’ is proposed at first. How to adopt this strategy? The relationship between the conception with facility agriculture is summarized. The current status of facility horticulture in China is reported. How is the situation in Xinjiang? What will be done in the near future about facility agriculture in Xinjiang?

Food Safety and Nutrition: An Important Aspect of Food Security and Health

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A variety and styles of foods served/consumed (Fast Foods, Traditional Foods, Junk Foods) occupy a great portion of the food market. The foods ready to consume are raw or cooked, hotor chilled, and can be consumed at the point of sale without further processing/treatment. Despite of advantages they offer these foods are considered a major source of food-borne illnesses for several reasons. Food handlers play an important role in ensuring the safety of food products due to a lack of knowledge about food safety and food hygiene plays an important role in a healthy nation. The data thus obtained in our studies indicate a serious concern about the health of the consumer in several aspects of microbiological standards, temperature variation, and handling till the food approaches its end phase.

The kind and status of food hygiene and handling with several variations causes food-related health issues including foodborne illness and other non-communicable diseases. The situation ultimately reflects inefficient food security to meet the future population's requirement for safe and healthy food. Policies are to be rephrased under the circumstances concerning agricultural produce, focused and critical postharvest technologies, processing, and storage of food products for healthy nations. The advanced practices will be helpful until awareness among consumers for food free from disease increases the economy of the country by providing guidelines to food processors and vendors to harmonize their production and processing patterns.

Reducing Muscle Food Loss and Waste: Extend Shelf Life and Utilize Muscle Food By-Products

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Muscle foods (meat, poultry, and seafood) provide high-quality protein foods and micronutrients (e.g., iron, zinc, and B vitamins) for humans. However, muscle foods are accidentally or intentionally lost or wasted throughout the supply chain, from initial production through to final household consumption. Food and Agriculture Organization (FAO) reported yearly global food loss and waste at roughly: 20% of meat and poultry, and 35% of fish. The loss and waste of muscle foods have a host of environmental impacts, including unnecessary greenhouse gas emissions and the inefficient use of inputs such as water, energy, land, etc., which in turn can lead to diminished natural ecosystems and the services they provide. If we want to meet the demand for muscle foods without further harming our planet, we're going to need to produce them more sustainably. Lipid oxidation is one of the most critical factors that affect muscle food quality and shelf life during process and storage. Furthermore, a huge amount of muscle processing by-products leaves the food chain and becomes animal feed or waste although the by-products (e.g., fish) contain high amounts of long-chained omega-3- and protein-rich muscle tissue. In this research showcase, we will present lipid oxidation mechanisms in selected meat, poultry, and fish sources, and different ways to control it. Results from the development of a new holistic process line for sorting, stabilization, and use of fish by-products are to be outlined. Based on a long collaboration with the Swedish and international seafood industry, our team is close to having the new techniques industrially implemented. Via ongoing EU/national projects, we already collaborate closely e.g., with Sweden's largest herring/sprat processor and upscaling trials on site have provided highly promising results.

Assuring Food Security Through Biofortification and Fermentation Technology

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The food security is a fundamental right of every individual, and it is the duty of the nations to ensure access of every individual to nutritious and safe food. The continuous growth of the world's population, which is predicted to reach 09 billion people by the year 2050, is a significant obstacle to achieving

global food security. As a result, it is vital to take into account the requirement to feed a growing global population in terms of not only quantity but also the quality which to ensure food safety and nutritional security. The nutritional insecurity causes due to lack of food diversification as well as the quality of the food including poor nutritional profiling and presence of anti-nutritional factors which make the nutrients un-available. Although different programs of food fortification and supplementation have been launched all over the world, however, these programs are also limited to the fortification of specific targeted nutrients, and ultimately, the consumer fails to get all necessary nutrients required for a healthy life. In such circumstances, it is of great significance to find ways to naturally fortify foods, and to increase the bioavailability of the nutrients in the foods to cope with the problems related to nutritional deficiencies. Biofortification and fermentation technology seems to be the good natural technique to manage nutritional insecurities. As a case study, we used fermentation technology to enhance the bioavailability of nutrients and found a significant increased bioavailability of the nutrients. The microorganisms and their metabolites have the availability to improve the nutritional profiling of the food products as well as have the ability to reduce the anti-nutritional factors.

The Role of Vitamin A in the Regulation of Glucose and Fatty Acid Metabolism

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We have investigated the roles of vitamin A in the development of chronic metabolic diseases such as obesity and type 2 diabetes. The data from my lab have clearly shown that vitamin A status and its metabolism contribute to metabolic homeostasis. The lowered dietary vitamin A status leads to the reduction of obesity and correction of type 2 diabetes in Zucker diabetic fatty rats. Further studies of vitamin A and its involvement in fuel metabolism will help us to identify targets for the intervention of metabolic diseases.

The Research and Application of Comprehensive Utilization Technologies of Sweet Potato By-Products

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Sweet potato is the fifth largest major food crop in the world, and it is rich in starch, dietary fibre, protein, vitamins, minerals, etc. Sweet potato is mainly used to produce starch, a large amount of residues and wastewater is generated during this process, while most of them are discarded as waste directly, and the aboveground sweet potato leaves are also not effectively utilized, resulting in significant resource waste and environmental pollution. The above-mentioned wastes are rich in protein, fibre, polyphenols, etc., however, their structure is not very clear, the functional characteristics have not been well explored and confirmed, as well as there is a lack of nutritional and healthy products. Therefore, our team is committed to researching the key technologies for comprehensive

utilization of by-products from sweet potato processing and nutritional and healthy foods, the main research and development progress was as follows: the green and efficient extraction technologies for protein, peptides, dietary fibre, pectin, nano cellulose (cellulose nanocrystals, cellulose nanofibers), polyphenols, anthocyanins, etc. from by-products of sweet potato processing were established, the nutritional and healthy foods, *e.g*., probiotic fermented beverages, low glycaemic index vermicelli, etc. were also developed based on the investigation of the structure and functional characteristics, *e.g*. anti-cancer, antioxidant, anti-hypertension, hypoglycaemic, hypolipidemic, and regulating gut microbiota of above components, finally, the industrialized production lines of the components and based foods of different scales were created. The relevant achievements are of great significance for accelerating the upgrading of the sweet potato processing industry, improving the nutritional health of the residents, and protecting the ecological environment.

Technical Session IV

Advances in Food Science & Technology

Poster Presentations

Identification and Quantification of Intact Glucosinolates at Different Vegetative Growth Periods in Chinese Cabbage Cultivars by UHPLC-Q-TOF-MS

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This study aimed to investigate glucosinolate variations in Chinese cabbage cultivars at different growth periods. Glucosinolates in two types of Chinese cabbage (Xiayangbai and Zaoshu-5) at different growth periods (seeds, germination, seedling, and rosette period) were investigated. Thirteen glucosinolates were identified and quantified using UHPLC-Q-TOF-MS. Concentrations of the glucosinolates were significantly different between Xiayangbai and Zaoshu-5. The seed period generated the highest concentration of glucosinolates, and aliphatic glucosinolate predominated in seeds, seedlings, and leaves of the rosette as well as during germination. However, the dominant glucosinolate in the roots was aromatic (gluconasturtiin). In addition, glucoerucin was only found in the roots of rosettes. There were positive significant correlations with each other among gluconapin, glucobrassicanapin, glucoraphanin, glucoalyssin, and 4-hydroxy glucobrassicin. Our results released the metabolism pathways of glucosinolates in Chinese cabbage, which provided scientific evidence to develop functional foods with higher glucosinolate.

Effect of Soil and Post-Flowering Foliar Zn Application on Growth, Physiology, Yield, and Grain Zn Content in Bread Wheat

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Zinc (Zn) and Iron (Fe) deficiencies are the most important types of malnutrition which affect one-third of the global population. Bread Wheat (*Triticum aestivum* L.) is a significant staple crop and a principal source of nutrition for more than 2.5 billion people around the world. Although it is a major source of a wide range of micronutrients in several less developed countries, however, it lacks important micronutrients like Zn and Fe. Biofortification is a long-term and cost-effective strategy to cope with malnutrition by enhancing the Zn and Fe accumulation in the edible plant parts. In the current study, a set of genotypes including commercial (biofortified and non-biofortified) wheat cultivars and advanced elite lines were tested with soil and foliar Zn applications to assess the response. The field experiments were conducted at the experimental area of the Department of Plant Breeding and Genetics on alkaline and Zn deficient soils. All genotypes were grown with four different treatments viz i) no soil or foliar Zn (control), (ii) Soil Zn only, (iii) Foliar Zn only (iv) Soil + foliar Zn. Foliar Zn was applied at the grain formation stage in the form of $ZnSO_4$. All the yield parameters including plant height, peduncle length, flag leaf area, spikelets per spike, no of tillers per plant, spike

length, mother spike weight, thousand grain weight, and grain yield per plant were significantly enhanced in soil and foliar Zn applications in all genotypes. Among all the tested genotypes, a biofortified commercial variety Akbar-19 showed the highest yield (3634.72 kg ha^{-1}) with all treatments followed by an elite line SD-75 (3409.6 kg ha^{-1}). Micronutrient profiling analysis of harvested grains showed that Akbar-19 had higher Zn content (45mg kg^{-1}) in soil+foliar treatment. In conclusion, soil + foliar Zn application is the most effective strategy to enhance the grain yield as well as Zn and Fe concentration in wheat grain.

Clove Oil Loaded Active Edible Nano-Coating for Extension of Kinnow Shelf Life

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Clove essential oil (*Syzgium aromaticum*) is a potential postharvest deterioration-controlling alternative to synthetic fungicides. *Penicillium digitatum*, the reason for citrus green mold, is a pathogenic fungus that adversely affects the postharvest quality of citrus fruit (Kinnow) and causes serious economic losses. During this investigation, active edible nano-coating containing clove oil nano-emulsion main component eugenol 76.8% and tween-80. An antimicrobial component from clove oil (*Syzgium aromaticum*) eugenol, was prepared using a microfluidizer as clove oil with tween-80 loaded active edible coating, and the antifungal activity of the nano-emulsions against *P. digitatum* was evaluated based on the conidial germination rate, mycelial growth, hyphae growth, spore growth rate, and compound electron microscopy analysis. The results discovered that the minimum inhibitory concentration (MIC) at 0.32% v/v and the inhibition rate of active edible coating loaded clove oil nano-emulsion was 70.2%, respectively, which was more potent than that of the clove-free nano-emulsion. After treatment with the loaded nano-emulsions as dip coating, the integrity of the *P. digitatum* cell membrane was disrupted, the cell structure was abnormal. The in-vivo antifungal technique using 0.32% v/v showed a significant impact against *P. digitatum*, inhibiting growth, and prolonging resistance to spore germination. In addition, the time-kill dynamic test on Kinnow revealed that the clove oil-loaded nano-emulsion inhibited citrus infection for longer periods, with an infection rate of 56.5% after 4-5 days. The current research showed that nano-emulsions containing clove oil and Tween -80 have effective antifungal activity against *P. digitatum* and may be used as a substitute for inhibiting green mold in Kinnow. This study recommends using plant natural extract like clove oil, which is more effective against fungal growth by combating fungal resistance in the form of an antifungal coating that will increase the shelf life and resistance against fungus in citrus.

Dietary Supplementation of Synbiotic vs Antibiotics as Growth Promoters in Japanese Quails (*Coturnix japonica*)

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The study was conducted to evaluate the effect of synbiotic levels in comparison to standard doses of antibiotics as growth promotors. The research was conducted at Raja Akram Animal Nutrition Research Center. The trial period was 42 days. A total of 240 quail birds was obtained. Birds were divided into four treatments with six replicates and ten birds in each. A corn-soybean-based diet was formulated with 21% CP and 2900 Kcal kg^{-1} ME. Dietary treatments were A) Zinc bacitracin 0.5 g kg^{-1} of diet, B) synbiotic 1.0 g kg^{-1} of diet (0.5 g kg^{-1} *Bacillus subtilis* + 0.5 g kg^{-1} Manna-oligosaccharide), C) synbiotic 2 g kg^{-1} of diet (1 g kg^{-1} *Bacillus subtilis* + 1 g kg^{-1} Mannan-oligosaccharide) and D) synbiotic 2.5 g kg^{-1} of diet (1.25 g kg^{-1} *Bacillus subtilis* + 1.25 g kg^{-1} Mannan-oligosaccharide). Data on feed intake, weight gain, and feed conversion ratio were recorded on a weekly basis. At the end of the research two birds from each replicate were slaughtered. There small intestinal parts and digesta of small intestine was preserved for intestinal morphology and intestinal microbiota parameters thereafter dispatched to respective laboratories. The results of feed intake for all treatment groups were non-significant ($P>0.5$). Highest feed intake was noticed in treatment A (690.11 g $bird^{-1}$) with lowest weight gain (170.44 g $bird^{-1}$). But the body weight gain and feed conversion ratio show significant change as compared to antibiotic-based treatment. The weight gain was significantly improved in treatment group D (181.45 g $bird^{-1}$). The feed conversion ratio of treatment group C (3.68) was significantly better as compared to other treatment groups. Supplementation of synbiotics at 2.5 g kg^{-1} improved the intestinal morphology of birds. Increased villus height and crypt depth ratio were observed with increasing amounts of synbiotics. The maximum value of villus height to crypt depth ratio was observed in treatment D. Increased intestinal microflora count (3.6 CFU g^{-1}) was observed in birds fed diet containing synbiotic 2.5 g kg^{-1}. It is concluded that probiotic and prebiotic-based synbiotics proved to be growth promotors and can be used as alternatives to antibiotic growth promotors. These synbiotics increase growth performance, gut health, and beneficial microbiota count in the intestine. Synbiotics can improve the feed conversion ratio. Its supplementation can increase body weight and improve meat quality.

Blockchain-based Cold Chain Logistic and Traceability Model for Agri-Products

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The cold chain in agriculture is a critical component of modern food supply system, ensuring that fresh products such as fruits, vegetables, dairy products, and meats reach consumers in a safe and high-quality condition. It involves careful planning, infrastructure, and technology to maintain temperature control throughout the journey from farm to table. Maintaining a consistent cold chain and traceability is essential to ensure these products' quality, safety, shelf life, reliability, and traceability. While the Internet of Things (IoT) has provided solutions for monitoring environmental conditions, product quality, and traceability, these solutions typically rely on a centralized architecture that lacks secure

data sharing. However, the cutting-edge technology of blockchain allows for tamper-proof real-time data sharing. This work presents a Hyperledger Fabric-based blockchain model for cold chain logistics to track and trace the supply chain, reducing risks associated with quality, safety, and reliability. This work offers decision support for monitoring real-time data like temperature, humidity, and bacteria growth in the cold chain and predicting the shelf life of products. The IoT collects real-time environment data transmitted to a remote server through a gateway. In the pilot model, radio frequency identification (RFID) technology tracks fresh products within the cold chain. This cold chain model helps to prevent harmful microorganisms' growth while reducing the risk of foodborne illnesses. Moreover, agri-products remain fresh longer, allowing for broader distribution and market reach. Furthermore, it helps to maintain the taste, texture, and appearance of agricultural products.

Crop Type Identification using Multitemporal Sentinel-2 imagery and Deep Learning Models

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Efficiently identifying crops on a large scale is essential for making policies that support sustainable agriculture in Punjab, Pakistan. This region is known for its intricate cropping patterns, posing a substantial challenge for conventional crop identification methods. However, recently accessible Sentinel-2 (S2) satellite imagery has emerged as a valuable data source, offering rich information on land cover and vegetation dynamics. This is mainly due to its impressive spectral, spatial, and temporal resolutions. For classifying S2 time series imagery, various deep learning (DL) models have recently gained significant popularity. Nevertheless, conventional DL models relying on temporally aggregated remote sensing imagery often exhibit suboptimal performance when applied to complex cropping patterns. Hence, it is imperative to develop a classification model by integrating appropriate feature sets to identify crops, especially in complex cropping regions of Punjab. Therefore, this work presents an innovative method for crop identification by leveraging a state-of-the-art deep-learning model and cropping parameters utilizing S2 multispectral imagery. Cropping parameters include multitemporal vegetation indices, textural and phenological features extracted from S2 imagery, and topographic features of the Punjab region, which are derived as input features. These experiments' results demonstrate the proposed approach's effectiveness in achieving high accuracy in crop identification across diverse agricultural contexts.

Fabrication, Performance and Curcumin-Controlled Release of Electro-spun Sarcoplasmic Protein Nanofiber Films Via Layer-By-Layer Self-Assembly

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The recycling and high-value application of fish sarcoplasmic protein (FSP) from the surimi rinsing wastewater can promote the sustainable development. This work successfully fabricated monolayer nanofiber films and three-layer nanofiber films with cellulose acetate (CA) nanofibers as the outer layer to encapsulate curcumin (CUR) based on chitosan flocculated and direct freeze-dried FSP (CFSP and DFSP) through electrospinning and layer-by-layer (LBL) self-assembly, and investigated the films microstructure, performance, and CUR release behaviour. The nanofibers exhibited uniform, smooth, and beadles' morphology, with a clear interface but strong interactions between the adjacent layers for three-layer films. The CA-CFSP/CUR-CA three-layer film possessed the best flexibility (elongation at break 6.5%), surface hydrophobicity (water contact angle 130.5° ± 2.6°) and thermal stability, suggesting its potential application in food packaging. The CUR release kinetics in all nanofiber films well fitted to First-order model, reflecting a release driven by concentration gradient. The monolayer films quickly released CUR in neutral PBS. The CA-DFSP/CUR-CA three-layer film could resist gastric acid and controllably released ~18% CUR in the first 60 min and cumulatively up to 45.2% within 480 min, following diffusion-controlled Fickian release in simulated gastric-intestinal fluid (SGF-SIF), implying great applications potential in sustained release. This study can not only advance the surimi processing field by recovering and utilizing FSP from the surimi rinsing wastewater, but also expand the application of FSP for food packaging and drug delivery fields.

Development of Food Science and Technology Based on Cell-Cultured Meat

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In recent years, significant advancements have been made in the field of food science and technology, revolutionizing the way we produce and consume food. This includes the development of cell-cultured meat, also known as lab-grown or cultured meat. This emerging technology presents a promising solution to address the environmental and ethical challenges associated with traditional meat production. The key technologies of cell-cultured meat are as follows. Firstly, advancements in tissue engineering and biotechnology have enabled researchers to isolate and proliferate animal cells, making it possible to produce muscle, fat, and connective tissues, thereby mimicking the composition of real meat. These isolated primary cells are cultured in a controlled environment using a nutrient-rich medium to support their growth and development. Furthermore, researchers have made significant progress in improving the scalability and cost-effectiveness of cell-cultured meat production. Novel bioreactors and cell culture techniques have enabled more efficient production of substantial amounts of meat. Additionally, the use of defined components in the growth medium has enhanced the sustainability of cell-cultured meat and reduced its dependence on animal-derived

serums. Cell-cultured meat technology can eliminate reliance on traditional livestock agriculture, aiding in the reduction of environmental footprints associated with animal production, including greenhouse gas emissions, land use, and water consumption. Moreover, it does not involve the slaughter of animals, potentially addressing ethical concerns regarding animal welfare. Additionally, with the maturation of cell-cultured meat technology, there is the potential to significantly lower meat costs and improve the quality of life for individuals. In conclusion, the advancements in food science and technology have paved the way for the development of cell-cultured meat as a sustainable and ethical alternative to traditional meat production. Further research and development are required to overcome the existing challenges and unlock the full potential of this innovative technology.

Effective Therapeutic Verification of Crocin I, Geniposide, and Gardenia (*Gardenia jasminoides* Ellis) on Type 2 Diabetes Mellitus In Vivo and In Vitro

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For many centuries, Gardenia (*Gardenia jasminoides* Ellis) is highly valued as a food homologous Chinese herbal medicine and various bioactive compounds are found in gardenia, of which crocin I and geniposide are representatives. However, the functional mechanism of underlying the hypoglycemic effect of gardenia is missing in literature. To evaluate the effect of gardenia and its different extracts on type 2 diabetes mellitus (T2DM) by in vivo-in vitro experiment, the dried powder of gardenia was extracted with 60% ethanol and eluted at different ethanol concentrations to obtain the corresponding purified fragments. After that, the active chemical composition of different purified fragments of gardenia was analysed by HPLC. Then the hypoglycemic effects of different purified fragments of gardenia were compared by in vitro-in vivo experiments. Finally, the different extracts were characterized by UPLC-ESI-QTOF-MS/MS and the mass spectrometric fragmentation pathway of the two main compounds, geniposide and crocin I, were identified. Experimental results indicated that the inhibitory effect of 40% EGJ (crocin I) on α-glucosidase was better than that of 20% EGJ (geniposide) in vitro. However, the inhibitory effect of geniposide on T2DM was better than that of crocin I in the animal experiments. The different results in vivo-in vitro presumed that the possibly different mechanisms between crocin I and geniposide on T2DM. This research can demonstrate that the mechanism of hypoglycemia in vivo by geniposide is not only one target of α-glucosidase and provide experimental background for crocin I and geniposide deep processing and utilization.

Technical Session V

Animal Health & Disease Control

Oral Presentations

Thematic Research and Services by the Faculty of Veterinary Science, UAF: A SWOT Analysis

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With a vision to provide state of the art veterinary education, services and skill development, promotion of animal health and production to cope food security in Pakistan, and policy guidelines and action plan for ministry of livestock, animal husbandry commission and Pakistan Veterinary Medical Council, the Faculty of Veterinary Science (FVS), University of Agriculture, Faisalabad (UAF), Pakistan has the following research groups including (a) emerging/infectious diseases of livestock and poultry with focus on tuberculosis, brucellosis, glanders, mastitis, IBD, CCPP, LSD, vector-borne disease, and their one health aspects, (b) insecticides/pesticides at animal-human interface, (c) ethno-veterinary products, (d) assisted reproductive technologies for *in-vitro* fertilization and embryo transfer. In diagnostics, FVS has developed/ standardized rapid, cheaper tests viz., detection of antibiotic residues and antimicrobial resistance (AMR) in animals, mastitis, LAMP assay (brucellosis) and lateral flow assay (glanders). Major strengths include conventional and modern facilities for risk assessment and mapping of diseases of one health significance, necropsy services for farmers, cell culture and egg-adapted vaccine production, vaccines (e.g., ND thermostable, IBD, mastitis) and hyperimmune sera, and mycotoxin binders from locally available bentonite clays and yeast sludge, use of indigenous phytochemicals for prevention of diseases, identification of natural anti-cancerous therapies. Significant products include Heat Stress Solution, Mycotoxin Binder, Poultry Gut Probiotic, Biomaskil- for mosquito control, MASTIPEP - vaccine for mastitis, ND thermostable vaccine- poultry, Lysibody and Bacteriophage prototype for drug resistant bacteria, and Biodewormer- herbal product. In livestock production and breed improvement, major services include semen production and sale, in-house cases, artificial insemination, IVF lab, pregnancy diagnosis, caesarean section, and clinical ambulatory services. The FVS runs state-of-the-art diagnostic laboratories in 9 departments/ institutes and BSL-3. This also closely works with the Brook's equine mobile unit for community service. Potential areas of collaboration include but not limited to veterinary vaccines and diagnostics, veterinary herbal products and binders, bacteriophage therapy and AMR, detection of drug/pesticides residues in animal products, clinical skill development, R&D and capacity building, veterinary vocational training for students and faculty. We aim to develop fruitful and sustainable professional ties for combatting the nuisances in the livestock production system; hence improving the livelihood of the farmers and ensuring food security through better livestock products.

Mechanisms of Environmental Adaption, Growth, and Pathogenesis of Veterinary and Zoonotic Bacteria

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Environmental and host adaption is prerequisite for the growth, transmission, and pathogenesis of a pathogen. To understand the adaption mechanisms of pathogenic bacteria, the transcriptomic method

SCOTS was used to identify the genes of *Streptococcus suis* and *Glaesserella parasuis* induced by different environments including infection in pig, cultivation at anaerobic, high temperature, low pH and iron-limit conditions, and the roles of these genes in environmental adaption and pathogenesis were investigated by *in vitro*, *ex vivo* and *in vivo* experiments. Some of these induced genes are real virulence factors (VFs) while most of them function as factors regulating the bacteria survival *in vitro* and/or *in vivo*, i.e., the environmental adaption factors (AFs). Identification and functional characterization of the AFs will contribute to full understanding of pathogenesis and found of targets to antibacterial infections. Antimicrobial resistance (AMR) is also a result of bacterial adaption and evolution and becomes a great threat for public health. Our survey and population genomic study identified a novel human-adapted and a pig-adapted clonal lineage of MRSA, and separate human and livestock ST398 clades in China. Understanding the diverse mechanisms of formation and transmission of AMR is of major important to tackle this global challenge. Identification of novel antibacterial targets is an urgent task to combat AMR. We are trying to find antibiotic targets on bacterial metabolic pathways, cell division machinery, virulence factors, and bacterium-host interaction. Several candidate targets have been identified and validated, and inhibitors were designed and screened out based on the targets. These efforts are only the first step of the Long March, but necessary!

Genotyping and Multi-locus Sequence Typing (MLST) of Extended-Spectrum Beta-Lactamase (ESBL)-Producing *Escherichia coli* Isolates from Cows with Mastitis in China

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The prevalence of pathogenic multidrug resistant ESBL-producing Escherichia coli is rapidly increasing, thus becoming a global concern in veterinary and public health. Therefore, this study was designed to investigate the genotypes and multi-locus sequence typing (MLST) of ESBL-producing E. coli from diverse dairy farms of China. The results showed that out of 150 *E. coli* isolates from 2038 mastitic milk samples belonging to 16 different provinces of China, a total of 20% *E. coli* (*n* = 49) was confirmed as ESBL-producers by double disc synergy test and further PCR assays. Sequence analysis revealed ESBL-producers belong mainly to CTX-M genotype (*n* = 44) *viz*., CTX-M-15 = 34, CTX-M-55 = 4, CTX-M-14 = 4, CTX-M-3 = 2 and CTX-M-1= 1. Epidemiological details of the prevalent STs based on the MLST data of all 49 isolates revealed a total of 34 STs, of which 12 STs were not assigned to any type, and identified as novel STs, reflecting the extent of diversity. STs 410 (10%), 361 (7%), 4085 (7%), 117 (7%), 58 (7%), 744 (5%), 2008 (5%), 121 (5%) and 1290 (5%) were the most prevalent, while STs 761, 5442, 3476, 2521, 392, 1080, 2035, 215, 5746, 88 and 69 were the least (2%) prevalent. MLST analysis revealed two lineages in the population, comprised of a dominant lineage containing most of the isolates. This study concludes that ESBL-producing *E. coli* are considerably contributing to mammary infection in cattle in China. This may threaten veterinary and public health due to robust dissemination mechanisms of ESBL encoding genes. This study may also demand to deeply comprehend the molecular epidemiology of ESBL-producing *E. coli* and other serious pathogens causing mastitis in dairy cattle of two neighbouring countries China and Pakistan and their cross-dissemination.

Research on Key Technologies for Prevention and Control of Equine Herpesvirus Type-1 Infection

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Equine herpesvirus type 1 (EHV-1) poses a global threat to equines. EHV-1 infection can cause a range of disease syndromes of variable severity that can result in a lethal outcome and restriction of horse movements, especially in the case of outbreaks involving neurological disease. This report briefly describes the pathogenesis and infection mechanism of EHV-1, with emphasis on the research progress of prevention and control technology in our laboratory.

Resurgence of Brucellosis: A Dual Threat to Animals and Humans in Pakistan

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Brucellosis, caused by Brucella species, continues to pose a significant public health challenge in Pakistan, marked by its endemic nature and recent resurgence. This study offers a comprehensive overview of the current status of brucellosis in both animals and humans in Pakistan, drawing upon the research conducted in last one decade in Pakistan. The studies shed light on the intricate epidemiological landscape of brucellosis, underlining its zoonotic potential and the close interplay between animals and humans in its transmission dynamics. Pakistan's vital livestock sector, which constitutes the backbone of the economy, acts as a pivotal reservoir for brucellosis, with notable seroprevalence rates observed in various species including cattle, buffalo, sheep, and goats. This exerts a significant economic burden owing to reduced productivity and trade limitations. Moreover, the study emphasizes the prevalent underdiagnosis and underreporting of human brucellosis cases in Pakistan, reflecting a substantial gap in disease surveillance and healthcare infrastructure. The occupational hazards faced by livestock handlers, veterinarians, and abattoir workers emerge as critical concerns, necessitating targeted interventions to curb transmission. The emergence of antibiotic-resistant strains of Brucella further complicates control endeavours, calling for a multifaceted approach. This approach should encompass vaccination strategies in animals, enhanced diagnostic capabilities, and prudent antimicrobial use in both veterinary and human healthcare settings. In conclusion, the resurgence of brucellosis in Pakistan warrants immediate attention from public health authorities, veterinarians, and healthcare professionals. A coordinated, interdisciplinary approach is imperative to tackle this resurgent threat, safeguarding the health of both animals and humans, and ensuring the sustainability of Pakistan's livestock industry. This review stands as a crucial resource for policymakers, researchers, and healthcare practitioners involved in brucellosis control

efforts in Pakistan.

Study on the Anti-Infection Mechanism of Traditional Chinese Veterinary Medicine

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The etiology of diseases in livestock and poultry breeding is multifactorial. In clinical cases, mixed viral and bacterial infections are predominant, necessitating reliance on vaccination for prevention and antibiotic therapy for treatment. However, this practice has led to the emergence of significant bacterial drug resistance, posing a substantial threat to the overall health management of livestock and poultry. Therefore, in clinical practice, there is an increasingly urgent technical need for alternative antibiotics to prevent and control infectious diseases, such as Traditional Chinese veterinary medicine. The active ingredients of Chinese veterinary medicine and traditional Chinese medicine, namely Huang Bai Jian Pi oral liquid, Asiatic Acid, Phillygenin, and Baicalin, are utilized in this study. They possess the advantages of a diverse array of sources, absence of drug residues, and multiple targets, however, the underlying mechanism behind their anti-infection induced by virus and bacterial remains elusive. In this study, the anti-IBV effect of Phillygenin and Baicalin, the anti-salmonella effect of asiatic acid, and the treatment of Huang bai jian pi oral liquid on calves with dampness-heat diarrhoea were studied. The results showed that phillygenin and Baicalin up-regulated the formation of stress granule, and activated PKR/eIF2α signalling pathway, ultimately inhibited IBV replication in cells, and protected inflammatory damage caused by IBV infection in cells and broilers by inhibiting TLR7/MyD88/NF-κB signalling pathway. Asiatic acid reduced the damage of central nervous system induced by salmonella via inhibiting the activation and inflammatory response of microglia. Huang bai jian pi oral liquid improved intestinal flora homeostasis of calf with dampness-heat diarrhoea by regulating the level of *Escherichia coli*, flavonifractor, koala bacillus and other microorganisms in intestine, and alleviated intestinal inflammatory response caused by dampness-heat diarrhoea via inhibited PI3K/AKT/NF-κB signalling pathway. Taken together, our results indicated that Huang Bai Jian Pi oral liquid, Asiatic Acid, Phillygenin, and Baicalin may be effective and novel drugs to against infection caused by virus and bacterial, which provides scientific evidence for their clinical application.

An Example of the China-Pakistan Collaborative Continuum on Tick-borne Diseases in Livestock Animals

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Ticks and tick-borne diseases are considered a major challenge for human and animal health in tropical, sub-tropical, and temperate regions of the world. We ran three studies on livestock, in Pakistan and China and other collaborating countries. Study 1 was conducted on Q fever in livestock in Pakistan. Coxiellosis, also known as Q fever, is a zoonotic disease caused by *Coxiella burnetii*, a gram-negative bacterium that exerts a significant deleterious impact on the productive and reproductive capabilities of livestock, severely effecting the economics of this sector. In this study, 448 sera samples from cattle (n = 224) and buffalo (n = 224) were collected from 112 farms in Pakistan and examined for antibodies against *C. burnetii* using an indirect ELISA. Serological analysis revealed a 23.66% and 27.23% seroprevalence of Q fever in cattle and buffalo, respectively. Odds ratio (OR) analysis of the factors associated with *C. burnetii* seropositivity was performed, and a multivariable logistic model identified five main variables associated with the seropositivity for coxiellosis. Study 2 was conducted on *Rhipicephalus microplus* ticks in Pakistan. A total of 600 cattle from 20 farms were examined for the tick infestation, among them 358 (59.7%) cattle were infested with ticks. A total of 2118 nymph, larvae and adult tick stages were collected and morphologically identified followed by molecular confirmation of *R. microplus*. Host-based demographic and ecological parameter analysis revealed significantly higher tick infestation in adult, female, exotic, freely grazing, and with irregular/no acaricides treated cattle. Microscopy-based examination identified four different species of ticks including *R. microplus* (44.5%), *Hyalomma anatolicum* (38.5%), and *Hyalomma marginatum* (10.5%) and *Hyalomma excavatum* (6.5%). Tick infestation pattern showed that 55.9% of cattle was found co-infested with *R. microplus* and *H. anatolicum* followed by *R. microplus* and *H. anatolicum* and *H. marginatum* (29.3%) then *R. microplus*, *H. anatolicum*, *H. marginatum*, and *H. excavatum* (11.2%). Study 3 reported KAPs in livestock owners in Pakistan about ticks and tick-borne diseases of respondents from Sindh, Pakistan. A total of 240 respondents were interviewed from different ecological zones: among them, 42.5% (n = 102) of the respondents practiced the manual removal of ticks from animals, while acaricide usage was indicated by 137 respondents (57.0%) as occurring sometimes, 50 (20.8%) monthly, 41 (17.0%) fortnightly, and 12 (5%) weekly, during the peak infestation season. Ticks were 2.6 times [OR = 2.5 (95% Cl = 1.47–4.06)] and viruses were 1.89 times [OR = 188 (95% Cl = 1.09–2.9)] more likely to cause the development of disease in animals than any other pathogen. Despite the appropriate usage of acaricides, the knowledge of participants was inadequate.

Development of Transmission-Blocking Vaccines Against Ticks and Tick-Borne Pathogens

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Transmission-blocking vaccines for Bovine babesiosis, theileriosis, and anaplasmosis targeted against tick-host remain a high-impact animal health strategy. A cost-effective tick-targeted transmission-blocking vaccine should be broadly protective and clear the pathogen within the tick vector. Our study aimed to develop a multi-subunit protective vaccine based on conserved tick and pathogen antigens. The enzootic cycle of *Babesia bovis* and *Theileria annulata* offer an opportunity to target the infection within the tick vector *Rhipicephalus microplus* and *Hyalomma anatolicum* because *Babesia bovis/Theileria annulata* are passed transovarially to the next generation. To interrupt the life cycle of *Babesia bovis/Theileria annulata* within the tick host, the vaccine needs to include tick and pathogen antigens required for the pathogen infection and the prolonged tick feeding on the host. We identified tick and pathogen antigens critical for the pathogen infection and formulated a multi-subunit vaccine candidate to specifically target the tick vector to block vertical and horizontal transmission of pathogen. We began addressing this need by utilizing massive RNA-Seq, discovery proteome, and reverse genetic approaches to identify such tick antigens. We tested the immunogenicity and protective role of the recombinant-protein based vaccines in animal models.

Challenges in the Poultry Sector of Pakistan

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Poultry is one of the leading industries of Pakistan with an annual turnover of 700 billion rupees It plays a remarkable role in nourishing quality protein in the form of eggs and meat to nearly 200 million people. To sustain its growth and its impact on the GDP, the poultry sector is advancing in housing, nutrition, breeding genetics, and biosecurity measures and implementation. Feed constitutes a major segment (70-80%) in the cost of poultry production and currently approximately 8.2 MMT of poultry, feed is produced annually. Recently in October 2022, there was a ban on the import of GMO soybeans from the government of Pakistan. Corn and soybeans are the major components of poultry feed manufacturing. This restriction increased the load on alternative protein sources. This situation shifted the burden to alternative sources including Canola Meal, Rape Seed Meal, Gluten, etc. Alternative available sources are limited in quantity and have certain quality issues. These substitute sources have anti-nutrition factors (ANF), higher mycotoxin, and fibre levels, resulting in rejection of feed and reduced growth. Resulting in a disrupted supply chain and an increase in prices. All these issues increased the input cost and reduced poultry feed production by up to 30-35 percent. This subsequently reduced the number of grandparents, parents, and commercial flocks, ultimately reducing the availability of chicken meat and eggs to consumers. Infectious diseases always remained a major threat to all types of poultry farming. Among viral diseases Newcastle Disease (ND), Avian influenza (AIV) H9, and Infectious Bronchitis (IB) remained predominant, and in bacterial diseases Colibacillosis, Mycoplasmosis, and Salmonellosis was prominent. The prevalence of all the diseases

remained low as compared to the previous year. This might be due to a reduction in poultry papulation during this year. However, the prevalence of the Adenovirus increased during the current year. The predominant serotype was 4. The increase in prevalence is due to the re-emergence of the fowl adeno serotype 4 virus, along with changes in feed ingredients and climate change.

Evidence-based Strategies to Tackle Antimicrobial Resistance

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Antimicrobial resistance is leading global issue that is compromising health and production of animals and adding more serious concerns to the public health. This issue is more pronounced if we talk about developing countries where availability of facilities to treat diseases are scarce that results in quack practices at peak. In such scenarios, conversion of drug susceptible pathogen into multiple drug resistance, extensive drug resistance, and pan drug resistance is becoming evident. In a survey, Pakistan faces 27,000 drug-resistant tuberculosis cases every year while more than 5000 cases are reported as extensive drug resistant. What we need to focus is evidence-based strategies to cover antimicrobial resistance which lies in 5R strategy that reads, responsibility, reduction, refinement, replacement, and review of use of antimicrobials. The option of judicious use of antibiotics with prior testing against prevailing pathogens and accordingly prescription of therapeutics is wise option. Shifting of use of antibiotics for one season to the other works better to tackle antimicrobial resistance and availability of effective therapeutics. Alternatives of antimicrobials include nanoparticles, phytochemicals, probiotics, bacteriophages, and vaccines. All the alternative options adhere to some of the limitations that invite for their use as an evidence-based medicine. It is also of great deal if more than one options can be used to lower burden of antimicrobials and to produce effective therapeutics. Verily, surveillance is important step in tackling antimicrobial resistance and for that a recent survey-based techniques are used. A recent example for this is the use of "Prediction of Antimicrobial Resistance via Game Theory" (PRAG) software that identifies antimicrobial resistance genes both from gram positive and gram-negative bacteria. Using such techniques along with alternative to antimicrobial in addition to reduction, refinement, responsibility, and review of antimicrobial resistance may help tackle this issue.

Animal Production and Husbandry Systems in Pakistan: Challenges, Solutions and Way Forward

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In Pakistan, animal production and husbandry are integral to the economic growth, food security and poverty alleviation. Generally, there are two types of production systems encompassing low input system (LIS) and high input system (HIS). More than 95% livestock keepers are small farmers that are well supported by LIS and only 2-3% can afford HIS. Indigenous breeds are providing 67 million tonnes of milk and 5.3 million tonnes meat for our masses under LIS. However, the genetic potential of exotic animals can be exploited under HIS only. Research based animal husbandry GMPs are available for both production systems. However, the sector faces multifaceted challenges including the limited adoption of modern and sustainable farming practices, availability of quality animal feed, healthcare facilities, and skilled manpower aggravates the challenges faced by farmers. To address these issues, embracing precision livestock farming technologies and implementing eco-friendly farming practices can significantly enhance productivity. Investing in research and development to breed disease-resistant and high-yielding livestock can revolutionize the sector. Collaborations between government bodies, research institutions, and private stakeholders are crucial to disseminate knowledge, provide training, and improve infrastructure. Education plays a pivotal role; empowering farmers with knowledge about modern techniques in relation to animal production can bring about a transformative change. Moreover, promoting financial inclusivity through microfinance initiatives for smallholders can enable them to livestock enterprises in a better way. In the journey towards a brighter future for animal production/husbandry in Pakistan, emphasis on genetic improvement, precision nutrition, innovative management, and animal welfare is vital for ensuring food security and a better quality of life for masses.

Highlights of the Veterinary Education and Research in Pakistan and Potential Areas of Collaboration with China

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Pakistan' veterinary education system, characterized by its comprehensive curriculum and diverse research initiatives, forms the backbone of the nation's animal health sector. Emphasizing subjects ranging from clinical practices to agricultural and environmental aspects, Pakistan's veterinary education fosters skilled professionals capable of addressing the diverse challenges in animal healthcare and agriculture. In light of China's advancements in veterinary research, technology and healthcare management, potential areas of collaboration between the two nations emerge. These areas include knowledge exchange programs, joint research initiatives, and collaborative projects aimed at enhancing disease control, veterinary biotechnology, and agricultural practices. Collaborative efforts

could also focus on strengthening veterinary infrastructure, promoting animal welfare, and advancing the use of cutting-edge technologies in veterinary medicine. Such partnerships have the potential to elevate the standards of veterinary education in both countries, fostering a global community of proficient veterinary professionals capable of tackling emerging challenges in animal health and agriculture. This study underlines the mutual benefits of collaboration, promoting the sharing of expertise and resources for the collective advancement of veterinary education and practices in Pakistan and China.

Technical Session V

Animal Health & Disease Control

Poster Presentations

Enriched Aluminium-Precipitated Vaccine for Prevention of Haemorrhagic Septicemia in Various Breds of Calves: A New Approach to Development, Standardisation, and Safety Testing

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Hemorrhagic septicemia is a fatal disease of cattle and buffalo all over the world including Pakistan and it causes heavy economic losses every year. The poor farmers cannot bear this loss in the form of less milk production and heavy expenditures on the animal treatment. An enriched alum-precipitated vaccine with reduced dose was prepared and standardized and safety testing of enriched vaccine was performed in Swiss albino mice as well as in natural host. In this experiment, a total of 36 cattle both male and female of different age groups ranging from 4 months to 4 years were used. All these animals belong to all major cattle breeds of Pakistan including Sahiwal, Red Sindhi (crossbred and purebred), Dhani (crossbred and purebred), Lohani (crossbred and purebred), and Cholistani, and exotic breeds including Holstein Friesian and Jersey. These animals were examined for current immune titer prior to vaccination. Animals were vaccinated subcutaneously with 2 mL and 4 mL dose of new vaccine and were observed for any untoward reaction for 48 h. All the animals were kept under close observation for the next 30 days and all were found safe. The experiment was designed to reduce the dose of the vaccine to 2 mL by using BHI as a growth medium, as well as to increase the number of doses prepared in the same infrastructure, hence reducing the cost of vaccine production. The study proved that vaccine with increased biomass in reduced dose is safe in local as well as in exotic breeds of cattle.

Effect of Dietary Supplementation of Humic Acid on Blood Parameters, Antioxidant Activity, Serum, and Bone Minerals in Laying Hens

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The study assessed the influence of different levels of humic acid supplementation on blood parameters, antioxidant activity, serum minerals, and bone mineralization in layers. Total 160 white commercial Crystal Nick laying hens, aged 37 weeks, were distributed into four treatment groups with 5 replicates and 8 hens per replicate. The experimental duration was 8 weeks. The basal diet was supplemented with 0, 0.125, 0.250, and 0.375% humic acid. Blood samples were collected from the wing vein at the beginning and end of the trial. Blood parameters (CBC, LDL, HDL, AST, ALT, and cholesterol), antioxidant activity (TAC, SOD, and GPx), and serum minerals (calcium, phosphorus, magnesium, sodium, potassium, and chloride) were analysed. Tibial ash was measured as an indicator of bone mineral content. Results showed that supplementation with 0.375% humic acid significantly increased antioxidant activity parameters (TAC, GPx, and SOD) and tibial ash minerals (calcium and phosphorus). Blood parameters (white blood cells, red blood cells, haemoglobin, cholesterol, and HDL)

and serum minerals (calcium and phosphorus) were positively affected by 0.375% humic acid. However, other blood parameters and serum minerals were not significantly affected. In conclusion, 0.375% humic acid supplementation positively influenced blood parameters, antioxidant activity, serum minerals, and bone mineralization in laying hens.

From Antibiotics to DFMs: A Paradigm Shift in Beef Cattle Farming

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The use of antibiotics in livestock farming, including beef cattle production, has long been a common practice to promote growth and prevent disease. However, concerns over antibiotic resistance, environmental impact, animal welfare and consumer demand for antibiotic-free meat have prompted a paradigm shift in the industry. Direct Feed Microbials (DFM) are emerging as a sustainable and effective alternative to antibiotics in beef cattle farming. DFM typically contains live microorganisms that are beneficial for the gut microbiota and health of cattle. These microorganisms, when ingested by cattle, can help maintain a balanced and healthy gut microbiota. A balanced microbiota is crucial for digestion, nutrient absorption, and overall health and can improve gut health and enhanced immune system by enhancing the population of beneficial bacteria in the cattle's digestive system that results in better feed conversion and overall growth. Tylosin is a macrolide antibiotic that works by inhibiting the growth of bacteria, particularly those that are susceptible to this class of antibiotics. It's effective against many Gram-positive and some Gram-negative bacteria. It has been traditionally used to manage and prevent liver abscesses in beef cattle. Liver abscesses are often caused by bacteria like *Fusobacterium necrophorum*, which are the susceptible to tylosin. There are some comparisons between Antibiotic (tylosin) and DFMs are, Tylosin works by directly inhibiting the growth of harmful bacteria, while DFMs work indirectly by promoting a healthier microbial balance in the rumen. Overuse of antibiotics like tylosin can lead to antibiotic resistance, whereas DFMs are less likely to contribute to antibiotic resistance. DFMs can be more cost-effective in the long term as they promote overall rumen health and can have benefits beyond liver abscess prevention. DFMs can be more cost-effective in the long term as they promote overall rumen health and can have benefits beyond liver abscess prevention.

Potential of Abattoir Waste for Sustainable Agriculture and Economic Growth

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In a world grappling with the dual challenges of economic prosperity and food security, innovative and sustainable agricultural practices are paramount. Abattoir waste, which comprises animal byproducts such as blood, bone, and offal, has long been considered an environmental burden and disposal challenge. However, recent research has unveiled its potential as a valuable input for agriculture. When managed effectively, abattoir waste can be converted into organic fertilizers, animal feed supplements, and biogas presenting a sustainable solution that aligns with the principles of circular economy and resource efficiency. The slaughtering of livestock animals in abattoirs usually generates many by-products that can be further utilized by humans as food or reprocessed. Meat has been an important component of the human diet for centuries as it is a rich source of essential nutrients required for development, growth, and maintenance. Ensuring food security has become an issue of key importance to countries with different degrees of economic development, and the agriculture sector plays a crucial role in achieving this goal. Improper disposal of abattoir waste can lead to water and soil pollution, which can have negative impacts on human health and the environment. Therefore, it is important to implement proper waste management practices to ensure that abattoir waste is utilized in a sustainable and environmentally friendly manner.

Evaluation of Potato Culls as Concentrate Source on Nutrient Intake, Digestibility, Growth Performance and Economic Efficiency in Nili Ravi Buffalo Calves

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The goal of present study was to evaluate the effect of potato culls as concentrate source on nutrient intake, digestibility, growth rate, blood urea nitrogen (BUN), feed efficiency and economics of feeding in Nili Ravi buffalo calves. Potato culls were collected, dried and grinded to get a powder that was named as dried potato concentrate (DPC). The DPC samples were examined for dry matter (DM), organic matter (OM), crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF) and gross energy. Three different iso-nitrogenous and iso-caloric concentrates were prepared using 10, 20 and 30% level of DPC. During the trial, 24 male buffalo calves were used in randomized complete block design for four months. First three weeks were for adjustment period while remaining time for collection period. Rations were offered twice daily at 07:00 and 21:00h. Animals were weighed after every 15 days before morning feeding to assess their growth performance and feed efficiency. Feed and orts were recorded daily. Total faeces collection was done to determine digestibility. Blood samples were taken to analyse blood urea nitrogen. Economic efficiency was also calculated. The

results indicated that there was non-significant difference (P>0.05) on DM, OM, CP, NDF and ADF intakes with different rations. The digestibility percentages of DM, OM, CP, NDF and ADF were not affected significantly (P>0.05) in different groups. There was no significant effect (P>0.05) on BUN, growth rate and feed efficiency with different treatments of DPC. However, a significant effect (P<0.05) was found in cost per kilogram live weight gain and decreased linearly with addition of DPC up to 20% in concentrate ration. Based on the findings of this study, it is inferred that potato culls can be supplemented in concentrate rations of Nili Ravi buffalo calves up to 20% without any negative impact on overall performance.

Immunopathological Effects of Concurrent Feeding of Ochratoxins and Sea Buckthorn in Commercial Broilers

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Mycotoxins are secondary metabolites produced by different genera of toxigenic fungi and cause significant economic losses, effecting poultry and human health, ultimately impacting national and international trade. Poultry is highly vulnerable to Aflatoxin and Ochratoxins induced toxicosis. Ochratoxin A (OTA) is harmful mycotoxin that is mainly produced by Aspergillus and Penicillium. OTA is primarily nephrotoxic and hepatotoxic, and it has also carcinogenic, embryotoxic, genotoxic, immunotoxic and neurotoxic effects. Sea Buckthorn (*Hippophae rhamnoides*), also called as Siberian pineapple, is a prickly deciduous shrub having nutritional and medicinal values. Its compounds have anti-viral and anti-bacterial properties. The hepatoprotective, cardioprotective, antioxidant, anti-diabetic, anti-carcinogenic, immunomodulating, vasodilating and anti-inflammatory properties of sea buckthorn are also appreciated. The present study was designed to evaluate the immunopathological effects of concurrent feeding of OTA and SBT in commercial broilers. A total of 120-day old broiler birds were evenly distributed in 6 treatment groups (A-F). The group A was kept as negative control, Group B was given OTA mixed feed (300 ppb), and Group C and D were supplemented with SBT in graded doses @ 2 & 4 g kg^{-1} respectively. In group E and F, SBT with OTA mixed feed was given with dose rate of 2 g kg^{-1} and 4 g kg^{-1} respectively. This experimental trial lasted for 5 weeks, during this time the birds were slaughtered twice, at mid and end of the trial, using the Halal / Humane slaughtering procedure. The birds' body weight was measured weekly, and their feed consumption was recorded regularly. Birds in control group A and in groups C, D, E, and F were healthy and alert due to SBT but the birds in group B were dull, depressed, pale due to OTA toxicity. Parameters including physical, clinical, immunological, and histopathological were observed. Feeding of SBT in SBT treated groups resulted in higher absolute and relative organ weights of immune organs. Histopathological alterations were more pronounced in OTA treated groups than SBT treated groups. To determine the cellular immunity, mononuclear phagocytic response by carbon clearance assay and Lymphoproliferative response to phytohemagglutinin P (PHAP) were performed. Whereas Antibody response to Sheep Red blood cells (SRBCs) for humoral immunity concluded that the use of SBT had a positive immune modulatory effect. This study concluded that OTA has immunosuppressive effect in birds. OTA intoxication severely affected immune response in birds indicated by lower antibody titters against SRBCs in group B and E. Concurrent feeding of Sea Buckthorn increased inflammatory response in OTA effected birds in response to PHAP. The use of SBT at higher doses completely ameliorated

immunosuppressive response of OTA in commercial birds.

Role of the Climate Change in Food Security, Infectious Diseases, and Reservoir Host Nexus

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Food security is a long-term global challenge, worsened by the unpredictable impacts of climate change. As climate patterns shift, the agricultural landscape is becoming increasingly susceptible to disruptions that threaten food production, availability, and access. Reservoir hosts, defined as organisms that harbour and transmit infectious diseases to other species, have multifaceted interactions with agriculture, climate, and food systems. These interactions necessitate a comprehensive exploration of how reservoir hosts influence food security dynamics under climate change scenarios. Climate change can alter the distribution and behaviour of wildlife species, including potential reservoir hosts. Changes in temperature, precipitation, and habitat can affect where these hosts are found, potentially bringing them into closer contact with humans or other susceptible species. Reservoir hosts play a crucial role in the maintenance and transmission of infectious diseases. Changes in the population or behaviour of reservoir hosts can impact the prevalence and spread of pathogens. Understanding the connection between reservoir hosts and food security begins with an examination of the ecological and epidemiological factors governing zoonotic diseases. Spillover events, where infectious diseases jump from animals to humans, can pose significant threats to food security. This is because spillover events can disrupt agricultural practices, trade, and food supply chains. For example, diseases affecting livestock can lead to reduced meat and dairy production Zoonotic pathogens, transmitted between animals and humans, can severely impact livestock and crop production, compromising food availability. The changing climate conditions can influence the distribution and behaviour of reservoir hosts, altering the prevalence and geographic range of zoonotic diseases. Climate change can have direct and indirect impacts on food security. It can lead to extreme weather events, such as droughts and floods, which affect crop yields and food production. Additionally, changing climate conditions can disrupt ecosystems and impact fisheries, further affecting food availability. Furthermore, the ethical and socio-economic dimensions of reservoir host management explore the delicate balance between safeguarding public health through the control of zoonotic diseases and preserving biodiversity. The potential conflicts between disease control measures and conservation goals underscore the necessity of a complete and sustainable approach to managing reservoir hosts in the context of food security.

Effect of White and Blue Light Emitting Diode (LED) on Production Performance and Immune Response in Different Strains of Broiler

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Lighting is an important administrative practice in chicken production. This study aimed to assess the impact of several LED light colours on broiler chicken strains, specifically Ross, Cobb, and Arbor Acres. A nearby hatchery supplied 180 broiler chicks of three strains—Ross, Cobb, and Arbor. These chicks were then separated into six treatment groups of three replicates with 10 birds each. This study assigned experimental groups to treatment: Group i included Ross chicks exposed to white LED light, Group ii included Ross chicks exposed to blue LED light, Group iii included Cobb chicks exposed to white LED light, Group iv included Cobb chicks exposed to blue LED light, Group v included Arbor Acres chicks exposed to white LED light, and Group vi exposed Arbor Acres chicks to blue LED light. The experiment used white and blue LEDs. Continuous 20-lux lighting was maintained throughout the experiment. The study examined growth performance parameters such body weight, feed intake, mortality rate, and feed conversion ratio. Dot-ELISA was used to measure Newcastle disease (ND) and infectious bursal disease (IBD) antibody titters. A substantial difference ($p<0.05$) was found in feed intake, feed conversion ratio (FCR), and body weight growth between white and blue LED diode illumination treatments. Both white and blue LEDs significantly impacted broiler chicks' random blood sugar (RBS) levels ($P<0.05$).

The Effect of Different Levels of Zinc Supplementation on The Growth Performance and Carcass Characteristics of Japanese Quails

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The primary objective of the present research was to assess the impact of different levels of zinc supplementation on the growth performance and carcass features of Japanese quails (*Coturnix coturnix japonica*). A total of 240 quail chicks, aged one day, were procured from a nearby hatchery. These chicks were then allocated randomly into 16 experimental groups, with each group consisting of fifteen quail chicks. The experimental units were allocated to four treatment groups (A, B, C, and D) in a manner that ensured each treatment had four duplicates. Group A served as the control group, receiving no supplementation of zinc sulphate. In contrast, the birds in groups B, C, and D were provided with zinc sulphate supplementation at rates of 60, 80, and 100 mg kg^{-1}, respectively. Seven Japanese quail were housed in a one-square-foot space. The experiment lasted from one to five weeks with consistent management circumstances maintained throughout. Weekly body weight, feed intake, and death. After the study, dressing percentage and mean heart, liver, and gizzard weights were carefully recorded in this study. The administration of zinc supplementation at dosages of 60, 80, and 100 mg exhibited a notable enhancement in both body weight increase and feed conversion ratio. The consumption of a dietary supplementation at a dosage of either 60 or 100 mg resulted in a notable

enhancement in dressing percentage. The utilization of zinc demonstrated advantageous outcomes in terms of growth performance, potentially enhancing the profitability of chicken farming through the augmentation of profit margins. Based on the available evidence, it can be inferred that the inclusion of zinc supplementation in the diet of Japanese quails yields positive outcomes in terms of growth performance and dressing percentage.

Foot-and-Mouth Disease Epidemiology and Control Prospects

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Foot and mouth disease (FMD) is highly infectious disease of cloven-hoofed animals, particularly cattle, sheep, pigs, and goats. Also, it is the most important animal pathogen on the global scale because of the potential for rapid and extensive spread through susceptible animal populations. Outbreak can lead to formidable economic consequence for domestic livestock production and international trade. FMD is caused by FMD virus, which is a small, non-enveloped, positive-sense RNA virus belonging to the genus Aphthovirus within the family Picornaviridae. There are seven immunologically unique serotypes: O, A, C, SAT (Southern African Territories) 1, SAT 2, SAT 3, and Asia 1, each with a diverse antigenic range of virus strains. The production of vesicles in the mucosal membranes of the mouth, snout, foot, and teats is a characteristic lesion of FMD. The most critical determinant in FMD spread inside endemically afflicted areas. It also demonstrates that the eco-system-based strategy to characterizing FMD epidemiology patterns in endemic areas, which was first outlined in South America, may be easily applied to other parts of the world. As a result of eradication efforts, several developed countries are now FMD-free. However, FMD outbreaks have occurred in several countries, including Europe, and the disease remains prevalent in Africa, the Middle East, Asia, and South America. Three FMD outbreaks happened in our country last year. The last outbreak, disclosed in November 2010, had massive social and economic consequences. The main FMD control techniques are culling sick animals, movement restrictions, and immunization. Each country has its unique strategy for controlling the disease based on the current state of FMD in that country. Any coordinated regional or global FMD control approach should be founded on a sound epidemiological assessment of FMD incidence and distribution, identifying risk sources as either primary or secondary endemic eco-systems.

Significance of Brucellosis in the Light of Innovative Control Strategies and Public Health

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Zoonotic illnesses, like brucellosis, have a significant impact on the wellbeing and economic progress of emerging nations. In terms of new epidemiological features, the appearance of brucellosis in new regions as well as the transmission of brucellosis from wild and domestic animals are of major

significance. The consumption of unpasteurized milk and milk products produced in endemic regions by unhygienic dairy farms poses a major hazard to the general public's health. Regular and strict surveillance is required, especially in areas where the disease is chronically prevalent, to fully comprehend the brucellosis status. The high levels of mobility of people, animals, and animal products make it more difficult to identify and cure diseases in regions where they are not prevalent. However, the most precise tests require expertise and entail isolation and identification techniques. To control the illness, better diagnostic methods are needed. Improved diagnostic techniques must be employed in conjunction with screening of recently introduced animals to control the disease. It is significant that research has shown how useful miRNAs can be in accurately diagnosing *B. abortus* infection. The most often used vaccine strains to prevent Brucella infection and related miscarriages in cattle are strain 19 and RB51. It's also important to keep in mind that there isn't a highly effective, safe, or protective immunization for either humans or cattle. Bacteriophage lysates may be utilized to treat cattle brucellosis, according to studies. The One Health approach can help in the management of this disease in both humans and animals.

Impact of Climate on Zoological Diversity and One Health

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Climate change is a worldwide occurrence that has significant consequences for biodiversity, especially in the field of zoology. This thorough analysis brings together current research on the complex effects of climate change on animal diversity, covering a variety of species and ecosystems. The world's wildlife and environments are also impacted by the climate issues, like humans. Increased temperatures have the potential to cause fragile ecosystems to collapse and a large wave of extinctions. One health and climate change are intertwined in their widespread effects on zoological diversity. The delicate balance of ecosystems is disturbed because of rising temperatures and habitat changes, which opens the door for zoonotic illnesses to spread from animals to people. Changes in migration patterns and mating seasons may result in more encounters between people and wildlife, which could help illnesses. The increase in vector-borne diseases shows the link between climate change, zoological diversity, and public health. In warm and humid areas, mosquitoes, ticks, and other vectors thrive, spreading their reach and leading to a rise in diseases such as malaria, dengue fever, and the Zika virus. These problems are made more complex by the fact that these diseases not only impact people but also have an impact on wildlife. One of the most significant aspects of the environmental problems our planet is experiencing is the complex interaction between animal farming and climate change. Livestock, especially ruminants like cows, make a sizable contribution to greenhouse gas emissions, mostly through the production of methane during digestion. A connection exists between livestock farming and climate change that extends beyond emissions, affecting land use, water resources, and food security as well. Recognizing the connections between climate change, zoological diversity, livestock, and public health is essential in this complicated interaction. A comprehensive strategy that includes wildlife protection, climate mitigation, and effective public health initiatives is needed to address these issues. We can create a more resilient and sustainable future for both the natural world and human societies by recognizing and acting upon these interconnections.

In-Vitro Therapeutic Efficacy of Puerarin Against Thiram-Induced Cytotoxicity of Cultured Chicken's Growth Plate Chondrocytes via HIF-1α, TIMP-3 and BCL-2 Expressions

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Tibial Dyschondroplasia (TD) is a common skeletal disorder primarily affecting broiler chickens. TD is by the widespread use of thiram in agriculture sector and is characterized by the deterioration of the chondrocytes in the growth plate, leading to weaker bones, lameness, and fractures. Puerarin is an important Traditional Chinese Medicine that is used to treat numerous bone disorders in people. Additionally, in-vivo clinical experiments on Puerarin demonstrated its effectiveness against TD. The goal of the current investigation was to determine if puerarincan treat thiram-induced cytotoxicity in avian growth plate chondrocytes via HIF-1, TIMP-3, and BCL-2 expressions. Western blotting and reverse transcription-quantitative polymerase chain (RT-qPCR) were used to analyse the expressions of these markers. Chondrocytes from chicken tibial growth plates were obtained, cultivated, and refined in a special medium. The chondrocytes were subsequently treated with a sub- lethal dose of thiram at 2.5 μg mL^{-1} to induce cytotoxicity, followed by an optimal dose of puerarinat 2.5 μg mL^{-1}. Thiram caused distorted morphology of chondrocytes with disintegrated nuclei accompanied with enhanced apoptosis and significantly increased mRNA and protein expressions of HIF-1α, and decreased TIMP-3 and BCL-2 expressions. Puerarin administration not only enhanced the viability of chondrocytes, but also well restored the damage caused by thiram on growth plate chondrocytes by significantly regulating the expressions of HIF-1α, TIMP-3 and BCL-2. In sum, this study provides a novel insight into the therapeutic efficacy of puerarin against thiram-induced cytotoxicity of chondrocytes and lays the foundation for prevention and treatment of other skeletal ailments.

Effect of Dietary Supplementation of Glucose Oxidase on Growth Performance, Nutrient Digestibility and Gut Morphology in Broilers

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An experimental trial was conducted to determine the effect of dietary supplementation of different levels of dietary glucose oxidase (GOD) on growth performance, nutrient digestibility, and gut morphology of broilers. For this purpose, day-old broiler chicks (n=700) were procured from a commercial hatchery. Chicks were randomly divided into four dietary treatments (T_1, T_2, T_3, T_4) each with seven replicates (25 chicks replicate^{-1}). The T_1 was act as control group (commercial diet without antibiotic growth promoter), T_2 was negative control, supplemented with 150 mg kg^{-1} enramycine, while T_3 and T_4 were supplemented 100 and 200 U kg^{-1} GOD. The experimental trial was of 35 days. Data on feed intake and weight gain were recorded weekly to determine the feed conversion ratio. Celite® was used as an external marker to determine nutrient digestibility for which faecal samples of birds were collected replicate-wise on days 34th and 35th. At the end of the trial, two birds from each replicate were slaughtered to determine gut morphology and carcass parameters. The data collected were analysed using a completely randomized design and means were compared by Tukey's test. Dietary supplementation of GOD in broilers diets on feed intake was non- significant effect. The inclusion of GOD 200 U kg^{-1} diets showed positive effect ($P<0.05$) body weight gain and Feed conversion ratio. The addition of GOD in basal diets showed positive effect (P0.05) on dry matter and ether extract. The supplementation of GOD in broiler diets significantly enhanced villus height, while carcass parameters were not affected ($P>0.05$) by experimental treatments. Based on the results it was concluded that dietary supplementation of Glucose oxidase, (200 U kg^{-1}) improves the growth performance, nutrient digestibility, and villus height at 35 days.

One Health Strategies to Combat Emerging and Re-Emerging Zoonotic Diseases

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Zoonotic diseases are infectious diseases that transfer naturally from vertebrate animals to humans. Pathogenic agents of many kinds, including bacteria, parasites, fungi, viruses, and prions, cause them. Climate change, urbanization, animal migration and commerce, travel and tourism, vector biology, anthropogenic impacts, and natural variables have all had a substantial impact on the emergence, re-emergence, distribution, and trends of zoonoses. Recurring outbreaks of emerging and re-emerging zoonoses, such as Ebola virus disease, avian influenza, and Nipah virus, serve as a reminder that human, animal, and environmental health are inextricably linked, and that early response to emerging zoonotic pathogens necessitates a coordinated, interdisciplinary, cross-sectoral approach. Although they have been known for millennia, their impact on public health has grown in recent decades because of advances in reducing the spread of human infectious diseases through immunization and effective treatments, as well as the emergence of new zoonotic diseases. A One Health strategy at the human-animal-ecosystem interface is widely acknowledged as essential for successful research, prevention,

and management of any emerging zoonotic disease. The One Health strategy is gaining traction as animals are increasingly identified as a primary source of emerging zoonotic infections. International agencies such as the World Bank, USAID (EPT Program), and UN partners have assisted several nations in developing, implementing, and strengthening national One Health systems. While some programmatic activities may be infeasible in the absence of external funding, one path to sustainability is the use of tried-and-true low-cost coordination systems, such as regular inter-ministerial meetings to share disease surveillance results and discuss coordinated mitigation efforts. Investments in human and animal health systems by countries, including development loans, reflect the significance that governments place on developing disease preparedness capacities.

Nexus of Animal Health and Global Well-being: Challenges and Pandemic Preparedness

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Animal health is a prerequisite for global health, economic development, food security, food quality, and poverty reduction. The global spread of H5 HPAI is cause for concern, given the high mortality in poultry, but also because of the numerous reported cases in humans. Avian influenza (AI) viruses are negative-strand, segmented RNA viruses that are members of the Orthomyxoviridae family. Clinical illness follows a short incubation period, and presentation ranges from asymptomatic to fulminant, depending on the characteristics of both the virus and the individual host. Influenza A virus can also cause sporadic infections or spread worldwide in a pandemic when novel strains emerge in the human population from an animal host. New approaches to influenza prevention and treatment for the management of both seasonal influenza epidemics and pandemics are desirable. Most infectious disease outbreaks in humans begin with zoonotic transmission. However, the mandate on how to address animal health epidemics is not robust, unless it involves livestock or there is a crossover to humans. Recognizing the historical origin of influenza pandemics in animal reservoirs, it emphasizes the urgency of preventing HPAI from becoming a future pandemic and, if unsuccessful, preparing for its consequences. Achieving these objectives necessitates a shift in approach— from pandemic response to outbreak control, from standardized large-scale operations to tailored research and development for local needs.

Bovine Ephemeral Fever-An Emerging Disease

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The dairy industry in Pakistan has long been considered a backbone of the nation& agricultural sector and primarily relies on the production of milk, which serves as a primary source of livelihood for rural communities. Pakistan's dairy sector has witnessed the emergence of a novel threat that has gained prominence in recent years - Bovine Ephemeral Fever (BEF). The changing climate patterns, marked by increased rainfall and flooding events in Pakistan, have inadvertently created conducive breeding grounds not only for insect vectors like mosquitoes and Culicoides species but also for the transmission and spread of BEF within the country. The etiological agent of this disease is bovine ephemeral fever virus, a member of the genus Ephemerovirus within the family Rhabdoviridae affecting mainly domestic cattle and water buffalo and characterized by rapid onset of fever, anorexia, muscle stiffness, excessive salivation, nasal and ocular discharge, loss of appetite, and sternal recumbency. BEFV causes economic losses by a sudden drop in milk production, weight loss, treatment expenses, disruption of national and international trade or sometimes the death of infected animals. Although mortality resulting from this disease is usually lower than 1%, it can reach 20% or even higher. The infection is distributed across many countries in Asia, Australia, the Middle East, and Africa. Prevention and control of the disease mainly relies on regular vaccination. Research on bovine ephemeral fever remains limited in Pakistan this abstract underscore the importance of BEF control in Pakistan, not only for the well-being of livestock but also for the country's food security and economic stability. It serves as a call to action for continued research, surveillance, and investment in BEF control strategies to safeguard the nation, dairy industry, and the livelihoods of those who depend on it.

Role of Symbionts in Tick Control

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Symbionts of ticks are the organisms that affect the physiology of host in terms of nutritional adaptations, fitness, and immunity. Symbionts may change the disease ecology as they interact with tick borne pathogens. Ticks (Acari: Ixodidae) are ravening hematophagus ectoparasites, bounteous of the deadly diseases are transmitted by ticks viz., Kyanusr forest disease, rickettsiosis, babesiosis, anaplasmosis, possowan fever, Lyme's disease, tick-borne encephalitis, and allergic reactions. They are posing highest risk threats to animals and human beings. Cattle, an essential vehicle of the livestock industry, are under stabbings of tick avarice and >80% of the world cattle population is infested with ticks. To control ticks, there are several chemical and biological methods viz., manual removal (plucking) of ticks, acaricidal treatment, use of disinfectants, use of dips, rural poultry involvement,

use of plant extracts, nanoparticles, entomopathogenic fungi and nematodes. These methods have somewhat reduced the abundance of tick populations however, few drawbacks are there. Transgenesis of symbionts in ticks is a novel potential candidate to control ticks. Tick control can be done by a) inducing the symbionts genetically in ticks to hamper the successful transmission of pathogens, b) isolating and modifying tick-gut associated rickettsia with cecropin A, an antimicrobial peptide, and c) by using transposons. A few stable germ lines of insects have been developed; Aedes, Culex and Anopheles mosquitoes' genes have already been developed and successful outcomings have been observed in case of dengue virus and plasmodium species. One of the major constraints observed in developing transgenic organism is the survivability of the ticks in their natural habitat. There is also inefficient information regarding the development of effect transposon transgene(s) that might abandon the pathogen load. To this end, a lot of efficient work is needed to be done prior to launching the transgenic vectors. The longevity of the study will be based on the effective transgenic transposons' development. The symbiotic relationship is currently need of the moment for as a potential alternate for control of ticks and tick-borne pathogens.

Effect of Dietary Replacement of Maize with Wheat-Based Bread Waste Pellets on Growth Performance, Nutrients Digestibility, and Carcass Response in Broiler Chicken

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The objective of the study was to evaluate the efficacy of wheat-based bread waste meal as a replacement for maize on the performance, nutrient digestibility, and carcass characteristics in broilers. Day-old broiler chicks (n=240) were randomly divided into twenty (20) replicates (12 chicks replicate^{-1}). Four iso-caloric and iso-proteic (ME: 3000 kcal kg^{-1}, CP: 20%) experimental diets A, B, C, and D based on 100% maize, 50% maize + 50% wheat, 50% maize + 50% bread waste meal and 100% bread waste meal as a cereal energy source were formulated. Each experimental diet was randomly allotted to five replicates. The duration of the trial was 35 days. Results of the feeding trial showed that the highest weight gain (WG) was observed in the birds that were fed with diets containing 100% bread waste as a cereal energy source. Diets based on 50% maize + 50% wheat had lower weight gain as compared to other rations. The results of the feed conversion ratio were also consistence with the WG. Feed intake of the birds remained unchanged with the 100% dietary replacement of maize with wheat-based bread waste pellets. The digestibility coefficients of dry matter, crude protein, and crude fat were highest (P0.05). It was inferred that wheat-based bread waste pellets can effectively replace maize by 100% as a cereal energy source in commercial broiler diets without any negative impact on growth performance.

Inbreeding Depression in Productive and Reproductive Traits of Sahiwal Cattle

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Effects of inbreeding on productive and reproductive traits were studied in Sahiwal cattle registered with Research Centre for Conservation of Indigenous Breeds (RCCIB) Jhang, Punjab. A linear regression was used to estimate the reduction or improvement in the inbred animals for different productive and reproductive traits. Out of 11117 animals in the data, 1415 animals (12.72%) were found inbred. Age at first calving was higher in the inbred animals as compared to non-inbred. The 305-day milk yield, total lactation milk yield, and lactation length were also in decreasing trend in the inbred as compared to non-inbred animals. In the present study inbred had 305-day milk yield by 1691.94 kg and non-inbreds 1359.79 kg while, inbreds have less total lactation milk yield 1282.09 kg as compared to non-inbreds 1410.48 kg. Inbreds have comparatively long age at first calving as compared to non-inbreds. Inbreds have lactation length by 221.22 days and non-inbreds have 207.56 days. It is also observed that inbreds have similar dry period as in non-inbreds. Inbreds have similar service period as in non-inbreds. In present study calving interval was better in the inbreds as compared with non-inbreds (425.88 vs 554.52 days). However, in some studies of inbreeding depression it has also been observed that for each 1% increase in inbreeding calving interval was increased. Improved pedigree information recording and better future mating planning may improve the performance in productive and reproductive traits.

Exploring the Influence of Bacteriophages on Microbial Communities and Nutrient Recycling in the Rumen

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The intricate and dynamic rumen ecology is home to multitude of microorganisms, such as bacteria, viruses, fungus, and archaea. These interactions change the ruminal environment and the substrates available for the host's digestion and metabolism. Bacteriophages help to control microorganisms, that reproduce more quickly and adversely affects the proper functioning of the rumen. As a result, the rumen generates less ammonia and has less protein oxidation that reduced the total amount of nitrogen excreted by the animal, and reduced methane generation. The lytic phages may perhaps affect bacterial populations, which would have the impact of population control, in addition to giving amino acids that cows can utilize. Proteins are recycled by bacteria-lysing bacteriophages as they kill their bacterial hosts in the rumen. Ultimately, this recycling produces volatile fatty acids, which ruminants consume as a source of energy. These pathogenic viruses possess traits that can be valuable (keep the population of bacteria in equilibrium, horizontal transfer of genes) and at the same time hazardous (negatively impact the efficiency of feed, pass on toxic genome). Despite the general impact of phage-host relationship regarding the health of the microbiome in the rumen as well as the animal's nutrition remains ambiguous, these viruses will likely influence the balance of bacterial populations and the

transfer of genetic material among microbes in the ecosystem. Initiatives to sequence the genomes of bacteria have shown the existence of phage that can incorporate their DNA into the genome of their hosts to create stable, lysogenic partnerships. These phage assault and spread throughout the host, resulting in host lysis and the release of young phage particles. Since there is not much research on bacteriophages, this article's objective is to provide an overview of what is known about how bacteriophages interact with one another and have an impact on the rumen.

Technical Session VI

Role of Agriculture in Socio-Economic Development

Oral Presentations

Analysis of the Contribution of Agricultural Development to Regional Economic Growth – A Case of Xinjiang, China

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For a large agricultural region, agricultural development plays an important role in the development of the national economy, and the quality of agricultural development also affects the speed and efficiency of economic growth. Agricultural development has both direct and indirect contribution effects on regional economic growth, including output contribution, market contribution, factor contribution, capital contribution and foreign exchange contribution. This paper takes Xinjiang, China as an example to further discuss the contribution of agricultural development to economic growth.

Present Status and Future Prospects of Agriculture Value Chain in Pakistan: The Role of BRI

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Pakistan produces diversity of crops, fruits and vegetables and usually traditional methods are employed by farmers. In spite of availability of modern production methods, farmers commonly rely on traditional practices. It is particularly true in the case of harvest and post-harvest practices. Huge quantity of agriculture produce is lost each year due to employing traditional and outdated practices. This causes losses to farmers and economy as a whole as large quantity of natural resources are consumed in the production of crops, fruits, and vegetables. Further, traditional value chain practices result in higher difference between farmers' price and consumers' price. There exists potential to improving value chain of crops, fruits and vegetables through interventions and investment and this will benefit all stakeholders involved in pulses, crops, fruits, vegetables, etc. in Punjab, Pakistan. This presentation will provide useful insights on the present status of value chain in agricultural produce in the province of Punjab and it will make attempt to identify contribution of BRI in improving value chain of agricultural produce in the province while benefiting from producers to consumers.

Study on The Impact of Digital Technology Adoption on Farmers' Income

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Focusing on the theoretical logic of digital technology empowering farmers to common prosperity, this paper uses CFPS micro data to empirically analyse the mechanism of digital technology empowering farmers to common prosperity. The results show that digital technology has a significant

empowerment effect on farmers' common prosperity, and the empowerment effect of digital technology on farmers' common prosperity is highly heterogeneous. The effect of digital technology on the common prosperity of farmers in the eastern region is stronger than that in the central and western regions, the effect of digital technology on the common prosperity of young and middle-aged farmers is stronger than that of elderly farmers, and the effect of digital technology on the common prosperity of middle and high-skilled farmers is stronger than that of low-skilled farmers. Further analysis of the mechanism of action found that digital technology can empower farmers to get rich together by broadening the social network effect mechanism of farmers, and compared with the weak relationship network, the strong relationship network contributes more to the common prosperity of farmers. it is proposed to consolidate infrastructure construction and deepen the development of digital technology; bridging the regional digital divide and empowering rural vulnerable groups; Broaden rural social networks and enhance farmers' social capital; optimize rural education resources and promote human capital accumulation; enriching farmers employment choices, improving the quality of rural employment and other countermeasures and suggestions, which has certain reference significance for rural revitalization and common prosperity of farmers.

Addressing Pakistan's Agricultural Productivity Challenge: Learning from China's Successes

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Crop productivity is a serious concern in Pakistan which is significantly lower than the global average and its neighbouring countries with similar agroecological conditions. Agriculture in Pakistan is the major consumer of water and several industries in Pakistan are dependent on this sector. However, low productivity needs efficient planning and management of the resources utilized in this sector to meet the demand of the increasing population. Efforts are being made to overcome this challenge, but the desired outcomes are yet to be cultivated. Collaborative efforts from various stakeholders, including academia, researchers, farmers, policymakers, and government officials, will be crucial in addressing this challenge. A comprehensive analysis of key indicators related to major crops in Pakistan was carried out. The results are compared with the productivity, production technology, and other related indicators of those crops in China. Results show a significant difference in almost all areas. In China, the advancements in agricultural technology, modernization of irrigation systems, crop diversification and farmers' education and capacity building significantly helped to improve the productivity of the crops. Under such circumstances, Pakistan can benefit from China's experiences through the Belt and Road initiative and apply context-specific initiatives. The Belt and Road initiative, which fosters collaboration between countries, offers a promising avenue for knowledge exchange. By embracing this opportunity, Pakistan can unlock the potential for improved agricultural productivity.

The E-commerce Training Cooperation History and Future Development of Huazhong Agricultural University in Pakistan

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The presentation mainly reflects the e-commerce training and research history of Huazhong Agricultural University, the main achievements and problems faced since 2018, and also suggests future potential cooperation models and directions.

Whether Can We and How to Achieve Sustainable Agriculture by Regulating Soil Microbial Communities

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We have systematically explored the maintenance and mediation mechanisms of soil microbial diversity in the agricultural and pastoral ecotone in northern China under the background of climate changes. The research mainly includes three aspects: first, the environmental change factors and management strategies which had great influence on soil microbial community were identified; second, the physicochemical mechanisms that cause these effects were analysed; finally, the theoretical mechanism of these effects was analysed from the perspective of ecological process. The main academic contributions include: 1) revealing the direction and mechanism of microbial positive feedback to climate warming at the molecular level; 2) observing specific correspondence among global change factors, ecological processes and microbial community components; 3) showing that nitrogen deposition had the greatest effect on soil microbial community in the northern farming-pastoral ecotone; 4) proving the necessity of protecting soil microorganism; 5) emphasizing the necessity of adding microbial seed bank; 6) identifying the close relationship between plant productivity and microbial functional diversity; 7) observing that the combination of moderate disturbance and resource niche is important for maintaining microbial diversity. As the first or corresponding author, I have published these results (> 30 publications) in professional journals such as ISME Journal, Global Change Biology and New Phytologist.

Determinants of Economic Zones, Employment, and Business Opportunities in the CPEC: A Belt and Road Initiative

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Big infrastructure projects have great importance for the economy along with bringing employment and business opportunities for the local population. On the negative side, it also affects the locals by taking away their livelihood significantly. This study mainly focuses on investigating the role and limitations of economic zones, energy projects, road infrastructure, and other activities of China Pakistan Economic Corridor (CPEC) project in employment and business opportunities specifically for the local affected population. Primary data from approximately 800 respondents as well as secondary data were collected. A multistage sampling technique was adopted to collect primary data. To collect data, four regions (provinces) of Pakistan including Gilgit Baltistan (GB), Khyber Pakhtunkhwa (KPK), Punjab, and Sindh provinces were selected according to the existence of CPEC economic activities. A Chi-Square test was used to open and describe the facts in the data. Then, the logit regression model was adopted to determine the probability of occurrence of an event due to certain factors and opportunities in the China Pakistan Economic Corridor Project. Results reveal that relation between the dependent variable (employment opportunities) and independent variables “economic zones” and “road linkages” are significant, where “no improvement” in employment opportunities is significantly linked to the absence of economic zones and road linkage to specific areas. Similarly, the odds of no improvement in employment opportunities are much higher where the government offers no job opportunities to affected and where there is no land acquisition. Energy projects and having smartphones have weaker impacts on employment opportunities as compared to other independent variables. No improvement in employment opportunities is also significantly linked to a lack of computer literacy and pessimism about the financial situation due to CPEC. Capacity building programs along with fairness and transparency in job provision is highly recommended. The article also provides further policy measures and recommendations for business and employment opportunities, especially for the local affected population recommended. The article also provides further policy measures and recommendations for business and employment opportunities, especially for the local affected population.

The Current Situation and Development Trends of China's Vegetable Industry

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Introduce the development status and trend of China's vegetable industry and explore the prospects and paths of vegetable trade between China and the Belt and Road countries such as Pakistan.

Role of Agriculture in Socio-Economic Development

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Agriculture has multiple functions; its contribution to economic development varies during different periods. Currently, it also contributes to national security and stability.

Research On the Rural Landscape Protection and Spatial Development According to Different Rural Development Models

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The sustainable development strategies of rural landscape should be treated differently according to the rural development models. We classify rural area into four types, including the primary industry developing type, the secondary industry transforming type, the tertiary industry transforming type, and the ecological restoration type. Furthermore, this article presents the strategies of landscape protection and spatial development of productive and living landscape, respectively. In the case of rural areas in central China, this article stresses the research on four villages including the landscape resources developing type, the primary industry developing type and the ecological restoration type, which is based on the analysis of the village landscape' modern evolvement in this area.

Sustainable Water Management Strategies under Climate Change and Growing Food Demand in Pakistan

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Pakistan's agricultural landscape is characterized by diverse environments, ranging from arid to semi-arid, necessitating extensive reliance on irrigation. The country's irrigated agriculture primarily relies on the surface water sourced from the Indus River. However, the Indus Basin irrigation system falls short of meeting the irrigation demands, resulting in a significant dependency on groundwater. This heightened reliance, coupled with the increase in harvested areas, has led to unsustainable groundwater extraction practices, subsequently causing a decline in water tables. Furthermore, inefficient surface irrigation methods exacerbate the strain on water resources. These challenges, compounded with the looming spectre of climate change, present a critical threat to Pakistan's irrigation agriculture. Potential impacts include affecting growing seasons length, intensified water scarcity, and food insecurity. While prior studies have examined the effects of technologies and water resources and food production, our study aim to consider the synergy between various factors such as

the substitution of high water-intensive crops with less water-intensive alternatives, the transition from conventional surface irrigation to advance technologies, and change in growth seasons length under different climate change scenarios. Recommendations based on this study will provide range of water-saving strategies for sustainable water management in Pakistan's irrigated agriculture.

Technical Session VI

Role of Agriculture in Socio-Economic Development

Poster Presentations

Climate-Resilient Agroforestry: A Pathway to Sustainable Agriculture for Climate Mitigation, Economic Prosperity, and Food Security

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The global agricultural sector stands at a crossroads, facing an unprecedented challenge. There is an urgent need to address climate change while ensuring economic prosperity and food security for a growing global population. It is important to explore a unique approach to this multifaceted issue, emphasizing the integration of climate-resilient agroforestry systems into mainstream agricultural practices. Climate change is altering the traditional agricultural landscape with extreme weather events, shifting precipitation patterns, and increased pest pressures. These changes threaten the livelihoods of millions of farmers and jeopardize global food security. In response, there is a growing imperative to adopt sustainable agricultural practices that not only mitigate climate change but also enhance resilience in the face of its impacts. Agro-Forestry, as a sustainable land management strategy, holds immense promise. By intermixing trees or woody perennials with traditional crops, Agro-Forestry systems can effectively sequester carbon, mitigate greenhouse gas emissions, and enhance soil health. Moreover, these systems diversify income sources for farmers, foster biodiversity, and reduce the vulnerability of agriculture to climate extremes. Agro-Forestry can help rural communities adapt to changing climate conditions while providing economic opportunities and ensuring food security. Furthermore, it highlights policy recommendations and innovative financing mechanisms that can incentivize the widespread adoption of Agro-Forestry practices, ensuring their scalability and long-term impact. Climate-resilient Agro-Forestry represents a unique and holistic solution to the complex challenges of sustainable agriculture, climate change mitigation, economic prosperity, and food security. By integrating trees into farming landscapes, we can not only combat climate change but also cultivate a future where agriculture thrives, communities prosper, and food is secure in the face of an uncertain climate.

Training Needs Assessment of Horticulturists in Punjab, Pakistan, Pertaining to Agricultural Entrepreneurship in the Horticulture Sector

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Conducting a training needs assessment is a vital process for evaluating the current knowledge, skills, and competencies of individuals in various domains. In the context of Pakistan, agriculture holds a paramount position, contributing significantly, with a share of 22.7%, to the nation's Gross Domestic Product (GDP). However, the share of the agriculture sector in the GDP has exhibited fluctuations over time. The agricultural landscape in Pakistan faces mounting challenges due to climate change, soil degradation, and water scarcity, rendering traditional farming methods increasingly unsustainable. In response, farmers must pivot towards adaptation and innovation to maintain competitiveness and enhance productivity. Developing entrepreneurial skills becomes imperative in this context, enabling

farmers to identify fresh opportunities, explore novel markets, and implement innovative technologies and practices that elevate yields and profitability. Entrepreneurship assumes a pivotal role in addressing the persistent issues of poverty and unemployment in Pakistan. Empowering farmers to embrace entrepreneurship not only enables them to generate income for themselves but also holds the potential to uplift their surrounding communities. Entrepreneurial initiatives have the capacity to stimulate demand for goods and services, foster the creation of new markets, and catalyse innovation and technology transfer. These ripple effects, in turn, propagate throughout the economy, contributing to its overall growth and development.

Population Dynamics of Insect Pests and Natural Enemies on Maize Along BRI

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Maize (*Zea mays* L.) is major cereal crop of Pakistan and known as Queen of Cereals in many countries. It also provides feed for rising poultry industry in Pakistan. To share this insect pests population dynamic along BRI countries, an open field survey was conducted to examine the population dynamics of insect pests and their natural enemies on maize crop phenology at the research area of Plant Breeding and Genetics at University of Agriculture, Faisalabad, Pakistan during spring season 2023.During this survey, the population of *Halyomorpha halys, Aphis gossypii, Dalbulus maidis, Pyrilla perpusilla, Spodoptera furgiperda, Amrasca bigutula*, and Coccinellids were observed. The results of weekly observation through random sampling method showed that the highest mean numbers (33.87 100 plants^{-1}) of Leaf hopper (*Dalbulus maidis*) was recorded on 23rd April at early growth stage. The highest mean number (24.73 100 plants^{-1}) of aphid (*Aphis gossypii*) was observed at early growth stage on 21st March. In natural enemies, the highest mean numbers (180.42 100 plants^{-1}) of Rove beetle (*Paederus fuscipes*) were recorded during middle growth stages on 31st May 2023. The Spider (Araneae) population was peaked (22.18 100 plants^{-1}) on 16th April at middle growth stage. Among Coccinellids, the highest population density of seven spotted beetle (*Coccinella septempunctata*) was observed (32.01 100 plants^{-1}) on 4th April at early plant growth stage and Asian beetle (*Harmonia axyridis*) was peaked (7.80 100 plants^{-1}) on 4th May at middle growth stage. These findings would play a crucial role in sustainable pest management of insect pests along BRI countries. Our foundation of this finding to green technology along BRI countries sharing of long-term data recording provides opportunities to student research.

Transforming Rural Livelihoods: The Impact of Digital Farming

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Across the globe, most of the rural communities depend upon the agriculture sector for their livelihoods. In the current scenario, traditional farming practices are not sufficient for better livelihoods. On the other end, digital farming is revolutionizing the way by integrating the latest technologies into traditional farming. Digital transformation is the systematic changes that modify people's way of working to perform their activities. This integration has a significant impact on rural livelihoods, fostering sustainable, social, and economic development. Integration of digital farm practices like precision agriculture, Sensors, drown technologies, and digital marketing enable the farming community to make informed decisions. This optimization of farming also enhances farm productivity with minimum usage of inputs, due to an increase in productivity in rural communities leading the higher income and improved food security. Moreover, digital farming opens up new ways for revenue generation for the rural population because it facilitates market accessibility and a global supply chain through online and e-marketing platforms. According to various studies, digital transformation is also a better solution for the challenges in agriculture and contributes to the agri-food system transformation. However, it has also a few challenges in some rural areas such as accessibility to technology, digital literacy, and awareness. Collaborative efforts will be required between the public, private sectors, and NGOs to overcome these challenges. This collaboration will also help provide training to the farming community for digital literacy. In conclusion, the integration of digital farming has the potential to boost the rural economy and improve the quality of life.

Impact of Urban Land Use Planning on The Upgradation of Slums in The Capital Area of Pakistan

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In the modern era, the prevalence of rapid urbanisation due to imbalance and unregulated migration from rural to urban areas have piqued the interest of academics and thus the focus is based on the determination of urban policy in Pakistan and its subsequent impact on up gradation of slums. The study covered an array of areas related to the concept of urban land planning and the slum up gradation areas about 2000 households' surveys through questionnaire in the capital area of Pakistan by using regression modelling. To determine and analyse the factors that are associated with urban resilience and sustainability with respect to the case of slum dwellers of Islamabad, data-driven urban management, and its impact on the up-gradation of slums in Islamabad in the mediation of privacy and security concerns. The study was quantitative, and the data was gathered from 301 personnel responsible for urban management planning. The SEM technique was utilised for analysing the responses determining the mediation effect. To study the significance of factors affecting urban

resilience and sustainability in Islamabad. The questionnaire was filled by 365 respondents with the help of simple random sampling techniques. To conduct SEM modelling, Smart PLS 3.0 through which all the important results were gathered including convergent validity, reliability, factor loading, composite reliability, discriminant validity, r-square, and path coefficients. The findings of the study also determined the strength of the relationship between the selected independent and dependent variables of the study. Through the analysis, it is observed that there is a strong correlation between the selected independent and dependent variables. Found that privacy and security concerns partially mediate the relationships.

Miscellaneous

Poster Presentations

Physiological and Biochemical Response of Mutated M3 Cotton (*Gossypium hirsutum* L.) to Different Level of Salt Stress

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Genetic variation in cotton for salinity tolerance is a prerequisite for developing genetically improved cultivars. The objective of the study was to assess the genetic variation for salt tolerance in mutated M3 population of cotton developed by gamma irradiation and EMS. A screening experiment was conducted for 12 mutated and one normal/untreated genotype in a hydroponics system under controlled conditions. The three salinity levels used were control, 150 mM, and 300 mM. Three leaf seedlings were transplanted to hydroponics having half-strength Hoagland solution at control, 150 mM, and 300 mM NaCl salinity levels. Salinity induced significant variation in root and shoot lengths, fresh root and shoot weight, dry root, and shoot weight, root shoot ratio, survival rate, protein contents, and α-amylase activity. Genotypes 9Ac, 47Ab, 1Aa, 45Aa and PB-899 were observed highest tolerant genotypes with a better performance at 150 mM salinity level. However, at 300 mM salinity level best genotypes included were 57ab, 47Ab, 1Aa, and 54Aa. On the other hand, genotypes 7Bb, 51Aa, and 57ab showed poor performance or susceptible response across the 150 mM saline environment. Genotypes 9Ba, 45Aa, 9Ac and PB-899 were susceptible at 300 mM salinity. Thus, the genotypes 57ab, 47Ab and 1Aa were found tolerant to adoption of salt stress and can be used as a source in crop improvement program.

Advancement of the 3D Model for Segmenting the Overlapping Leaves in High Throughput Phenotyping

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High-throughput plant phenotyping is a critical component of crop improvement and agricultural research. Leaves are essential for high throughput phenotyping (HTP) because they are incredibly insightful markers of plant health and performance using different sensors. Traditionally, it is challenging and time-consuming to assess these features due to their leaf structures and utilizing segmentation to separate them from a dense plant canopy. Leaf edges are difficult to distinguish from images because of their colour similarities. Additionally, because leaves are nearly identical in colour, texture, and shape, therefore, it is not easy to separate them. They frequently rely on discrete boundaries between objects, so 2D models may not function appropriately when leaves overlap. However, traditional 2D methods often need more accuracy to capture complex leaf structures comprehensively. This research explores the emerging field of 3D modelling for HTP using the RGB camera with depth sensor to generate detailed three-dimensional representations of leave structures. As a result, this research work helps to segment the tightly overlapped leaves in an efficient manner. Further, it makes it easier for plant breeders to properly determine the desired traits of the plants in a non-destructive manner.

Assessment of Protein Content in Different Genotypes of Bread Wheat (*Triticum estivum* L.)

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Wheat is an important cereal crop enriched in minerals, dietary fibre, vitamins, and crude protein. It is used as a staple food in many countries. Proteins are the essential dietary component for humans and livestock. Wheat flour has different type of proteins that are classified based on their solubility in solvents such as albumins; soluble in water, globulins; insoluble in pure water but soluble in sodium chloride solution, gliadins; soluble in 70% ethyl alcohol and glutenin; soluble in dilute acid and sodium hydroxide solutions. Among all these proteins, albumins and globulins are smallest proteins present in wheat flour. These are concentrated in seed coat, aleurone and germ cells and to some extent present in mealy endosperm of wheat grain. The gliadins and glutenin are the storage proteins of wheat and these are present largely inside mealy endosperm. These are high molecular weight subunits of gluten protein that is very important for dough and bread making qualities of wheat flour. There was not any other activity of enzyme to form dough but the ability of gliadins and glutenin to retain gas helps to develop spongy dough. There is variation in fraction of gluten protein among various genotypes of bread wheat. This experiment was conducted to assess the protein in ten different genotypes of bread wheat viz. Kohistan-97, Chakwal-86, Maxi Pak-65, 36 ESWYT-142, 36 ESWYT-145, Chakwal-50, Aas-2011, Johar-2016, Anaj-2017 and Akbar-2019. The quality characters and physical parameters of these genotypes were measured. Statistical analysis has been done using Statistix 8.1. Tukey's test was applied to compare the mean values of parameters. There was noticeable variation among all genotypes for gluten protein content and other quality parameters. The genotypes also showed variation for moisture content, crude protein, wet gluten, dry gluten, gluten index, falling number and fibre percentage. There were two quality parameters that were similar in all genotypes named as starch percentage and fat percentage. The physical parameters were quite different for all genotypes. So, the results showed that all the genotypes were different from each other in most of the physical and quality parameters.

Exploring the Genetics of Wheat Tiller Angle: Insight from Rice

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Crop plant architecture is considered as a key agronomic trait that contributes greatly to crop adaptation, stress tolerance and yield. Like plant height, tiller angle is one of the most important components of crop plant architecture, which affects grain yield due to its large influences on disease infestation, photosynthetic efficiency, and plant density. Force of gravity influences all organisms on earth including plants. Plant organs sense gravity to adjust their growth orientations including tiller angle in wheat (*Triticum aestivum* L). Understanding the genetics underlying wheat tiller angle is fundamental to manipulate tiller angle for designing wheat varieties with desired plant architecture and agronomic performance. Herein, we present the advances made to discover QTLs or genes and regulatory mechanisms for wheat tiller angle and discusses the future prospects of exploring genes for wheat tiller angle. The current progress in discovering QTLs and genes for wheat tiller angle is far

behind than that made in molecular genetics for rice tiller angle. Since very few QTLs and genes for wheat tiller angle have been discovered so far, thereby, exploring genetic mechanism for wheat tiller angle can greatly improve future wheat varieties. Finally, we propose to take insights from the genetics of rice tiller angle to speed up gene discoveries for wheat tiller angle.

Chemical Priming Strategies for Stress Tolerance in Plants

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The development of technologies to mitigate the damage caused by drought stress is essential for ensuring a sustainable food supply for the increasing global population. We herein report that the exogenous application of ethanol, an inexpensive and environmentally friendly chemical, significantly enhances drought tolerance in *Arabidopsis thaliana*, rice, and wheat. The transcriptomic analyses of ethanol-treated plants revealed the upregulation of genes related to sucrose and starch metabolism, phenylpropanoids, and glucosinolate biosynthesis, while metabolomic analysis showed an increased accumulation of sugars, glucosinolates, and drought-tolerance-related amino acids. The phenotyping analysis indicated that drought-induced water loss was delayed in the ethanol-treated plants. Furthermore, ethanol treatment induced stomatal closure, resulting in decreased transpiration rate and increased leaf water contents under drought stress conditions. The ethanol treatment did not enhance drought tolerance in the mutant of ABI1, a negative regulator of abscisic acid (ABA) signalling in Arabidopsis, indicating that ABA signalling contributes to ethanol-mediated drought tolerance. The nuclear magnetic resonance analysis using 13C-labeled ethanol indicated that gluconeogenesis is involved in the accumulation of sugars. The ethanol treatment did not enhance the drought tolerance in the aldehyde dehydrogenase (aldh) triple mutant (aldh2b4/aldh2b7/aldh2c4). These results show that ABA signalling, and acetic acid biosynthesis are involved in ethanol-mediated drought tolerance and that chemical priming through ethanol application regulates sugar accumulation and gluconeogenesis, leading to enhanced drought tolerance and sustained plant growth. These findings highlight a new survival strategy for increasing crop production under water-limited conditions. Updated data regarding the application of ethanol on commercial crops would also be discussed.

Understanding Differential Effects of Hot Semi-Arid and Mild Temperate Regions-Soils on Growth and Yield of Rice

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Rice (*Oryza sativa*) is staple food crops of Pakistan. It provides protein and calories to 75% of the world population. About 2.5 billion of the people around the world need rice for energy. Rice is a source of 23% of energy and 16% of protein needs per person. The recent research improves understanding of the differential effect of two different (hot semiarid and mild temperate) regions on the growth and

yield of rice and indicates the comparative effect of different biochemical treatments on soil and rice plant. The pot experiment was designed to assess the effects of application of biochar, compost with 1% C in each and PGPR and NPK fertilizer on plant health and characteristics of indigenous soil. There were nine treatments. Rice was sown after application of these treatments in 5 kg soil pot. Plant physical parameters were recorded at different time intervals in addition to soil chemical analyses after harvest. Soil samples were collected from both sites of Nakyal and Gujranwala and each pot too before sowing and after harvest of rice and were analysed for soil pH, electrical conductivity, soil saturation, total organic matter, phosphorous (P) and potassium (K). Observations of plant physical parameters and biological yield after rice harvest showed a conspicuous differential outcomes effect between both climatic sites. From the present study, it is concluded that response of rice to different biochemical treatments in the soils of both regions showed a significant impact on plant growth and soil characteristics. Among the treatments, effect of biochar was better as compared to other treatments.

Phycoremediation of Tannery Wastewater

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The tanning industry is awfully a capitalism that comes up with the development of many countries. Asia is the main assembler of tannery industry. Effluvium that comes from leather manufacturing have excessive congregation of heavy metals explicitly with high inorganic nutrients and organic matter. Tannery processes create adulterate due to the liberation of toxicant in the nature. This study was designed to assess the outcome of microalgae Scenedesmus for bioremediation of chromium in Tannery wastewater. In addition, another technique i.e., Advance Oxidation Process (AOP) was also applied for treatment. The physicochemical parameters and heavy metal analysis were performed like BOD, TS, TDS, TIDS, TVSS, chromium and chloride etc. The highest BOD removal was 99.8%, COD removal was 99.8% and chlorides were 96.1% removed. The highest removal was 98.6% by AOP. The phycoremediation by Scenedesmus gave the highest removal of 99.1%. The removal of chromium was more in advance oxidation process than bioremediation. The adaptability and the tolerance of Scenedesmus not to be affected by the harsh environments and ability to detoxify heavy metals in wastewater are significant and the comparative treatment using AOP proved to be remarkable.

Role of Acid Invertase in Yield Formation of Maize Under High Temperature and Water Stress

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Abiotic stresses are known to reduce the grain yield of cereals due to affected physiological development and plant growth under stress conditions. According to recent studies, one of the main biochemical processes affected by salt stress is the activity of acid invertase enzyme which is responsible for the hydrolysis of sucrose into hexoses during fruit/grain development. In case of maize, poor grain setting has been observed by scientists under drought stress conditions. One assumption is that the poor activity of acid invertase under stress conditions could be the reason of reduced yield. Therefore, the present study was focused to confirm the previous observations and information of the subject and observe shifting trend under the semi-arid conditions of Pakistan. In addition to drought, the invertase activity was also examined under heat stress under these climatic conditions that is not reported before. The objectives of the present work were to examine whether (1) acid invertase activity decreases right after pollination under water and heat stress, (2) reducing or non-reducing sugars limit assimilate supply for developing grains, (3) genotypic differences exist under drought and heat stress in invertase activity. The results indicated that there were differences in physicochemical responses between maize hybrids and acid invertase activity under both stress conditions. The decline in the grain setting was compensated by grain weight in some hybrids, but high yield is achievable by more number of grains and grain weight.

Effect of Silicon and Salicylic Acid Application on The Growth and Yield of Quinoa under Saline Conditions

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Salinity is one of the main abiotic factors impacting crop growth and output around the world. About 56% of Pakistan's salt-affected soils are saline sodic, and the salinity issue is progressively getting worse due to the country's climatic conditions. Silicon is very effective to alleviate salinity stress, improve water holding capacity and soil fertility. The Si affects major metabolic processes and cellular functions in plants. Salicylic acid (SA) has been demonstrated to protect different plant species from abiotic stress and contribute to stress tolerance mechanisms. In the worst climatic conditions, including salinity, quinoa can maintain its growth and has potential to survive and grow in stress conditions to meet future human food demands. Thus, to investigate the effect of different levels of Si (i.e., control, 100 and 200 mg kg^{-1}) and salicylic acid (control and 1 mM) on quinoa growth under saline conditions (control and 9 dS m^{-1}), a pot experiment was conducted in the green house of Institute of

soil and environmental sciences. Treatments included: T_1= Control, T_2=100 mg kg^{-1} Si, T_3=Si 200 mg kg^{-1} Si, T_4 = 1.0mM SA foliar application, T_5 =100 mg kg-1 Si+ 1.0 mM SA foliar application, T_6= 200 mg kg^{-1} Si+ 1.0 mM SA foliar application, T_7= 9 dSm^{-1} EC, T_8=9 dSm^{-1} EC+ 100 mg kg^{-1} Si, T_9=9dS m^{-1} EC+ 200 mg kg^{-1} Si, T_{10}=9 dSm^{-1} EC+1.0 mM SA foliar application, T_{11}=9 dS m^{-1} EC+100 mg kg^{-1} Si+1.0 mM SA foliar application and T_{12}=9 dSm^{-1} EC+ 200 mg kg^{-1} Si+1.0 mM SA foliar application. Completely Randomized Design (CRD) under factorial arrangement was used to establish the experiment with three replications. Plants were treated with foliar application of SA after 30 days of sowing at an interval of ten days for three times. Crop was harvested at maturity stage. It was clearly proved that salinity stress resulted in significant reduction in growth and yield of quinoa. However, application of silicon and salicylic acid improved the fresh and dry weight of shoot, relative water content, membrane stability index, chlorophyll contents and yield of quinoa under normal and saline condition. Therefore, it is concluded that SA and Si application proved effective to alleviate the salinity stress and found effective in increasing the salinity tolerance in plants.

Silicon and Salicylic Acid Application Alleviates Water Deficit Stress in Quinoa (*Chenopodium quinoa*)

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Water deficit stress is a drastic issue in Pakistan. The worldwide issue of global warming and less uncertain rainfall results in climatic change and water deficit stress conditions which have various effects on the agro ecosystem. Pakistan faces adverse water deficit conditions. Si exists as beneficial component in soil and has significant role in overcoming water scarcity problem. Si can maintain the crop yield and growth even in stress conditions like salinity and water deficit stress. Salicylic acid supports the crop to withstand the harmful effects of salinity and drought stress. This growth regulator together with silicon works to alleviate the water deficit stress condition. Foliar spray of SA is beneficial for plants. A pot experiment was conducted in the green house of Institute of Soil and Environmental sciences to evaluate the effect of Si (Control, 100 & 200 mg kg^{-1}) and SA (Control & 1 mM) on quinoa under water deficit condition. Two water levels; control (100% field capacity) and Water deficit (60% field capacity) were used. In the first four weeks after germination, all pots were equally irrigated and after this, water deficit stress started. Completely Randomized Design (CRD) was used to establish the experiment with three replications under factorial arrangement. It was clearly proved that water shortage followed substantial decline in growth and yield of quinoa. However, silicon and salicylic acid improved the fresh and dry weight of shoot, plant height, SPAD value, relative water content, membrane stability index and yield of quinoa under normal and water deficit conditions. Therefore, it is concluded that SA and Si application proved effective to improve the plant growth in water deficit stress condition by increasing deficit water stress tolerance of quinoa plant.

Effect of Silicon Application on The Growth and Yield of Lentil Grown in Saline Conditions

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Salinity is the leading concern in Pakistan that lessened crop yields and growth. Salinity stress inhibits the growth and yields of crops by influencing the photosynthetic process, inhibiting root growth, reducing water uptake, and interfering with nutrient uptake and chlorophyll production. Lentil is one of the most nutritive legumes, yet it is quite sensitive to salt stress. Silicon is a nourishing component for many crops and has been used to moderate abiotic stress in several species of plants. Furthermore, silicon in nano-form is predicted to enhance the favourable characteristics of silicon. However, little is known about the possibility of using nano-silicon (nSi) to alleviate the effects of salt stress on non-silicified legumes such as lentils. A pot experiment was conducted at the wire house of the Institute of Soil and Environment Sciences (ISES), UAF, to investigate the effect of different levels of Si (i.e., control, 100 mg kg^{-1} and 200 mg kg^{-1}) and nano-silica at level (125 mg kg^{-1}) on lentil (variety Punjab Masoor 2020) growth under saline condition (i.e., control, 6 dS m^{-1} and 9 dS m^{-1}). A factorial arrangement was employed in a completely randomized design, comprising of 12 treatment groups, each with three replicates. The crop was harvested at maturity. Physiological and growth parameters were observed using standard methods. The result showed the detrimental effect of salinity on the growth and yield of lentils resulting in reduced plant growth, yield, SPAD value, MSI, RWC, shoot and root growth, K+ concentration, and enhanced Na+ concentration. While Si lessened the effect of salinity and improved lentil yield in normal as well as saline conditions. The application of Si significantly enhanced plant growth, yield, SPAD value, membrane stability index, RWC, K+ concentration, and reduced Na+ concentration. Hence, it can be concluded that Si treatment proved effective in mitigating the salinity stress and was proven to be beneficial in increasing the salinity tolerance in plants.

Assessment of Insect Community in Soybean Crop Along BRI

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Soybean meal is an important component of poultry and fish feeds. To share this insect community along BRI countries an experiment was conducted to assess the population abundance of insect pests and their natural enemies of soybean crop in spring season 2023 at the Soil and Environmental Research Area of the University of Agriculture Faisalabad, Pakistan. As a result, we find out the insects' community were *Bemisia tabaci*, *Aulacophora fovocollis*, *Psinida fenestralis*, *Dysdercus cingulatus*,

Halyomorpha halys and *Phyllotreta vittula* and their natural enemies were *Allograpta oblique*, *Paederus fuscipes*, *Coccinella septempunctata* and spiders. As a result, the highest mean number of the *Aulacophora fovocollis* (13.63±2.98 100 plants^{-1}) was recorded on 07th June 2023 and then the highest mean number of *Bemisia tabaci* (7.27±3.02 100 plants^{-1}) was observed on 24th June 2023. Meanwhile, the highest mean value natural enemies (*Paederus fuscipes*) were recorded (17.27±5.34 100 plants^{-1}) on 23rd May 2023. The highest mean value of coccinellids was (10.90±4.58 100 plants^{-1}) on 2nd May 2023. This study provides gateway to future pest management strategy of Soybean crop by using fixed plant method along BRI countries. Our basic foundation of this finding to green technology along BRI countries sharing of long-term data recording provides opportunities to student researchers.

Impact of Silicon Application in Lentils Grown in Pb Contaminated Soil for Promoting Growth and Reducing Lead Concentration

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Soil heavy metal contamination is a global environmental problem that is causing significant public concern, especially regarding the safety of agricultural products. These elements contaminate soil through natural processes and human activities. Heavy metals have toxic effects on living organisms. Lead (Pb) is known for its highly toxic effects on plants, animals, and humans. Exposure to Pb can have detrimental consequences on various living organisms. Lead toxicity is a major issue faced by farmers which inhibits plant growth and decreases crop yield. From contaminated soils, Pb enters plants and then in the food chain. Pb immobilization in soil and reduction in its mobility and availability to plants is crucial. Silicon (Si) is a nourishing component for many crops and has already been used to moderate abiotic stress in several plant species. Silicon reduces Pb availability to plants and is helpful in Pb immobilization in soil. To assess the reduction in Pb toxicity and improve the yield of lentils using silicon was the objective of this research. In the warehouse of the Institute of Soil and Environmental Sciences, a pot experiment was conducted. Lentil variety Punjab Masoor 2020 was examined under normal conditions and Pb toxic stress. The Si was applied at two levels 100 mg and 200 mg kg^{-1}, and nano-silica at one level 125 mg kg^{-1} and 500 mg kg^{-1} Pb was applied for developing Pb toxic stress in lentils. A completely randomized design with factorial arrangements was used along with three replications. Growth, physiological, and ionic parameters were recorded using standard methods. To examine the recorded data, a suitable statistical procedure was used. The result showed the negative impact of Pb toxicity on the growth and yield of lentils resulting in reduced plant growth, yield, SPAD value, membrane stability index, relative water content, shoot fresh weight, and dry weight. While Si lessened the negative effect of Pb toxicity and improved lentil yield in normal and Pb-contaminated soil conditions. The Si application significantly enhanced plant growth parameters and physiological parameters and reduced shoot and root Pb concentration. Hence, it can be concluded that Si application mitigated the negative effect of Pb toxicity and improved plant growth under Pb-contaminated soil conditions.

Author's Index

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