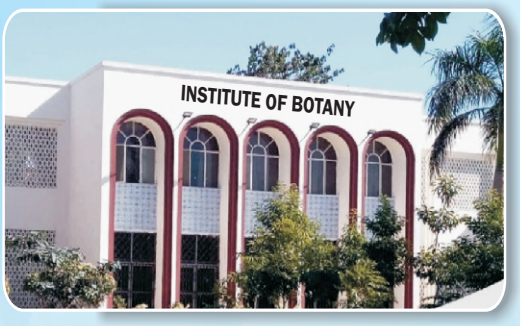
ABSTRACT BOOK

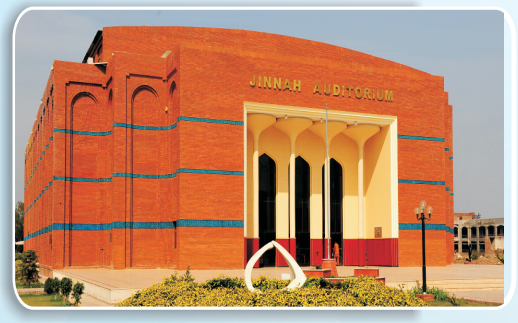
INCPS-2024

9th International & 18th National Conference of Plant Scientists

"Capitalizing Plant Diversity for Ensuring Food Security"

October 28-30, 2024





Organized by:

Institute of Botany
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A word from Organizing Committee

The 9th International & 18th National Conference of Plant Scientists (INCPS-2024), themed “Capitalizing Plant Diversity for Ensuring Food Security,” is scheduled to be held from October 28th to 30th, 2024, at the Institute of Botany, Bahauddin Zakariya University, Multan.
The field of plant sciences is rapidly evolving, transcending traditional boundaries and embracing the integration of diverse disciplines. This conference exemplifies this interdisciplinary approach. By converging these fields, we aim to foster innovation and explore groundbreaking solutions for harnessing the potential of plants in food, medicine, and industry.

The conference will provide a platform for presenting new advances and research results.
The conference is organized by the Botanical Society of Pakistan (BSoP), which has a long history of promoting scientific research through conferences, workshops, and other events. The BSoP’s goal is to create an interdisciplinary platform for plant scientists to exchange ideas, collaborate, and share their research findings.
We cordially invite all scientists and students to attend INCPS-2024. We believe that this conference will foster a new era of scientific exchange, collaboration, and innovation.

International Advisory Board

National Advisory Board

Editorial Committee/Co-Organizing Committee

Message from Patron in Chief -Vice Chancellor

It is with great pride that I extend a warm welcome to all participants of the 9th International & 18th National Conference of Plant Scientists (INCPS-2024), hosted by Bahauddin Zakariya University, Multan, in collaboration with the Botanical Society of Pakistan. The theme of conference, "**Capitalizing Plant Diversity for Ensuring Food Security"**, is both timely and relevant, reflecting our commitment to addressing some of the most pressing global challenges.

As the Patron-in-Chief of this significant event, I am honored to witness our university playing a pivotal role in advancing scientific inquiry and innovation. This conference serves as a powerful testament to Bahauddin Zakariya University's dedication to academic excellence and its focus on fostering research that can make a meaningful impact on society.

By hosting INCPS-2024, our primary goals are to elevate the academic and research profile of our university, particularly in the field of plant sciences. This event will provide an invaluable platform for faculty, researchers, and students to engage with leading scientists from around the world, fostering collaboration and knowledge exchange. The insights gained from this conference will not only enrich the academic pursuits of our institution but would also enhance the quality of research being conducted at our Department of Botany.

Furthermore, the economic and social impact of INCPS-2024 on the region of South Punjab cannot be overstated. The influx of national and international visitors will contribute significantly to local industries such as tourism, hospitality, and services, thus aiding in the economic development of the Multan region.

I would like to express my deepest gratitude to the Botanical Society of Pakistan, the esteemed keynote speakers, and all the distinguished participants who have come together to make this conference a success. Your contributions reflect the critical importance of plant diversity in ensuring food security, particularly in the context of global climate challenges.

I firmly believe that the discussions and research shared during this conference will have a lasting impact, not only on our academic community but also on the broader efforts to ensure food security and sustainable development. I wish the organizers of INCPS-2024 a resounding success and look forward to the new ideas and collaborations that would emerge from this landmark event.

Prof. Dr. Muhammad Zubair Iqbal
Vice Chancellor, Bahauddin Zakariya University, Multan

Message from Patron -Dean Faculty of Science

Welcome to the 9th International & 18th National Conference of Plant Scientists (INCPS-2024). This conference emphasizes the importance of interdisciplinary research in addressing plant-based challenges. By integrating Botany, Biotechnology, Chemistry, Physics, AI, and more, we aim to explore innovative solutions for food, medicine, and industry.

The scope of plant sciences extends far beyond traditional boundaries, and this conference exemplifies the integration of multiple disciplines such as Botany, Biochemistry, Biotechnology, Bioinformatics, Agricultural Sciences, Chemistry, Physics, Mathematics, Statistics, Data Science, Machine Learning, and Artificial Intelligence. By converging these fields, we aim to develop innovative, out-of-the-box solutions for exploring new plants with potential applications in food, medicine, and industry. For instance, plants can offer exciting opportunities in the production of biofuels from algae, plant-based cosmetics, herbal medicines, mushroom-based food products, and biopesticides.

The potential of plant-based innovations is vast, from biofuels to herbal medicines and biopesticides. I encourage our faculty, researchers, and students to explore the entrepreneurial opportunities in these fields, with full support from the Dean's Office.

This conference will drive academic development, inspire new interdisciplinary programs, and strengthen ties between academia and industry, fostering collaborative research for real-world impact. Let's make the most of this opportunity to advance plant science for a sustainable future.

I wish INCPS-2024 a great success.

Prof. Dr. Javed Ahmad
Dean, Faculty of Science
Bahauddin Zakariya University, Multan

Message from Chief Organizer

It is a great honor to welcome you to the 9th International & 18th National Conference of Plant Scientists (INCPS-2024) at Bahauddin Zakariya University, Multan. The Conference theme, “Capitalizing Plant Diversity for Ensuring Food Security,” holds immense significance in addressing the global challenges of food security and environmental sustainability.

At the Institute of Botany, we are proud of our faculty and students who are making remarkable contributions, particularly in the fields of plant ecology and evolution, plant stress physiology, photosynthesis research, protein structural biology and plant microbe-interaction. The research environment at the Institute is rich with opportunities for exploration and innovation, making it an ideal place for students to thrive and pursue impactful scientific careers.

We encourage aspiring students to join the Institute of Botany at BZU and become part of a vibrant academic community. Here, you will find an excellent environment to groom your research skills, contribute to cutting-edge discoveries, and build a bright future in plant sciences.

Best wishes for a successful conference.

Prof. Dr. Seema Mahmood
Chief Organizer, INCPS-2024
Director, Institute of Botany, BZU Multan

Message from Distinguished National Professor, Prof. Dr. M. Qaiser, Ex-Vice Chancellor, University of Karachi and Chief Editor, Pakistan Journal of Botany

It brings me immense pleasure to extend my heartfelt congratulations to the Institute of Botany at Bahauddin Zakariya University, Multan, for nicely organizing the 9thInternational and 18thNational Conference of Plant Scientists (INCPS-2024) under the esteemed umbrella of the Botanical Society of Pakistan.

My association with the Botanical Society of Pakistan goes back to 1968, and over the years, it has been my privilege to support and nurture the society, particularly through my role as the Chief Editor of the Pakistan Journal of Botany. As one of the key contributors to the compilation of the Flora of Pakistan, I have always believed in the importance of advancing plant sciences in our country. This conference is a testament to the flourishing state of botanical research and education at Bahauddin Zakariya University.

Two years ago, when my colleagues and I decided to entrust the responsibility of hosting this conference to BZU, we had full confidence in their ability to deliver an event of great significance. Now, seeing the overwhelming response in the form of abstract submissions from researchers across Pakistan, I am pleased to say that our decision was indeed the right one.

This conference is set to highlight critical issues such as plant systematics, plant diversity, and their potential exploitation for food, feed, and shelter—all crucial areas that align with the Sustainable Development Goals (SDGs). I am confident that INCPS-2024 will offer meaningful insights that contribute to the achievement of these goals and inspire future generations of plant scientists.

I am particularly delighted to see how this conference will benefit the students from the region, providing them with a unique platform to engage with leading experts and to showcase their own research capabilities.

I wish the conference immense success and hope it continues to propel the Institute of Botany, BZU Multan, toward even greater heights in the field of botanical research and education.

With best wishes,

Prof. Dr. M. Qaiser
Distinguished National Professor
Ex-Vice Chancellor, University of Karachi
Chief Editor, Pakistan Journal of Botany

Message from Chief Guest

Distinguished National Professor, Dr. M. Ashraf (*HI, SI, POP, IF; Fellow TWAS; IAS; PAS*), Rector, The University of Lahore on the occasion of INCPS-2024

It gives me immense pleasure and joy to see the Institute of Botany at Bahauddin Zakariya University, Multan, hosting the prestigious 9th International and 18th National Conference of Plant Scientists (INCPS-2024). This institute holds a special place in my heart as I began my academic career therein, serving as Lecturer, Assistant Professor, and later Associate Professor from 1987 to 1999.

During my time here, I had the privilege of establishing the Plant Physiology Lab and was involved in the breeding of the salt-tolerant wheat cultivar, S-24. Some of the brightest students I mentored during that time have gone on to achieve remarkable success in their careers. The Institute of Botany has always been a hub of innovation and research excellence, and I am thrilled to witness its continued tremendous growth and success.

This conference is a reflection of the institute's commitment to advancing plant sciences and it will serve as a platform for scholars and researchers to share their groundbreaking work. I am confident that INCPS-2024 will have a profound impact, not only on the research community, but also on the students from the region who will gain valuable insights and inspiration from the discussions and presentations by eminent plant scientists.

I extend my heartfelt congratulations to the organizing committee for putting together this remarkable event. I look forward to the exciting contributions that will emerge from this gathering, and I am proud to see my alma mater flourishing in such an impactful way.

With best wishes for continued success,

Prof. Dr. M. Ashraf
Distinguished National Professor
Rector, The University of Lahore

Message from Emeritus Prof. Dr. Javed Iqbal – Lifetime Achievement Awardee

The Institute of Botany, Bahauddin Zakariya University Multan, under the banner of Pakistan Botanical Society is hosting the 9th International and 18th National Conference of Plant Scientists (INCPS 2024) from October 28th to 30th 2024. A large number of delegates (763) from over 46 public/private universities of the country are attending the conference.

During the deliberations of the conference, 151 oral presentations and 103 posters will be displayed. Eleven scholars of international repute will address the participants either oral or online oral. Three renowned scientists of the country will be awarded the “Lifetime Achievement Award.

The main challenges of the day Pakistan is facing are climate change and an increase in human population resulting in water and food security.

The conference will deliberate on these issues and will promote interdisciplinary dialogue regarding contemporary issues confronting plant scientists of the country and presentations in the conference and ensuing discussions will provide guidelines for future work to younger scientists of the country.

To manage a conference at such a huge level is a gigantic task and I wish the Organizing Committee all success.

Emeritus Prof. Dr. Javed Iqbal
Institute of Botany
University of the Punjab
Lahore

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Plenary Lectures

INCPS-2024-54 Primary and Secondary Reaction of Photosynthesis as Non-Invasive Indicators for the Degree of Stress on the Plant

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Photosynthesis, the cornerstone of plant life, is a complex process divided into primary and secondary reactions. These reactions, sensitive to environmental stresses, offer valuable insights into a plant's health. By monitoring changes in these processes, researchers can non-invasively assess the degree of stress a plant is experiencing. The primary reaction, light-dependent, occurs in the thylakoid membranes of chloroplasts. Light energy is captured and converted into chemical energy in the form of ATP and NADPH. Stress factors, such as drought, salinity, or extreme temperatures, can disrupt this process by damaging the photosynthetic apparatus or limiting light absorption. By measuring chlorophyll fluorescence, a non-invasive technique, researchers can evaluate the efficiency of primary photochemistry and identify early signs of stress. A decline in fluorescence parameters indicates reduced photosynthetic efficiency and potential damage to photosystem II. The secondary reaction, light-independent or Calvin cycle, takes place in the stroma. This phase involves the fixation of carbon dioxide into organic compounds, utilizing the energy from the primary reaction. Stress conditions can impair this process by affecting enzyme activity, reducing carbon dioxide uptake, or altering the balance of metabolites. Gas exchange measurements, another non-invasive method, can assess the efficiency of carbon dioxide assimilation. A decrease in stomatal conductance or net photosynthesis rate signifies stress-induced limitations on carbon fixation. By combining measurements of primary and secondary photosynthetic reactions, researchers can gain a comprehensive understanding of a plant's stress response. For instance, a decline in both fluorescence parameters and gas exchange rates suggests severe stress affecting both light and dark reactions. Conversely, an isolated reduction in gas exchange might indicate stomatal closure as a protective mechanism against water loss, while the plant's photosynthetic machinery remains relatively intact. The ability to monitor photosynthetic processes non-invasively has significant implications for crop improvement. By identifying stress-tolerant genotypes, breeders can develop cultivars better equipped to withstand adverse environmental conditions. Additionally, real-time monitoring of crop stress can optimize irrigation and fertilization practices, leading to increased yields and resource efficiency. Ultimately, understanding the relationship between photosynthesis and stress is crucial for developing sustainable agricultural strategies in a changing climate.

INCPS-2024-99 Importance of Millets for Climate-Resilient Agriculture and Food Security

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As global population surges, the need for food escalates accordingly. Cereals currently account for nearly half of global calorie consumption. However, expanding production of major cereals faces hurdles due to increasing dry land areas and declining groundwater levels. In this context, millet emerges as a critical player for global food security and sustainable agriculture, especially in drought-prone and soil-depleted regions. Millet is a nutrient-dense grain, offering essential proteins, dietary fiber, and key minerals like iron, calcium, and magnesium. It is also gluten-free, providing a viable alternative for those with gluten intolerances. Its high fiber content benefits digestive health and aids in blood sugar management, making it a nutritious option for diabetics. Environmentally, millet is a low-impact crop, requiring minimal water and resources. Millet's climate resilience is noteworthy; it thrives in a range of ecological conditions, requires less irrigation, and exhibits high productivity even in low-fertility soils. It also shows less dependence on synthetic fertilizers and is less vulnerable to environmental stresses. Nutritionally, millet outperforms other major cereals, offering abundant dietary fiber, resistant starches, vitamins, essential amino acids, storage proteins, and other beneficial phytonutrients. Given the challenges of meeting the dietary needs of a growing global population and the threats posed by climate change to agriculture, millet's adaptive traits are invaluable. Unlike major cereals, millet possesses unique morphological, molecular, and biochemical features that enhance its environmental stress tolerance. Its impressive resistance to abiotic stressors like drought, salinity, and temperature variations makes it a model species for studying stress adaptation at multiple biological levels. Features like short stature, small leaf area, thick cell walls, and robust root systems further equip millet to cope with environmental stresses. Therefore, millet is increasingly recognized as a next-generation crop with significant promise for bolstering global food security and nutrition amid rising agricultural challenges and climate uncertainties.

INCPS-2024-102 - Latest Developments in Serial Crystallography: Applications in Structure Based Drug Discovery

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Due to the progress in medical and pharmaceutical research in recent years, most diseases can now be identified and explained today at the molecular level. This applies for example to infections caused by bacteria or viruses. The corresponding complex molecular processes are mostly known in detail, at the atomic level. With this knowledge molecular targets can be identified and when their activity is inhibited a bacterium can be exterminated or viruses can be prevented from multiplying. This procedure is called "drug design". The method of high-resolution X-ray structure analysis is the workhorse in drug discovery and drug design. Using structural X-ray analysis at atomic resolution most suitable active substances can be identified bei X-ray screening techniquzes according to the key (active substance) - lock (target) principle, and further optimized. This search and optimization is supported by modern computer programs once the 3D structure has been identified. However, there is often a long way from the first identification to application. Today, however, this path can be followed more efficiently by carrying out so-called high-throughput searches of molecular libraries, with a focus also on natural compound libraries and also using compounds that are already approved as active drugs for the treatment of other diseases. This procedure and application is named drug-repurposing. DESY in Hamburg, Germany, with the modern and very intense X-ray sources as the PETRA III storage ring, as well as the European X-ray laser EuXFEL, provide unique and ideal conditions for structure based drug discovery. Latest procedures of structure-based drug development will be presented and explained, using examples from local corona-research activities and structural methods to identify and design new antibiotic compounds.

INCPS-2024-55 Plantish: The Languages of Plants

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Our work explores an innovative approach to plant communication through the integration of artificial intelligence (AI) and biological feedback systems, leveraging photosynthesis as the key physiological process. By monitoring real-time photosynthetic activity, AI algorithms interpret plant responses to various stimuli, enabling a bidirectional communication framework. This method utilizes sensors to capture photosynthetic parameters, which are then analyzed by machine learning models to decode plant signals and generate appropriate responses. Our results demonstrate the potential for AI-driven systems to enhance understanding and interaction with plant biology, offering new avenues for agricultural optimization and ecological research.

INCPS-2024-91 Post-Transcriptional Regulation Controls Bacterial Virulence in Rice

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Adenosine-to-inosine (A-to-I) RNA editing is an important posttranscriptional event in eukaryotes; however, has been relatively unexplored in prokaryotes. This study investigated A-to-I RNA editing in *Xanthomonas oryzae*pv. *oryzicola* (*Xoc*) and discovered two editing events. The first event, induced by oxidative stress, resulted in an A-to-I change that recoded serine to proline (S128P) in the mRNA of *fliC,* encoding a flagellar filament protein. Using genome-wide RNA immunoprecipitation–coupled high-throughput sequencing (iRIP-Seq) analysis with HA-tagged TadA from *Xoc*, we found that TadA binds to the mRNA of *fliC*, and the binding motif is identical to that previously reported. The editing event led to changes in flagellar filament structure, increasing motility and enhancing tolerance to oxidative stress, as modelled in 3D and measured by TEM. The S128P mutant also showed an increase in biofilm formation, measured by 3D laser scanning confocal microscopy. RNA-seq analysis revealed that a gene cluster contributing to siderophore biosynthesis and Fe^{3+} uptake was upregulated in S128P compared with wild-type. Intracellular levels of reactive oxygen species and an oxidative stress survival assay indicated that this gene cluster reduces the Fenton reaction, increasing biofilm formation and bacterial virulence.

Another A-to-I RNA editing event shows that *xfeA* in *Xoc* senses extracytoplasmic iron and changes the hydrogen bonding network of ligand channel domains. The frequency of A-to-I RNA editing during iron-deficient conditions increased by 76.87%, which facilitated the passage of iron through the XfeA outer membrane channel. When bacteria were subjected to high iron concentrations, the percentage of A-to-I editing in*xfeA* decreased, which reduced iron transport via XfeA. Furthermore, A-to-I RNA editing increased expression of multiple genes in the chemotaxis pathway, including methyl-accepting chemotaxis proteins (MCPs) that sense concentrations of exogenous ferrienterobactin (Fe-Ent) at the cytoplasmic membrane.

In summary, our study demonstrates the importance of A-to-I RNA editing in bacterial pathogenicity and adaptation to environmental stress. These findings provide new insights into the mechanisms by which *Xoc* respond to extracellular iron and oxidative stress, which may lead to the development of novel targets for the control of bacterial leaf streak.

INCPS-2024-95 Precious Medicinal Plants Diversity for Socio-economic Development in Uzbekistan

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Uzbekistan boasts a rich and diverse flora, including a treasure trove of medicinal plants with significant potential for socio-economic development. This presentation will explore the unique biodiversity of medicinal plants in Uzbekistan, their traditional and contemporary uses, and their role in promoting sustainable livelihoods and economic growth. The presentation will delve into the ethnobotanical knowledge and practices surrounding these plants, highlighting their importance in traditional Uzbek medicine. It will discuss the phytochemical composition and pharmacological properties of key medicinal plant species, emphasizing their potential for drug discovery and development. Furthermore, the presentation will address the conservation challenges faced by these valuable resources and explore sustainable harvesting and cultivation practices. By harnessing the potential of medicinal plants, Uzbekistan can create new economic opportunities through the development of herbal products, pharmaceuticals, and cosmetics. This presentation will discuss strategies for value addition, market development, and building sustainable supply chains. It will also highlight the importance of capacity building, research, and collaboration among stakeholders to maximize the benefits of medicinal plant resources. Ultimately, this presentation aims to contribute to the understanding of Uzbekistan's medicinal plant diversity and its potential to drive socio-economic development while preserving this invaluable natural heritage.

INCPS-2024-100 Insights into the Dynamic Responses of Plants under Combined Stresses using High-throughput Image Based Phenotyping

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The occurrence of severe heat waves, flooding, and drought events in the field conditions threatens crop productivity, particularly when plants are frequently exposed to multiple stresses. Thus, investigating the underlying mechanism of plants in response to combined stresses to find climateresilient traits of interest is highly demanded. This study, in the frame of ADAPT project, aimed to investigate the dynamic morphological and physiological responses of potato plants to single and combined abiotic stresses by using high throughput image-based phenotyping. The applied approach elucidates how plants respond to drought, heat, and waterlogging stresses individually and in combination. Moreover, it enabled the identification of early and late responses in different cultivars. Different responses, including plant biomass, photosynthetic efficiency, canopy temperature, and leaf reflectance indices, were observed under single and

combined stresses. Overall plants were severely affected primarily by waterlogging, reflecting the detrimental effect of this stress on potato plants. The drastic reduction in the quantum yield and efficiency of photosystem II was observed with an increase in canopy temperature and water index due to stomatal closure, particularly in the susceptible cultivars under waterlogging followed by the triple stress combination of drought, heat, and waterlogging. The negative impact of stress was reflected in the reduction of final yield. Reduction in the harvest index was observed in all stresses, however, the most severe impact was detected under waterlogging and combined stresses. Here we highlight that applied phenotyping protocol based on using multiple imaging sensors is a valuable tool for revealing new insights into understanding plant mechanisms,including crops and cereals, in coping with rapid climate change.

INCPS-2024-103 Phenotypic Diversity and Stability of Gorgak Melon Cultivars (*Cucumis melo* L.) in Sar-e Pol

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The Gorgak melon, a subspecies of *Cucumis melo* L., is a prominent crop in Afghanistan, exhibiting remarkable morphological and phenotypic diversity. This study aimed to investigate the phenotypic characteristics and stability of Gorgak melon cultivars grown in Sar-e Pol province. A randomized complete block design with two replications was employed at the Gangalbagh Research Station. Results showed that Gorgak cultivars demonstrated significant differences in morphological, growth, and yield traits, primarily attributed to fruit characteristics. Stem color, number of lateral stems, stem length, and germination percentage were found to be stable among cultivars. Notably, *Gorgakseya* and *Gorgaksabz* exhibited distinct phenotypes derived from *Gorgakablaq*. The findings suggest that adjacent ranges can undergo shifts in color due to environmental factors such as light intensity fluctuations or nutrient deficiencies. In conclusion, the Gorgak melon cultivars display remarkable phenotypic diversity and stability, with each cultivar exhibiting unique characteristics. *Cucumis melo* L., commonly referred to as the melon, is a genetically diverse and economically significant species cultivated worldwide. Among the various species of Cucumis, *C. melo* L. occupies the third position in terms of production quantity. The Afghan variety, particularly the Gorgak melon, has gained recognition for its local and regional market demand. In Sar-e Pol province, Afghanistan, the Gorgak melon is widely cultivated for commercial purposes. A randomized complete block design with two replications was employed at the Gangalbagh Research Station in Sar-e Pol province. Morphological traits were evaluated using a standardized protocol. The results show that Gorgak cultivars exhibited significant differences in morphological traits, primarily related to fruit

characteristics. Stem color (RHS 143B), number of lateral stems, stem length, bio products, germination percentage, and 50% germination were found to be non-significant among cultivars. The observed phenotypic diversity among Gorgak cultivars may be attributed to both positive and negative selection pressures. The stability of certain characters such as stem color and number of lateral stems suggests that these traits are relatively conserved across cultivars. However, adjacent ranges can undergo shifts in color due to environmental factors such as fluctuations in light intensity or nutrient deficiencies. This study demonstrates that Gorgak melon cultivars exhibit remarkable phenotypic diversity and stability, with each cultivar displaying unique characteristics. The findings suggest that *Gorgaks*eya and *Gorgaksabz* exhibit distinct phenotypes derived from Gorgakablaq. The stability of certain characters highlights the importance of preserving genetic diversity within this crop species.

INCPS-2024-104 Back to the Origins: Biopesticides as Promising Alternatives to Conventional Agrochemicals

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Presently, the world is using eco-friendly products to limit pollution in soil, air, water, and marine environments and to mitigate rapid climate change according to the sustainable development goals of the United Nations Development Programme. As a result, most countries attempt to produce environmentally friendly herbicides, fertilizers, and pesticides from plants, algae (e.g., *Cladophora glomerata, Laurencia pinnata, Plocamiumcartilagineum,*Polcamium spp.) or animal manure. Plants, such as *Anethum sowa, Thymus vulgaris, Foeniculum vulgare, Syzygium aromaticum, Pinus* sylvestris, Citrus spp., Piper spp. and *Mentha spicata*, areecofriendly sources of essential oils, containing safe components, which can resist harmful pests. This review evaluates the common plants and algae used for extracting biopesticides, geographical distribution, target pests, mode of action, and commercial viability.

INCPS-2024-243 Molecular Mechanisms of Regulation of Boron Transporter Gene Expression in Response to Boron Conditions

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Boron is essential and toxic to plants depending on the concentrations. Boron transporters of *Arabidopsis thaliana* have been identified and their expression are regulated in response to boron conditions. The regulation involves protein degradation/sensing by transporters, translational and transcriptional regulation. BOR1 the efflux transporter of boron (Takano et al 2002) is regulated at the levels of protein degradation under high boron conditions (Takano et al 2005, 2010、Kasai et al 2011) and it has been suggested that BOR1 acts as a sensor of boron (Yoshinari et al 2020). NIP5;1, diffusion facilitator of boron (Takano et al 2007) is regulated through mRNA degradation in response to high boron (Tanaka et al 2011) mediated by ribosome stalling at the AUG-Stop sequence in the 5' UTR of NIP5;1 mRNA (Tanaka et al 2016). Structural study indicates cytosolic boron affects translation termination (Tanaka et al 2024). BOR1 is also regulated at translationally (Aibara et al., 2018) Our recent study suggested universal effect of boron on translational termination (Sotta et al 2021). In this presentation I will present overview and recent knowledge on complex and well-organized process of the regulation.

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INCPS-2024-101 From Weed to Seed with Future Potential: The Role of Hemp in Climate and Social Justice

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Introduction: I have been trying since many years to explore the multifaceted consequences of prohibiting plants such as Cannabis and hemp, particularly their untapped potential for climate mitigation and social justice. Despite Pakistan's prominent position in global hashish production, particularly in regions like Khyber Pakhtunkhwa and the tribal areas along the Afghan border, the country remains underrepresented in the broader cannabis and hemp industry. This talk will elucidate the historical, cultural, and socio-economic impacts of this prohibition, emphasizing its effects on indigenous and peasant communities in ecologically fragile high-altitude regions.

Background: Pakistan, along with countries like Morocco, Afghanistan, and Lebanon, has a rich history of cannabis cultivation and charas production. These traditional practices, handed down through generations, underscore the cultural significance and economic potential of the plant. However, the stringent legal frameworks surrounding cannabis and hemp have relegated these practices to the realm of illicit production, preventing their integration into regulated operations that could contribute significantly to climate mitigation efforts.
Impact of Prohibition: The political choice to prohibit cannabis and hemp cultivation has disproportionately affected vulnerable communities in regions such as the Moroccan Rif Mountains, the Mongolian steppes, and the Indian and Pakistani Himalayas. These areas are not only ecologically fragile but also socially marginalized, bearing the brunt of both environmental degradation and socio-economic exclusion. Prohibition has hindered opportunities for sustainable development and exacerbated social injustices in these regions.
Potential of Hemp for Climate and Social Justice: Hemp possesses remarkable properties that make it a viable candidate for addressing climate change and promoting social equity. The plant's applications in bioremediation, the production of artisanal and industrial goods, regenerative agriculture, and carbon sequestration are manifold:

- **Bioremediation:** Hemp's ability to absorb toxins and heavy metals from the soil makes it an excellent choice for restoring polluted environments and revitalise depleted and poor soils.
- **Consumer Goods:** From textiles to paper, bio-composites and ecological building materials, hemp-based products offer sustainable alternatives to conventional materials.
- **Regenerative Agriculture:** Hemp can improve soil health, enhance biodiversity, and support sustainable farming practices and provides a super-food.
- **Carbon Sequestration:** The plant's rapid growth and carbon absorption capabilities contribute significantly to reducing atmospheric CO_2 levels, especially once turned into long-lasting products.

INCPS-2024-92 Species richness and diversity of Zingiberaceae at the Bangladesh Agricultural University Botanical Garden

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A study was carried out from January 2022 to December 2023 at the Bangladesh Agricultural University Botanical Garden (BAUBG) to evaluate the species diversity within the Zingiberaceae family, document their flowering periods, ethnobotanical uses, and conservation status. The BAUBG conserves a variety of plant species sourced both locally and internationally, functioning as a living germplasm center. The study identified a total of 50 species across 14 genera within three tribes of the ginger family. The Zingibereae tribe exhibited the highest species diversity with 24 species across 6 genera, including 9 species in the genus Curcuma and 5 species in the genus Zingiber. The Alpinieae tribe, with 17 species across 5 genera, was the second most diverse, featuring Alpinia (9 species),

Amomum (3 species), Elettaria (1 species), Etlingera (2 species), and Plagiostachys (1 species). The third tribe, Globbeae, included two genera: Globba (8 species) and Hemiorchis (1 species). Most species flowered between March and August. Zingiberaceae plants are widely used as food, spices, medicine, ornamental plants, and in rituals. Eight species were classified as of least concern on the IUCN Red List, while two rare species were listed in the Bangladesh Red Data: Plants. Based on Saensouk's (2011) criteria, six species were identified as rare, and two species were endemic to Bangladesh. This study serves as a baseline for documenting the Zingiberaceae species in Bangladesh and their various applications.

INCPS-2024-274 Root-derived Bacteria and Root Exudates are Crucial for the Salt-tolerance of Perennial Ryegrass (*Lolium perenne* L.)

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Salinity poses a significant threat to plant growth and development. The root microbiota plays a key role in plant adaptation to saline environments. Nevertheless, it remains poorly understood whether and how perennial grass plants accumulate specific root-derived bacteria when exposed to salinity. Here, we systematically analyzed the composition and variation of rhizosphere and endophytic bacteria, as well as root exudates in perennial ryegrass differing in salt tolerance grown in unsterilized soils with and without salt. Both salt-sensitive (P1) and salt- tolerant (P2) perennial ryegrass genotypes grew better in unsterilized soils compared to sterilized soils under salt stress. The rhizosphere and endophytic bacteria of both P1 and P2 had lower alpha-diversity under salt treatment compared to control. The reduction of alpha-diversity was more pronounced for P1 than for P2. The specific root-derived bacteria, particularly the genus of *Pseudomonas*, were enriched in rhizosphere and endophytic bacteria under salt stress. Changes in bacterial functionality induced by salt stress differed in P1 and P2. Additionally, more root exudates were altered under salt stress in P2 than in P1. The content of important root exudates, mainly including phenylpropanoids, benzenoids, organic acids, had a significantly positive correlation with the abundance of rhizosphere and endophytic bacteria under salt stress. 14 potential growth promotion bacterium strains in *Pseudomonas* were isolated from the rhizosphere salt-tolerant perennial ryegrass genotype and most of them can promote the growth of a commercial perennial ryegrass cultivar. These results indicate that the interactions between root-derived bacteria and root exudates are crucial for the salt tolerance of perennial ryegrass, which provides a potential strategy to manipulate root microbiome for improved stress tolerance of perennial grass species.

INCPS-2024-219 Evolutionary Plant Breeding as a Practical Strategy for Yield Stability in Saline Environments

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Evolutionary plant breeding (EPP) offers a means to enhance crop resilience in the face of climate change, promote biodiversity, and support sustainable farming practices. To date, there has been a lack of studies or reports addressing the application of EPP in saline conditions. This research aimed to evaluate the yield stability of two evolutionary barley populations against three pure genotypes under saline conditions over the growing seasons from 2017 to 2022. The experimental setup included two evolutionary populations, Kashkooli and Partoei, alongside control genotypes comprised of Golshan and Khatam cultivars as well as a promising line, MBS-89-17. The results indicated that the Kashkooli and Partoei populations performed relatively well in comparison to the control genotypes. Across all experimental years, the Kashkooli population consistently produced the highest grain and biological yields, followed by the promising line MBS-89-17. The superior yield of the Kashkooli population can be attributed to its higher ear grain count, while the lower performance of the Partoei population was linked to leaf rust disease. Overall, the ranking of grain yield was as follows: Kashkooli evolutionary population > MBS-89-17 line > Golshan genotype >Partoei evolutionary population > Khatam genotype. Given its strong performance in saline soil and water conditions, the Kashkooli evolutionary population appears to be a viable option for cultivation in challenging environmental scenarios, pending validation of these results on a broader scale. The EPP, as a successful example of overcoming the lack of available genetic resources, is a method to adapt agricultural products to climate change, increase biodiversity and support the sustainable livelihood of farmers.

Micelles: Soap Industry & Drug delivery

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The ability of a soapy solution to act as a detergent has been recognized for centuries. However, it was only at the beginning of the twentieth century that the constitution of such solutions was scientifically studied and a new word for "tiny particle the concept of micelles was introduced. It is also noticed that the aggregation of these phospholipid molecules give rise to two aggregation entities. It is therefore, important to know the difference between these two formulations. The major difference between these two types of aggregates is in the size of their building blocks. The surfactant molecules have

a molecular weight which is generally of a few hundreds of grams per mole while block copolymers are generally one or two orders of magnitude larger. Further, thanks to the larger hydrophilic and hydrophobic parts, block copolymers can have a much more pronounced amphiphilic nature when compared to surfactant molecules.Because of these differences in the building blocks, some block copolymer micelles behave like surfactant ones, while others don't. It is necessary therefore to make a distinction between the two situations. The former ones will belong to the *dynamic micelles* while the latter will be called *kinetically frozen micelles.* Micellular chemistry is also considered a form of Green chemistry. Micelle formation is essential for the absorption of fat-soluble vitamins and complicated lipids within the human body. Bile salts formed in the liver and secreted by the gall bladder allow micelles of fatty acids to form. This facilitates the absorption of complicated lipids (e.g., lecithin) and lipid-soluble vitamins (A, D, E, and K) within the micelle by the small intestine. Micelles can also be used for targeted drug delivery as gold nanoparticles

National Invited Speakers

INCPS-2024-90 Plant Biodiversity of Northern Hemisphere in Asia: A way forward along China-Pakistan Economic Corridor (CPEC) for Cooperation and Conservation

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Northern Hemisphere in Asia is one of the important and richest hotspot of Plant biodiversity in the world. In this region Pakistan hosted diverse ranges of plant diversity in Himalaya, Karakoram and Kohindukush with long chain of mountain supporting with cultural communities. In this region, currently a project China Pakistan Economic Corridor (CPEC) is consider to bring revolutionary changes to the research sector particularly by the application of Plant diversity. China and Pakistan are diverse phytogeographical countries with unique plant diversity of Gymnosperms, Angiosperms and lower plant species along this corridor. The experts from both countries have started number of international projects on plant resources using modern technologies including digitization of floral diversity, conservation of wild natural plant resources, conservation of trans-border indigenous knowledge and exchange of ideas by institutions through smart technology to cope 15th SDGs in order to conserve plant diversity under fast climatic changes. This study contributes to a deeper understanding of the interplay between the built environment, biodiversity, and the SDGs, allowing key industry actors and policymakers to prioritize biodiversity in SDG-related policies and programs. In order to do this, we have compiled all of the empirical data that is currently available on the connections between biodiversity and economic growth, concentrating on changes in climate, invasive alien species, and land use. Finally, we demonstrate how scenario planning for significant policy instruments such as the Convention on Biological Diversity can aid in shifting national and international goals away from growth and toward biodiversity protection. This project supported to develop modern Herbaria and Botanic Garden to protect endemic and endangered species in this part of Northern Hemisphere of Asia. Quaid I Azam university Botanic Garden and Herbarium (ISL) initiated projects with Institute of Botany Beijing, Chengdu institute of Biology (CIB), and number of other institutions in China cooperating to support Pakistani researchers and experts in the field of plant biodiversity, plant documentation, collection and conservation in line with global efforts for protection. This initiative may further leads to trained post graduate students, scientists, Plant Taxonomists, Biodiversity Experts, Horticulturists, Plant botanists, traditional health practitioners and layman regarding the equal sharing benefits of Plant diversity with sustainable way.

It is further suggested to exchange of knowledge and information followed by the setting up of a joint departments of biodiversity through which the public will bring the China and Pakistan closer and strengthen the ties between the two brother countries.

INCPS-2024-93 Role of Botanic Gardens for the Promotion of Food Security in the Present Scenario of Climate Change

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Climate change is one of the greatest challenges faced by human society. Global warming and the increasing aridity make growing conditions unsuitable for the plants. Moreover, plant biodiversity is currently being lost at an unprecedented rate. About 1/3rd of vascular plants are facing the threat of extinction due to various devastating anthropogenic activities. According to a report of FAO about 75% of crop diversity was lost between 1900 – 2000. A recent study predicts that as much as 22% of wild relatives of crop plant such as peanuts, Potato, beans will disappear by 2055 under changing climate. At present slightly over 100 plants species provide 90% food to mankind, of which 3 species *Triticum aestivum* (wheat) *Oryza Sativa* (Rice) and *Zee mays* (maize) provide 2/3 of total food. This base has to be broadened. In order to protect crop diversity crop wild relatives (CWRs) are to be conserved as they are genetically resilient to heat, drought diseases there is a dire need to collect, identify, document these CWRs. In the global agricultural gene bank CWRs collection are poorly represented (2 to 10%). Whereas Botanic Gardens have 70% live collection of CWRs representing crops and other economically important plants. Most of the botanic gardens have expertise in plant taxonomy, physiology, plant breeding and conservation. They can play a significant role in *ex situ* andin *situ* conservation of these CWRs. Some of large Botanic Gardens such as Kew (U.K) Missouri Botanic Gardens (USA) are already working on this strategy. In the past Botanic Gardens located in tropics have played a major role in plant introduction and spread of germplasm of economically important plants such as coffee (*Coffea arabica*), tea (*Camellia sinensis*), oil palm (*Elaeisguinensis*), rubber (*Hevia brasilensis*) and cassava (*Manihot esculenta*). Moreover some Botanic Gardens are also exploiting neglected but editable plants for future. Botanic Gardens are also playing an important role in public education regarding foods security biodiversity conservation. Under the influence of climate change there is a possibility of the spread of invasive species which will be threat to agricultural productivity food security along with spread of weeds pests and diseases. There is a need to introduce of adaptable exotic species for agriculture, biofuel etc. However, care must be taken in the selection of such species. Botanic Gardens can play important role before introducing on larger scale. Hence the Botanic

Gardens can play a multifarious role in the present scenario of climate change including plant conservation and plant introduction for addressing food security.

INCPS-2024-162 Evolution and Revolution in Botany/Plant Science

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The old botanical record can be traced from India, Egypt, Greece and China dating back to 1100 BCE. Thus, botany is a very old branch of life sciences, which originated as an indispensable exploration of knowledge of plants for human and animal healthcare. Theophrastus (a Greek; 371-287 BCE), an intelligent student of Aristotle, is considered as "**Father of Botany**" due to his excellent works "*Enquiry into Plants*" (*Historia Plantarum*) which focuses on classification and description of plants and "*On the Causes of Plants*" (*De causis plantarum*), on plant domestication, laying the foundation of agriculture.In the Muslim Era, particularly during 9th to 13th centuries, some eminent Muslim scientists including AbūḤanīfaDīnawarī from Iran during 9th Century, Ibn e Wahshiyya from Iraq in 10th century and Ibn Bassal from Spain during Muslim regime in 11th century wrote different books on domestication and agronomic practices of plants. However, in the European Era starting from the end 15th century, several authors, though being not true botanists, wrote books on plants and their uses. In the European Era, the contribution of Carl Linnaeus ((1707-1778), a Swedish taxonomist, had been considerable because of giving rise "**binomial nomenclature**" of plants. Since mid-1960s there have been significant developments in understanding plant physio-biochemical processes such as transpiration, stomatal conductance, rate of photosynthesis, respiration, N-fixation, hormone metabolism, mineral nutrition, etc. In 1974, Chang and Cohen (both American biologists) developed "**Transgenic approach**" – Genetic engineering of organisms. Subsequently, in 1986, Tom Roderick coined the term "**Omics**". Thereafter, in 2003, Paul Hebert developed "**DNA barcoding"** or sequence-based specimen identification. Recently, several gene/genome editing techniques such as **CRISPR-Cas9**, **RNAi, SeekRNA, Transposase-assisted Target Site Integration (TATSI), Click Editor, Allele Sale**, etc. have been developed. Thus, with the conspicuous evolutionary process occurring in all scientific disciplines including plant science, multiple advanced tools are emerging frequently which can make a considerable progress in comprehensively understanding the natural phenomena, yet obscure, taking place in plants.

INCPS-2024- 290 Impact of Weeds on the Crops, Environment, Agriculture and Human Health

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Weed is a plant that grows where it is not wanted, including plants that were not intentionally sown or those that are more competitive and interfere with human activity. Weeds are one of the major threats to the natural environment, they are responsible for destroying the native habitats, threatening the native flora and fauna, also choke rivers and canals e.g. *Eichornia crassipes* and *Salvinia natans.*
Weeds play a very important role in our life in various ways.
Impact of weeds on crops – Weeds cause reduction in crop yield through competition for light, nutrient, water and space. It is estimated that uncontrolled weed infestation may reduce 40% yield in maize, rice 41.6% and sugar beet 70% Moreover weeds also reduce the crop yield through allelopathy by releasing toxic substances in the soil such as quack grass (*Elymus repens*) secrete the toxic substance which is harmful for the crop plants.
Impact of weeds on the environment: Weeds are one of the important threats to the natural environment. The invasion of exotic species change the natural vegetation consequently disbalancing the natural ecosystem. *Prosopis juliflora*and*Salvinia natans*are the two classic examples of these invasive species. In Pakistan the natural vegetation in plains is greatly disturbed and at some places completely replaced by *Prosopis juliflora,* a South American species. Similarly*Salvinia natans*another Brazilian weed has greatly damaged aquatic ecosystem of Europe and some parts of Asia. It has been estimated that these invasive species have invaded more than 15% flora of Australia.
Impact of weeds on human health: Certain weeds cause skin and respiratory allergies such as *Parthenium hysterophorus*, a tropical American weed, widely naturalized in Asia, Africa and Australia is not only a serious threat to agriculture, highly poisonous causing skin and respiratory allergy. Similarly A*mbrosia artemisiifolia* another weed from tropical Americas is the main cost of allergic rhinitis.

NCPS-2024-88 Enhancing the Yield of Rice and Wheat by Editing Multiple Negative Regulators of Yield Traits

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Recent advances allow the deployment of cluster regularly interspaced short palindromic repeats (CRISPR)-associated endonucleases (Cas) system for the targeted mutagenesis in the genome with accuracy and precision for trait improvement in crops. The CRISPR-Cas has been utilized to induce knockout or frameshift mutations in the targeted sequence of mostly negative regulating genes for rice and wheat improvement. Here, we report CRISPR-Cas9 mediated multiplex editing of four yield-related negative regulators for yield improvement in Super Basmati. By employing the polycistronic tRNA-gRNA strategy, four guide RNAs were expressed to target *OsD27*, a negative regulator of the number of tillers, *OsGN1a*- the negative regulator of grain number, and two negative regulators of grain weight, namely *OsTGW6* and *OsGW2*. This resulted in a co-editing efficiency of 30% in T_0 generation. The T_0 and field evaluation of T_1 quadruple edited plants doubled the yield of Super Basmati as compared to the wild-type control, without compromising other agronomical traits. The combinatorial effect of simultaneous modifications of four yield negative regulators has the potential to increase the estimated per hectare yield up to 124% in Basmati rice. Wheat yield is controlled by various genes such as positive and negative regulators. *TaD27* gene is described as a related negative regulator of shoot branching or tillering and is involved in the biosynthesis of strigolactones. In this study, we developed *Tad27* knockout mutant lines of an elite wheat cultivar that showed a twofold increase in the number of tillers, 2.5-fold increase in the number of grains per plant, and 1.1-fold increase in the hundred grains weight. Subsequently, enhancing the grain yield without any morphological penalty in the architecture of the plants. The co-transformation of regeneration enhancing growth regulator (GRF4-GIF1) under single T-DNA cassette improved the regeneration efficiency up to 6% of transgenic events from mature embryos of wheat. Our results indicate that the CRISPR-mediated targeted mutagenesis confers the potential to knockout yield-related negative regulators in elite cultivars of rice and wheat that can substantially enhance grain yield per plant. The yield trials have shown very significant yield increase.

INCPS-2024-22 Environmentally Sustainable Management of Tannery Waste through Biological Approaches

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Tannery waste is a potentially hazardous waste polluting water, soil and air and is a high environmental risk for food chain contamination in areas having the leather industry. Long term logging of tannery effluents on soil not only adds undesirable quantities of heavy metals but also increase its pH and

EC, rendering it unsuitable for agricultural purposes. The effluents when added to water bodies increase their TDS, TSS, cations and anions along with BOD and COD. The tannery solid waste is another type of hazardous solid waste that needs effective management either through recycling of heavy metals or proper disposal into the land fill in a sustainable manner. In specifically engineered constructed wetlands comprising of three levels and using highly efficient heavy metal resistant nurseries of *Hemarthriacompressa*and *Typha latifolia*, BOD of real tanning effluent was reduced by 90%, along with all pollution parameters and the effluent was safe enough for irrigation purposes for the cultivation of vegetables like okra. Autochthonous microbes can be utilized in specifically formulated consortia for effluent treatment. The tannery solid waste can be dried and crushed and used as a 15% organic amendment in soil that promotes plant growth and is safe to grow ornamentals and oil yielding crops. Assisted phytoremediation of such soils in three cycles completely brings the hazardous metals within permissible limits. The voluminous amount of tannery solid waste can be reduced in bulk through biochar formation that can be used as a soil amendment in specific percentages to grow ornamental plants and energy crops like oil-yielding varieties of sunflower and canola. Biochar impregnated with autochthonous microbes can be used in agricultural soils that can detoxify the heavy metals and it is safe to cultivate agronomic crops with permissible limits of heavy metals in the edible parts.

INCPS-2024-98 Large Scale Application of Floating Treatment Wetlands in Pakistan for the Treatment and Reuse of Wastewater

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In developing world, due to very high capital and operational costs of conventional technologies, > 99% wastewater is discharged in water bodies untreated. The presence of toxic items such as heavy metals, antibiotics, and pathogens in water results in 80% of diseases (e.g., kidney damage, cancer) and 40% of deaths. It is mainly due to the lack of an indigenous, low cost, and sustainable wastewater treatment technology. At NIBGE, an innovative indigenous floating treatment wetlands (FTWs) technology has been developed using locally designed and developed floating mat and available indigenous plants and microbes. FTWs is a low cost, sustainable, and environment friendly technology for wastewater treatment and reuse. Moreover, it is an innovative roots filter technology for the cost-effective treatment of wastewater, sewage, and sludge without relying on energy or chemicals. It requires ~100 times lower capital investment than conventional technologies, without any operational cost. The plants associated microorganisms colonizing on/in the roots, degrade the organic

contaminants, whereas inorganic pollutants like nutrients and potential toxic metals are taken up by the plants. The use of FTWs is an innovative approach in Pakistan for the remediation of wastewater polluted with organic and inorganic pollutants. Until now 200,000 sq ft floating wetlands have been applied at more than 50 sites in Pakistan and it has improved the quality of 200 billion m^3 wastewater. It removes (up to 90%) both organic and inorganic pollutants from the wastewater, and treated water is being safely discharge in the environment or reuse in agriculture and horticulture.

INCPS-2024-70 Use of Modern Genomic Approaches for Developing Resilient Cotton Varieties

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Over the last decade, several remarkable milestones have been achieved including high-quality contagious genome assemblies of tetraploid and diploid cottons, got insight into various genetic pathways controlling complex and simple traits and detecting QTLs associated with traits of interest. The genomic information is being used to improve resilience against emerging challenges depressing cotton production in Pakistan. After conducting field trials for several years, various cotton varieties, mutant lines and accessions were re-sequenced for identifying SNPs associated with traits including resistance to cotton leaf curl disease, heat tolerance, fiber quality traits, etc. The generated information has been deployed for selecting cotton plants containing the maximum alleles from the adapted cotton cultivars in a backcross population developed for introgressing indigenously engineered three genes (*Cry1Ac+Cry2Ab +2xEPSPS*) into selected cotton varieties. Tolerance to herbicide was tested up to 85 days after emergence of cotton seedlings in all generations. At the moment, we have stable cotton lines which showed the effectiveness of the biotechnological, genomic as well as conventional breeding approaches. The newly developed cotton lines will be instrumental for overcoming the challenges depressing cotton production in several cotton growing regions across the globe including Pakistan.

INCPS-2024-80 Genomics-Enabled Wheat Breeding for Improved Productivity and Nutritional Quality

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Improving the crop productivity, resilience to climate extremes, resistance to biotic stress and improving the quality are the main breeding objectives. Different tools, resources and strategies are used to precisely select the desirable cultivars in crop breeding. One of such tools is the genomics-assisted breeding (GAB), which improves selection accuracy during breeding cycles. However, practicing GAB depends on the availability of molecular markers for selecting the desired phenotypes. Once a marker is available for use in breeding, the efforts are then made to make it cost-effective and high-throughput to integrate its use in applied breeding. However, different breeding scenario like gene tagging, marker-assisted recurrent selection (MARS), background selection, diversity estimates, and genomic selection require different genotyping platforms, and there is no 'one size fits all' solution. We provided an overview of the efforts around developing cost-effective, high-throughput and breeding-oriented genotyping platforms in wheat. Furthermore, we showed that CRISPR-Cas9 mediated gene editing to knock-down a bHLH transcription significantly enhanced grain iron contents, which would facilitate the development of biofortified wheats.

Keywords: SNP markers, NGS, Gene editing, Biofortification, Grain iron contents

INCPS-2024-89 Carbon sequestration Potential of pure *Quercus incana*Roxb. forest of the Temperate region of Pakistan

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Carbon sequestration involves **capturing and storing carbon dioxide (CO_2)** from the atmosphere. This CO_2 storage involves transferring atmospheric CO_2 into various long-lived global pools to **reduce the net increase** of CO_2 in the atmosphere. Carbon-determining plant traits are found in temperate forests. Carbon sequestration and consumption are different among all the plant species in these forests. However, the broad-leaf trees are more efficient for carbon sequestration than other deciduous plants. The aim of this study is to calculate the carbon sequestration potential for pure *Quercus* forests in Swat, Pakistan. A total of 195 plots (20m×20m) were established for pure *Quercus incana*Roxb forests in the temperate region of swat Pakistan. This study investigates the effects of stand structure diversity i.e. DBH, H, CA, and community-weighted traits Mean i.e., BT, WD, SLA, LDMC on carbon sequestration. The Arc GIS software was used to map the study area. The Linear structure equation model SEM, regressions, and Pearson correlation were conducted using R software. The results show that an increase in elevation leads to enhanced

height, and DBH, and, therefore positively affects the carbon sequestration of the trees while the increase in elevation leads to decreased tree crown area which negatively affects carbon sequestration. On the other side, an increase in community, weighted traits mean i.e. bark thickness, specific leaf area, leaf dry matter content, and wood density leads to increased carbon sequestration. The *Quercus Incana*forestplays a crucial role in carbon sequestration more research is required to explore the other determinants of Quercus species and their role in ecosystem services in Pakistan.

Key Words: Carbon sequestration; *Quercus incana*; temperate region; Elevation

INCPS-2024-87 Enhancing Wheat Growth Potential through Potent Zinc-Solubilizing Bacteria

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Zinc (Zn) is an indispensable element for proper plant growth. A significant proportion of inorganic zinc (Zn) added to soil undergoes a transformation into an insoluble form. Zinc-solubilizing bacteria (ZSB) offer a promising avenue to convert insoluble Zn into forms that plants can readily access, thus presenting a potential solution for Zn supplementation. This research aims to delve into the Zn solubilization potential of indigenous bacterial strains and assess their impact on wheat growth and Zn biofortification. The experiments were conducted at the National Agriculture Research Center (NARC) in Islamabad during 2020-21. A total of sixty-nine strains were meticulously evaluated for their Zn solubilizing capability using plate assay techniques with two insoluble Zn sources, namely ZnO and $ZnCO_3$. Qualitative assays measured the solubilization index and efficiency. Promising Zn-solubilizing bacterial strains were subsequently quantitatively assessed through broth culture for Zn and phosphorus (P) solubility, employing tricalcium phosphate as an insoluble P source. The results revealed a noteworthy inverse correlation between the pH of the broth culture and Zn solubilization, specifically for ZnO (r^2=0.88) and $ZnCO_3$ (r^2=0.96). Ten novel strains stood out, including Pantoea sp. NCCP-525, Klebsiella sp. NCCP-607, Brevibacterium sp. NCCP-622, and more, selected from Pakistan's ecological diversity based on their plant growth-promoting rhizobacteria (PGPR) traits and the presence of positive nifH and acdS genes. Prior to assessing the plant growth potential of these bacterial

strains, a control experiment was conducted to determine the highest critical Zn level from ZnO for optimal wheat growth. The subsequent step involved inoculating the selected ZSB strains alone and in consortia onto wheat seeds, both with and without ZnO, within sterilized sand culture. Consortium ZSB inoculation without ZnO substantially improved various growth parameters, including shoot length (14%), shoot fresh weight (34%), and shoot dry weight (37%). Conversely, with ZnO, root length (116%), root fresh weight (435%), root dry weight (435%), and Zn content in the shoot (1177%) experienced remarkable enhancement compared to the control. Interestingly, Wadaan-17 exhibited superior growth attributes, while Zincol-16 displayed a slightly higher shoot Zn concentration by 5%. In essence, this study concludes that the selected bacterial strains showcase substantial potential as ZSB, manifesting as efficient bio-inoculants to counter Zn deficiency. Moreover, consortium inoculation outperformed individual inoculation in terms of growth promotion and Zn solubility for wheat. Additionally, the study underscores that a Zn concentration of 50 mg kg-1 from ZnO did not compromise wheat growth, whereas higher concentrations hindered growth potential.

Keywords: nifH and acdS genes; PGPR

INCPS-2024-81 Next Generation Genomic Innovations for Crop Productivity Enhancement using Wild Relatives

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According to food security analysts the global agricultural production must double by 2050 to meet the demands of increasing world human population. Lack of application of new breeding technologies (NBTs) is the major bottleneck for speedy development of high yielding climate resilient varieties. For rapid increase in yield, the utilization of NBTs including implementation of UAV-based high throughput phenomics, speed cloning, genome–based **breeding by design,** genomic selection, and Express-Editing galvanized by speed breeding are the desirable strategies to meet the rising food demand. Wild relatives in the form of landraces offer the required diversity for future genome-based crop breeding. Speed cloning can reduce the linkage drag to a minimum level -imminent during the Marker Assisted Selection. Pre-breeding in the form of the discovery of new genes and association of markers with traits through Genome Wide Association Studies (GWAS) has

added to traits-specific breeding. Advancements in NGS have revolutionized genome-based breeding by determining the genomic constitution of parents and offspring for a particular target environment (TE). In this regard, new genomic platforms, PCR-based KASP markers, and options for indigenous PCR-based NGS library preparation kits have facilitated the use of genomic selection based on genetic variants existing in indigenous cultivars. Pangenome analyses have unveiled larger variations in the wild relatives. A decade of CRISPR/Cas technology has brought improved nutritional value, disease resistance, and improvement and expansion in crops. i.e., Genomics to phenomics (G2P) along with integrated applications of all these technologies - if supplemented with speed breeding, the desirable crops can be achieved in less than half time. Hence, the implementation of genome-based speed breading technologies has a great potential for accelerating the pace of development of new high-yielding climate-smart varieties for food security.

Keywords: Genomics, Biotechnology, Phenomics, Crops, Genetics, Variations, Diversity, Gene editing, GWAS, Breeding

INCPS-2024-03 Pyramiding RNAi with Cry Toxins in Local Cotton Germplasm for Protection against Pink Bollworm

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Cotton, *Gossypium* spp*,* is an important cash crop that significantly contribute to the country‘s GDP with most common cultivated species around the world are *Gossypium hirsutum*and*Gossypium barbadense.* Insect pests cause 20-40% yield loss in Pakistan annually. Genetically modified Bt cotton was developed in the 1990s to control the insect pest attack. But with time, insects developed resistance against the Bt toxins. This study aimed to pyramid RNAi with Bt cotton to prolong the resistance against pink bollworm. Pink bollworm is a notorious insect that causes the loss of millions of cotton bales annually. We hypothesize that pyramiding RNAi with Bt synergistically enhances the plant's resistance against insects by lowering the survival rates. We exploited Cadherin and V-ATPase genes in PBW as potential RNAi targets and revealed their efficacy in plant-mediated insect bioassays. It was evident from this study that the RNAi strategies and Bt genes can control the insect effectively rather than Bt genes alone.

Key words: RNAi targets, Cadherin gene, transgenic cotton.

INCPS-2024-59 CRISPR Cas Based Genome Editing and Genetic Modification to Improve Important Crop Traits

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CEMB, being pioneer in developing insect and weedicide resistant crops, is successful in approval of its insect and weedicide resistant cotton varieties on commercial basis. To further enhance the toxin level next generation Bt along with fusion gene strategy is also addressed to cope with challenges of resistance buildup in insect pests. Advancement of technology to edit different traits of crop plant is fundamental to be utilized for improvement of major traits of plants like dealing with challenge of CLCuV in cotton, enhancing the storage life of potato, development of potato with enhanced vitamin A and development of resistance in potato against fungus and PVX, PVY. Further abiotic stress tolerant crop is the challenge of current and years to come to be dealt with genome editing is also established at CEMB. Two success stories of genome editing through CRISPR Cas9 system includes knock out of CLCuV targeting DNA A and Beta satellite akong with improved shelf life of potato through knockout of VInv has been discussed in current presentation. The knockout efficacy of the 72% for DNA-A, 90% of betasatellitewas achieved during this study. The qPCR confirmed the successful reduction of the vial titre and the feeding assay showed 90% of mortality in the whiteflies. The study results were also validated by the change in Alpha chain, Beta Chains, and loops of the 3D protein models of native and edited proteins predicted with Alpha Fold2. The knockout efficiency and the virus inoculation assay magnificently determined the faith in using this technology for plant virus control along with its vector. The amplicon sequencing data showed maximum indel frequency for potato plant T12 (14.3%) resulting in 6.2% gene knockout and 6% frame shift. While for plant B4, the maximum indel frequency of 2.0% was found which resulted in 4.4% knockout and 4% frameshift as analyzed by Geneious. The qRT-PCR data revealed that mRNA expression of VInv gene was reduced 90–99-fold in edited potato plants when compared to the non-edited control potato plant. Following cold storage, chips analysis of potatoes proved B4 and T12 as best lines. Reducing sugars' analysis by titration method determined

fivefold reduction in percentage of reducing sugars in tubers of B4 transgenic lines as compared to the control.

INCPS-2024-106 Integrating Sustainable Development Goals into Applied Research for Societal Impact

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The 2023 Sustainable Development Goals (SDGs) report presents a stark reminder that many nations are still lagging in their commitment to the SDGs. This shortfall is often due to a misalignment between current research priorities and the critical objectives outlined by the SDGs. In this keynote, we will explore methodologies for effectively aligning research endeavors with the 17 SDGs, ensuring our work contributes to tangible societal benefits and the well-being of future generations. Practical strategies to transform laboratory research and industrial production processes to support these global goals must be our priority. Emphasizing key indicators essential for planning and executing research projects, we need to know how integrating SDGs can enhance project relevance, attract funding, and address real-world challenges. This approach not only advances industrial profitability but also elevates educational standards, creating a virtuous cycle of innovation and societal improvement. We must learn, how embedding SDGs into research frameworks can drive meaningful change and secure a sustainable future for all.

Keywords: SDGs; Societal Impact; Climate change; Sustainability; Business profitability.

INCPS-2024-66 Ethnobotanical Studies, Phytochemical Investigation and Antimicrobial Efficacy of Selected Medicinal Plants of Family Zygophylaceae, District Gilgit

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The present research study was conducted during 2021-23 in the Jalalabad, Batkore and Shamogar valleys of district Gilgit. The Ethnobotanical data was collected by using semi structured questionnaire and interviews. Total of 164 plant species were studies, representing 53 families and 123 genera. Out of these 44 were herbs, 07 are shrubs and 14 were trees. On the basis of life forms, 46 were classified as hemicryptophytes as dominant followed by phanerophytes (45), therophytes (37), chaemephytes (33), geophyte (2) and epiphyte (1) species. It was observed that, among the 53 families, Asteraceae was a dominant family (19 species) followed by Rosaceae (14 species), Poaceae (11 species), Papilionaceae (11 species) and others had less than 10 species. The ethnobotinacal studies revealed that out of 164 plants 65 are used for medication which belongs to 32 families and 52 genera. In medicinal perspective, the dominant family was Rosaceae (with 8 species), Asteraceae (6), Polygonaceae and Laminaceae (5) and other less than (5) species. Leaves, fruit, root, seed and flowers have frequently been utilized. The direct use of these plants was leading tradition as decoction, powder, oil, paste and juice. Moreover, majority of the plant species were used to treat respiratory, abdominal problems and back pain problems (11, 8 and 8 plants respectively). While two potential medicinal plant species *Peganum harmala* and *Tribulus terrestris* were evaluated for bio assay screening. The methanolic extract of *Peganum harmala* showed a significant inhibition against the growth of bacterial strains like Escherichia *coli* 60 %*, Staphylococcus aureus 55* %, and moderate against *Bacillus subtilis* 25 %,*Pseudomonas aeruginosa* 20%while the S*almonella typhi* shown no inhibition. The methanolic extract of *Peganum harmala* applied to check the antifungal activity against the *Fusarium lini* which is about 40%, *Candida glabarata* 35%, *Trichophyton rubrum* 30%, and *Candida albicans* 20 % *respectively*. *Ttribulus terrestris* plantmethanolic extract showed a significant antibacterial activity against *Staphylococcus aureus* 60%, *Escherichia coli* 50 %*, Pseudomonas aeruginosa* 25 %, *Bacillus subtilis* 20 %, while the *salmonella typhi* shown no inhibition. Anti fungal activity of *Ttribulus terrestris* against *Fusarium lini* is about 45%, *Trichophyton rubrum* 40%, *Candida glabarata* 30%and *Candida albicans* 20 %repectively. The fungal

strains *Aspergillus niger*, *Microsperumcanis*and *Aspergillus fumigatus*are resistant against the both plant methanolic extracts. The anticancer activity of *Tribulus terrestris* against prostate cell line was also found to be moderate (28.2%). However, methanolic extract of *Tribulus terrestris* and *Peganum harmala* showed a significant antioxidant activity. *Tribulus terrestris* showed 89% and *Peganum harmala* showed 79% DPPH free radical scavenging activity. This study provides a comprehensive set of information on different dimensions including floristic diversity, phytochemicals and validate the folk wisdom regarding medicinal plants application.

INCPS-2024-105 AI and other Intelligent Manufacturing Technologies Implications in Science Research for a Sustainable World

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The world is evolving rapidly, and traditional technologies used in applied and basic research are being transformed. With the advent of industrial revolutions, the integration of intelligent manufacturing techniques across all sectors has become a prerequisite for research endeavours. The application of AI, big data, and real-time monitoring in both basic and applied research is essential. To meet the demands of Industry 5.0 and Industry 6.0, we must upgrade our traditional laboratories to achieve right-first-time results, minimize batch-to-batch variations, and work towards net-zero emissions. Adopting a circular economy, achieving net-zero carbon emissions, reducing our carbon footprint, and embracing eco-friendly green synthesis with sustainable approaches are imperative in our research. These challenges can be effectively addressed with the latest AI, big data analytics, and real-time monitoring technologies. We need to explore the profound impact of these technologies on basic scientific research, demonstrating how they accelerate discoveries, facilitate complex simulations, and enable data-driven insights that were previously unattainable. The tangible benefits of leveraging AI, big data, and intelligent manufacturing technologies in advancing scientific knowledge and driving technological progress are limitless. We need to highlight the transformative power of these technologies in shaping the future of research and innovation.

INCPS-2024-254 Organic Agriculture Particularly Cotton Production-a new initiative in Pakistan for climate change adaptation and mitigation

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Pakistan is among countries which emits lowest amount of Green House gases (GHG) but among top ten vulnerable countries as per Global Environment watch list. It is likely to be hit the hardest because of the myriad food and health challenges, and the exploding population numbers. Cotton is the life line for the economy of Pakistan due to its role in food, feed and fiber sectors. Cotton is known as the “dirtiest” crop due to maximum use of pesticides, fossil-fuel based synthetic fertilizers and water. In Pakistan up to 80% pesticides is being applied exclusively on cotton crop. In recent years’ global efforts have been made to reduce environment damage by cotton crop by launching Better Cotton Initiatives which aimed to have judicious use of all inputs. Realizing more compelling issues due to climate change and serious challenges to cotton crop, Organic cotton platform was launched by the textile fashion house consortium like Laudes Foundation, OCA and many other international development partners.

Pakistan recently (2019) joined the community of organic cotton producers and able to obtain third party certification for 34,000 organic cotton bales. This remarkable journey of totally eliminating synthetic fertilizers as well as of pesticides in some new cotton zones of Baluchistan. Because fossil fuel-based fertilizers and most synthetic pesticides are prohibited in organic farming, it has a significantly lower carbon footprint. Global studies show that the elimination of synthetic nitrogen fertilizers alone, as is required in organic systems, could lower direct global agricultural greenhouse gas emissions by about 20%. The organic cotton faring resulted in healthy soils by foregoing most fossil fuel-based inputs, organic farmers are also more resilient and adaptable not only to stressors related to climate change but also other disruptive global stressors.

Efforts have also been made to architect Organic Agriculture (OA) Policy, OA standards as well as Organic Agriculture Act thus setting the entire landscape for organic agriculture in Pakistan. The success story of farming organic cotton led by WWF-Pakistan and CABI-Pakistan its potential and challenges will be shared.

INCPS-2024-287 Salinity Tolerance Mechanisms from Grain to Grain Formation in Major Cereals: An Overview

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Cereal grain crops are naturally or anthropogenically exposed to multiple stresses, which have led to considerable losses in crop production. Increasing NaCl concentration in soil and water is one of the major threats for the development of grain crops. The increasing demand of food by the burgeoning human population has led to the adoption of new strategies to achieve enhanced production of food grain crops on stress-ridden lands including salt affected ones. Recent advances in modern topics like genomics and biotechnology as well as conventional breeding approaches are useful to generate salt resistant lines/cultivars of the grain crops, which could thrive well on salt affected lands. Prior to exploiting conventional and advanced biotechnological tools, detailed information on mechanism of salt tolerance from whole to molecular level is indispensable. Since salt tolerance is known as a multigenic trait, so the mechanism of salt tolerance contemplated as quite intricate. This review sheds light on the mechanisms and improvements achieved in salt resistance in grain crops through different approaches such as conventional breeding, agronomic approaches, and advanced biomolecular techniques such as bioengineering and marker assisted selection.

Keywords Salinity stress .Wheat .Rice .Maize . Barley

Oral Presentations

Agricultural Sciences, Agronomy, Horticulture

INCPS-2024-119 Effect of Arginine on Callogenesis, Biochemical Alterations and Growth of Jackfruit (*Artocarpus heterophyllus* L.)

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Artocarpus heterophyllus L. is tropical plant with recalcitrant seeds, belongs to family Moraceae. The seeds with low germination rate make the propagation of jackfruit tree challenging. Due to challenges associated with seed, alternative methods utilizing different plant parts are employed to multiply the plants. Therefore, the current study was designed to investigate the effect of arginine on in-vitro grown jackfruit tree. Each experiment was conducted in randomized complete block design with 4 treatments comprising of different concentrations of Arginine (0, 1.5, 2.5, 3.0 ppm). Although rooting was not achieved till 180 days of experiment, however, different concentrations (0, 1.5, 2.5, 3.0 ppm) of arginine significantly promoted callogensis. The result of in vitro experiment revealed the maximum percentage response of callus induction (90, 80%) and proliferation of shoots under the treatment of 2.5, 3.0 ppm of arginine, respectively. It was found that the application of arginine at varying concentrations have a differential impact on biochemical indices, higher concentrations of arginine (2.5, 3.0 ppm) lead to increase the total soluble protein content (57.3, 65.8 mg/g) and a concomitant decrease to the total soluble sugars (7.43, 4.97 mg/ml) and proline content (9.39, 8.30 µg/ml) as compared to control (36.93 mg/g, 8.62 mg/ml, 22.05 30 µg/ml) respectively. From results it concluded that arginine plays crucial role in initial stage of plant development and affects the biochemical parameters. This research highlights the valuable potential of arginine in plant tissue culture and recommended the need for further investigations to overcome the challenges in propagation of jackfruit tree.

Keywords: *Artocarpus heterophyllus*, Arginine, Biochemical alterations, Callogenesis

INCPS-2024-24 Allelopathic Weed Management in Different Wheat Cultivars under Arid Agro-climatic Conditions in D.I. Khan, KP, Pakistan

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Weeds are the major pest in achieving higher yield of any crop. Yield losses have been reported from 5-100% indifferent crops by weeds. To study the effect of weed management practices on weed control in wheat, an experiment was conducted at Agriculture Research Farm, Faculty of Agriculture, Gomal University, D. I. Khan, for the year 2019-20 and 2020-21. The experiment was laid out in split plot design with three replications. The factor included in the experiment were varieties (Bakhtawar-92, Galaxi-13 and Fakhar-e-Bhakhar) being assigned to main plots while herbicides such as broad spectrum herbicide, (2,4-D 72 EC+ Isoproturon 75 WP @623 and 649 g a.i. ha^{-1}, respectively). Broad leaf herbicide, (2,4-D 72 EC @ 711 g a.i. ha^{-1}), grasses weeds herbicide, (Isoproturon 75 WP @968 g a.i. ha^{-1}), and weedy check (no herbicide) were applied in sub plots. The experiment was planted on 15 November in both years at Dera Ismail Khan. Data were recorded on weed density and some Agronomic, morphological and physiological traits of wheat. The data for the individual trait were subjected to analysis of variance (ANOVA) and the means were separated by LSD. Variety Fakhar-e-Bhakhar was more productive and profitable than Bakhtawar-92 and Galaxi-13. It's produced higher number of tillers m-2 (6% and 13%) grain yield (5% and 10%) over Galaxi-13 and Bakhtawar-92 respectively. The plots sown to Fakhar-e-Bhakhar, which is tallest and has vigorous early growth had lesser number of grasses and broad leaves weeds than other varieties. The application of broad spectrum herbicide consistently controlled both grasses and broad leaf weeds in all varieties. The increase in number of tillers m-2 (17%), number of productive tillers m-2 (18%), spikelet's spike-1 (5%), 1000 grain weight (4%), biological yield (19%), grain yield (21%), straw yield (18%), harvest index (11%), and net profit (32%), over weedy check was due to application of broad spectrum herbicide, which controlled both grasses and broad leaf weeds. The interaction effect of broad spectrum herbicide with variety Fakhar-e-Bhakhar produced significantly higher grain yield (24%). In the light of findings, it is suggested that for the weed management in wheat, the broad spectrum herbicide may be useful and beneficial treatment to obtain maximum output.

Keywords: Weeds, Management, Wheat, Cultivars, Herbicides, Grain yield

INCPS-2024-218 Hydrocolloids Based Edible Coatings Effectively Preserve the Postharvest Quality of Guava Fruits During Ambient Storage

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Guava, a commercially important fruit crop, is prone to rapid spoilage and physicochemical transformations during marketing, transport and storage. The application of edible coating is emerging as a low-cost, simple to implement and efficient method for extending the postharvest life of fresh horticultural produces, such as fruits and vegetables. This study aimed to assess the potential of edible coatings to improve storability and maintain the overall fruit quality of stored guava fruits. Freshly harvested guava fruits were coated with Albizia gum (AZG) and Xanthan gum (XG). After coating treatment, the fruits were stored at 20 °C and 85–90 % relative humidity for 15 days. The results revealed that 4.5% AZG and 0.75% XG coatings suppressed the weight loss and decay incidence as compared with control. The AZG & XG coated fruits showed the remarkable ability to preserve bioactive compounds, such as total phenolics, flavonoids and antioxidants, while minimizing the levels of oxidative stress markers, such as electrolyte leakage, malondialdehyde and H_2O_2. Consequently, as compared to uncoated fruits, AZG & XG-coated fruits exhibited reduced activities of fruit softening enzymes. To sum up, the application of AZG- and XG-based edible coatings could markedly improve the storage life of guavas and maintain overall fruit quality during storage.

INCPS-2024-139 Artificial Ripening of Date Palm Variety Aseel Using Sodium Chloride (NaCl) and Potassium Hydroxide (KOH)

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Date palm is the most important cash crop of Pakistan. The ripening of Date Palm fruit is synchronizing with the monsoon season. Hence, the crop loss purely depends on the density of monsoon rain. As in 2022 the 100% crop was lost due to the heavy and continuous rain. There was a dire need to explore the ways to save Date Palm crop from monsoon rain. The present study discovers the use of sodium chloride (NaCl) and potassium hydroxide (KOH) for artificial ripening of Aseel dates to enhance fruit quality and mitigate weather-related damages. The fresh Aseel fruit at the early khalal stage (physiologically not ripened) was subjected to different treatments of NaCl and KOH to boost artificial ripening. The physical, chemical, and nutritional characteristics of the fruit were assessed and compared across

treatments. The results demonstrated that the use of NaCl and KOH, either individually or in combination, effectively accelerated the ripening process from khalal to tamar (Dates) stage. The combination of 2.00% NaCl and 0.35% KOH emerged as the most efficient treatment which significantly improved the physical and sensory attributes of the tamar fruit. The use of chemicals shortened the ripening period of Date Palm fruit by two weeks compared to natural ripening. This approach offers a promising alternative to conventional ripening, potentially reducing post-harvest losses and improving the economic viability of Aseel date production. These findings provide valuable insights into improving the quality and yield of Aseel dates under adverse climatic conditions, offering a workable alternative to traditional ripening of fruit.

Key Words: Date palm, artificial ripening, sodium chloride (NaCl), potassium hydroxide (KOH), monsoon, fruit quality, ripening acceleration, traditional ripening, sensory evaluation

INCPS-2024-11 Karyotype Variation and Comparative Analysis of Native and Exotic Varieties of Date Palm (*Phoenix dactylifera* L.) Growing in Pakistan

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Date palm (*Phoenix dactylifera* L.) is a monocot and dioecious plant species having uncertain diploidy levels because of scarcity of cytogenetic knowledge. Chromosome number and karyotype was investigated of commercial elite date palm cultivars grown in four provinces of Pakistan. Additionally, the study includes comparison with exotic varieties. The chromosome number of all the studied cultivars has been determined as 2n=36. The detailed karyotype of Date palm cultivars is presented which includes total chromosome length (TCL), short and long arm length (SCL), the relative length (RL) of each chromosome and centromeric index (CI). The chromosome complement consists of metacentric (m), sub metacentric (sm), sub telocentric (st) and telocentric (t) chromosomes and average length of chromosomes varies in all cultivars which is ranging from 1.2 µm to 6.46 µm. It is believed that these karyological data will enhance the karyological knowledge of date palm and will prove to be an important source of information for new researches relating to the origin and advanced varieties of this plant.

INCPS-2024-248 Evaluating the Interactive Impact of Nitrogen Levels and Cultivars onYield Traits, Nitrogen use Efficiency, Water use Efficiency and BenefitCost Ratio of Ratoon Rice in Punjab, Pakistan

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Ratooning of rice (*Oryza sativa* L.) is process of obtaining grain from tillers that grow from crop stubbles that have already been harvested. Ratooning has gained attention since it has a potential for obtaining yield with conventional techniques. Field experiment was conducted during 2021–2022 at the research farm, Institute of Agronomy, Bahauddin Zakariya University Multan, Punjab, Pakistan. The response of various nitrogen (N) levels (0, 25, 50, 75, and 100 kg ha^{-1}) was studied on the growth and yield of three rice cultivars (Guard Lp-02, Guard Lp-18, and Super Fine) grown as ratoon rice. In cultivars, Guard Lp-02 and Guard Lp-18 were hybrid, but Super Fine was a non-hybrid cultivar. The hybrid cultivars showed a significant response to N levels. The cultivar Guard Lp-18 with higher level of N 100 kg ha^{-1} resulted in more plant height, total tillers, fertile tiller, panicle length, and biological yield while the higher number of branches and grains per panicle, 1000-grain weight, and grain yield was achieved by Guard Lp-18 with the application of 75 kg N ha^{-1}. Maximum agronomic nitrogen use efficiency (ANUE) and economic nitrogen use efficiency (ENUE) was observed at cultivar Guard Lp-18 with N level of 50 kg ha^{-1}. Likewise, water use efficiency (WUE) was recorded maximum at cultivar Guard Lp-18 with N level 75 kg ha^{-1}. The highest gross income, net income, and benefit cost ratio (BCR) were noted at 75 kg N ha^{-1} among all cultivars but Guard Lp-18 with 75 kg N ha^{-1} respond better in ratoon rice. Among rice cultivars, hybrid rice performed better and out yielded non-hybrid cultivars in ratoon rice. The findings of this study revealed that growing ratoon rice will be helpful for increasing farm income; enhancing resources use efficiency and ensuring food security under prevailing agro-climatic conditions of Punjab, Pakistan.

INCPS-2024-175 Inheritance of Cotton Leaf Curl Virus in Back-cross Progenies (BC_1 to BC_3) Derived from Linterspecific Cross *Gossypium arboreum and Gossypium hirsutum*

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Cotton leaf curl virus disease (CLCuD) is an important constraint to cotton production. The resistance of *G. arboreum* to this devastating disease is well documented. In the present investigation, we explored the possibility of transferring genes for resistance to CLCuD from G. *arboreum* (2n = 26) cv 15-Mollisoni into *G. hirsutum* (2n = 52) cv CRSM-38 through conventional breeding. We investigated the cytology of the BC1 to BC_3 progenies of direct and reciprocal crosses of *G. arboreum* and G. *hirsutum* and evaluated their resistance to CLCuD. The F_1 progenies were completely resistant to this disease, while a decrease in resistance was observed in all backcross generations. As backcrossing progressed, the disease incidence increased in BC_1 (1.7–2.0%), BC2 (1.8–4.0%), and BC3 (4.2–7.0%). However, the disease incidence was much lower than that of the check variety CIM-496, with a CLCuD incidence of 96%. Additionally, the disease incidence percentage was lower in the direct cross 2(G. *arboreum*) x G. *hirsutum* than in that of G. *hirsutum*x *G*. *arboreum*. Phenotypic resemblance of BC_1, BC_3 progenies to G. *arboreum* confirmed the success of cross between the two species. Cytological studies of CLCuD resistant plants revealed that the frequency of univalents and multivalents was high in BC1, with sterile or partially fertile plants, but low in BC_2 (in both combinations), with shy bearing plants. In BC_3, most of the plants exhibited normal bearing ability due to the high frequency of chromosome associations (bivalents). The assessment of CLCuD through grafting showed that the BC_1 to BC_3 progenies were highly resistant to this disease. Thus, this study successfully demonstrates the possibility of introgressingCLCuD resistance genes from *G. arboreum* to *G. hirsutum* L.

Keywords: Interspecific hybridization, cotton leaf curl disease, cytology, back-cross population

Biochemistry, OMICS, Bioinformatics

INCPS-2024-44 Lycium*RIN*NegativelyModulate the Biosynthesis of Kukoamine A in Hairy Roots through Decreasing ThermospermineSynthaseExpression

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Root bark (Lycii cortex) of Lyciumcontains high contents of characteristic bioactive compounds, including kukoamine A (KuA) and kukoamine B (KuB). RIPENING INHIBITOR (RIN) is well known as a master regulator of Solanaceaous fruit ripening. However, the role of RIN in the biosynthetic pathway of KuA in Lyciumremains unclear. In this study, integrated transcriptomic, metabolomic analyses and hairy root system are used to characterize the role of RIN in KuA biosynthesis in Lycium. The ultra-performance liquid chromatography electrospray ionization tandem mass spectrometry analysis revealed that KuA was significantly induced in LrRIN1 RNAi lines and not detected in overexpression lines. A total of 20,913 differentially expressed genes (DEGs) and 60 differentially accumulated metabolites (DAMs) were detected in LrRIN1 transgenic hairy roots, which were used for weighted gene co-expression network analysis. Our result reveals a high association between KuA and structural genes in the phenolamide pathway, which shows a negative correlation with LrRIN1. In addition, overexpression of the polyamine pathway gene thermospermine synthase LcTSPMS, a potential target gene of LyciumRIN, increased the contents of both KuA and KuB in L. chinensehairy root, indicating that TSPMS is responsible for KuA biosynthesis and is also the common upstream biosynthetic gene for both KuA and KuB. Our results lay a solid foundation for uncovering the biosynthetic pathway of KuA, which will facilitate the molecular breeding and genetic improvement of Lyciumspecies.

Keywords: *Lycium RIN,* Kukoamine A, Phenolamide, Thermospermine synthase

INCPS-2024-167 Isolation And Antimicrobial Activity of Patatin Tuber Storage Protein from *Solanum tuberosum*: Insights from Phylogenetic Analysis and Molecular Docking

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The utilization of plant-derived proteins as potential reservoirs of antimicrobial agents has garnered considerable attention in recent years due to their perceived effectiveness and safety. The current investigation is centered on the isolation and characterization of *Solanum tuberosum*Patatin (*St*P), a predominant protein (storage) present in the tubers of *Solanum tuberosum* L. (potato), with purported antimicrobial attributes and computational analysis. *St*P was isolated, purified, and quantified utilizing ammonium sulfate precipitation and the Bradford reagent assay, respectively, confirming its identity via SDS-PAGE, revealing a singular 42 kDa band. Examination of *St*P'*s* primary sequence unveiled a theoretical isoelectric point (pI) of 5.05, underscoring its pH-responsive nature. Possessing an instability index of 32 and an aliphatic index of 83.73, *St*P appears to be stable at ambient temperature and displays low hydrophobicity. Investigation identified three potential ligand-binding regions on *St*P, with a principal site exhibiting substantial surface area and volume. Molecular docking investigations involved N-Acetyl-beta-D-glucosamine and beta-glucan, pivotal constituents of bacterial and fungal cell walls, manifested robust binding affinities (ΔG values ranging from -7.9 to -12.5 kcal/mol). Assessment through antimicrobial assays disclosed that *St*P exhibited noteworthy activity against *Aspergillus niger*and*Sclerotinia sclerotiorum*, resulting in appreciable zones of inhibition. However, the antibacterial impacts varied, showcasing modest inhibition against *Staphylococcus aureus and Pseudomonas aeruginosa.*Following successful isolation, the antibacterial and antifungal efficacy of the purified patatin was assessed against a spectrum of clinically significant pathogenic bacterial and fungal strains.

Key words: Patatin, Tuber storage protein, SDS-PAGE, Anti-microbial activity, Molecular docking

INCPS-2024-50 Enhanced efficacy of Trypsin Inhibitors through nanoencapsulation for control of stored grain insect pest, *Trogoderma granarium* (Everts)

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Attaining food security is crucial to feed increasing population. Minimizing post-harvest losses is an effective solution to food scarcity. Since cereals are staple food for most developing countries, there is a need to develop a biopesticide against stored product pests to avoid post-harvest losses. The current study involves the development of an eco-friendly tool to manage stored product insect pests through the nanoencapsulation of plant-derived Kunitz-type and Bowman-Birk trypsin inhibitors. The nanoencapsulation was tested on *Trogoderma granarium* (Everts) (Dermestidae; Coleoptera). The insecticidal activity of both TIs was assessed through bioassays, with and without nano-formulation (using Graphene Nanoparticles (GNPs) and Zinc Oxide nanoparticles (ZnONPs)), against *T. granarium* at three concentrations (1.0, 2.0 and 3.0 mg/g). The insecticidal assays of both TIs without nano-formulation delayed life stages development in *T. granarium*. The results also revealed increased insecticidal activity of both TIs after formulation with nanoparticles, among which the GNPs nano-formulation was the more promising. The nano-formulated TIs have the potential to control stored grain insect pests as an alternative to chemical pesticides.

INCPS-2024-127 Optimizing Expression and Refolding of *Nelumbo nucifera* Chitinase for Crystallization

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Plant chitinases are pathogenesis-related proteins, which are believed to be involved in plant defense responses to pathogen infection. In this study, comparative analysis of native chitinase extracted from *Nelumbo nucifera* and recombinant chitinase gene cloned and expressed in *Escherichia coli*. Chitinase (32 kDa) was isolated and purified. Since the protein was produced as insoluble inclusion bodies, the protein was solubilized using

dilution method that allows refolding of recombinant proteins, especially at high protein concentrations, is to slowly add the soluble protein to refolding buffer. For this purpose: first, the inclusion bodies containing insoluble proteins were purified; second, the aggregated proteins were solubilized; finally, the soluble proteins were refolded using glutathione redox system, guanidinium chloride, dithiothreitol, sucrose, and glycerol, simultaneously. Recombinant chitinase was purified by Ni-NTA affinity column chromatography. Secondary structural elements of native and recombinant chitinase were determined by Circular Dichroism (CD) spectroscopy which showed those exhibited well folded secondary conformations. The pure proteins were concentrated up to 10 mg/ml and Dynamic light scattering (DLS) showed a highly monodisperse status of the protein. The pure protein (20mg/ml) showed phase separation followed by crystallization under high salt concentration in the sitting drop method using commercial screens. Chitinase was successfully expressed in *E. coli* and purified from insoluble inclusion bodies.

Keywords: Chitinase, Circular Dichroism (CD), Crystallization,Inclusion bodies, *Nelumbo nucifera*.

INCPS-2024-45 Comparative *In-Silico* Analysis of Plant Based Agonist of $GABA_B$ Receptor against Epilepsy

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The current study is aimed on in silico studies plant-based agonist against $GABA_B$ receptor against epilepsy. Epilepsy is currently considered to be prominent neurological disorder with a global prevalence of approximately 50 million. It is a central nervous system (neurological) disorder which is characterized by abnormal neural activity thereby causing seizures or periods of unusual behavior, sensations and sometimes loss of awareness. Gamma amino butyric acid (GABA), has been reported to be the principal inhibitory neurotransmitter in the cerebral cortex, which maintains the inhibitory tone that counterbalances neuronal excitation and its deficiency causes the said neural disorder thus can be improved by activating its efficiency. Therefore to this end, primary sequence of two chains (A and B) of *Bos taurus* $GABA_B$ were extracted from UniProtKB and subjected to SWISS-MODEL for model prediction. The predicted model consists of 18 Alpha-helices, 18 Beta-sheets and 3 disulphide bonds. The structure has two huge domains which capture the GABA like Venus fly trap and are connected by a linker peptide to the seven transmembrane domains.

Predicted model was docked into four plant based ligands (Epigallocatechin gallate, Apigenin, Hesperidin and Luteolin) via Autodock vina with good binding free energy values. LIGPLOT of docked complexes showed hydrogen bonding and hydrophobic interactions between $GABA_B$ and natural compounds. These results suggest that plant based organic compounds are good therapeutic agents as agonist of $GABA_B$ in the treatment of epilepsy.

Keywords: GABA receptor, *Bos taurus*, Epilepsy, Molecular docking

INCPS-2024-77 Evolutionary Prediction of Fructose Bisphosphate Aldolase from Different Plant Species: An *in Silico* Approach

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Fructose-bisphosphate aldolase, often just aldolase, is anenzyme catalyzing areversiblereactionthatsplitsthealdol,fructose1,6-bisphosphate,intothetriosephosphatedihydroxyacetone phosphate (DHAP) and glyceraldehyde 3-phosphate (G3P). In this studyproteinsequences of aldolase forcomputationalanalysiswereretrievedfromNCBI database. An Expasyprotparam tool was used to compute the physiochemical parameters of the selected enzyme and its accuracy was checked by MEGA (molecular evolutionary genetic analysis) version 6.1.TheclustalWprogramperformsmultiplealignmentofsequences in order to construct the phylogenetictreeusingNeighbourjoiningmethod(NJ) andUPGAMA. Theanalysiswasdonebyusing MEMEtool and data was analyzed by using BLAST. Then SOPMA (self–optimized prediction method with alignment) was used for the prediction of secondarystructure. The comparative homology was done by using the SWISS MODEL, evaluated by using CAT MODEL and verified by ERRATvalue PROCHECK. Finally, protein –protein interaction was determined by using STRINGv10.0.Theaimofthestudyistounderstandthefructosebisphosphatee volutionaryrelationshipof plant species and analyzed its physiochemical characteristics, homology, phylogenetic treeconstruction, secondary structure prediction and 3D modeling of protein sequence and itsvalidationby using variety ofcomputationaltools.

Keywords: Fructose-bisphosphate aldolase, Evolutionary lineage, Bioinformatics tools.

INCPS-2024-134 A Potent Plant Based Chitinase: Detailed Structural Informatics and Insecticidal Activity Against *Helicoverpa. armigera*

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Helicoverpaarmigera is damaging the global economy with annual loss of 5 billion USD worldwide. Class I family 19 chitinases are pathogenesis related plant proteins that have ability to interact and hydrolyzed the chitin residues of insects. The aim of this project is to evaluate the insecticidal potential of *Nelumbo nucifera* chitinase (NnChi) against *Helicoverpaarmigera* through structural informatics and insecticidal bioassays. LC-MS/MS analysis of purified NnChi provided a single fragment of 10 amino acids which showed 100% identity with already reported chitinase of *Mangifera indica* in NCBI. SDS-PAGE showed a single band of ~32 kDa under reduced conditions. NnChi predicted structure revealed its two domains (ChBD and CatD) connected through linker region typical to Class I, Family 19 chitinases. Molecular docking analysis confirmed the strong binding affinities of ChBD and CatD domains with chitin oligomer showing values of -5.6 and -6.2 kcal/mol respectively. MD simulation studies of 100 ns showed that 4 residues (RQCR) of ChBD and 4 residues (NRIP) of CatD are contributing in the binding of chitin oligomer in each domain. These computational findings were further verified through insecticidal assay. So, the combination of structural informatics and in-vivo functional analysis depicted that NnChi has potential to control *Helicoverpaarmigera* insect pest.

INCPS-2024-43 Assessing the Impact of Green-Synthesized Silver Nanoparticles (AgNPs) on Wheat Carbohydrate Metabolism and Protein Quantification under Heat Stress in Pakistan's Changing Climate

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In the present investigation, the role of GS-AgNP treatment in wheat plants was carried out in reducing heat stress with the aim of facilitating scientists on this topic. The effect of GS-AgNPs against heat stress has rarely been deliberated in wheat plants, and only a few studies have been established earlier in this scenario. This work illustrated the effect of GS-AgNPs on the regulation of carbohydrates metabolism, SOD, proteins, crude fibers, and minerals changes in wheat plants. Data were analysed using PCA analysis, correlation parameters, and normal probability distribution in PAST 3 software. The results indicated that heat stress alone caused severe changes in carbohydrates metabolism, SOD, proteins, crude fibers, and minerals immediately so that plants could not recover without foreign stabilizers such as GS-AgNPs. The application of GS-AgNPs increases the flux of carbohydrates metabolism, SOD, and proteins, including HSPs, crude fibers, and minerals, in wheat plants to reduce the effect of heat stress. The 50 mg/l concentration of GS-AgNPs has shown an increase in carbohydrates metabolism and SOD activity, while crude fibres have shown a significant enhancement at 100 mg/l of GS-AgNPs. The crude and true proteins were also shown pronounced increase in treatment to a concentration of 50 mg/l of GS-AgNPs. GS-AgNPs stimulated HSP production; most importantly, smHSP production was observed in the present results with other HSPs in wheat plants treated with a 50 mg/l concentration of GS-AgNPs. The mineral distribution was also regulated by the respective treatment of GS-AgNPs, and the highest amounts of Ca, P and Fe were found to be highest in wheat under heat stress. In general, we computed the expected model based on GS-AgNPs on the genes/factors that respond to heat stress and their potential role in mitigating heat stress in wheat. In addition, we discussed the prospective signalling pathway triggered by GS-AgNPs in wheat against heat stress. In the future, this work might be helpful in distinguishing the genetic variation due to GS-AgNPs in promoting tolerance in wheat against heat stress.

Keywords: *Triticum aestivum*; Nanobiotechnology, Metabolism; Minerals; Fibres; Heat Shock Protein

INCPS-2024-273 Protein Models & DNA Barcoding of Lamiaceae Species from Poonch Valley, AJK, Pakistan

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Lamiaceae is the sixth-largest angiosperm family and the largest one in the order ‘Lamiales’. The family members are widely used for medicinal

purposes and to produce perfumes, oils, and culinary products. There are 21 Genera and approximately 36 species of Lamiaceae in Poonch valley, Azad Jammu & Kashmir, Pakistan. It is important to identify and characterize the Lamiaceae species to explore its taxonomical status. The current research was conducted based on DNA sequence data to assess the current status of Lamiaceae species. DNA barcoding of Lamiaceae is performed to ensure correct identification and to address the issue of adulteration. For this purpose, Lamiaceae plants were collected from different regions of Poonch valley. The total genomic DNA was extracted from the leaves of these species. Three plastid barcoding loci (rps11, rbcLa, and trnL-trnF) were chosen for PCR amplification. The amplified products were purified through PCR cleanup with an ExoSAP kit and sent to Eurofins Genomic Company, USA for sequencing. Electropherograms were assembled and edited byGeneious 6.1.8 software. The novel sequences were compared against previously available data using GenBank services and the Basic Local Alignment Search Tool (BLAST). In the current study, rps11, rbcLa, and trnL-trnF regions were successfully amplified and sequenced in 97% (35), 85% (30), and 75% (26) species respectively. Based on BLAST, 100%, 91%, and 41% of the rps11 sequences were accurately identified at the family, genus, and species levels respectively. Furthermore, 100%, 100%, and 63% of the rbcLa sequences were identified at the family, genus, and species levels, respectively; and 86%, 86% and 46% of the trnL-trnF sequences were accurately identified at the family, genus, and species levels, respectively. Moreover, in the present findings, rbcLa is suggested as the best plant barcode among the potential molecular markers for Lamiaceae with success rate of 100% and 73% for genus and species level, respectively.

Key words: DNA barcoding, Lamiaceae, rbcLa, rps11, trnL-tmF

Biodiversity Conservation

INCPS-2024-64 Integrating Biodiversity Conservation into Sustainable Agriculture: Strategies for Food Security

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Global food security depends increasingly on the convergence of sustainable agriculture and biodiversity protection. This study delves into the interrelationships between biodiversity and agricultural methods, emphasising the vital function that a variety of plant species play in augmenting ecosystem services including soil fertility, insect control, and pollination. Through an analysis of several case studies and scholarly publications, this study pinpoints practical approaches for integrating biodiversity into agricultural systems. Ecosystem-Based Adaptation (EbA) techniques, which have been demonstrated to increase agricultural production and biodiversity, include crop diversification, agroforestry, and organic farming. The Convention on Biological Diversity (CBD) and other international frameworks emphasise these practices' significance in accomplishing sustainable development objectives. Furthermore, the promotion of integrated pest control and a decrease in the use of chemical inputs are emphasised as critical measures for maintaining biodiversity in agricultural settings. The assessment emphasises that to successfully adopt biodiversity-friendly agricultural methods, community engagement, farmer education, and policy integration are essential. Agriculture may help conserve genetic resources and improve climate change resistance by

promoting these synergies, which will eventually promote food security for expanding people.

INCPS-2024-67 Harnessing Plant Diversity to Ensure Food Security: Strategies and Implications

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The world's increasing population, mixed with the stressful situations posed by way of using climate alternate, has made ensuring international food protection even extra pressing. Exploiting plant genetic diversity, which include underutilized agricultural species, is considered as a likely choice to this intense problem. Genetic range offers the muse for the development of novel and more productive crop sorts which are proof towards pests and illnesses and adaptable to moving environmental conditions. Underutilized crop species, such as Bambara groundnut, have great genetic assets and favorable abilities that might help make bigger a greater numerous and resilient agricultural device. This precis explores thoughts for the use of plant variety to increase food safety and the potential outcomes of such a technique.The worldwide agricultural system presently specializes in a small number of important crop species, posing a threat to meals protection, in particular in light of weather change. recognizing the relevance of underused plants, instructional groups, governments, and policymakers around the sector have underlined the want to broaden them to satisfy rising food call for. Underutilized plants, with their genetic assets and acceptable capabilities, can offer new food resources and assist to diversify the agricultural device, that is crucial for tackling meals and nutritional safety problems.

Keywords: Climate change, Diversity, Food safety

INCPS-2024-16 Evaluating the Efficiency of Chloroplast Markers as Barcodes for *Abutilon* Species Identification: Biodiversity Conservation and Sustainable Agriculture

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The genus *Abutilon*, encompassing 150-200 species worldwide, is vital for horticulture, traditional medicine, agriculture, and food production. Accurate species identification is crucial for effective biodiversity conservation and the sustainable use of these plants. This study evaluates the efficiency of chloroplast DNA regions *mat*K, *psb*A-*trn*H, and their combination (*mat*K+*psb*A-*trn*H) as barcoding markers for identifying Abutilon species. DNA from eight Abutilon species and one outgroup (*Sida ovata*) was analyzed. Both *mat*K and *psb*A-trnH primers achieved 100% success in PCR amplification and sequencing. The *psb*A-*trn*H region demonstrated a distinct barcoding gap between intraspecific and interspecific divergence, offering higher species discriminatory power and supporting monophyletic clades with significant bootstrap values (>60%). Combining matK with *psb*A-*trn*H did not enhance species resolution beyond *psb*A-*trn*H alone. The superior performance of the *psb*A-*trn*H marker underscores its potential for precise species discrimination and phylogenetic analysis of Abutilon. This study highlights the importance of accurate species identification in conserving plant biodiversity and promoting sustainable agriculture, advocating for the integration of advanced DNA barcoding techniques in ecological and agricultural research.

INCPS-2024-21 The Floristic Composition, Structure, and Ecological Value of Planted Forest

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The floristic composition means the pattern of plant species distribution in certain region of the world. Forest floristic composition affected by natural and anthropogenic influence essential for understanding the fundamental ecological process and ecosystem services. The current study aims to document the floristic composition, diversity along the soil gradient. We sampled 100 plot (20 m × 2o m), (5 m × 5 m), (1m × 1m) for trees, shrubs and herbs in spring 2023. PC-ORD, CANOCO, and R software were used for two-way cluster, CCA, and linear regression analysis respectively. A total 36 plants species was documented belong to 21 different families which consist of herbs (53%) followed by shrubs (14%) and tree (33%) respectively. The results shows that Shannon diversity has a positive relationship with p.H and TDS of soil. However, the E.C, organic matter and nitrogen had a negative correlation with Shannon diversity. The floristic diversity is affected by deforestation, over exploitation, over grazing, and natural disaster. Based on results of study, the forest floristic diversity and ecosystem will be conserved using criteria for species population structure due to different anthropogenic and natural based activities. The study revealed that there is a need for conservation priority of trees, sherbs and herbs with low floristic pattern and structure.

Keywords: Floristic composition, Shannon diversity, Soil gradient, Forest ecosystem

Microbiology and Plant Microbe Interaction

INCPS-2024-75 Characterizing of the Soil Microbial Community in Poplars of Diverse Health Status in the Bashing Plateau: Insights from a Semiarid Region of China

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Rhizosphere soil microbes are closely related to forest health. Poplar trees of the Three-North Shelterbelt Project have been implemented for four decades in a semiarid region and show a significant degradation trend in the Bashang Plateau of North China. This study explore the soil microbial community formed by poplar trees under different health states. Through field investigation, rhizosphere and non-rhizosphere soil of poplar trees with different health status were obtained, soil physical and chemical analyses were carried out and soil microbial community structure, diversity and their influencing factors were analyzed based on high-throughput sequencing. The results showed that there are 34 phyla, 89 classes, 105 orders, 209 families, and 266 genera of soil bacteria and 11 phyla, 36 classes, 103 orders, 207 families and 345 genera of soil fungi. The dominant bacterial phyla (≥ 5%) were Proteobacteria, Actinobacteria, Acidobacteria, and Chloroflexi, and the dominant fungi phyla were Ascsomycota and Basidisomycota. In rhizosphere soil, the soil bacterial richness and evenness of degraded poplar were lower than those of healthy and dying poplars, while the soil fungi abundance was higher than that of healthy and dying poplars. The soil microbial communities between the rhizosphere and non-rhizosphere of degraded and healthy poplar trees had differences, while dying poplar did not show such a difference, which indicated that degradation had a significant effect on soil microorganisms.The main influencing factor of soil microbial distribution in healthy poplar is carbon and nitrogen sources in soil. When poplars died, their influencing factors were transformed into various enzymes. It was concluded that decay caused by the soil degradation enhance the promotion of enzymes on the decomposition and utilization of organic matter by microorganisms in poplar soil. This study on the Bashang Plateau's soil microbial community of

poplars with varying health status can offer insights for identifying the causes of degradation and inform effective soil management practices.

Keywords: Poplar; Healthy state; Soil microbes; Rhizosphere soil

INCPS-2024-25 Mitigating Heavy Metal Pollution in Pakistan: The Role of Microbial-Assisted Phytoremediation

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Heavy metal pollution in soil poses a significant environmental challenge in Pakistan, adversely affecting public health and agricultural productivity. This study reviews various strategies for mitigating heavy metal contamination, including phytoremediation, chemical immobilization, and soil washing. Phytoremediation employs plants to extract heavy metals but is limited by slow remediation rates and disposal issues. Chemical immobilization reduces metal bioavailability but serves as a temporary solution, necessitating repeated applications. Soil washing effectively removes heavy metals but is costly and generates contaminated wastewater. This study highlights the potential of bacterial-assisted phytoremediation as a promising, eco-friendly, and cost-effective alternative. By synergizing the use of plants with specific microorganisms, this innovative approach enhances the remediation process, improving plant growth and facilitating heavy metal uptake, with reported removal efficiencies of up to 90% for lead (Pb), 60-80% for cadmium (Cd), and 70% for arsenic (As). Furthermore, microbial-assisted phytoremediation significantly improves soil quality by enhancing nutrient availability, reducing toxicity, and promoting better soil structure, leading to increased agricultural output of 30-50% in contaminated soils. It can also improve public health by reducing heavy metal exposure, potentially benefiting 30-50% of the population in heavily contaminated regions. Additionally, this method can restore up to 90% of contaminated ecosystems and enhance biodiversity. As research in this field evolves, the potential for these innovative approaches to mitigate the adverse effects of heavy metal contamination remains substantial. This study underscores the necessity for a combination of techniques, particularly phytoremediation and microbial-assisted phytoremediation, to achieve a more effective and sustainable solution for soil remediation in Pakistan.

Keywords: Soil contamination, Public health, Agricultural productivity, Microbial-assisted phytoremediation, Ecosystem restoration

INCPS-2024-145 Antibacterial, Antifungal Activity and Phytochemical Characterization of Citrus Fruit Peel and Pulp

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Pakistan is big citrus producer so present research was executed to appraise the phytochemical attributes, antimicrobial and antifungal activities of *Citrus limon, C. reteculata, C. paradise* and *C. limetta*. In the preliminary examination solvent extracts were assessed for total phenolics, flavonoids, saponins, terpenoides. Significant presence of bioactive compounds flavonoid, steroids, phenols, saponin, terpenoids in peel and pulpof the citrus species. Presence of bioactive compounds directed the research for antimicrobial potential and samples of selected citrus species were tested against microbes and identified very promising antimicrobial activity against fungus and bacteria. Dilution method and disk diffusion method was used for antifungal activity and antibacterial activity respectively. Samples showed significantly reduction in fungal biomass with enhanced concentration trend in acetone solvent than ethanol. Whereas, both ethanol and acetone extract showed zone of inhibition against all bacterial strains at 50 mg/mL concentration. For supporting research study characterization of citrus samples was performed using GC-MS (QP2010 Shimadzu) for identification of different bioactive compounds. Many inter varietal chemicals were found through mass spectrometry analysis. Presence of bioactive phenolic and flavonoids, aldehydes and kenotic compounds in selected citrus specie with confirmation of antibacterial and antifungal activity it may be concluded that citrus species of Pakistan has great potential of nutraceutical applications.

INCPS-2024-190 Investigation of Chromium-Reducing Potential of Indigenous Microbial Strains in Tannery Wastewater

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Anthropogenic activities driven by agricultural, urban and industrial demands have polluted the earth through uncontrolled disposal of contaminated wastewater. Tannery wastewater contains numerous organic and inorganic chemicals which are used during leather production. These chemicals are released as pollutants into the tannery wastewater drains thus ultimately polluting the nearby soil and water resources. Chromium (Cr^{6+}) is one of these chemicals/pollutants which poses serious risks to human, animal, and plant health, highlighting the urgent need for innovative, cost-effective, and environment friendly methods to remove Cr^{6+} from the wastewater. Multiple strategies are employed to remediate Cr^{6+}, and among these, microbial bioremediation is emerging as a noteworthy approach gaining global attention. This investigation aimed to identify and characterize bacterial strains capable of reducing Cr^{6+} from tannery wastewater. In this study, several bacteria resistant to high levels of Cr^{6+} were isolated from tannery effluents, exhibiting varying degrees of Cr^{6+} reduction under static conditions at room temperature. Notably, two bacterial isolates (*Bacillus* sp. and *Shewanella* sp.) demonstrated remarkable efficiency, achieving over 90% reduction of Cr^{6+} in the medium. Both isolates showed resilience against various other metal ions, including zinc (Zn^{2+}), cobalt (Co^{2+}), nickel (Ni^{2+}), cadmium (Cd^{2+}), and lead (Pb^{2+}). Furthermore, these strains were able to reduce Cr^{6+} while maintaining tolerance to fluctuations in NaCl concentrations and pH levels. The findings suggest that these bacterial isolates hold significant potential for bioremediation applications in wastewater contaminated with hexavalent chromium.
Keywords: Bioremediation; Tannery effluent; Hexavalent chromium; *Bacillus* sp.; *Shewanella* sp.

INCPS-2024-191 Pesticide-Tolerant Rhizobacteria Enhance Malathion Tolerance in Cotton Plants Through Physiological Mechanisms

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The increasing frequency and severity of crop pests and diseases due to global warming necessitate sustainable pest management strategies. Organophosphate pesticides, such as malathion, are commonly used to

control these threats, but their environmental toxicity is a significant concern. However, biological remediation offers a promising alternative for mitigating pesticide pollution. The present study aimed to investigate the potential of a bacterial strain [M2(4)], for bioremediating malathion-contaminated cotton soil. M2(4), a gram-negative bacterium isolated from cotton rhizosphere, exhibited remarkable malathion degradation capabilities and possessed various plant growth-promoting traits. It demonstrated proficiency in ammonia production, nitrogen fixation, hydrogen cyanide (HCN) production, bioflocculant production, exopolysaccharides production, and biofilm formation. M2(4), being the best malathion-degrading and plant-growth promoting strain was further evaluated in pot experiment using cotton plants. Results showed that cotton plants cultivated in malathion-contaminated soil (0-4.5 mM) exhibited significant reductions in growth parameters, photosynthetic attributes, and antioxidant enzyme activities. However, the maximum decrease was observed at 4.5 mM concentration of malathion. Although, the inoculation with M2(4) significantly ameliorated these adverse effects by enhancing plant growth, photosynthetic efficiency, and antioxidant defense mechanisms, while simultaneously reducing malondialdehyde and hydrogen peroxide levels. These findings highlight the potential of M2(4) as a promising bioremediator for mitigating the detrimental impacts of malathion contamination on cotton agriculture. Further research is necessary to elucidate the mechanisms underlying bioremediation capabilities of M2(4) and evaluate its field-scale applicability.

Keywords: Malathion, Bioremediation, PGPR, Cotton, Antioxidants

Mycology, Plant Pathology and Disease Management

INCPS-2024-113 Exploration of Symbiotic Association and Identification of Fungal Species from Roots of Wheat in District Bhimber, Azad Kashmir

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This study was determined the frequency of symbiotic interactions between *Triticum aestivum* and fungi. The root volume, dry biomass and fertility of wheat as well as the fungus growth rate were measured in order to assess the interactions between the wheat crop and the fungi. A greater understanding of the extent to which these interactions affect population and community dynamics needs the assessment of the role played by the ecological context (biotic/abiotic) under which the interactions developed. *Mortierella, Penicillium sp, Arbuscular mychorrhizal fungi*. *Paraglomus*, *Piriformospora indica*, *Lachnum, Serendipita fungi* were isolated from the soil and roots of the wheat crop from the fields of Barnala. Except *Sistoterma,* all fungi were isolated from Samahni. Recent years have seen a shift in the emphasis of conceptual models of biological interactions from competition and predation to symbiotic interactions. *Mortierella, Penicillium sp, Arbuscular mychorrhizal fungi*, *Paraglomus*,*Piriformospora indica*, *Lachnum, Sistotrema*, *Podospora*,*Serendipita*fungiwere among the isolated species from wheat fields of the study area. *Mortierella* had the highest frequency and appearance percentages, at 21.6 and 20.4%, respectively. *Penicillium sp* came in second with a frequency and appearance percentage of 16.11 % and 14.10 %, respectively. The relative abundance and isolation frequency in different seasons also showed the diversity of symbiotic fungi in different seasons and locations.

INCPS-2024-72 Efficacy of *Parthenium hysterophorus*-Based Silver, Copper, and Nickel Oxide Nanoparticles in Citrus Canker Management

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This study examines the antibacterial efficacy of silver nanoparticles (AgNPs), copper nanoparticles (CuNPs), and nickel oxide nanoparticles (NiONPs) synthesized from *Parthenium hysterophorus* for the management of citrus canker. Characterization of the nanoparticles was performed using several advanced techniques to determine their size and confirm their structural properties. The size and morphology of the synthesized nanoparticles were analyzed through Transmission Electron Microscopy (TEM), which provided high-resolution images revealing the AgNPs to be approximately 50 nm in diameter, CuNPs to be around 11 nm, and NiONPs to be about 23 nm. Additionally, Dynamic Light Scattering (DLS) was employed to assess the size distribution and stability of the nanoparticles in suspension. The results from DLS complemented the TEM findings, confirming the particle sizes and ensuring consistent measurements. X-ray Diffraction (XRD) analysis further supported the structural characterization by identifying the crystalline phases of the nanoparticles, verifying the purity and composition of the synthesized materials. The anti-*Xanthomonas citri*pv. *citri* (Xcc) potency of these green-based nanoparticles was investigated under both lab and field conditions. *In vitro* assessment was performed at concentrations of 15, 30, and 45 µg/mL. At the highest concentration of 45 µg/mL, AgNPs exhibited the maximum inhibition zone of 24.08 mm, followed by CuNPs (20.21 mm) and NiONPs (18.3 mm). In the field-scale study, nanoparticles were tested at concentrations of 50 µg/mL, 100 µg/mL, and 200 µg/mL. At the highest concentration of 200 µg/mL, AgNPs showed minimum disease incidence (22.26%) followed by CuNPs (27.29%) and NiONPs (34.21%) as compared to the control. Future research should focus on scaling up NPs application and investigating their mechanisms to optimize their use in managing citrus canker.

Keywords: Citrus canker, *Parthenium hysterophorus*, Green Synthesis, Bioreduction, NPs

INCPS-2024-73 Assessment of Biocidal Potential of Desert Phyto-Extracts for the Management of Whip Smut of Sugarcane

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Sugarcane (*Saccharum officinarum*) is an important agro-industrial crop, widely grown for its high sugar content. It is a source of 85% of global sugar consumption, it is susceptible to various diseases that can significantly reduce the quantity and quality of the crop. Whip smut, caused by *Sporisoriumscitamineum*, is a major disease that affects sugarcane

production. Understanding the disease is important for protecting sugarcane production, ensuring economic stability for growers, and maintaining the supply of sugar and related products to consumers. This study aims to manage the whip smut of sugarcane by using desert plant extracts as sett treatment and foliar spray methods. In greenhouse conditions, the study found that five extracts were effective in managing whip smut: *Rhazya stricta*, *Calotropis procera*, *Peganum harmala*, *Citrullus colocynthis*, and *Salvadora oleoides*. *R. stricta* was the most effective and evaluated in field conditions with three concentrations. It significantly suppressed the disease in both foliar spray and sett treatment methods and improved the quality and quantity of the crop. This study also determined the Total Phenolic Content (TPC) and Total Flavonoid Content (TFC) of *R. stricta* methanol extracts through a spectrophotometric assay. The extracts were found to contain abundant phenolic and flavonoids, which can also induce systemic resistance in plants, reduce disease severity, and provide eco-friendly alternatives to synthetic pesticides.

Keywords: *Rhazya stricta*, *Calotropis procera*, *Peganum harmala*, *Citrullus colocynthis*, and *Salvadora oleoides*

INCPS-2024-32 Two New Species of Genus *Coprinopsis*(*Psathyrellaceae, Basidiomycota*) from Dera Ghazi Khan, Punjab, Pakistan

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During surveys of macrofungi in Dera Ghazi Khan in 2023, unique mushrooms were collected. Detailed morphoanatomical and DNA analyses identified these specimens as belonging to the genus *Coprinopsis*. Phylogenetic studies revealed two species that seem to be new and proposed here as *Coprinopsisderaghaziensis*(section *Quartoconatae*) and *C. cinerascens*(section *Niveae*). Phylogenetic analyses involved the Internal Transcribed Spacer and Large Subunit regions of ribosomal DNA. *Coprinopsisderaghaziensis*is distinguished from its nearest species, *C. musae*, by its campanulate to conical, non-striated pileus, basidiospores with a germ pore, absence of cheilocystidia, and the presence of pleurocystidia and caulocystidia. *C. cinerascens*differs from its closest species, *C. nivea*, by its applanate pileus, smaller velar elements (20−28.5 × 11−22.8 µm), and smaller hexagonal basidiospores (11 .5 × 9 µm). As a result of this study, the current number of *Coprinopsis*species in Pakistan has increased to ten.

INCPS-2024-76 Combine Role of Endophytic Fungi and Seaweeds in Induction of Systemic Resistance in Sunflower Against Root Rotting Fungi, and GC-MS Profiling of Mycelium of *Penicillium citrinum*

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Thirty isolates of fungi were isolated and identified based on their morphological feature. Species of fungi were identified as *Penicillium citrinum, Fusarium anthphillum, Fusarium culmorum, Aspergilusterreus, Aspergillus niger, Aspergillus flavos, Penicillium italicum, Fusarium solani, Drechslera, Alternaria, Trichoderma viridae, Curvularialunata, Fusarium proliferatum and Aspergilus fumigatus.* The efficacy of isolates of endophytic fungi with seaweeds (*Padina pavonica, Melanothalamusafaqhussaini*) have shown significant results against four common root rotting fungi. In this study, biocontrol potential of endophytic fungi and seaweeds were evaluated against root rotting disease in sunflower, on induced systemic resistance, and compound characterization of *n*-hexane mycelial extract of *Penicillium citrinum*. Most of the treatment showed significant ($P<0.05$) results of *R. solani,F.solani* and *M. phaseolina* as relation to control plants. Application of *P. citrinum* showed highest plant height, shoot weight. *P. citrinum* showed significant result for resistant biomarkers viz., antioxidant activity, salicylic acid, and total polyphenols as compared to untreated control plants. GC-MS analysis of *n*-hexane extract of mycelium of *P.citrinum*revealed the presence of variety of 17 different chemical compounds were obtained from mycelium fraction. Volatile compound such as normal hydrocarbon (alkane and alkene), fatty acid, alcohol, ether, terpenoids and benzene derivatives including cyclohexane and other compounds that were found among the volatile metabolites were identified by mass spectral data b1zase.

INCPS-2024-168 *Xerophoruspunjabensis* (Callistosporiaceae), a New Gilled Mushroom Species from Southern Punjab, Pakistan

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A novel species of family Callistosporiaceae,*Xerophoruspunjabensis*, has been identified from Southern Punjab, Pakistan, based on morphological characters and molecular phylogenetic analyses.A Phylogenetic analysis, based on the nrITS dataset, was constructed to assess the phylogenetic position, resulted in *Xerophoruspunjabensis* sp. nov. within the genus

Xerophorus. We present the new species with an illustrated morphological description and comparison with similar morphological or phylogenetically related species. Previously only one species of this genus has been reported from Asia. This novel species raised the total number of species of the genus *Xerophorus* to five globally. We believe morphological and molecular data of X. *punjabensis* in this study significantly contributes to our knowledge on distribution of this rare macrofungi species and helps understand its ecological preferences in Pakistan and worldwide.

Keywords: new species, Plain area, phylogeny, rare taxon, taxonomy

INCPS-2024-130 Fungistatic Potential of Leaves of *Solanum nigrum* Against Ochratoxin Producing Fungi

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The present study was designed to assess antifungal, antioxidant and detoxifying efficacy of leaves of *S. nigrum* against ochratoxin producing fungi. All the tested concentration (1%-3%) of ethanolic extract exhibited antifungal potential while 3% showed best antifungal potential i.e. 47% against *T. viride*, 57% against *C. cladosporiodes*and 61% against *P. verrucosum*. Antioxidant activity of *S. nigrum* leaves was also intended. Five concentration (10%-50%) of plant extract were made in methanol along with the standard (Butylated Hydroxytoulene BHT) Highest antiradical activity was given at 77% and minimum efficacy was investigated at 57% in comparison with standard BHT. *In vitro* bioassay guided fractionation was done to analyze the best isolated fraction against test fungi. Ethyl acetate proved to be best antifungal as compared to other fractions against ochratoxin producing fungi i.e. 0.10% and 0.01% concentration of ethyl acetate fraction showed maximum reduction at 64% and 68% against *T. viride*, 62% and 58% against *C. cladosporoides* and 62% for both concentrations against *P. verrucosum*. GC-MS analysis of ethyl acetate fraction revealed the presence of 26 compounds 9,12-octadecadienoic acid (28.60%), methyl 8,11,14-heptadecatrienoate (18.26%), n-hexadecanoic acid (17.13%), phytol (4.72%), all-cis-7,10,13-hexadecatrienoic acid (4.67%), ethyl linolenate (3.65%), octadecanoic acid (3.09%), glycerol 1-palmitate (2.72%), undecanoic acid, ethyl ester (2.31%), linolenic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester (z,z,z) (1.93%), dl-à-tocopherol (1.76%), phytyl stearate (1.43%), 1,2,3,4,5-pentamethoxycyclopentane (1.39%), octadecanoic acid 2,3-dihydroxypropyl ester (1.28%), 9,12,15-octadecatrienoic acid, methyl ester (1.18%), 9,17-octadecadienal, (z)-(0.95%), ethyl octadecenoate (0.72%), hexadecanoic acid, methyl ester (0.67%), 9,12-octadecadienoic acid, methyl ester (0.63%),nitrobenzene (0.61%),methyl alpha-linolenate (0.48%),methyl

octadecenoate(0.46%),trans-1-butyl-2-methylcyclopropane (0.37%),cyclononasiloxane, octadecamethyl (0.35%),3-isopropoxy-1,1,1,7,7,7-hexamethyl-3,5,5-tris(trimethylsiloxy) tetrasiloxane (0.33%) andtetradeca methyl hexasiloxane (0.32%). Results indicates that active compounds identified through GC-MS analysis of leaves of *S. nigrum* could be responsible for antifungal properties.

Key Words: Ochratoxins, ethanolic leaves extract, bioassay guided fractions, antioxidant, GC-MS

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NCPS-2024-34 Systematics of Some Ectomycorrhizal Taxa based on nrDNA sequences from *Quercus* Dominating Forests of Pakistan

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This research is based on the systematics of some distinct ectomycorrhizal taxa from *Quercus* dominating forests of Pakistan. The ectomycorrhizal symbiosis represents one of the most prominent and ecologically crucial mutualistic associations in terrestrial habitats and plays an important role in the forest ecosystem dynamics and maintenance. It has been estimated that around 25,000 fungal species are ectomycorrhizal in association with 8,000 plant species, though the number is likely to be much higher. Most of these fungi belong to basidiomycetes comprising 45 distinct genera. Hundreds of ectomycorrhizal morphotypes have been recorded from Pakistan, indicating a diverse range of fungal species in the region. During this investigation, some ectomycorrhizal specimens were collected from *Quercus* dominating forests of Khyber Pakhtunkhwa, Pakistan. Among which, four taxa were found distinct on the basis of morphological and ITS based molecular phylogenetic analysis of nrDNA. These taxa belong to the following genera: *Amanita*, *Boletus*, *Cortinarius*, and *Russula*, belonging to the family *Amanitaceae*, *Boletaceae*, *Cortinariaceae* and *Russulaceae*, respectively. *Amanita* is a globally distributed genus, comprising more than 650 species worldwide, around 30 species identified in Pakistan. *Boletus* is represented by approximately 300 species worldwide and about 12 species reported in Pakistan. *Cortinarius* is widely distributed across the globe, with over 22 species described from Pakistan while *Russula* encompasses more than 2000 species worldwide, including 57 species from Pakistan. This study provides a baseline for future taxonomic investigations of ectomycorrhizal communities in deciduous forests and contributes to the exploration, documentation and upgradation of fungal diversity in Pakistan.

Keywords: Broad leaf vegetation,Mycorrhizal, Swat, Taxonomy

INCPS-2024-85 PCR Based Molecular Characterization of Bacterial Pathogens from Citrus Fruit withMajorFocusonCitrus Canker Disease

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The ratio of losses attributable to bacterial pathogen-caused citrus disease has grown globally. In Pakistan, mature citrus trees show signs of disease both before and after harvest, however, the exact causes of these diseases are yet unknown. The evaluation of citrus disease prevalence, incidence, and severity, as well as the morphological and molecular characterization of the bacterial pathogens, were complex aspects of the current investigation. In the first phase of the study, a comprehensive survey was carried out in December. Using tissue culture and streaking techniques, the bacterial pathogens were isolated from infected collected samples and their morphology was used to characterize them. Secondly, strains that were isolated were characterized using primers 27F (5-CTTCAACTCAAACGCCGGA-3) and 1492R (3-CATCGGCTGTTCGGGAG-5), which were used for the molecular 16S rDNA region analysis used for identification. *Pseudomonas syringae, Pseudomonas viridiflava, Serratia marcescens, Xanthomonas axonopodis*, and *Candidatus liberibacter* were the species that were identified. Third, three citrus cultivars (Kinnow, Succri, and Moro blood) were utilized for the pathogenicity test of the isolated bacterial strains. The results showed that the Xanthomonas sp. pathotypes induced the most severe symptoms. This study demonstrates the molecular-based association of bacterial pathogens with citrus diseases, which helps to provide recommendations on genetic testing and develop disease management programs. This is important because citrus fruits contribute significantly to household income and foreign exchange in Pakistan

INCPS-2024-178 New Records of Wood Rotting and Medicinal Macrofungi from Pakistan Corroborated by Multigene Phylogeny

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During a survey in the Shiwalik hills (AJ&K), Achh and Pabbi Forest Park Gujrat, Pakistan, in rainy seasons of years 2021-2023, many macro-fungal species were collected. Of these, five new records for the country viz; *Cellulariellawarnieri*, *Flavodonflavus,Gloeophyllumlongisporum G. trabeum*and*Panaeoluscyanescens* belonging to the Basidiomycota have been presented with detailed morpho-anatomical descriptions, line drawing illustrations, microphotographs and phylogenetic analyses based on nrITS

and nrLSU. First four species are wood rotting group of fungi belonging to the orders Polyporales and Gloeophyllales and are of great medicinal value. *C. warnieri* and *F. flavus* are represented by only two species worldwide according to Index Fungorum. However, *Gloeophyllum* is a comparatively species rich genus represented by seventeen species worldwide. *Panaeoluscyanescens* is a magical mushroom producing psychoactive compounds demonstrating promising therapeutic benefits such as acute reduction in obsessive-compulsive disorder (OCD) symptoms. This study of phylogenetic identification provides a baseline for further research on medicinal and therapeutic properties of these fungal species.

INCPS-2024-206 Taxonomic and Phylogenetic Analyses Reveal New Record of Inonotuss.l. (Hymenochaetaceae), from Pabbi hills, Punjab, Pakistan

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The present research work was done to identify and characterize Inonotuss.l. from Pabbi hills and Pabbi Forest Park, Sarai Alamgir, Punjab, Pakistan due to its medicinal importance. Several species of poroidHymenochaetaceae were found parasitizing angiospermic trees in Pabbi forest park. Of the collected specimens, ITS sequences were generated and phylogenetic analysis was performed. After morpho-anatomical and molecular analyses, a wood rotting fungus was identified as *Inonotusrickii* (Pat.) Reid that is a new record from Pakistan. Previously, seven species of this genus are reported from Pakistan morpho-anatomically. This is the first report of Inonotusrickii from Pakistan on the basis of morpho-anatomic and phylogenetic analyses.

INCPS-2024-249 Prevalence of Soil-Borne Phytopathogenic Fungi in Cotton Crop

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Cotton (*Gossypium hirsutum* L.) is considered significant cash crop of Pakistan. The economic growth of Pakistan is directly related to the output of cotton and exports of cotton goods make up about 55% foreign exchange profits of the country. Cotton prefers a hot, dry climate; hence, it is primarily farmed in South Sindh and Punjab. Plant diseases in the soil damaged and declined the cotton yield and resulted in significant losses. Lower Punjab regions like Dera Ghazi Khan, KotChutta, Basti Jam Muhammad, Muhammad Pur, Jampur, Basti Surani, Samandri Choti, and Basti Ganga are primarily known for producing cotton. The majority of the time, synthetic

chemicals are employed to manage soil-borne plant infections; however, these chemicals are toxic to the environment and also detrimental to healthy soil fauna and flora. In present study, different control strategies have been adopted to stop the use of these synthetic chemicals and with the use of various growing media as well as isolation of mycobioya techniques were used. In present study, several soil-borne fungal phytopathogens genera have been recorded but very common fungi including *Aspergillus flavus*, *A. niger, A. terreus,* and *Penicillium* sp. were isolated and identified as a were predominated microbes. They were separated from various samples gathered from various locations in Punjab. However, numerous viral and fungal infections are severely prevalent in the aforementioned regions. These soil-borne phytopathogens cause infections and affect plant growth and development during different stages of plants. These major symptoms of infections are plant wilting, drying of the leaf margins, and the development of yellow spots on the surface of the leaves. It is concluded that sampling of cotton plants from different field areas with various infected diseases confirms that the soil-borne disease causes major losses to the yield and quality of cotton.

Keywords: Pathogenicity; Phytopathogens; Fungi; Cotton

INCPS-2024-278 Evaluation of Different Fungicides against Root Rot of Carrot Caused by Fusarium spp.

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Carrot (*Daucus carota* L.) is a major crop in the world. It is thought that this crop originated from the Afghanistan and its neighbouring countries. Carrot is the most essential vegetable that gives high-quality nutritional value. It also contains high amounts of vitamin A, K, protein-rich and high sugar concentration of carrot leaves. In the world carrot is affected by many fungal diseases. Among these fungal diseases, root rot of carrot caused by fusarium spp. is the most destructive disease of carrot. As a result, it is an important to keep this pathogen under control. The matured, ripened and infected carrots with typical symptoms was collected from the local fruit markets of Gojra and Faisalabad. These samples were further processed in the Diagnostic Laboratory, Department of Plant Pathology, University of Agriculture Faisalabad, for the isolation and purification of the suspected pathogen. Four different fungicides named as Nanok (Flutrifol + Azoxystrobin), Kasumin (Azoxystrobin + difenacanazole), Novice (Azoxystrobin + Difenoconazole) and Bloom (Myclobutanil) were used at different

concentrations to evaluate against root rot of carrot caused by fusarium spp. Bloom (Myclobutanil) shows the best result against fusarium spp. All the fungicides were evaluated against root rot of carrot caused by fusarium spp. under field condition and minimum disease incidence was recorded by Bloom (Myclobutanil). Data was analyzed statistically to verify the effectiveness of fungicides against fusarium spp.

Keywords: root rot of carrot, fungicides and Bloom (Myclobutanil).

Phycology, Marine Biology

INCPS-2024-78 Spatial and Temporal Dynamics of Phytoplankton Dwelling in Mangrove Dominated Channel Water and Tidal Creek area along Karachi Coast

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Phytoplankton plays a key role in primary productivity of an ecosystem. Their diversity and abundance vary with environmental conditions. Present study was initiated to assess seasonal variation in community composition (qualitatively and quantitatively) in mangrove dominated channel water and creek area (Manora channel and Port Qasim) with relation to hydrographical conditions quarterly along Karachi coast during SWM (Southwest Monsoon), AIM (Autumn Inter Monsoon), NEM (North-East Monsoon), and SIM (South Inter Monsoon). Overall, two major groups of phytoplankton (diatoms and dinoflagellates) were assessed. Diatom species showed highest abundance as compared to dinoflagellate throughout the study period. Maximum cell density of diatom was recorded during SIM and SWM seasons at creek area of Port Qasim and Manora channel, respectively. However, maximum abundance of dinoflagellates was recorded in SWM and SIM seasons, respectively. Stephanocyclus meneghinianus was most abundant species at Manora channel whereas, at Port Qasim Cylindrothecaclosterium,Stephanocyclus meneghinianus, Guinardiaflaccida, Chaetoceros sp. and Navicula sp. were the dominant species throughout the study period. High values of Shanon, Simpson, and species richness were observed during AIM season at both stations. The K dominance curve for diatom and dinoflagellate species revealed that at Port Qasim, diatom prevalence was highest during AIM season however at Manora Channel it was highest during SIM season. In present study it has been observed that channel water at Manora and creeks of Port Qasim are highly influenced by pollutants received through domestic sewage and other effluents respectively. It has been noticed that only resistant species of diatoms were dominated in harsh conditions. Besides, dinoflagellates were occurred in very low abundance due to their sensitive nature. A continuous monitoring is required to indicate the impact of pollution in the coastal waters of Karachi which ultimately affect the community composition and structure of phytoplankton.

INCPS-2024-36 *Aegiceras corniculatum*: Antidiabetic Potential of Fruit Extract

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Mangrove ecosystems are one of the important natural wetlands in tropical and subtropical region around the world that possesses highly beneficial and pharmaceutically important metabolites. Present study was design to investigate *In-vivo* anti-diabetic potential of *Aegicerascorniculatum*fruits. Four groups (normal control, diabetic control, mangrove treated and diabetic+ mangrovestreated)were tested for up to 10 days. The methanolic fruit extract were injected in normal and diabetes induce (Alloxan monohydrate) mice. After induction blood glucose level was measured of each group (alternate days) till the end of experiment. In diabetic control body glucose level was increase (156.7±3.72) whereas, in Diabetic + Mangrove treated group showed overall decrease (130±5.38) in blood glucose level. In general,anti-diabeticactivitywasobserved,Diabetic + Mangrovestreated>Mangrovestreated> Control > Diabetic control trend was noted. Generally results depicted that, incomparison with diabetic control, mangrove dose was more effective than standard drug because on eachobservationday. It was noticed that fruit extract of *A. corniculatum* was also affect the animal body weight by decreasing up to4g during the experimental period. Results of this study revealed that effect of fruit extract onbloodserumparameters(urea, creatinine, uric acid, cholesterol HDL ratio, cholesterol, triglycerides,HDL, LDL, VLDL, total protein, albumin, globulin, A/G ratio)werealmostatnormallevelsexcepttriglycerides. Overall, the studysuggeststhatthe fruit of *A.corniculatum*possessesanti-diabeticpotential,asitwasassociatedwithareductioninbloodglucoselevels.However,more researchisneededtounderstanditsunderlyingmechanismofaction,potentialside effects,andeffectiveness comparedwithcurrentlyavailablediabetestreatments.

INCPS-2024-08 Assessing the Potential use of Seaweed as Biofertilizer for *Spinacea oleracea*under Saline Conditions

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Spinach (*Spinacea oleracea* L.) is grown worldwide as a food crop. It is a rich source of calcium, iron and many other minerals that are essential for

human health. Its cultivation is facing challenges due to increased soil salinity in various agricultural lands around the globe. To mitigate the effect of salinity, marine alga can be potentially used as biostimulant in agricultural sector. This study investigates the efficacy of seaweed (*Enteromorpha intestinalis)* powder as a biostimulant for spinach cultivation under diverse saline conditions (0, 40 mM, and 80 mM NaCl). This research focuses on the impact of two concentrations of seaweed powder (3 g and 6 g per 500 g of soil) as soil amendment on spinach growth. Assessed parameters include germination rate, shoot and root lengths, fresh and dry weights, and biochemical properties such as protein, carbohydrate, phenol, flavonoid, mineral content, chlorophyll, and carotenoid levels. It was observed that chlorophyll content, proteins and phenols significantly increased in treatments where *E. intestinalis* powder was applied as compared to untreated plants. Fresh weight and dry weight of roots as well as shoots were also increased in plants treated with seaweed powder under saline stress. It was also found that low concentration of seaweed powder (3g/500g of soil) was more effective than high concentration i.e., 6 gm/500 g of soil. Thus, the results indicated a significant impact of the algal treatment on improving plant growth and biochemical parameters, suggesting its utility as an eco-friendly alternative to chemical fertilizers in salt-affected agriculture.

Keywords:biostimulant; biofertilizer; seaweed; *Enteromorpha intestinalis*

Plant Biotechnology and Genetic Engineering

INCPS-2024-60 Identification of Molecular Markers Linked to Rust Resistance Genes in Pakistani Spring Wheat

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Wheat diseases such as leaf rust and stripe rusts are common in Pakistan resulting in considerable quantity of yield loss. Growing varieties containing rust resistant genes are the best solution for the problem. Gene-specific DNA markers are employed to introgress the rust resistance genes in the chosen wheat background and prevent linkage drag. We employed a panel of 150 spring wheat genotypes in this investigation, which included 40 land races, 58 NIGAB advanced lines, 40 NUWYT lines 2016-17, and 12 varities. The panel was screened for leaf rust and stripe rust resistance genes *Lr16*, *Lr19*, *Lr22*a, *Lr32*, *Yr5*, *Yr10* and *Yr18*/*Lr34* using gene specific DNA markers. It was discovered that land races are particularly poor in the studied rust resistance genes, while NUWYT advanced lines and varieties were postulated as good sources of resistance genes studied.

INCPS-2024-71 Development of useful Genetic and Genomic Resources of Spring Wheat through Bridging Mutational and Next Generation Sequencing Approach

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Exposing genetic material with physical mutagens can create novel genetic resources capable of combating different stresses. Gamma rays (γ rays)

were used to induce mutations in wheat cultivar Punjab-11 (Pb-11). A total of 33 stable mutants (M_7) were developed, followed by characterization by conducting multi-location trials over three seasons at two sites. The genotype by trait (GT) bi-plot revealed significant associations between yield and its components among the mutants. Positive correlations were estimated for tillers per plant, plant height, 1000-kernel weight, and grain yield. The mutant lines Pb-M-59, Pb-M-1027, and Pb-M-1323 exhibited maximum grain yield, 1000-grain weight, and tillers per plant. High throughput GBS-DArTseq™ assay was deployed to estimate the frequency of presence-absence variants (PAVs) of 33 newly developed stable wheat mutants. In total, 113,279 SNPs and 157,787 PAVs were identified after filtering. The identified PAVs and SNPs were randomly distributed on all chromosomes of three sub-genomes. The maximum number of PAVs were detected on Chr7D (2877) followed by Chr-7B (2711). Maximum number of SNPs (2884) were found on Chr-7D followed by Chr-7B (2715) and Chr-2B (2664). The largest number of variants were identified in mutant line Pb-M-2061 (23,643). Out of 7,910 PAVs consistently identified over replicates, 3,252 were specific to mutants but were absent in wild type. Out of these, 1,480 were found in Pb-M-1027 followed by 656 in Pb-M-1323. Out of these (3,252), 1,238 were found in wheat transcriptome that contained 152 characterized and 1,196 uncharacterized genes. Clusters of orthologous genes (COGs) and Gene ontology (GO) terms associated with PAV-containing genes showed that maximum number of PAVs identified in Pb-M-1027, Pb-M-2302 and Pb-M-1323 were involved in tolerance to diseases and abiotic stresses, improved photosynthetic efficiency, larger grain size, increased grain yield and harvest index pathways. The PAVS of Pb-M-1575, Pb-M-1946, Pb-M-196, Pb-M-2517, Pb-M-2260, and Pb-M-1530 demonstrated their involvement in pathways including disease resistance, increased grain yield and drought tolerance. These findings can help molecular geneticist and breeders for exploiting the induced genetic diversity for unravelling the genetic circuits as well as exploiting in wheat breeding for developing resilient cultivars.

Keywords: disease resistance, genetic diversity

INCPS-2024-143 Comparison of Mother Plant Canola with Somaclone for NaCl Tolerance

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In the current study tolerant selected somaclone S9 of *Brassica napus* L. variety Hyola 401 regenerated from viable callus under various levels of

NaCl (0, 50, 100, 150, 200, 250 mM) were evaluated for the comparison of NaCl tolerance level with mother plants. The biochemical and mineral analysis (soluble sugars, protein, proline content and Na^+ and K^+) of somaclone S9 was compared with germinating seedling of Hyola 401, mother plant (MP) at various concentrations of NaCl (0, 50, 100, 150, 200 mM) *in vitro.* In the present study somaclones S9 of *Brassica napus* L. contained more proline content, more accumulation of carbohydrate content and protein content as compared to mother plant of *Brassica napus* L. in all treatments of salt. ANOVA showed that the proline amount has increased significantly with raise in salt concentration, soluble carbohydrate contents of mother plant (MP) and somaclone S9 non-significantly increased with increasing salinity in contrast to control except at 100 mM in mother plant and at 100 mM and 150 mM in somaclone S9 soluble carbohydrate content increased significantly whereas physiological parameter protein had negative effect of salt treatments on mother plant (MP) and somaclone S9 of *Brassica napus* L. as compared to control. Results indicated that mineral ion Na^+ is directly proportional and K+ is inversely proportional to salt stress. Present study indicated that mother plant (MP) of *Brassica napus* L. contained more Na^+ and less K^+ as compared to somaclone S9 in all salt treatment. Results indicated that *Brassica napus* L. Hyola 401 somaclone S9 was more tolerant as compared to mother plant (MP).

Keywords: *Brassica napus* L., biochemical and mineral analysis, somaclones (S9), mother plant (MP)

INCPS-2024-20 The Glycine soja Cytochrome P450 Gene GsCYP82C4 Confers Alkaline Tolerance by Promoting Reactive Oxygen Species Scavenging

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Recent studies have demonstrated the crucial role of Cytochrome P450 enzymes (CYPs) in the production of secondary metabolites, phytohormones and antioxidants in plants. However, their functional characterization specifically under alkaline stress remains elusive. CYP82C4 was the key gene screened from a family of wild soybean CYPs in our previous studies. The aim of this present study was to clone the Glycine soja GsCYP82C4 gene and characterize its functions in Arabidopsis and Glycine max. The results showed that the GsCYP82C4 gene displayed a high expression in different plant tissues at mature stages compared to young stages. Further, higher temporal expression of the GsCYP82C4 gene was noted at 6, 12 and 24 h time points after alkali treatment in leaves compared to roots. In addition, overexpression of GsCYP82C4 improved alkaline stress tolerance in Arabidopsis via increased root lengths and fresh biomass and strengthened the antioxidant defense system via a reduction in superoxide radicals in transgenic lines compared to wild type (WT) and atcyp82c4 mutants. Further, the expression levels of stress-related marker genes were

up-regulated in GsCYP82C4 OX lines under alkali stress. The functional analysis of GsCYP82C4 overexpression in soybean displayed better hairy root growth, increased fresh weight, higher antioxidant enzyme activities and reduced lipid peroxidation rates in OX lines compared to the soybean WT (K599) line. In total, our study displayed positive roles of GsCYP82C4 overexpression in both Arabidopsis and Glycine max to alleviate alkaline stress via altering expression abundance of stress responsive genes, stronger roots, higher antioxidant enzyme activities as well as reduced rates of lipid peroxidation and superoxide radicals.

Keywords: cytochrome, GsCYP82C4, alkaline stress

INCPS-2024-196 Modulating Pectin Methylesterification: A Strategy for Root-Knot Nematode Resistance in Tomato Plants

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Root-knot nematodes (RKNs) are sedentary endoparasities that establish specialized feeding structures called giant cells (GCs) within the host plant's roots. These cells provide a continuous supply of nutrients to the nematodes throughout their life cycle. The life cycle of RKNs consists of two distinct phases: a migratory phase and a sedentary phase. After hatching from eggs, the second-stage juveniles (J2s) penetrate the host root near the root tip and migrate intercellularly toward the vascular cylinder, where they establish feeding sites and begin the sedentary phase of their development. The J2s extensively manipulate the host plant’s developmental machinery to orchestrate the formation of feeding cells. During the initial phases of infection, the expression of several host plant genes related to cell wall-modifying enzymes, particularly those involved in pectin modification, is significantly altered. Nematodes also release pectin-degrading enzymes to facilitate their migration to the vascular tissues. Pectin is an important component of the plant cell wall and acts as a cement between adjacent cells. In this study, we explored the potential of pectin-related genes to enhance tomato plant resistance against RKNs. We analyzed the sequences of the Pectin Methylesterase Inhibitor (PMEI) gene family, which is highly expressed in tomato roots. We identified conserved amino acid domains and developed an RNA interference (RNAi) construct based on Virus-Induced Gene Silencing. Silencing the PMEI gene family is expected to enhance the methyl esterification of pectin in roots, thus preserving its integrity against both indigenous and nematode-secreted enzymes, posing a challenge for

nematodes during migration and the development of feeding structures. This approach offers a promising strategy for developing RKN-resistant tomato varieties.

Keywords: Root-knot nematodes (RKNs), Pectin methylesterase inhibitor (PMEI), RNA interference (RNAi), Virus-induced gene silencing (VIGS), Pectin modification

INCPS-2024-97 In vitro Rooting of Rescued Mature Zygotic Embryos of *Pinus roxburghii* Sarg

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The aim of present study was to investigate the potential for in vitro rooting of mature zygotic embryos of *Pinus roxburghii*. Seeds were extracted out from mature cones, surface sterilized and megagametophytes containing zygotic embryos were then aseptically removed. The zygotic embryos were also aseptically extracted and both zygotic embryos and megagametophytes were separately cultured on modified LP 505 medium + BAP (0.45 mg/L) + NAA (2 mg/L) + Kinetin (0.43 mg/L) for culture initiation and extrusion. Such cultures were initially incubated in dark for 20 days and then shifted to 16 h photoperiod for another 20 days. Results demonstrated that 75% extrusion was possible from embryos and 19.04% from megagametophytes in light (40 days old cultures). After 30 days of initial culture, the length of shoot was 2cm whereas 3cm long shoots were achieved from megagametophytes. After 40 days in 505 medium, these elongating shoots were shifted to LP or DCR semi-solid media supplemented with 10, 20, 30 or 40 µM of IBA + NAA for further growth and rooting under 16 h photoperiod. On these media, rooting could not achieve where shoots grew further up to 4 cm long on LP + 30 µM IBA + NAA after another 20 days (2 months old cultures). Such cultures were shifted to half DCR, LP or full MS media, 50% rooting with 2cm long roots were achieved on both MS and DCR. After a month, rooted shoots were shifted to potting media (peat moss + sand in 3:1 ratio) in 8 x 15 cm plastic pots, covered with polythene bags to control humidity and placed under the culture room conditions for acclimatization. Irrigation with ¼ DCR was carried out every 10 days for one month. The plants obtained from MS survived for 35 days, and plants grew on DCR remained green up to 15 days in potting media. After all plants wilted and got necrosis.

INCPS-2024-240 Development of Fungal Resistant Berseem Lines by Nuclear Incorporation of Chitinase Gene

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Trifolium alexandrinum L., commonly known as Berseem, is an important winter leguminous crop that serves as a primary source of green fodder for livestock in Pakistan. As Pakistan does not possess natural pastures to fulfill the nutritional needs of its large animal population, it depends heavily on cultivated fodder crops, mainly corn & sorghum in summer and berseem in winter along with other minor crops. Therefore, any damage to these critical fodder crops can severely impact the livestock sector of Pakistan. However, forage production research, particularly on the availability of green forage throughout the year, has been insufficient, and it is crucial that both the public and private sectors undertake research seriously. Root rot disease complex, which includes root rot, collar rot, and stem rot, has been a significant cause of yield decline of at least 20-25% in berseem. Unfortunately, no berseem variety in Pakistan has yet shown resistance to this disease complex, and the farming community lacks knowledge about it, resulting in the absence of routine control measures. To address this issue, we conducted research to produce transgenic berseem lines that may be resistant to this disease complex by expressing a synthetic antifungal gene for Chitinase in berseem. Nucleotide sequences of Chitinase gene was retrieved from NCBI, codon optimized for improved expression in plants. Firstly, chitinase gene family members were characterized by systematic in-silico genome-wide analyses. Then, a highly efficient in vitro regeneration protocol for promising indigenous cultivars of berseem was also optimized. It is one of the pre-requisites for successful plant transformation. Biolistic method was used for genetic transformation of tobacco as well as berseem using transformation vector containing chitinase gene. The putative transgenic plants were selected on selection media containing phosphinothricin as selection agent. After regeneration on selection media, molecular analyses were carried out using PCR. Further analysis and fungal bioassays. The present study may be regarded as first step towards the and development of fungal of resistant lines.

Keywords: Fungal diseases, winter fodder crops, antifungal genes, transgenic technology, herbicide tolerance.

Plant Ecology and Environment Pollution

INCPS-2024-42 Organic Pollution Treatment Efficiency Through Recycled Plastic Bedding Materials' Microbial Biofilm

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Ultimately, only few wastewater treatment plants are installed in Pakistan which are unable to treat the 99% municipal wastewater (MWW) containing 50 to 60% organic pollution (OP) load. MWW is contained biological oxygen demand (BOD) ranges from 100 to 400 (mgL^{-}). Due to comfort, plastic is extensively used in society but not biodegradable if lying hundreds of years. Developed assembly containing recycle plastic bedding material (PBM) is used in the treatment of OP in MWW with the help of temporal microbial biofilm (MBF) developed on the PBM. PBM in assembly provide roughage surface area for MBF from where aerobic bacteria fed oxygen from air to stabilize 85% BOD and COD (mg L-) in MWW furthermore physio-chemical parameters of MWW including pH, high range pH, NH_3/NH_4^+ (ppm), NO_2^- (ppm), NO_3^- (ppm), EC (µS/cm), TDS (µS/cm), NaCl (%), total solids (mgL-), fixed solids (mg L-) and volatile solids (mg L-). Thermogravimetric (TGA), X-ray diffraction (XRD) and Fourier transfer infrared (FTIR) results analysis indicate treatment efficiency of recycled PBM. Environmental plastic pollution is managed in recycled PBM in developed assembly which treats MWW is reduced OP environmental footprints and available for irrigation of vegetables. PBM is the most preferred solution for recovery of MWW and managing plastic pollution as it is cheap, sustainable and environment friendly.

Keywords: Organic pollution, Plastic bedding material, Microbial biofilm, Municipal wastewater, Safer irrigation

INCPS-2024-124 Ecological Interaction of Russula Genus; A Case Study from the Moist Temperate Region of Murree Forest Division

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The genus Russula is widely distributed globally and has significant economic and research importance. It represents a group of ectomycorrhizal fungi utilized for culinary and medicinal purposes. Worldwide, there are 2759 identified taxonomic units identified within Russula. The aims of the present study to determine the relationship of abiotic variables with Russula genus. The current study is conducted in the moist temperate region of Murree Forest division. Extensive flied work and seasonal sampling were carried out in the study area. Quadrate quantitative ecological and host preferences determination method were used. The macrofungi specimens were identified by Mycologist of Quaid-i-Azam University Islamabad and Hazara University Manshera, Pakistan. A total of four species of Russula has been identified in the study area are *Russulalaurocerasi, R. aerugenia, R. padulosa, R. betularum*. Canonical correspondence analysis is performed for these four species. These analyses show that *Russulalauricerasi* has a strong relationship with organic matter, pH and Nitrogen but show a weak relationship with brightness. *R. padulosa* shows a positive relation with humidity and phosphorus while shows the negative relationship with pH, Nitrogen and organic matter. The *R. aerugenia* and *R. betularum* have a strong relationship with Electrical conductivity and Total Dissolved Solid while the negative relationship shows with Brightness, pH, Nitrogen and organic matter. The future research should leverage multi-omics technologies, particularly proteomics and metabolomics, to conduct comprehensive investigations into the material basis provided by host plants.

Keyword: Ecological, Russula, Interaction, Abiotic, Murree

INCPS-2024-19 A Phytosociological Study of Weeds Distribution under the Influence of Edaphic, and Farming Dynamics in the Wheat Field of District Mianwali

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Weeds significantly threaten global agriculture by adversely affecting crop yield and quality. The hypothesis was that agroecological variation leads to diverse weed species associations influenced by different soil factors and farming practices in small and large habitats. A comprehensive scientific study was conducted to evaluate the spatial distribution of existing weed species influenced by edaphic factors and farming practices across 100 wheat fields in the district of Mianwali. Phytosociological attributes such as density, cover, frequency, and Important Value Indices of weeds were assessed by randomly placing three 1m² quadrats in each field. Various edaphic factors, along with farming practices, including soil texture, electrical conductivity, soil pH, total dissolved solids, organic matter, phosphorus, soil

saturation, irrigation methods, duration, previous crop types, fertilizer application, herbicide types and quantities, and many more were analyzed. Multivariate statistical analyses were performed on the data using PC-ORD version 5, CANOCO version 4.5, linear regression and pearson correlation. The study identified 82 weed species belonging to 29 families and 68 genera across 300 quadrats, with Poaceae (15 species) and Asteraceae (13 species) being the most prevalent. *Anagallis arvensis* L., *Cynodondactylon* (L.) Pers and *Rumex dentatus* L. were the most dominant weed species of selected area. This research concludes that agricultural practices and soil conditions significantly impact the distribution of weed flora and the development of weed associations/communities in the region. Although weeds are typically regarded as undesirable plants, some economically significant and rare weeds also require appropriate conservation management.

INCPS-2024-263 Assessment of the Genotoxic Effect of Pesticide (Profenofos and Cypermethrin) on *Allium cepa* L. through Comet Assay

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Pesticides are specially designed to control pests and help in increasing the yield of crops. This study aims to investigate the genotoxic effect of the major ingredients of commonly used pesticides (Profenophos and Cypermethrin) on *Allium cepa* L. in different regions of the province of Punjab, Pakistan. Profenophos and Cypermethrin pesticides are extensively used by local farmers. six different dilutions of Profenophos and Cypermethrin pesticide ranging from, 0.5 ml/L, 1 ml/L, 1.5 ml/L, 2 ml/L, 2.5 ml/L and 3.0 ml/L were applied initially on seeds germination. Seeds grown in a 3.0 ml/L concentration showed a lower radical length percentage as compared to other dilutions. The radicle length of the 0.5 ml/L concentration was the same as in the control. Onion bulbs were grown in the sand to obtain roots later the onions were transferred into different dilutions of Profenophos and Cypermethrin for 72 hours. DNA was isolated through the modified CTAB method. The DNA damage was observed through the technique of comet assay. The tail DNA % (35.71±2.18) of the control group (simple tap water) was same as the tail DNA % (35.74±2.10) of 0.5 ml/L pesticide dilution. The moment of tail DNA % length showed that the DNA was damaged by the pesticide, The results indicated that the concentration of pesticides and exposure time have a deep effect on plants' growth and development. There is a need to highlight stricter regulations, sustainable agricultural practices, and consumer awareness regarding concentration.

INCPS-2024-155 Temporal Variations in Polyphenols and Antioxidant Capacity of A Coastal Dune Grass *HalopyrumMucronatum*

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Halopyrummucronatum L. Staph. (Poaceae) is a perennial halophytic grass, commonly found on the coastal dunes along Arabian Sea. This grass produces two type of seeds in two seasons (summer and winter), which vary in color (black and brown), weight (light and heavy) and polyphenol contents (high and low). To determine, the physio-chemical relationship between vegetative and reproductive attributes, temporal variations in polyphenols (total phenols- TPC, flavonoids- TFC, and tannins- TTC) and antioxidant capacity (using DPPH, ABTS, FRAP, and TAC tests) of leaf and seed of *H. mucronatum* were studied. Highest TPC in leaves was found in December (winter), from where a gradual decline was observed until May, after that TPC again begin to rise. TFC and TTC did not follow the trend of TPC and showed a transient increase from October to September and reached maximum in March (summer). Data obtained from all four methods indicated a considerable antioxidant capacity of leaves, which was in line with TFC and TTC data, rather than TPC. In general, antioxidant capacity and polyphenols were higher during brown seed producing season (winter) than black seed season (summer). This difference is also reflected in polyphenols and antioxidant capacity of both seeds, where higher values were found in black compared to brown seeds. These differences may be due to the resource allocation. Winter is cooler and drier period, during which plant use more polyphenolic antioxidants for protection of metabolically active parts rather storing them in seeds (brown). While, in summer, warmer temperature and monsoon rains provide relatively moist and conducive conditions for plant growth, hence more polyphenolic antioxidants were stored in seeds (black) . These findings suggest a relationship between physio-chemical attributes of leaf and seeds of *H. mucronatum*, which is dependent on seasonal variations and their metabolic demand..

Plant Genetics and Breeding

INCPS-2024-83 Exploring the Genetic Variability of Common Bean (*Phaseolus vulgaris* L.) in Subtropical Conditions: A Study from the Kashmir Himalayas

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The common bean (*Phaseolus vulgaris* L.), traditionally a temperate climate crop, holds significant potential as a vital source of nutrition and income for smallholder farmers. However, its cultivation has been limited in the subtropical climates of the Kashmir Himalayan region, where food security remains a pressing concern. Current research was conducted as a pioneering experiment to assess the feasibility of cultivating 20 common bean genotypes in subtropical conditions within this region. The study has evaluated the crop's growth performance, yield potential, and resistance to local biotic and abiotic stresses by quantifying a diverse array of agromorphological trails and genetic variability attributes. Results revealed a wide range of variability among the genotypes. Plant height varied significantly, with values ranging from 205.7 cm to 350.67 cm. Leaf length and width showed moderate variation whereas Pod length and width were fairly consistent, with some genotypes like NGR1 and LPA58 showing higher values. Seed traits, including length, width, and weight, also exhibited variability, with hundred-seed weight ranging from 13.88 g to 51.28 g. The number of seeds per pod and pods per plant varied, impacting the overall seed yield per plant, which ranged from 8.46 g to 27.35 g. Days to flowering showed differences among genotypes, with some flowering as early as 58.37 days and others taking up to 70.3 days. The broad-sense heritability values ranged from 58.95% to 96.15%, indicating varying degrees of genetic control over the traits. Traits like seed yield per plant, hundred-seed weight, and seed per pod showed high heritability coupled with substantial genetic advance (GA%) values, suggesting a strong potential for improvement through selection. In contrast, traits such as days to flowering exhibited lower genetic variability, reflected in lower GCV% and GA% values. These results indicate that while some traits are highly heritable and responsive to selection, others may require more nuanced breeding strategies to enhance their genetic potential. These findings underscore the significant genetic diversity present among the common bean genotypes, offering substantial potential for selective breeding. Harnessing this variability could lead to the development of high-yield, adaptable cultivars suitable for the subtropical climates of the Kashmir Himalayan region, thereby enhancing food security and sustainability.

INCPS-2024-53 Cyto-genetic Sequel of Soft Drinks via *Allium cepa* L. Chromosomal Aberration Assay as a Cancer Prediction Tool

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Nowadays most of the population relies on soft drinks just for the taste of freshener and mood changer, despite the fact, that it has no nutritional value and rather contain unhealthy constituents for humans. Sky touching consumption of soft drinks in Pakistan and the high rate of liver kidney failure incidence have created a great need for evaluation of the genotoxicity and oxidative effects of these drinks. Our work schemed to assess the genotoxicity and oxidative properties of 5 soft drinks flavours via Allium cepa L. chromosomal aberration assay for 48, 72, and 96-hour incubation. Simple dH_2O and saline water were used as negative control and .2% EMS was used as positive control for toxicity. The cytology was carried out by squash method and Acetocarmine was used for staining. The findings revealed all the test soft drinks mediated mitotic aberrations in dose dependent manner. Chromosomal aaberrations a key evident of mutagenicity generated by all soft drinks were; scattered nuclei, sticky metaphase, bridges, fragmentation, translocation rings, di-nuclei, and micronuclei. All soft drinks caused oxidation of membrane protein and lipids leading to irregular shape of cells and nuclei. The induction of ghost cells with pillus like tubular connections indicates how cancer cells invadesneighboring healthy cells. Tested soft drinks signify the concentration and incubation-dependent proliferation of oxidative effects as well. Based on all the toxicity parameters tested soft drinks are categorized in ascending order as follows: **Sprite<Dew<Fanta<Coca-Cola.** It is concluded that soft drinks are potentially mutagenic and carcinogenic and must not be consumed.

INCPS-2024-181 Inheritance of Seed Cotton Yield and Component Traits in Cotton

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The experiment was conducted to assess the hybrid vigor and mode of inheritanceof various agronomic traits in nine crosses developed at the farm area of Department of Plant Breeding & Genetics, Ghazi University, DG Khan. The crossing material was comprised of six cotton cultivars including 3 CLCuD tolerant (male parents) and 3 CLCuD susceptible (female parents)

cultivars. The crosses were attempted in all possible combinations of CLCuD tolerant and susceptible cultivars and nine crosses were obtained in total. F1 was sown in the field and selfed to produce F2 population. Parents, F1 and F2 were planted in the next growing season together in the triplicate in the Randomized Complete Block Design (RCBD). At maturity 10 guarded plants per replication were selected to record the data on final height of main stem (cm), Number of sympodial branches per plant, Number of monopodial branches per plant, Number of bolls per plant, Average boll weight (g) and Seed cotton yield per plant (g). All the traits were highly affected due to CLCuD infestation in susceptible mother parents compared to their respective pollen parents.CLCuD had an adverse effect on seed cotton yield and reduced the seed cotton yield significantly. On an average basis decrease in plant height in CLCuD infected plants was recordrd at -31.8% compared with the healthy plants. Similarly seed cotton yield was also reduced -70% in CLCuD infected plants compare with those of the healthy plants.The highest heterosis was recorded for cross combination S-12 × CIM448 (95.74%), S-12 × LRA-5166 (72.7%) and CIM-70 × MNH-554 (60%)for seed cotton yield. However, the highest inbreeding depression was recorded in the cross combinations ACALA-1517-C × MNH-554 (20.13%), S-12 × LRA-5166 (15.37%) and S-12 × MNH554 (13%). The estimates for potaence ratio indicated that non additive type of gene action was found to be playing major role in the inheritance of all of the traits under study.

Keywords: Cotton, CLCuD, Gene action, Mode of inheritance, Heterosis

INCPS-2024-235 Genome Wide Linkage Mapping of Various Morpho-Physiological Traits Under Heat and Drought Stress in Wheat (*Triticum aestivum* L.)

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This study aimed to identify quantitative trait loci (QTL) associated with 17 morpho-physiological traits in wheat, including chlorophyll content, canopy temperature before heading, canopy temperature after heading, days to heading, flag leaf length, flag leaf width, days to physical maturity, number of spikes per plant, plant height, peduncle length, extrusion length, spike length, awn length, number of spikelets per spike, grain yield, thousand grain weight, and number of grains per spike. For this purpose a recombinant inbred line (RIL) population comprising 119 lines, derived from a cross between Millet-2011 and PBW-343, was evaluated. The study was conducted over two years (2020–2022) under normal, drought, and heat stress conditions, with field trials designed in an augmented incomplete block design. Drought stress was induced by withholding irrigation, while

heat stress was applied through a walk through tunnel. The Analysis of variance (ANOVA) demonstrated significant differences between the RILs under different treatments. Pearson correlation analysis revealed a positive association between canopy temperature before heading and traits such as days to physical maturity, number of spikes per plant, plant height, peduncle length, awn length, and number of spikelets per spike. The population was genotyped using genotyping by sequencing platform (GBS). QTL analysis identified 41 QTLs across the two-year study, with 12 QTLs linked to yield, thousand grain weight, and the number of grains per spike. Of these, 8 QTLs were detected under normal conditions, 3 under drought, and 1 under heat stress. The RIL population demonstrated tolerance to drought and heat stress, offering potential for enhancing wheat adaptability to challenging environmental conditions. This study provides valuable insights for future breeding programs aimed at improving wheat resilience and productivity under stress conditions.

Keywords:Abiotic stresses, cereal, spring wheat, QTLs

Plant Nutrition and Soil Science

INCPS-2024-146 Fertigation of Wheat (*Triticum aestivum* L.) Cultivars with Zinc Leads to Enhanced Yield and Marginal Rate of Return in Silty Loamy Soils

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This study was aimed to understand the role of Zn fertilizer ($ZnSO_4 \cdot 7H_2O$) applied through soil media, foliar spray and in combination for enhancing yield and marginal rate of return of wheat crop in filed conditions. Four wheat cultivars; Anaj-2017; Akbaer-2019; FSD-2008 and Zincol-2016 were sown in randomized complete block design in field. The Zn fertilizer was applied as soil media, foliar spray and in combination of soil + foliar media. A significant enhancement in plant height (18.2 %), leaf area index (28 %), heat unit efficiency (25.1 %) and SPAD (23 %) value was observed in wheat cultivars with Zn fertilization. However, the impact of soil + foliar media (T4) Zn application (15 kg ZnSO4 ha^{-1} (soil) + 1 % ZnSO4 foliar spray solution) was higher than soil media or foliar spray. The protein, ash, fat and phytate contents were enhanced to 13.38 %, 2 %, 0.57 % and 27 % respectively while significant decrease in α-amylase (−29 %) and was recorded after Zn fertilization. At T4 considerable enhancement in grain yield (4.2 tons ha^{-1}), harvest index (55.3 %), internal use efficiency and partial nutrient budget was recorded. It was observed that uptake K, N, Zn and Fe were enhanced while that of P were reduced after Zn fertigation especially at T4 in wheat cultivars. The value cost ratio (VCR) and marginal rate of return (MRR) to farmers was better at T4 as compared to T1-T3 in all wheat cultivars. Finally, Zn applied as soil + foliar spray was most effect while among cultivars Zincol-2016 and Akbar-2019 showed more yield potential than Anaj-2017 and FSD-2008. It has been established that the soil–plant-mineral nutrition nexus is the road leading to fetching higher income, sequestration of carbon dioxide from the air and also ensuring food and nutrition security.

Key words: Zn fertilizer, wheat, SPAD, harvest index

INCPS-2024-18 Soil Liming Ameliorates Crude Oil Stress and Promotes Biochemical Indices and Photosynthetic and Antioxidant Enzyme Activities in Lemongrass (*Cymbopogon citratus*)

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Crude oil contamination is a serious environmental threat to agricultural soils. Different methods have been employed to ameliorate crude oil-contaminated soils. However, little is known about the effects of liming on plants grown in crude oil contaminated soils. In a glasshouse experiment, fresh soil was mixed with different amounts (0, 1.75, 3.5, 5.25, or 7.0 kg) of crude oil-contaminated soil equivalent to 0%, 25%, 50%, 75%, and 100% dry weight basis of the total soil.pot−1 (i.e., 7 kg soil.pot−1). To half of the contaminated soils, agricultural lime (aglime) was added as 3% of the amount of contaminated soil. Thereafter, lemongrass (Cymbopogon citratus) was grown in all the pots. After 45 days, growth, physiological, and biochemical properties of lemongrass were measured. Compared to plants without crude oil exposure, increasing amounts of crude oil in the soil significantly decreased all measured plant parameters (shoot and root lengths and dry weights, chlorophyll and carotenoid contents, total soluble proteins and amino acids, antioxidant enzyme activities, and secondary metabolites). However, compared to stressed plants without amendment, lime application increased lemongrass shoot and root lengths and biomass by about 20–50%, chlorophyll content by about 20–60%, carotenoid content by about 20–30%, total soluble proteins by about 15–30%, total free amino acids by about 10–40%, antioxidant enzyme activities by about 10–50%, and secondary metabolites by about 30–50%. Our findings suggest that soil liming could be a simple environmentally friendly method to ameliorate the deleterious effects of crude oil contamination on plants.

INCPS-2024-37 Effects of Different Rates and Ratios of Nitrogen and Phosphorus on Growth, Yield and Nutrients Uptake in Newly Developed Rice (*Oryza sativa* L.) Genotype

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Imbalanced application of mineral fertilizers is one of the major constraints to low productivity of rice in Pakistan. Rice genotypes varied in their fertilizer requirements depending on the potential yield, morphology, soil conditions,

environment and use efficiency. This study was designed to assess the application of diverse rates and ratios of nitrogen (N) and phosphorus (P) on yield, nutrients uptake and recoveries of newly developed rice genotype "GSR-1". Field experiments were conducted at experimental farm of Nuclear Institute of Agriculture during consecutive Kharif seasons 2019 and 2020. Ten combinations of treatments including T_1: control, T_2: 90-30, T_3: 90-45, T_4: 90-70, T_5: 120-30, T_6: 120-60, T_7: 120-90, T_8: 150-40, T_9: 150-75 & T_{10}: 150-110 kg N-P ha^{-1} repeated thrice were arranged in RCBD. The pooled results of both the years showed that the application of fertilizer rates significantly ($p < 0.05$) influenced the growth traits, yield, nutrients uptake & recoveries of "GSR-1". The genotype produced the maximum tillers per plant, No. of grains per panicle, 1000-grain weight, paddy & biological yields, with the application of T_{10} (150-110 kg N-P ha^{-1}). The T_7 (120-90 N-P ha^{-1}) remained statistically parallel to T_{10}. However, the total N uptakes in paddy and straw was significantly higher in T_{10} as compared to T_7. Total N & P recoveries were increased with increasing rates of N & P fertilizers. Thus, 120-90 kg N-P ha^{-1} was found as most economical dose of fertilizer for rice genotype "GSR-1". However, regional trials with different soil types, fertility status and Argo-ecological zones are recommended for general cultivation of newly established rice genotype "GSR-1".

Key words:*Oryza sativa* L., Nitrogen, Phosphorus, Ratios, Genotypes

INCPS-2024-38 Evaluating Zinc Biofortification Potential of Salt Tolerant and Sensitive Rice (*Oryzasativa* L.) Genotypes

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Zinc is the most widely spread micronut disorder of wet land rice, which falls next to nitrogen and phosphorus deficiencies. Zinc deficiency of rice may result in malnutrition of people dependent on a rice-based diet. A field study was carried out to evaluate Zn-biofortification potential of 10 pre-evaluated salt tolerant and sensitive rice genotypes under saline conditions (ECe: 8 dSm^{-1}) using 0 and 15 kg Zn ha^{-1}. The biomass and grain yield showed the significant genotypic variation by application of Zn and interaction of genotypes X zinc in saline conditions. Zinc concentrations in all genotypes increased with Zn application of 15 kg Zn ha^{-1} but slight increase was recorded in genotype Shua-92, which is a Zn efficient genotype. Maximum grain yield index was recorded in Shua-92, Shandar and IR-36, while low Zn deficiency tolerance observed in RG-120, and Sarshar, respectively. Highest Zn efficiency was recorded in Shua-92 while RG-120 exhibited lowest one. The saline soil containing HCO_3^- can be an ecological strategy for plants

grown on calcareous and Zn deficient soils. The Shua-92 showed the clear response in the field conditions. The Shua-92, Shandar and IR-9 proved to be the most Zn efficient genotypes while RG-120 and Sarshar Zn inefficient one. The rest of all genotypes were observed as intermediate in efficiency. It can be concluded from this study that because of different chemical factors of soil on which these genotypes are grown and the physiological mechanism of rice plants, the Zn efficiency trait is also associated with bicarbonate tolerance of rice genotypes. Thus, the rice genotypes Shua-92, Shandar, IR-9 (salt tolerant) proved as Zn efficient in Zn deficient field conditions, are suggested for cultivation in Zn deficient soils. The genotypes Sarshar and RG-120 showed as Zn in-efficient, Zinc fertilizer application of 15 kg ha^{-1} is suggested to achieve maximum yield and Zn nutrition for human beings.

Key words: Zinc efficiency, salinity, rice genotypes, paddy yield

INCPS-2024-133 Analysis of Comparison between Zinc Soil and Foliar Application to Improve Zinc Biofortification of Coarse Rice

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Zinc (Zn) is an essential micronutrient its deficiency caused complicated health problems. Among different strategies to tackle Zn deficiency, biofortification of rice crop is considered easy and environmentally safe method. Thereby, this study aimed to compare the potential of two agronomic biofortification methods; soil and foliar application in rice under field condition during year of 2021 in kharif season. Experiment consists of total four treatments as T1 control, T2 Zn soil supplementation at rate of 10 kg ha-1, T3 Zn foliar spray at booting stage at the rate of 0.25%, T4 Zn foliar spray at booting + flowering stage at rate of 0.25%. Each treatment replicated thrice following randomized complete block design (RCBD). At harvest, crop growth, physiology, yield, and Zn concentration in paddy grain straw, Zn uptake parameters were analyzed. The findings revealed maximum growth (5.6%), number of tillers (90.9%), panicle length (48.5%), weight of panicle (54.7%), and number of grain (32.7%), at T4 from their respective control. The highest value of Chlorophyll a (42.9%) at T3, T4, chlorophyll b (100%) at T2, T3, T4, Total chlorophyll (62.5%) at T4, carotenoid (33.3%) at T2 in compared to control. Yield parameters obtained such as grain yield (56.3%), straw yield (8.2%) and biological yield (13.7%) to than their control. Maximum Zn concentration in paddy grain and uptake

400, 300 folds at T4, T3 respectively. While Zn concentration in rice straw 300 folds at T4 and uptake in paddy straw also 300 folds at T4 in comparison to their control. In conclusion above results Zn doze at flowering time at the rate of 0.25% suitable for the desirable increment in paddy grain straw and their uptake as well however gap of the study suggests further investigation at cellular level of plant is needed.

Keywords: Essential micronutrient, Agronomic biofortification, Foliar applications, Growth physiology, Zinc concentration

INCPS-2024-46 Evaluating Soil Carbon Sequestration and Physicochemical Dynamics in Subtropical Pine and Mixed Forest Ecosystems of Muzaffarabad: Implications for Climate Change Mitigation and Sustainable Development

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Soil carbon sequestration plays a basic role in climate change mitigation by removing carbon dioxide from the atmosphere. Soil carbon pools hold more carbon than both vegetation and the atmosphere combined. This study aimed to quantify organic carbon stock and other physicochemical attributes of soil to achieve overall sustainability in the dominant lesser Himalayan subtropical forests of Muzaffarabad. Ten representative sites in each forest type were selected for soil sampling. A total of 100 soil samples were analyzed for SOC through the Walkley-Black method. The SOC averaged 63.86±3.29 Mg ha^{-1} in coniferous forests and 50.05±3.05 Mg ha^{-1} in mixed forests, with a total average of 56.95±1.40 Mg ha^{-1}. SOC levels in coniferous forest soils ranged from 82.11±6.52 Mg ha^{-1} to 48.63±3.82 Mg ha^{-1}, while mixed forest ecosystems exhibited SOC range of 62.29±4.71 Mg ha^{-1} to 35.57±2.34 Mg ha^{-1}. The average soil pH was 7.1±0.14, whereas soil bulk density (BD), and electrical conductivity (EC) were 1.1±0.01 g $cm^{-3}$and 0.95±0.07dS m^{-1}, respectively. Statistical analysis indicated a significant difference in SOC between forest types. The sampled forests harboured 103 plant species from 48 families and 92 genera, with trees, shrubs, and herbaceous plants constituting 17%, 12%, and 71% of the flora, respectively. Dominant plant families included Poaceae, Compositeae, Fabaceae, and Lamiaceae. The study implicates sustainable forest and soil management policies, focusing on the forest conservation to improve SOC. These initiatives are vital to achieve Sustainable Development Goals (SDGs) related to the environment, economy, and society.

Keywords: Climate change, Forests, *Pinus roxburghii,* SDGs, Sustainability

INCPS-2024-180 Role of Nitrogen Application to Improve the Radiation use Efficiency and Quality of Cotton *Gossipumhirsutum* L.

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Climate change has a pronounced impact on radiation use efficiency and quality of fiber. A field study was designed using a split-plot design to investigate the impacts of nitrogen on radiation use efficiency and fiber quality of cotton cultivars in Punjab, was carried out. The study under representation was conducted over two years at three different locations viz., Adaptive Research Farm-Dera Ghazi Khan, Regional Agriculture Research Institute Bahawalpur, and research farm of College of Agriculture, University of Sargodha. Cultivars FH-lalazar, FH-142, and MNH-786 were treated to six different nitrogens levels 0, 60, 120, 180, 240, and 300 kg ha^{-1}. The CROPGRO-cotton model was tested and applied as a research tool which showed significant results at all locations. The nitrogen level improved the radiation use efficiency, cotton fiber quality. For cotton productivity, the arid climate of Bahawalpur is far superior to the semi-arid climates of Sargodha and Dera Ghazi Khan.

Keywords: Nitrogen application, radiation use efficiency, fibre quality, *Gossypium hirsutum* L., CROPGRO-cotton model

Plant Physiology and Stress Physiology

INCPS-2024-61 Assessing Lead and Cadmium Tolerance of *Chenopodium ambrosioides* During Micropropagation: An In-Depth Qualitative and Quantitative Analysis

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The tolerance of Chenopodium ambrosioides to some heavy metals under in vitro environment was thoroughly investigated. A micropropagation protocol was developed to facilitate the mass production of plants and to identify metals-tolerant species for potential use in the restoration of polluted areas. Nodal explants exhibited callus formation when treated with N6-benzyladenin (BA) (1.5 mg/l) and a combination of BA/_-naphthalene acetic acid (NAA) at concentrations of 1.5/1.0 mg/l on the Murashige and Skoog (MS) medium. The optimal shoot formation was achieved with the callus grown on a medium enriched with 1.5/1.0 mg/l BA/NAA, resulting in an impressive number (21.89) and length (11.79 cm) of shoots. The in vitro shoots were rooted using NAA (1.0 and 1.5 mg/l) and were acclimatized in pots with 71% survival rate. After standardizing micropropagation protocol, the in vitro shoots were subjected to various doses of lead nitrate $Pb(NO_3)_2$ and cadmium chloride ($CdCl_2$). $Pb(NO_3)_2$ and $CdCl_2$ in the media let to a reduction in shoot multiplication, decreasing from 18.73 in the control group to 11.31 for Pb(NO3)2 and 13.89 for CdCl2 containing medium. However, $Pb(NO_3)_2$ and $CdCl_2$ promoted shoot length from 5.61 in the control to 9.86 on $Pb(NO_3)_2$ and 12.51 on $CdCl_2$ containing medium. In the case of $Pb(NO_3)_2$ treated shoots, the growth tolerance index (GTI) ranged from117.64% to 194.11%, whereas, for $CdCl_2$ treated shoots, the GTI ranged from 188.23% to 264.70%. Shoots treated with a high level of $Pb(NO_3)_2$ induced reddish-purple shoots, while a low level of $Pb(NO_3)_2$ induced shoots displayed both green and reddish-purple colors in the same explants. In $CdCl_2$ treated culture, the toxic effects were narrow leaf lamina, elongated petiole, and a dark reddish purple coloration. These findings highlight the remarkable potential of C. ambrosioides to maintain growth and organogenesis even in the presence $Pb(NO_3)_2$ and $CdCl_2$ on the MS medium, indicating a high degree of metal tolerance.

INCPS-2024-26 Acclimation of Fruit Crops to Climate Change-Induced Stresses: A Comprehensive Review

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

INCPS-2024-27 Proline Induced Changes in Cellular Redox Balance by Modulating Photosystem-II and Antioxidant Activity under Salinity Stress in Bread Wheat (*Triticum Aestivum* L.)

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Adverse effects of salinity on physiological processes such as photosynthesis can be mitigated through activation of antioxidants or

accumulation of osmo-protectants like proline. Present study aimed to assess whether or not exogenous application of 100 mM proline protect photosystem II in wheat cultivars under saline conditions and up to what extent cellular redox balance contributed in it. Two wheat cultivars out of seven were (selected based on growth improvement due to proline application) exogenously applied to 100 mM proline grown under control or salt stress (0, 150 mM NaCl). Salinity stress decreased the growth of wheat cultivars, plant water status, photosynthetic pigments, structural stability of PSII (active reaction centers, donor end of PSII Fv/Fo), and electron transport through PSII to PSI and increased NPQ in wheat cultivars. Salinity stress also caused oxidative stress by producing H_2O_2. However, foliar treatment of 100 mM proline improved growth of plants of both wheat cultivars under salt stress, which was associated with increased endogenous level of proline. Increased endogenous level of proline improves the plants osmotic potential in cultivar Galaxy-13. Application of proline improved functional activity of PSII by increasing the reaction center density, and electron transport through PSII to PSI. Proline also lowered the ROS generation in Galaxy-13 by enhanced the cyclic electron transport and increased the antioxidants activities (peroxidase, superoxide dismutase and catalase) in both cultivars of wheat. Increase in PSII activity, and reduction in oxidative stress due to proline application is greater in cv. Galaxy-13 than in salt tolerant cv. S-24.

INCPS-2024-28 Ascorbic Acid-Mediated Enhancement of Antioxidants and Photosynthetic Efficiency: A Strategy for Enhancing Canola Yield under Salt Stress

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The ameliorative role of AsA (200 ppm) in improving growth by changing antioxidant response, photosynthetic capacity and mineral nutrient status of two canola varieties (Dunkled and Cyclone) under 200 mM NaCl salinity stress was studied. Salt stress reduced plant biomass, photosynthetic activity, and accumulation of macro and micronutrients such as K^+, Ca^{2+} and Zn^{2+} in two canola varieties, while it increased in accumulation of Na^+ and Cl^-. The salinity-induced oxidative stress (H_2O_2 and MDA) caused photoinhibition of PSII at the donor and acceptor ends leading to limited ETRII. Salt stress increased in NPQ and ETRI in both canola varieties. In addition, salt stress enhanced CEF around PSI. However, foliar application of AsA ameliorated the negative effects of salt stress on both canola varieties. Application of AsA improved the stomatal conductance, inter-cellular CO_2 concentration and net CO_2 assimilation rate thereby resulting in

improved consumption of extra-electrons in CO_2 fixation generated by photosynthetic electron transport. Exogenous AsA application reduced the oxidative stress and improved the antioxidant potential by managing extra-electrons produced in CO_2 fixation. Application of AsA improved the structural stability of PSII, linear electron transport and reduced donor end limitation of PSI activity by improving electron transfer from PSII to PSI. All these physiologicaland biochemical changes due to AsA application helped the canola plants to improve growth and yield under salinity. Thus, the application of ascorbic acid has the potential to ameliorate the detrimental effects of NaCl stress on canola plants.

INCPS-2024-135 Effect of Ecofriendly Hydrogels on *Oryza sativa* L. under Water Stress

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More than one third of the whole cultivated region of the globe is affected by water stress. *Oryza sativa* L. consumes most of the total irrigation groundwater and is highly susceptible to water stress, particularly at the reproductive stage. Hydrogel Technology in agriculture can ensure better crop productivity in moisture stressed environments by delaying the permanent wilting point of the plants. In this study, 3 types of hydrogels were selected on the basis of environmentally friendly nature which were not toxic to soil. Chitosan based potato peel based hydrogels, cellulose based hydrogels, gum arabica based hydrogels were prepared. After preparation, hydrogels were characterized on the basis of swelling properties, Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), scanning electron microscopy (SEM) analysis. After characterization, in vitro germination of rice seeds was examined. Then the hydrogels were dried and grinded into powder form and then a pot experiment was conducted in which both soil application of powdered hydrogels (at 2g/kg concentration was applied) and seeds coated with these hydrogels were grown to check which method is best for rice against drought stress. Drought was applied to rice at the reproductive stage for 7 days. Results of this research concluded that both seeds coated with cellulose based hydrogels show best results against drought in the yield parameters of rice. And also, both soil application and seed coated with hydrogels were found effective for improving yield related attributes under water stress. But the seed coated method is more beneficial because of cost effectiveness.

Keywords: Drought, Hydrogels, *Oryza sativa* L, Seed coating, Soil Application.

INCPS-2024-265 Hexavalent Chromium Uptake and its Effects on Mineral Nutrients Status, Photosynthesis and Key Metabolites Related to Amino acids and Glactose Metabolism in *Brassica napus*

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Brassica napus is a biennial crop that is widely used for oil, fodder, biofuel, and it is the third-largest source of vegetable oil in the world, after soybeans and palm oil. Current studies suggest that *B. napus* has significant potential for cultivation in marginal lands polluted with heavy metals. To assess the effects of 50-μM Cr treatment on *B. napus* seedlings, a hydroponic experiment was conducted to measure the Cr accumulation, cell wall components, and metabolomics profiling. Cr treatment significantly increased the Cr uptake and accumulation by 31% in cultivar ZS758 and 57% in cultivar ZD622. The Cr treatment reduced shoot and root fresh and dry biomass by 57% and 73%, and 29% and 42%, respectively. It also decreased Pn, Gs, and Tr by 42% and 64%, 36% and 47%, 32% and 42% in ZS758 and ZD622, respectively. Additionally, chlorophyll fluorescence indices indicated a decrease in PSI performance. The 50-μM Cr treatment significantly reduced the calcium (Ca) by 62%, potassium (K) 58%, phosphorous (P) 49%, iron (Fe) 42%, copper (Cu), 40% and manganese (Mn) 36% in cultivar ZS758. While decrease was more obvious in cultivar ZD622 including Ca, K, P, Fe, Cu and Mn by 86%, 74%, 68%, 58%, 62% and 48%, respectively. The findings show that Cr treatment led to 256 and 136 differentially expressed metabolites (DEMs) in cultivars ZS758 and ZD622. Additionally, cultivar ZS758 displayed 218 unique DEMs, while cultivar ZD622 displayed 98 DEMs, with 38 DEMs shared by both rapeseed cultivars. These metabolites were related to amino acid biosynthesis, particularly cysteine/homocysteine, lysine, tryptophan, alanine, glutamate, and proline. These results suggest that Cr triggered defence mechanisms through metabolome profile reprogramming, cell wall biosynthesis, plant hormone signalling pathways, and transporters. These findings contribute to a better understanding of the morpho-physiological and metabolomics changes in Cr-resistant crop species.

Key words: *Brassica napus*, Heavy metal, Phytoremediation, Metabolomics, cell wall, plant growth

INCPS-2024-57 Role of Polyethylene Glycol to Alleviate Lead Stress in *Raphanus sativus*

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The continuous contamination of heavy metals (HMs) in our ecosystem due to industrialization, urbanization and other anthropogenic activities has become a serious environmental constraint to successful crop production. Lead (Pb) toxicity causes ionic, oxidative and osmotic injuries which induce various morphological, physiological, metabolic and molecular abnormalities in plants. Polyethylene glycol (PEG) is widely used to elucidate drought stress induction and alleviation mechanisms in treated plants. Some recent studies have unveiled the potential of PEG in regulating plant growth and developmental procedures including seed germination, root and shoot growth and alleviating the detrimental impacts of abiotic stresses in plants. Therefore, the current study aimed to assess the effects of seed priming with various concentrations (10%, 20%, 30%and 40%) of PEG on the growth and development of radish plants growing under Pb stress (75 mg/kg soil). Lead toxicity reduced root growth (32.89%), shoot growth (32.81%), total chlorophyll (56.25%) and protein content (58.66%) in treated plants. Similarly, plants showed reduced biomass production of root (35.48%) and shoot (31.25%) under Pb stress, while 30% PEG seed priming enhanced biomass production of root (28.57%) and shoot (35.29%) under Pb contaminated regimes. On the other hand, seedlings obtained from 30% PEG priming demonstrated a notable augmentation in the concentrations of photosynthetic pigments, antioxidative activity and biomass accumulation of the plants. PEG-treated plants showed modulations in the enzymatic activities of peroxidase (PO), catalase (CAT)and superoxide dismutase (SOD). These changes collectively played a role in mitigating the adverse effects of Pb on plant physiology. Our data revealed that PEG interceded stress extenuation encompasses numerous regulatory mechanisms including scavenging of ROS through antioxidant and non-antioxidants, improved photosynthetic activity and appropriate nutrition.Hence, it becomes necessary to elucidate the beneficial role of PEG in developing approaches for improving plant growth and stress tolerance.

INCPS-2024-41 Influence of CuO Nanoparticles on Photosystem II Structural Stability and Functional Activity of Corn (*Zea mays* L.) under Drought Stress

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Drought stress is an important limiting factor for plant growth and agricultural sustainability. Photoinhibition and photooxidation of photosystem II (PSII) is one of the key damages caused by the drought stress. To alleviate drought-induced physiological and biochemical damages in plants, use of nano-particles is one of the potential strategies. However, the effect of nano-particles on plant growth and physiology is variable. The present study aimed to assess whether or not foliar application of *copper oxide nanoparticles(Cu*ONPs) are effective in promoting PSII stability and activity under drought stress. Three-week old plants of corn were subjected to drought stress and varying levels of CuOnano-particles (*0, 25, 50 and 100 mM).* In this study, the effects of foliar application of c*opper oxide nanoparticles(0, 25, 50, and 100 mM Cu*ONPs) on growth, plant water status, nutrient uptake and structural stability of photosystem II of corn plants under drought stress were assessed. Drought stress impeded overall growth of corn by reducing leaf relative water content, water potential chlorophyll *a* content, and accumulation of K^+ in leaves and root. Drought stress also increased the root length of corn plants. Exogenous application of 25 mM CuO nanoparticles enhanced the growth of corn. Exogenous application of CuOnano-particles improved the dry biomass of root and root length of corn plants under drought stress. Although application of nano-particles did not change photosynthetic pigments, relative water content, accumulation of K^+ in leaves, it enhanced the accumulation of K^+ in roots. Drought stress did not affect the structural stability of PSII, but reduced its activity (performance index, PI_{ABS}) due to changes in reaction center density ($\gamma_{RC}/(1-\gamma_{RC})$ and biochemical reaction efficiency or electron transport capability ($\Psi_{Eo}/(1-\Psi_{Eo})$. Exogenous application of CuO-nano-particles improved PI_{ABS} due to increase in active reaction center density and electron transport efficiency. However, 100 mM CuO nano-particles application caused PSII damage at the donor end and reduced active reaction center density in corn plants under both normal and drought stress conditions. The present findings provide baseline information that foliar application of CuO-nanoparticles in low concentration can improve the growth of corn by improving accumulation of K^+ and increasing PSII activity.

INCPS-2024-86 Physiological Screening of Some Sunflower Genotypes Against Abiotic Stress

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The physiological screening of sunflower genotypes under salt, drought stress individually and in combination were performed. The ssalt and drought treatments to the plants were gradually increased. Stresses were applied 30 days old plants that lasted for 14 days. To evaluate the physioplogical performance; PSI and PSII efficiencies relative water content, osmotic potential, stomatal conductance, chlorophyll contents, ion analysis and antioxidants activities were investigated. Combined stress found to be erroneous for photochemical activities in sunflower cultivars compared to single stress. Maximum quantum yield of PSII, light absorption flux per cross section of leaf, phenomological fluxes, plastoquinone pool size, rate of reaction centre closure,performance indexes and driving force of absorption were calculated and inferred from chlorophyll fluorescence measurements and were greatly affected by combined stress. The photosynthetic apparatus of the sunflower cultivars S.28111 and SF0049 was found less effected to salt and drought stress compared to both Hysun cultivars. The Hysun-33 and Hysun-39 showed a very low value of Fm and then essentially lowest fluorescence transient curve; this may result in structural changes as well as changes in energy dissipation and electron transport. Proline and carotenoid contents in drought stress were elevated compared to salt stress. Combined stress reduced the activity of antioxidant enzymes which ultimately decreased the physiological performance of sunflower plants. Superoxide dismutase (SOD), ascorbate peroxidase (APX) and catalase (CAT) showed the highest activity in individual salt and drought stress with less accumulation of H_2O_2 and electrolyte leakage. The antioxidant activities were also higher in S.28111 and SF0049 to both Hysun cultivars under stressful environments. S.28111 and SF0049 had greater capacity to scavenge the reactive oxygen species and less Na^+ and Cl^- concentration, hence protect their photosynthetic apparatus under combined stress. The effects of combined stress on Hysun-39 was synergistic whereas in S.28111 cross tolerance in most of the physiological processes were found. However, among the genotypes, S.28111 and SF0049 were found to be more tolerant to drought, salt and combined stress as compared to both Hysun genotypes. The screened genotypes may be recommended after field trials for use by the farmers of salinized or decertified areas and would be helpful to fulfil the demand of edible oil of ever growing population of Pakistan.

INCPS-2024-125 Comparative Physiological Responses to Antibiotic Stress in Radish (*Raphanus sativus* L.) and Turnip (*Brassica rapa* L.)

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Underground vegetables are the cheap source of food, having high nutritional values, continuously affected due to addition of antibiotic into soil by anthropogenic activity. The aim of current research was to assess the direct effect of antibiotic (doxycycline) on two crops radish and turnip with following concentrations (0, 5, 10, and 15 mM)at field area. Completely randomized block design with three replicate was used. Germination data shown that 15 mM antibiotic stress did not affect germination of radish seeds however root/shoot length was decreased, but no germination was observed in turnip at 15 mM. Fresh and dry biomass, RWC, WUC, RSD, and LWC showed reduction at 15 mM in both crops. However, respective parameters showing better growth at 10 mM. Increased level of proline was observed at 15 mM in both crops. Reduction in photosynthetic pigments and QY of PS-II at 15 mM was observed except carotenoids in both crops. OJIP results reveled that in both crops under antibiotic stress maximum increased in Fo, Fj, Fi, Fv, Fm, Mo, ABS/RC, ETo/RC, TRo/RC, and DIo/RC were examined at 10 mM. However, the rate of closed reaction center accumulation (Mo), absorption of energy (ABS/RC), trapping of electrons (TRo/RC), transport of electrons (ETo/RC), and dissipation of absorbed energy as heat (DIo/RC) increased at 10 mM. Increased in number of closed reaction center indicating safe mode for plants. It was concluded that 10 mM having promoting effects while 15 mM is threshed hold level for both crops. Both crops showing the same response of sensitivity towards antibiotic stress at the concentration of 15 mM.

INCPS-2024-17 Redox Priming of Seeds to Ameliorate Salinity Tolerance of Plants for Saline Agriculture: Efficacy and Mechanistic Insights

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The increasing demand for food, combined with rising world population, necessitates the development of strategies to use marginal areas and saline resources for agricultural production. Seed redox priming provides a simple, practical, and cost-effective solution to enhance not only the seed germinability but also the tolerance of seeds and seedlings to common abiotic stresses including salinity. It entails controlled hydration of seeds in a redox compound solution, which triggers key pre-germination metabolic activities, providing seeds a head start to germinate while also improving overall stress tolerance during germination and seedling establishment stages. Ascorbic acid, hydrogen peroxide (H_2O_2), nitric oxide (NO), and melatonin are some commonly used compounds for redox seed priming. Most research on this topic is limited to crop seeds, and there is little data available on the seeds of several recently developed crops, including stress-resistant halophytic crop candidates. We therefore explored the potential and underlying mechanisms of redox priming in improving salinity tolerance of some local halophyte crop candidates. Our results indicate that redox

priming treatments improved salinity tolerance of tested species in dose- and species-specific manner. Biochemical analysis indicated a H_2O_2-NO signaling may be involved in enhancing tolerance of halophyte seeds and seedlings following redox priming.

INCPS-2024-04 Effect of Humic acid on Seed germination and Seedling growth of Sub-Tropical Halophyte

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This study was carried out to determine the effects of three types of humic acids (HA1 and HA2 and HA3) and different humic acid concentrations (0, 250 and 500 mg L^{-1}) on seed germination of ten halophytic species under two thermoperiods (10/20 and 20/30 ^{o}C); two photoperiods (12/12h dark/light and 24h dark) and two NaCl treatments (non-saline control vs. salinity reported to induce 50% germination inhibition, respectively). Humic acid did not seem to alleviate seed germination of most halophytes under non-saline conditions at sub-optimal thermoperiod (10/20 ^{o}C) except for *Aeluropuslagopoides*and*Arthrocnemummacrostachyum*. Humic acid alleviated seed germination of *Urochondrasetulosa*in the presence of light (12/12h; light/dark photoperiod) under saline conditions. Lower concentration (250 mg L^{-1}) of the three humic acid types improved seed germination of *Aeluropuslagopoides*, *Cyperus conglomeratus*, *Desmostachyabipinnata*, *Halopeslis. perfoliata*, *Pharagmiteskarka*under saline conditions in the absence of light. However, all humic acids at 500 mg L^{-1} alleviated the salinity effects on seed germination of *Sporobolus ioclados*. Humic acid treatments could partly substitute the light requirement of few halophyte seeds germinated under saline conditions. The role of humic acid (HA1) was also studied on the seedling growth, water relations, ion regulation and photochemistry of *Urochondrasetulosa*under saline conditions (0, 300 and 600 mM NaCl). Plants maintained water use efficiency regardless of increasing NaCl concentrations but the increase in Na^+ was counter-balanced by lowering Na^+/K^+ ratios of root and shoot. Selective absorption of K^+ over Na^+ was improved by humic acid in both NaCl treatments whereas, K^+ over Na^+ transport was improved only in 600 mM NaCl. Humic acid improved electron transport rate (rETR) and Non-photochemical quenching of fluorescence (NPQ) at 300 mM NaCl. Humic acid treatment improved anti-oxidantdefense at cellular level by decreasing the percentage of blue stained cells, malondialdehyde (MDA), and hydrogen peroxide (H_2O_2) in leaves under saline conditions. Humic acid application appears to be a low cost bio-stimulant for enhancing seed germination and growth of halophytes under saline conditions.

Keywords: Halophyte, Seed Germiantion, Growth, Humic Acid Salinity.

INCPS-2024-10 Drought and Salinity Induced Alterations in Growth and Ecophysiology of *Phragmites karka*

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Water scarcity and salinity are increasing ecological issues and constraints that unfavorably affect plant growth. This research aims to investigate resistance of P. karka to well water (subirrigation) and reduced water (40% WHC) under 0, 100 or 300 mM NaCl. Growth decreased in drought compared to sub-irrigation treatment. Some growth parameters was maintained at 300 mM at water deficit which was achieved by increased in WP and OP and decreased turgor potential. Plant sodium was enriched in both salinity and water deficit but leaf K+ was declined only at water deficit treatments of salinity. Selective absorption of K+ over Na+ enhanced with increasing salinities and selective transport were increased only in water deficit and salinity treatment compared to control. The root Na+/K+ was higher compared to leaf but declined significantly in both plant organs in water deficit compared to sub-irrigation. Leaf KUE was unaffected at saline treatment of drought but decreased in sub-irrigation compare to control. Proline and MDA were enhanced significantly in 300 mM NaCl under sub-irrigation and water deficit conditions. Stomatal number decreased significantly as increasing salinity in each stress treatments. DPPH, ABTS, TAC and FRAP activities were enhanced in salinity of sub-irrigation and drought. SOD, CAT, GPx, anthocyanin, polyphenols, flavonoids, proanthocyanidins, β-carotene, carotenoids and tannins were increased in drought at 300 mM NaCl. Total chlorophyll decreased in 300 mM NaCl during water deficit. Plant increase their non-photochemical quenching (NPQ) in saline drought treatments. ETR, Fv/Fm, qP, YII were not significantly different in all saline drought treatments. NDF and ADF were decreased at 300 mM NaCl drought and sub-irrigation. Lignin deposition improved at 300 mM NaCl in drought than subirrigation. Our results indicates that P. karka could produce minimum biomass for economical purposes in water deficit and saline areas.
Keywords: Anatomy, antioxidant activity, ion homeostasis, lignocellulosic biomass, water deficit.

INCPS-2024-31 Evaluating the Efficacy of Melatonin seed priming technique in Alleviation of Drought Stress in Bread Wheat

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Melatonin (MT= N-acetyl-5-methoxytryptamine) is a natural antioxidant and indolic compound that is derived from the precursor tryptophan. It has a

significant role in numerous morpho-physiological developments in plants such as germination, biomass accumulation, photosynthesis, and most prominently stress alleviation. Drought stress (DS) adversely affects plants' development and growth by negatively altering plant's physio-biochemical functions. Previous investigations have illustrated that seed priming with growth regulators is an accessible, affordable, and effective practice to elevate plant's tolerance to drought stress. Therefore, to examine the effect of melatonin seed priming technique in alleviation of drought stress in wheat cultivars, the present research was implemented using different concentrations of melatonin (i.e., M0, M1, M2, M3, M4, and M5). Our results approved that seed priming with M2=2mgL-1 concentration of MT alleviates the negative effects of DS by boosting germination rate +54.84% in Akber-19 and +33.33% in Fakhar-e-Bhakkar, similarly, relative water contents were enhanced by +22.38% and +13.28% in Akber-19 and Fakhar-e-Bhakkar respectively. Melatonin pre-treatment with 2mgL-1 significantly enhanced fresh and dry biomass of shoot and root, leaf area, photosynthetic pigments, Osmo-protectants accumulation [total soluble proteins (TSP), total free amino acids (TFAA), proline, soluble sugars, glycine betaine (GB)] and lowered the amount of melondialdehyde (MDA) and hydrogen per oxide (H2O2) production by elevating antioxidants [Ascorbic acid, catalase (CAT), Phenolics, peroxidase (POD) and superoxide dismutase (SOD)] activity. Whereas under control conditions, melatonin treatment M1=1mgL-1 effectively enhanced all the growth-related physio-biochemical attributes in both wheat cultivars. These findings suggested that seed priming with melatonin promotes antioxidant enzyme activities that ultimately scavenge reactive oxygen species (ROS) and enhance plant tolerance to drought stress.

Keywords: Drought stress, Antioxidant activity, Seed priming, Melatonin, Chlorophyll content

INCPS-2024-30 Menadiol diacetate mediated subcellular Cd accumulation and nutrients uptake alleviates Cd toxicity and increases growth and yield of summer squash

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Cadmium (Cd) has shown toxicity to reduce growth and productivity in different plants. The Present study investigated the efficacy of menadiol diacetate (MD) to reduce Cd stress on growth and yield of summer squash plants. The experiment was performed under saturated Hoagland's nutrient solution (control) while the other group was supplemented with 0.1 mM CdCl2 (Cd stress). Surface sterilized seeds of summer squash were primed in different concentrations (10, 20 µM) of MD as well as in distilled water for 24 h and sown in the pots. Different morphological and physio-biochemical attributes were determined after 35 d of growth whereas the data for yield

attributes was collected after 70 d. Cd concentration was determined in various subcellular compartments i.e., cell walls and cell wall debris, chloroplast, cell membrane and other organelles including vacuoles. The Cd stress decreased photosynthetic pigments, osmoprotectants and ultimately caused reduction in the yield attributes. Further, it increased the secondary metabolites and oxidants (MDA and H_2O_2) in the summer squash tissues. The exposure to Cd also altered ions accumulation in the tissues. The MD-priming, particularly at 10 µM concentration mediated increase in the total phenolics, ascorbic acid, and anthocyanins concentration, and thus enhanced growth and yield attributes of summer squash exposed to Cd toxicity. Further, MD-priming facilitated Cd compartmentalization in subcellular compartments. In this context, cell wall and vacuole were the key compartments for Cd sequestration. This study highlights MD-priming as a potential strategy to counter Cd toxicity in summer squash plants.

Keywords: MD- priming, Subcellular Cd accumulation, Cd toxicity

INCPS-2024-65 Interaction of Cadmium, Copper and Salicylic Acid on Physiological Parameters in Two Varieties of Pea

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The goal of the current study was to evaluate the effectiveness of foliar salicylic acid spray in reducing the negative effects of heavy metal (cadmium, copper) stress on two varieties of pea (*Pisum sativum* L.) Meteor and Green Cross during 2020-2021. Heavy metal stress on plants (40, 60, 80 and 120 ppm) eventually caused the loss of several of their morphological traits. All morphological parameters such as root and shoot length as well as dry and fresh biomass, leaf area, number of leaves and leaf area ratio were declined with the heavy metals (Cd, Cu) stress. Antioxidant levels as well as biochemical attributes were decreased by heavy metal stress. After plants were exposed to stress, the amount of protein and carbohydrates decreased. All photosynthesis-related pigments, including chlorophyll a, b, and carotenoids, were similarly decreased. The outcomes of the experiment demonstrated that spraying plants with salicylic acid both under normal circumstances and when they were exposed to heavy metal stress was beneficial. The negative effects of heavy metal stress on plants were reduced with the use of foliar sprays containing salicylic acid. The Meteor variety of pea produced the best effects across the board, according to overall data. The study found that foliar treatments of 30 and 40 ppm of SA could help plants under heavy metal stress by enhancing morphological, physiological, biochemical, antioxidant activity, and yield catalogues in pea plants. Salicylic acid, when used to relieve heavy metal stress, can therefore be advantageous in this regard. This can be done to increase crop output, despite the fact that salicylic acid application has also

proved successful. According to our research, oxidative stress is the main contributor to the phytotoxicity of heavy metals (Cd and Cu), and salicylic acid is a key component of pea plants' defence mechanisms against Cd and Cu exposure.

INCPS-2024-118 Interactive Effects of GA3-biochar and Alga-based Titanium Oxide Nanoparticles on Growth and Physiological Traits of Maize under Copper Stress

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Copper toxicity constitutes a formidable obstacle to sustainable crop production, jeopardizing the overall performance and output of agricultural systems and food security, necessitating effective mitigation strategies for sustainable agriculture. This study investigated the Interactive effects of GA3-biochar and alga-based Titanium oxide nanoparticles on growth and physiological traits of maize under copper stress. Maize seedlings were treated with different concentrations of TiO NPs (0, 50, and 100 mg/L) and GA3-enriched BC (0 and 0.5% w/w) separately and in combination, to assess their impact on germination, plant growth, biochemical responses, and copper content in plant and soil under copper-contaminated soil.The results showed that copper stress negatively impacted all agronomic, biochemical, and copper-related parameters. However, GA3-enriched BC significantly enhanced seedling germination. While co-application of TiO NPs and GA3-enriched BC significantly enhanced leaf index, shoot length, and plant height. The combined treatment also increased enzymatic antioxidant activity (SOD, POD, CAT, APX) and non-enzymatic antioxidant activity (soluble protein, sugar, flavonoid, phenolic content), thereby reducing oxidative stress markers (H_2O_2, MDA, EL) in plants. The result also revealed that the 50NPs+0.5% BC treatment exhibited the most profound effects on copper content in soil and plant, with a 51% reduction in shoot copper content, 50% reduction in root bioconcentration factor, and 55% reduction in bioaccumulation factor, in comparison with control. The evidence indicates that the co-application of TiO NPs and GA3-enriched BC can effectively alleviate copper toxicity in maize, highlighting the potential of nanotechnology and biochar in mitigating heavy metal toxicity and promoting sustainable agriculture. This study's outcomes have significant implications for agricultural productivity, food security, and environmental sustainability, and lay the groundwork for future research into integrated approaches to alleviate heavy metal stress in crops.

INCPS-2024-69 Environmental Regulation in Tissue Specific Ion Distribution and Salt Secretion of Coastal Grass *Urochondasetulosa*

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Salt secretion is an important adaptive strategy of halophytes and its efficiency depends on the environmental conditions especially at root zone. However, little is known about the dynamics of salt excretion in recretohalophytes under varying environmental conditions. This work was focused on the growth attributes, tissue ion-flux and salt secretion rates of *Urochondrasetulosa* (a high salt resistant grass) under 1) different seasons condition in field (winter and summer), 2) different concentrations of NaCl (0, to 600 mmol L^{-1}), 3) different duration with salinity exposure (0 to 30 days), and 4) different light intensities (low - 500 and high -1500 µmol m^{-2} s^{-1}). In winter, soil of *U. setulosa* habitat had high EC (due to increase in Na^+, Cl^-, NO_3^- and NH_4^+ content) than summer season. Moreover, the high Na^+ and Cl- secretion in winter linked with their soil salt content. In greenhouse condition, optimal plant growth was found at 50 mmol L-1, while plant resisted high salinity by utilizing Na^+ and Cl^- as a cheap osmotica to maintain tissue water content and nutrient (NO_3^- and NH_4^+) homeostasis. Whereas, decrease in shoot K^+ was negatively related to shoot Na^+. Ion secretion mechanism excluded >50% absorbed Na^+ and Cl^- to protect plant from ion toxicity. The accumulation of Na^+ and Cl^- was high in root than shoot during early period (within a week) of salinity treatment. The higher accumulation of Na^+ and Cl^- in shoot than root during long term (after a week) salinity exposure is linked with high salt secretion rate. In addition, decline in shoot K^+ from 7th day of 200 mmol L^{-1} NaCl treated plants was associated with high Na+ uptake. High light enhanced the ion uptake and ion secretion rate in comparison to plants growing in low light condition. Knowledge of tissue related ion flux and salt secretion can help us in understanding the ability of the plants to survive in a saline habitat and improve the salt-tolerance of crops like low salt secretor-*Zea mays*.

INCPS-2024-74 Assessing Salt Tolerance in Some Synthetic Lines of Wheat (*Triticum aestivium* L.) at Early Seedling Stage

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Twelve advanced synthetic wheat (*Triticum turgidum* × *Aegilops squarrosa*) lines from International Maize and Wheat Improvement Center (CIMMYT),

Mexico,weretestedto assess the salt tolerance potential of these lines at early seedling stagein water culture using ½ strength nutrient solution (in programmed controlled growth cabinets). The genotypes were exposed to control (ECw = 1.9 dS/m) andsaline (ECw =16 dS/mNaCl), arranged in randomized manner, replicated thrice. The experiment was continued for 10 days. The genotypes were categorized on the basis of salt tolerance trait indices (STTI) of multiple growth parameters i.e. shoot & root length, shoot & root fresh and dry weights, root morphology and ionic relations (K/Na ratio). Three genotypes three genotypes (Syn-4, Syn-5 and Syn-9) were categorized as tolerant, five (Syn-2, Syn-3, Syn-13, Syn-17 and Kiran-95) as medium tolerant, four (Syn-6, Syn-8, Syn-19, Syn-25) as medium sensitive and one (Syn-30) as sensitive. It was also observed that among the tolerant genotypes Syn-5 and Syn-4 have comparatively high potassium accumulations under salinity. Potentially tolerant genotypes at early seedling stage will be included in our ongoing breeding program to improve salt tolerance potential of commercially available high yielding wheat varieties.

Keywords: Synthetic wheat, salt tolerance, early seedling stage, K/Na ratio.

INCPS-2024-39 Lead And Chromium Stress Effect on Growth and Biochemical Attributes of Various Quinoa Accessions

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Quinoa (*Chenopodium quinoa*) is an important cereal of America and it is newly introduced in Pakistan and had great nutritional importance. Halophytes have capacityto extract heavy metals. By using phytoremediation halophytic plants like quinoa can be used to decontaminate the metal polluted soil. This study was conducted to evaluate the phytoremediation potential of quinoa in soil contaminated chromium [Cr (VI)] and Lead (Pb). Germination rates, growth and yield over approximately 150 days of experiment were evaluated in order to measure the quinoa tolerance to the Cr & Pb contamination soil. The treatments of the study were two quinoa varieties; Ames 13724 and Ames 13744 were grown in contaminated soil. In the form of chromium and lead metal elements were applied at different concentration of 0 (control), 150, 300 and 450 mg kg^{-1} soil. The study was conducted at the agronomic farm, Bahauddin Zakariya University, Multan during the Rabi season 2020-2021 under natural climatic conditions. Responses of quinoa plant were examined in terms of number of roots/leaves, length of shoot/root, shoot weight fresh/dry and chlorophyll content. The results showed that quinoa could easily germinate in the Cr & Pb contaminated soil. But gradually, Cr appeared to be more toxic, plant growth was stunted in high dose treatment 450 mg kg^{-1} after 50 days of sowing, in 300 mg kg^{-1} treatment plants becomes dead at 80 days after sowing (DAS). Stunted growth and yellowing of leaves were also observed at higher levels of metals. The metal stress considerably

inhibited number of roots, number of leaves, root and shoot length, leaf area, plant height, chlorophyll content, plant seedling and shoot weight, grain yield and biological yield of quinoa of both genotype but effects were more visible in Ames 13724. Overall, Ames 13744 showed better growth as compared to Ames 13724. So, Ames 13744 was tolerant variety while Ames 13724 was sensitive variety. Quinoa plants were able to uptake heavy metals though, poor metal translocation took place. The outcomes of this research suggest that quinoa Ames 13744 shows better resistance to Cr &Pb stress as compared to quinoa Ames 13724 genotype.

INCPS-2024-179 Determination of Physiological and Biochemical Response of Maize Inbred Lines for Resistance Against Mechanical Wounding and *Spodoptera Frugiperda* Infestation

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Wounding and herbivory are significant threats to plant growth and crop productivity by damaging photosynthetic tissues. as they impair the integrity of photosynthetic tissues. This study aimed to evaluate whether growth reduction due to mechanical injury and/or herbivory by *Spodoptera frugiperda* (fall armyworm) is linked to alterations in photosynthesis and antioxidant potential in resistant and susceptible maize inbred lines. For this purpose, four-week-old maize plants of twelve inbred lines were subjected to mechanical wounding and insect herbivory. Results showed differential resistance mechanisms among the lines: v-121 was identified as susceptible, while v-108 and v-122 demonstrated resistance. Wounding and herbivory decreased PSII quantum efficiency and increased non-photochemical quenching (NPQ) with herbivory having the most pronounced negative effects. However, the reduction in PSI quantum yield was linked to donor-side limitations Y(ND), with resistant genotypes showing lower Y(ND), indicating that downstream physiological processes remained unaffected. Wounding or insect herbivory caused the generation of reactive oxygen species (ROS, measured as H_2O_2) that resulted in membrane damage (measured as MDA). In response, resistant genotypes v-108 and v-122 exhibited enhanced activities of enzymatic and non-enzymatic antioxidants. This study highlights that genotype v-108 and v-122 exhibit resistance to mechanical wounding and herbivory, attributed to their robust antioxidant defense and osmoprotectants accumulation, which maintain PSII function.

Keywords: insect herbivory; photosynthetic capacity; antioxidant enzymes

INCPS-2024-174 Nano-enabled Strategies in Agriculture: Enhancing Plant Growth, Mineral Nutrition and Stress Resilience

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The integration of nanotechnology with conventional farming practices has provided new frontiers for optimizing resource use, reducing agrochemical dependence, and achieving food security. This presentation focuses on how different carbon nanomaterials (e.g., fullerenes, nano-biochar) and metal-based nanomaterials (e.g., Fe and Zn) could improve plant performance under abiotic stress conditions (particularly drought, salinity and oxidative stress). Our findings suggest enhancements in nutrient uptake, crop yield and biofortification in various crops (wheat and rice) and vegetables (spinach, cauliflower, radish and turnip). In addition, nanomaterials have shown promising results in mitigating the negative impacts of salinity and drought by improving plant water relations and photosynthetic activity. This presentation will address the role of nanotechnology in promoting soil and plant health, making it a key player in modern agriculture's push toward environmental sustainability.

Keywords: Nanotechnology, Nano-biochar; Crop biofortification; Sustainable agriculture;

INCPS-2024-170 Zinc oxide (ZnO) Nanoparticles Ameliorate the Drastic Effects of Cadmium Heavy Metal by Activating Physiological and Antioxidant Activities in Chilli Plant

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Abiotic factors like drought, salinity, temperature extremes and heavy metals (HMs) toxicity are major barriers to increase plant productivity and sustainable agricultural management. Cadmium (Cd) heavy metal has deleterious effects on plant growth and physiological attributes including photosynthetic assimilation and water relations of the plants through oxidation stress by reactive oxygen species (ROS) production. Variety of strategies has been adopted by many researcher to ameliorate toxic effects

of Cd heavy metal. Application of ZnO nanoparticles (NPs) is one of the encouraging regime elucidating plant responses with enhanced growth and decreased toxicity of Cd, but most of the trials were conducted at germination stage of pants. The present trial was arranged to study growth responses of chilli varieties growing under Cd contaminate soil and foliar application of green synthesized ZnO nanoparticles for six weeks after establishment of seedling transplantations. Four treatments given to chilli varieties were T1= Control, T2= ZnO NPs (100 ppm), T3= Cd HM (100 ppm), T4= ZnO NPs (100 ppm) + Cd HM (100 ppm). Physiological attributes like rate of transpiration, rate of photosynthesis, water use efficiency, water relations of the plants, enzymatic and non-enzymatic activities of the plants and uptake and accumulation of Cd heavy metal by fruit of the plants were assessed and studied. It was found that ZnO NPs have positive increasing effects on SOD, CAT, POD, and APX activities and increase in proline and total phenolic content of the plants were in establishment of the view of activation of both enzymatic and non-enzymatic antioxidant defense activities and providing tolerance potential to the Cd stressed plants. It may be established that ZnO NPs mitigate Cd toxicity by activation of antioxidant activities and adjustment in physiological attributes of the plants and inhibiting Cd uptake in fruit.

INCPS-2024-188 Modulation of Photosystem II Activity by WRKY Transcription Factors in *Arabidopsis Thaliana*

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WRKY transcription factors (TFs) play essential role in orchestrating plant defense responses by balancing defense activation with energy trade-offs. Photosynthesis is a major energy source and its regulation during (a)biotic stresses is crucial, particularly within photosystem II (PSII). The photosynthetic disruptions during environmental stresses are well-documented, however, the role of WRKY TFs in mediating these changes remains unclear. Therefore, this study investigates the function of WRKY62 and WRKY63 TFs in modulating PSII and PSI activities. Four-week-old wild-type and homozygous *wrky* mutant plants of Arabidopsis were used to assess the structural and functional efficiency of PSII. The measurement of chlorophyll *a* fluorescence showed a significant decrease in quantum yield of PSII in *wrky* mutants, indicating PSII photodamage. OJIP induction curves revealed slight alterations in fluorescence steps, and double-normalized OJIP curves highlighted damage to the oxygen-evolving complex in the mutant plants. Results also revealed a significant reduction in the

performance index of *wrky* mutants compared to wild-type plants, accompanied by increased energy dissipation, absorption, and trapping fluxes per reaction centre. Rapid light-response curves further showed reduced quantum efficiencies and electron transport through PSII and PSI, alongside increased non-photochemical quenching in *wrky* mutant plants. In addition, the differential expression of PSII genes in mutant plants compared to wild-type plants highlighted the regulatory roles of WRKY TFs in maintaining PSII functionality. Thus, it can be suggested that WRKY62 and WRKY63 TFs are the crucial regulators of photosynthetic activity, particularly PSII efficiency and stability, contributing to plant defense mechanisms.

Keywords: WRKY, Photosystem II, Chlorophyll *a* fluorescence, Light harvesting complex

INCPS-2024-176 Ferulic Acid-Induced Modulation in Photosynthesis, Redox Homeostasis, and Osmolyte Accumulation in Barley (*Hordeum vulgare* L.) under Chromium Stress

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Chromium (Cr) is a significant limiting abiotic factor that has a negative impact on agricultural productivity globally. In Pakistan, it is found in water and soil, posing a significant problem for both plants and humans. Therefore, the current investigation assessed the efficacy of ferulic acid application (0.25, 0.5, 0.75, 1.0 mM) to decrease chromium (150 µM) phytotoxic effects in barley plants. Chromium stress reduced growth, chlorophyll content, and photosynthesis in plants. Additionally, Cr-stressed plants experienced oxidative damage. Ferulic acid significantly improved growth and pigments content in plants under chromium stress. It helped mitigate oxidative stress by promoting redox homeostasis through enhanced detoxification of radicals. Ferulic acid also enhanced the activities of superoxide dismutase (SOD), catalase (CAT), and peroxidase (POD), as well as the accumulation of osmolytes in barley plants under Cr toxicity. Overall, ferulic acid increased tolerance in barley varieties under chromium stress. These outcomes suggest that foliar application of ferulic acid is a promising technique for mitigating chromium toxicity in barley plants, allowing for their cultivation in soils with elevated chromium levels. In the future, ferulic acid may be utilized as an effective technique for stress management in other important crops facing abiotic stressors.

INCPS-2024-224 Aspartic Acid Nano-Magnetite Mediated Changes in Growth and Grain Yield of Salt-Stressed Wheat

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Salinity stress is a significant environmental factor limiting wheat (*Triticum aestivum* L.) production. This study examined the effects of nano-magnetite and its aspartic acid conjugate (50 and 100 mg/L) on wheat (subhani-21) grain production and its physiological and biochemical response under salinity. Scanning electron microscopy (SEM) and Energy Dispersive X-ray analysis (EDX) were used to characterize the crystallinity and morphology of iron nanoparticles (Fe-NPs). We found that salinity negatively affected agronomic and biochemical traits of wheat plants including biomass, photosynthetic pigments and grain yield attributes. Salinity also caused increase in root and shoot Na^+ concentration at toxic levels. By contrast, we found that aspartic acid nano-magnetite significantly improved biomass accumulation and grain yield attributes of both control and salt-stressed wheat plants. Moreover, improvements in chlorophyll contents were also recorded in response to aspartic acid nano-magnetite conjugate. After a comprehensive evaluation, the plants treated with AA-NM nanoparticles exhibited increased production, absorption of nutrients, and chlorophyll levels, leading to improvements in salt tolerance and grain yield. This study highlighted the potentials of AA-NM to enhance crop resilience and productivity under salt stress.

Keywords: Aspartic acid nano-magnetite; Fe-nanoparticles; Nano-magnetite; Subhani-21

INCPS-2024-225 Effects of Root-Zone Applied Nano-Iron Oxides on Wheat Root Phenotypic Characteristics under Salt Stress

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This study investigated the effects of root-zone application of nano-iron oxides and salt stress on wheat (*Triticum aestivum* L.) roots using phenotyping techniques to characterize root system architecture (RSA). The effects of different doses of nano-hematite and nano-magnetite were investigated during the first experiment. During the second experiment, the selected concentrations of nano-hematite and nano-magnetite were applied to salt-stressed wheat seedlings, and changes in RSA were studied. Likewise, during the third phase, the effects of root zone-supplied nano-iron oxides on salt-stressed wheat seedlings were analyzed in a sand culture

experiment. Results indicated significant variations in root morphology, including root length, surface area, relative growth rate, leaf area ratio, and net assimilation rate, in response to the treatments. Root-zone application of nano-iron oxides showed significant results. Under salt stress the application of nano-iron oxides resulted in a considerable in root system architecture. Also, improvements in shoot growth rates were recorded in response to nano-hematite. Both nano-hematite and nano-magnetite improved allometric features (RGR and NAR) of wheat seedlings. Above all, the high concentrations of both nano-hematite and nano-magnetite (200 – 500 ppm) were toxic for root growth, and only concentrations below 100 ppm were effective in mitigating salinity.

INCPS-2024-230 Genetic Diversity in Various Elite Rice Genotypes under Salt Stress

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Genetic diversity in crop species is a prerequisite for any crop improvement which helps breeders in selecting desirable genotypes. Rice is a valuable cereal crop with nutritional benefits having carbohydrates, proteins and vitamins. Nowadays, global warming have led the lands under salt stress. Understanding the importance, a research was investigated for assessing various genotypes under normal and saline fields. Significant results were obtained for different morphological and physiological parameters under both salt and normal soils. The assessment of various elite genotypes depicted that SAL-20 considered performed better for number of tiller plant^{-1} and panicle length under normal soils. However, under salt stress greater grains panicle^{-1} and grain yield plant^{-1} were observed in the genotype SAL-2, SAL-20 and Kharagnjial. Chlorophyll content was found more in SAL-20 and Kharagnjia, whereas SAL-12, SAL-14, SAL- 20 and Kharaganjia occupied greater sodium and potassium content in normal field condition. Cluster analysis separated the rice genotypes into four main groups according to their genotypic homogeneity. Cluster 1 contains twelve genotypes (Shua-92, SAL-20, SAL-8, Kharagnjia, SAL-12, SAL-6, SAL-4, SAL-14, SAL-10, SAL-18, SAL-16, SAL-12) and analytical findings revealed that there is a close relationship among these elite genotypes. Cluster 2 included only Kharagnjia and Cluster 3 contained genotypes SAL-8, SAL-14 and SAL-12. Cluster 4 exhibited eight genotypes SAL-16, SAL-10, SAL 6, SAL-8, SAL-4, SAL-20, Shua-92 and SAL-2. Similarly, the factor loadings observed greater in the second principal component (PC-II) for plant height, grains panicle^{-1}, 1000 grain weight, harvest index and leaf area. The cumulative PCA component values depicted highest variability in PC-XII and PC-XI which showed 100%and 98.3% variability and the least variability was observed in PC-I with 26.7% among different traits of rice accessions. Hence, the

determination of genetic diversity in saline and normal soil could be utilized in the development of future breeding program.

INCPS-2024-231 Effect of Water Stress on Growth and Carbohydrates Metabolism in Drought Tolerance and Drought Sensitive Wheat Genotype

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Drought is a major environmental stress threatening wheat productivity and growth at all stages, but it is particularly harmful during flowering and grain-filling periods. Wheat (*Triticum aestivum* L.) is main cereal crop, which fed approximately one-fifth of the world's population by its 676 million tons annual production worldwide. However today concern is drought stress which badly affects the wheat plant productively and biochemistry (soluble sugars). Soluble sugars supply from source and sink is extremely affected by environmental stresses. A pot experiment was conducted to check the growth and carbohydrates accumulation in wheat under drought stress condition. Two maize genotypes, drought tolerance (Ehsan-16) and drought sensitive (Rohtas 90) were manipulated to different filed capacities viz. well watered 80% water holding capacities (WHC) and 30% water holding capacities (WHC) for drought stress after sowing. Plants were harvested after 4 weeks. Morphological parameters were analyzed upon harvesting. Shoot and root length, plant fresh and dry weight decreased significantly under drought stress. Results shown the low mobility of macronutrients (P, K) in stress as compared to control due to low water availability. Carbohydrates were determined by the following phenol sulfuric acid method by using spectrophotometer. Plants with drought sensitive genotype (Rohtas 90) accumulated a standard amount of carbohydrates as compared to drought tolerance genotype (Ehsan-16). Crop has evolved complex strategies to cope with drought stress for survival.

INCPS-2024-116 Physio Biochemical Response of *Zea mays* Seedlings under Heavy Metal Lead with DTPA Biochar

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Heavy metal stress severely impacts maize production by interfering with plant physiological functions, hindering nutrient and water uptake, resulting in stunted growth and reduced yields. This study investigates the potential of DTPA-treated biochar and different maize genotypes to mitigate lead stress effects. DTPA enriched biochar improves soil properties, promote nutrient uptake and enhances plant growth due to its ability to chelate heavy metals

and foster beneficial microbes. We examined the effect of biochar on five maize genotypes (RS111, AH9272, AS376, SG2002,RS999) under varying lead stress conditions.A completely randomized design was used with four treatments (control, lead stress,DTPA biochar and lead+ DTPA biochar) in four replications.Results showed that under lead stress, maize plant height (~45%), shoot length (~68%), root length (~60%) and fresh weight (~78%) decrease significantly compared to control. The DTPA biochar+ lead treatment significantly improved these parameters with increase in plant height (~30%), shoot length (~95%), root length (~75%) and fresh weight (~120%) compared to lead stress alone. Chlorophyll contents also improved significantly with DTPA biochar lead treatment, showing increases in chlorophyll a(~75%), chlorophyll b (~80%) and total chlorophyll (~78%) compared to lead stress. Soil nutrient availability (P, K, N) and organic mattercontent were better maintained with DTB application under lead stress. Among genotypes, RS111 shoewd highest tolerance to lead stress, while AS376 exhibited the most pronounced responses to both lead stress and DTB treatment. These findings demonstrate that DTB application is an effective method for mitigating lead stress in maize plants, with potential for improving crop resilience in heavy metal contaminated environments.

INCPS-2024-251 Jasmonic Acid and Salicylic Acid Improved Resistance Against *Spodoptera frugiperda* Infestation in Maize by Modulating Growth and Regulating Redox Homeostasis

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Exploring host plant resistance and elevating plant defense mechanisms through the application of exogenous elicitors stands as a promising strategy for integrated pest management. The fall armyworm, a pernicious menace to grain crops in tropical and subtropical regions, stands as a formidable threat due to its capacity for devastation and a wide-ranging spectrum of host plants. There is no literature regarding artificially induced resistance in maize against fall armyworm (Spodoptera frugiperda) by exogenous application of phytohormones. The present investigation was performed to evaluate the role of jasmonic acid (JA) and salicylic acid (SA) on two maize hybrids namely FH-1046 and YH-1898 against fall armyworm. Results showed that plant height, biomass and lengths, fresh and dry weight of root shoot which decreased with armyworm infestation improved with phytohormonal application. JA treatment resulted in a higher increase in all attributes as compared to SA treatment. Improvement in relative water contents, photosynthetic pigments and pronounced levels of phenol and proline accumulation were observed in infested plants after JA treatment. Infested

plants recovered from oxidative stress as JA application activated and increased the antioxidant enzyme activity of superoxide dismutase, peroxidase and polyphenol oxidase activity in both FH-1046 and YH-1898. The oxidative stress reduction in infested plants after JA treatment was also evident from a fair decrease in MDA and H2O2 in both varieties. The SA and JA mediated genes expression found that JA dependent genes, particularly marker genes PR1 and Lox5 were highly expressed along with TPS10 and BBT12. Whereas SPI, WRKY28, ICS and PAL were shown to be activated upon SA application. It was inferred that phytohormones regulated redox homeostasis to circumvent oxidative damage and mediate essential metabolic events in maize under stress. To our current understanding, this study is the very first presentation of induced resistance in maize against *S. frugiperda*.

INCPS-2024-284 Crocin derived from saffron (*Crocus sativus* L.) stimulates growth and secondary metabolism in turnip (*Brassica rapa* L.) plants subjected to saline stress

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Crocin, known for its antioxidant properties, can mitigate the adverse effects of salinity stress on plants. Salinity poses a critical threat to agricultural productivity by reducing plant growth, disrupting physiological and biochemical processes, and impairing the oxidative defence system. Turnip (*Brassica rapa*), a member of the Brassicaceae family, is valued for its nutritional content and use as fodder. This study aimed to evaluate the efficacy of crocin as a growth enhancer in two turnip cultivars (Xiazao and Hybrid) under saline conditions. The experiment was conducted at Government College University, Faisalabad (GCUF), employing six crocin concentrations (0, 10, 20, 30, 40, and 50 ppm) as a priming agent under 60 mM salinity stress, with treatments replicated thrice in a completely randomized design. Salinity stress significantly reduced plant biomass, relative membrane permeability (RMP), chlorophyll a and b, shoot and root lengths, and total chlorophyll content. However, no significant changes were observed in glycine betaine (GB), chlorophyll a/b ratio, or peroxidase (POD) activity under salt stress. Conversely, salinity increased malondialdehyde (MDA), proline, hydrogen peroxide (H_2O_2), RMP, and both non-enzymatic (ascorbic acid, AsA) and enzymatic antioxidants (catalase, CAT; superoxide dismutase, SOD). The seed treated with crocin, improved growth parameters, AsA levels, chlorophyll content, and antioxidant activities under saline conditions. Seed priming with crocin at 10, 20, and 30 ppm was particularly effective in alleviating salt stress, promoting plant growth, and

enhancing the antioxidant defence system. Of the two cultivars, Xiazao exhibited superior performance under saline conditions. Overall, crocin at 10–30 ppm was found to be optimal for enhancing growth, improving antioxidant responses, and scavenging free radicals in turnip plants under salt stress.

Plant Taxonomy and Ethnobotany

INCPS-2024-177 Contribution of Yaylakonak Town Flora (Adıyaman-Centre)

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Türkiye has a rich biodiversity due to its geographical location, different habitats, geomorphological structure, ecological differences and being at the intersection of three phytogeographic regions. Türkiye is one of the country in the world in terms of plant diversity and richness. According to current situtiations, more than 13 thousand plant taxa are distributed in Türkiye.
The research area is in the Anatolian-Turan phytogeographic region. The vegetation of the study area and its surroundings mostly depends on the topographic structure and ecological characteristics of the region. Although the continental climate type is generally seen in Adıyaman, the features of the Mediterranean climate are also encountered in some parts of the province. As a result of the field studies and observations, there are three dominant vegetation types in the project area and its surroundings. These are; degraded forest-bush vegetation, steppe vegetation and aquatic-humid area vegetation. The research method is briefly as follows; during the vegetation periods of May 2023 - May 2024, plant samples will be visited periodically and plant samples will be collected, pressed, dried, identified, and suitable ones will be turned into herbarium samples. So far, 233 plant samples were collected from the research area. A total of 185 taxa were identified, of these taxa, 3 belong to Pteridophyta and 230 Spermatophyta divisions. Coniferophyta and Magnoliophyta subdivisions contain 5 and 225 taxa, respectively. It was determined that 197 Magnoliopsida and 28 Liliopsida class. With this study, it is aimed to contribute the flora of Yaylakonak Town (Adıyaman-Center) and to enrich Adıyaman University Pharmacy Faculty Herbarium.

Key Words: Türkiye, Adıyaman, Flora, Yaylakonak.

INCPS-2024-159 Palynological Study of the Genus Saussurea and Allied Genera from Pakistan andKashmir

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Pollen morphology of 27 species distributed in eight genera i.e., Saussurea, Aucklandia, Himalaiella, Dollomiaea, Lipschitziella, Frolovia, Jurinea and Shangwua has been investigated using light and scanning electron

microscope. Pollen grains are usually radially symmetrical, isopolar, sub-prolate to prolate-spheroidal rarely prolate or oblate-spheroidal, generally tricolporate. Tectum echinate rarely spinulose, tectum in between spines ranging from finely scabrate-punctate to medium –coarse reticulate rarely - rugulate..On the basis of exine ornamentation and apertural types 4 distinct pollen types have been recognized viz., Dolomiaeamegacephala – type, Himaliellaafghanica – type, Lipschitziella var. pinnatisecta-type, Saussureabracteata –type. Pollen morphology is significantly helpful at specific level.

Keywords: Pollen, Sassurea, Tricolporate, Echinate, Pakistan

INCPS-2024-52 Palynomorphic Assessment of Herbaceous Flora of Tehsil Pakpattan, Punjab Pakistan

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The present study was caried out to assess the palynomorphic characterization of the herbaceous flora of Pakpattan Tehsil. A total of 60 herbaceous (wild and cultivated) plant species belonging to 26 families and 56 genera were collected. Out of 60 plant species 3 were monocotyledonous and 57 were dicotyledonous. The pollen characteristics i.e., size, shape, tectum, aperture, colpi length and width and pori length and width were studied by using Light and Scanning Electron Microscopy. On the basis ofcolpi and pori four distinct types of pollen were identified viz., Type-1 pollen colpate pollen, Type-II porate pollen, Type-III colporate pollen, and Type-IV inaperturate pollen. The Type-I colpate pollen were found in 23 species of dicots and monocots. The maximum colpi length and width were observed in *Plumbago auriculata* Lam. (19.22 µm) and *convolvulus arvensis* L. (14.6 µm) respectively. The minimum colpi length and width were observed in *Lobularia maritima* (L.) Desv. (3 µm) *Coriandrum sativum* L. (0.94 µm) respectively. The Type-II porate pollen were found in 12 species of dicots. The maximum pori length and width were observed in *convolvulus arvensis* L. The minimum pori length and width were observed in *phlox drummondii*. *Plumbago auriculata* Lam. showed the maximum exine thickness (7.22 µm) and *Fumaria vaillantii* Loisel showed the minimum exine thickness (0.1 µm). The Type-III colporate pollen were observed in 24 species of dicots. The Type-IV inaperturate pollen were observed only in *Mimosa pudica*L. Pollen size ranges from large to very large. The most common pollen shape was oblate and prolate spheroidal. Different types of wall ornamentations were observed that ranged from echinate, psilate, reticulate to rugulate. Majority of the observed pollen were monocolpate, tricolpate, triporate, tricolporate, hexacolpate and pentacolpate with respect to aperture.

Keywords: Herbaceous plants, Monocots, Dicots, Qualitative and Quantitative characters, Exine ornamentation, LM and SEM.

INCPS-2024-48 Cultivation and Morphological Characterization of *Stevia rebaudiana* (Bertoni) Grown in District Muzaffarabad

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Stevia rebaudiana is a naturally sweet herb belonging to Asteraceae family, which is recognized as an alternative to table sugar. The present study encompasses the assessment of various growth parameters including plant height, branch count, stem girth, leaf dimensions, fresh / dry leaf weights, as well as shoot fresh / dry weights per plant. Soil pH and fertility for *Stevia* cultivation were also analyzed. High-performance liquid chromatography (HPLC) is employed to differentiate steviol glycosides and rebaudioside A, with retention times (RTs) of 3.3 and 4.1 minutes, respectively, from *Stevia* leaves. A randomized complete block design (RCBD) experimental setup is used, focusing on the impact of manure on Stevia growth. Block A (soil with manure) showed better growth rate of morphological characters as compared to block B (soil without manure). Flavonoids were absent in the ethanol extract, while glycosides, steroids, and phenol were present in both distilled water and ethanol extracts. This study highlighted favorable soil and environmental conditions for the cultivation of *S. rebaudiana* in Muzaffarabad and also confirmed the presence of valuable sugar contents.

Keywords: *S. rebaudiana,* High-performance liquid chromatography (HPLC), Flavonoids, *Stevia* leaves

INCPS-2024-123 Phytodiversity Conservation and Ethnomedical Evaluation of Plants of Alpine Peatland Broghil Valley, Chitral

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The plant resources of Broghilwereevaluated during 2022-23. The study aimed to explore the Phyto-diversity and ethnobotanical importance of plant resources of this remote area. A total of 100 plant species belonging to 60 families were enlisted. Asteraceae was the leading family with 27 species followed by Anacardiaceae with 18 species. The remaining had fewer number of species. Growing was of short duration starting from May to mid of August where herbs contributed the highest number of species.

Therophytes and geophytes were dominated with 40.78% followed by Hemicryptophytes with (15.96%). Phytosociological studies recognized a total of 3 communities at three different sites at different altitude. The study also provided detailed information on the ethnobotanical uses of different plant species, including their frequency citation (FC), relative frequency citation (RFC), family importance values (FIV), use reports (UR), and use values (UV). Based on FIV, the most prominent families were Asteraceae with (73.43) FIV and Moraceae with (83.59) FIV. The highest Relative Frequency of Citation was found for *Malva neglecta* (0.28), followed by *Pyrus pashia* with (0.27). Similarly, some 10 different species were recorded as part of conservation. The result shared this a large percentage of the species are currently classified as Vulnerable (87.74%), and 4 species critical endangered, showing extreme threat toward extension. All the collected information about specific plant species, including their population sizes, area of occupancy (AOO) and extent of occurrence (EOO), related to 17 families of vascular plants. Each family contains multiple species with their respective population sizes range from 6 to 18 and EOO, and AOO ranges from 3.4 to 11.3 values. The vegetation in the area suffered greatly due to erosion and snow fall. The people are living poor life with very short season of availability to normal life activities. Yalk is the key stone species in the area

Keywords: Broghil, ethnomedicinal, conservation, Pakistan

INCPS-2024-06 Cypsela Morphology and its Significance for the Taxonomic Delimitation of the Genus *Saussurea* DC. (S. Str.) and its Allied Genera

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Cypsela macro and micromorphological features of 32 taxa belonging to 7 genera namely Saussurea DC. s.str., LipschitziellaKamelin, Himalaiella Raab-Straube, Dolomiaea DC, Aucklandia Falconer, Frolovia (DC.) Lipsch. and Shangwua Yu J. Wang of the tribe Cardueae (Asteraceae) were studied through light and scanning electron microscope to assess the cypsela features of the studied taxa from Pakistan and Kashmir. The cypsela morphological data could also help to find out the taxonomic relationship as there were no specific and detailed reports available of all the taxa reported from the area under consideration. Various cypsela features like pappus series, cypsela shape and surface patterns were found to be the most significant characters for the taxonomic delimitation of Saussurea (s.l.). The genus Saussureas.str. was delined from its allied genera by having biseriate pappus. While, in remaining genera pappus were either uniseriate or multiseriate and among these genera, Dolomiaea was characterized due to multiseriate pappus. While, remaining genera such as, Lipschitziella, Himalaiella, Aucklandia, Shangwa and Frolovia had uniseriate pappus. Furthermore, these genera could be delimited based on cypsela shape and

surface patterns. Similar to the generic delimitation, cypsela micro and macromorphological characters were also found to be useful for specific delimitation within studied genera. Most of the cypsela morphological variables when analyzed numerically, also proved the taxonomic affiliation for most of the taxa of the genus Saussurea and its allied genera. Similarly, these cypsela features could be well correlated with the gross morphological and molecular decisions at generic and partially for specific and infraspecific delimitation of Saussurea (s.l.) from Pakistan and Kashmir.

Keywords: Asteraceae, cypsela, miscroscopy, Saussurea, Pakistan.

INCPS-2024-09 Leaf Architectural Study within Some Papilionaceous Herbs of Pakistan and its Taxonomic Significance

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Papilionaceous herbs from Karachi-Pakistan were analyzed for the leaf architecture, leaf macro and micromorphological characters. The studied characters were used as an additional aid to strengthen the taxonomic delimitation of the Papilionaceous herbs from Karachi, Pakistan. The investigation was taken on 36 taxa from the studied area. The Papilionaceous herbs were characterized by the presence of alternate leaves, apex angle acute, marginal petiole and pulvinate petiole base. On the other hand, each taxon can be identified on the basis of specific leaf architecture and micromorphological characters. Compound leaves were the dominant character within taxa. While, simple leaves were present in only 4 species. Four types of stomata were found i.e., Anisocytic, anomocytic, actinocytic and paracytic. Among them, anisocytic was the most dominant type. Majority have their stomata at the level of epidermis while, completely sunken stomata were observed in 2 species only. Similarly, unicellular trichome type was dominant within the taxa. Artificial keys were constructed based on all studied aspects and the data was analyzed numerically by clustering to find out the relationship among the studied taxa from Karachi, Pakistan. It was observed that findings of numerical analysis showed a different pattern of taxonomic relationship in comparison to gross morphological treatment.

INCPS-2024-186 Morphological and molecular characterization of *Uromyces hedysari-obscuri,* causing rust disease on *Hedysarumfalconeri*in Northern Pakistan

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The present work was done to investigate, characterize and identify a rust fungus that is infecting *Hedysarum* plants in different regions of Northern Pakistan. *Hedysarum* L. (Fabaceae) is a medicinally important plant that is also being used as food resource in different areas of Northern Pakistan. About 12 species of *this genus* are reported from Pakistan that are also declared as 'Critically Endangered' (CR) at national level. During fungal surveys in Northern Pakistan, leaves of *Hedysarumfalconeri* were found to be infected by a rust fungus. Molecular and morpho-anatomical techniques were used to characterize and identify thisrust fungus. Phylogenetic analysis based on LSU sequences supports its recognition as *Uromyces hedysari-obscuri* that is a new report for Pakistan. This is the first molecular evidence of this species as *U. hedysari-obscuri* from Pakistan. This study highlights the utility of molecular markers in uncovering fungal pathogens and contributes to the growing knowledge of fungal taxonomy in Pakistan. Further, this research work will help inconservation of the local valuable edible and medicinal flora, assuring the food security of the local communities as it provides baseline data that may lead to development of control strategies to protect this critically endangered plant (*Hedysarumfalconeri*).

Keywords –Basidiomycete, Rust fungi, molecular phylogeny, plant pathogen

INCPS-2024-200 Phytochemical Screening of Selected Cholistani Plants and Their Biological Activities by In-Vitro Assays

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There is a surge of appeal with taking naturally occurring compounds extracted from plants to develop treatments that can combat infections. These plant-based extracts and compounds possess the ability to act as potent agents against harmful pathogens, thereby opening up new opportunities for treating diseases. Consequently, there is a growing preference for natural medicines, which are typically milder, more economical, and less toxic than their synthetic counterparts. This study ventures to investigate the antibacterial activity, antioxidant activity, enzyme inhibition activity, and phytochemical constituents of methanolic extracts of *ZaleyaPentandra* (L.) Jaffery (Azioaceae) and *Lasiurus scindicus*(Henr.) (Poaceae), are medicinally used by herbalists from the Cholistan region, Pakistan for the treatment of bacterial infections, cough, colds, kidney stones, UTIs, gastrointestinal disorders, and as anti-venom. In vitro biological assays were used to test antibacterial (Agar disc diffusion), antioxidant (DPPH), and enzyme inhibition (urease) capabilities. To determine the important components, qualitative phytochemical analysis was

performed. The antibacterial efficacy of organic crude extracts of *Z. pentandra* and *L. scindicus* towards bacterial strains is notable. Generally, alkaloids, saponins, flavonoids, tannins, terpenoids, and phenols were present in both plants, although the methanolic extract of both *Z. pentandra* and *L. scindicus* conspicuously lacked the presence of glycosides. Organic crude extracts of *Z. pentandra* and *L. scindicus* were found to be decent in antioxidant activity (41.86% and 54.28%, respectively) with standard (Ascorbic Acid) scoring 84.05%, but high in anti-urease activity (96.42% and 98.36%, respectively) in comparison to the standard (Thiourea) used; 95.83%. It is also evident from the study that organic crude extracts of *Z. pentandra* and *L. scindicus* were rich in nutrients, adding value to the specifically chosen medicinal plants in order to keep them in use in ethnomedicine.

Keywords: Cholistan, *Zaleyapentandra*, *Lasiurus scindicus*, Antibacterial, biological assays

INCPS-2024-232 Diversity and Distribution Pattern of Orchids in western Himalayas, Kashmir Pakistan

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Orchids belong to the family Orchidaceae and are one of fragile species which require unique microhabitat. Orchids are found in almost all types of ecological zone right from tropics to alpine regions and are prone to threats due to their ecological as well as economical importance. This study was designed to check the distribution patters by using the diversity, richness, importance value index and to highlight the important driving factors important for conservation of the species .The main aims of this study were to explore the richness and distribution of orchids and neighboring vascular flora and to identify the principal driving environmental factors, as no study has yet targeted these plant species specifically in the study area. Field data collection surveys were conducted from August 2018 to July 2021 using the vegetation sampling method. The presence of two individuals belonging to any orchid species in a 20 m2 land area criterion was used to select the study sites along the elevation gradient for data collection. Multivariate statistical tools, such as hierarchical classification and ordination, were used to analyze the data. A total of 32 orchid species belonging to 18 different Orchidaceae genera were recorded at the 57 study sites. Only one individual each of Herminiummonorchis, Habenariafurcifera, and Malaxismuscifera was collected, depicting these orchids as extremely rare in the study area. A total of 324 vascular plant species (including orchids and their neighboring plant species in the studied plots) were classified into seven significantly ($p < 0.05$) different plant associations, each with a unique species composition.

The results of canonical correspondence analysis showed that temperature variability was the most influential among the 28 environmental factors considered. Different microhabitats with an elevation range of !15003500 m a.s.l. in the central part of the study area are moister and richer in organic matter and support high orchid diversity. It was observed that a higher density of co-existing tree and shrub species and a higher geographic slope were supporting the growth and survival of orchid species as well. Conversely, higher deforestation activities and potassium levels in the soil were observed as negatively influencing factors. The influence of non-native plant species on orchid species distribution was not significant, indicating that the local orchid species were not remarkably affected when growing in microhabitats with optimal conditions. This study concluded that the central part of the study area is richer in orchid abundance and diversity and needs effective conservation and management planning.

INCPS-2024-262 RbcLa Marker-based Identification and Phylogenetic Analysis of Kasuri methi (*Trigonella foenum-graecum* L.): A Native Plant of Kasur District of Punjab (Pakistan)

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Trigonella foenum-graecum (L.) is one of the potent medicinal plants and is a well-known spice for its specific aroma. It is native plant of Kasur District of Punjab Pakistan commonly known as Kasuri methi. Kasur district is a semi-arid subtropical area, famous for its production worldwide. The exact plant identification up to the species level is hard for plant taxonomists and herbalists, due to its resemblance with its close relatives. DNA barcoding is the most modern approach for plant identification based upon a highly conserved chloroplast genome. Rbcla marker is considered one of the most conserved regions used for highly complex and confusing species-level identification. The current study is the first effort for molecular identification of Trigonella foenum-graecum (L.) based upon DNA barcoding in South Asia. Chloroplast DNA was isolated by applying the modified CTAB method. Specific primers for rbcLa were used for polymerase chain reaction (PCR) amplification. Purified PCR products were then subjected to DNA sequence for rbcla DNA barcode. After DNA sequencing, the chromatogram file was analyzed by using Chromas. Then align sequences by multiple sequence alignment by using clustal W in Geneious. Afterwards, BLAST the sequence from the NCBI database and align this query sequence. The rbcLa barcode showed 99.80% precision for species identification. The cataloging derivative from the DNA barcode tree was then compared with archaic morphology-based taxonomy. This will help identification of Kasuri methi from its closely related species for better business opportunities and safer usage by the public as spice and medicine.

Keywords: Trigonella species · Molecular taxonomy · DNA barcode · Rbcla

Plants for Industrial Products/Medicinal Plants/Pharmacognosy

INCPS-2024-210 Banana peel as an ecofriendly biosorbent in dye removal: Methyl orange

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Banana peel has many important applications such as it can be used to produce biogas, in synthesis of carbon based nanoparticles from activated carbon, in the manufacturing of bio plastic and in waste water treatment. This research project is focused on the application of adsorbent prepared from banana peel to remove methyl orange dye which is present in industrially contaminated waste water. The process of adsorption is studied by using parameters such as determining the effect of adsorbent dose on adsorption by using different amounts of adsorbent and also the effect of contact time of adsorbent in dye solution. Adsorbent dosages of 0.5 g, 1 g, 2 g and 3 g were added in the solution of methyl orange. The absorbance of these solutions was taken after every 60 minutes for 3 hours by using UV/Visible spectrophotometer at wavelength of 464 nm. The results showed that absorbance decreases as the dose concentration increases from 0.5 to 1g and finally becomes constant at 3g. Thus banana peel is an effective biosorbent in waste water treatment.

INCPS-2024-129 Wild Plants as Natural Biostimulants: A Study on their Impact on Maize Growth

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Wild plants contribute to the region's biodiversity, providing habitat and food for various animals. Many wild plants have medicinal properties, used in traditional and modern medicine. A research study was conducted to explore the potential of wild plants in Multan as biostimulants to enhance maize growth and productivity. The study aimed to 1) Evaluate the potential of wild plants as biostimulants, 2) Assess the impact of different plant extracts on maize growth, 3) Identify the most effective plant extracts for biostimulation. 20 wild plants were selected, and their shoot parts were used to prepare extracts. Five levels of treatments (5ml/100ml to 25ml/100ml) were prepared from each plant extract. The growth pattern of maize was observed and recorded. Almost all plants showed some growth potential as

biostimulants.Varied constituents in different plant parts affected maize growth differently. While the study indicates promising results, further intensive research is required to confirm the potential of these wild plants as biostimulants and to identify the most effective ones for enhancing maize growth and productivity which can help reduce the reliance on fertilizers and promote sustainable agriculture practices.

Keywords: Biostimulants, wild plants extracts, sustainable agriculture

INCPS-2024-138 Synthesis and Biological Applications of Silver Nanoparticles from Leaves of *Centella asiatica* L.

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In the present study leaves of *Centella asiatica* were used for the synthesis of silver Nanoparticles. Four different extracts were obtained from the plant using different solvents. The biosynthesis of Nanoparticles was optimized by using 1g and 5g powder of leaves treated with 0.5mMol solution of silver nitrate. The characterization of synthesized silver Nanoparticles was done by using UV- visible spectroscopy, XRD, FTIR and SEM. The synthesized Nanoparticles were also impregnated in soap prepared by cold method. The green synthesized Nanoparticles and solvent extract were also subjected for antibacterial activities against a skin pathogenic bacteria strains i.e. *Bacillus subtilis,Klebsiellapneumonia,Escherichiacoli*and*Staphylococcus aureus* by using agar well diffusion method. UV-visible spectroscopy displayed maximum peak value of AgNPs and reaction mixture at 280nm. X-ray Diffraction showed in crystalline nature. FTIR analysis confirms the presence of biocomopnent in the leaves of *Centella asiatica* which are responsible for the Nanoparticles synthesis. The synthesized Nanoparticles displayed as spherical structure, cubic in shape and size ranging showed 1µm to 500nm of both samples by SEM. The maximum ZOI showed by 1g AgNPs against by *Klebsiella pneumonia* at concentration of 500µg/ml was 1.675±0.170 while ZOI showed by *Escherichia coli* at concentration of 1500µg/ml was 1.5±0.081. The present study reveals the efficacy of *Centella asiatica* derived green synthesized AgNPs and its applications an antibacterial agent in industry like medicines and cleaning agents. The potential biological uses of silver Nanoparticles are increased by this environment friendly technique.

INCPS-2024-242 Traditional Knowledge and Biological Activities of Indigenous Herbal Teas used in District Poonch, Azad Jammu and Kashmir

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Plant resources have remained an integral part of human society throughout history. After fulfilling the primary needs like food and shelter, man has sought for a suitable remedy among plants for curing various diseases. The wild herbal plants grown naturally in the environment are rich in medicinal properties and meet human medicinal needs. The objective of the research was to observe the rich traditional knowledge surrounding wild herbal teas in District Poonch and explore their fascinating biological activities. The questionnaire method was used to conduct this study and data were collected from the local people having traditional knowledge of useful herbal teas.50 Informants were interviewed. All the ethno botanical parameters were analyzed through descriptive statistics using following indices: Frequency citation, Use report for species and fidelity level of species. In this study, a total of 15 plants were recorded which are used as herbal teas. RFC suggested 3 top listed plants Berginiacilliata, Swertia alata and Achillea millefolium. These plants contain high amount of total phenolic and flavonoides (254.15±1.52 mg GAE/g and 182.8±1.40 mg QE/g respectively). Furthermore, Antioxidant activity of these herbal teas suggested that Bergenia cilliata is highly antioxidant against DPPH..This research showed that traditional treatment using wild herbal teas is still widespread in the study area. The findings from this study not only enrich our knowledge of traditional herbal teas but also provided a foundation for further research and development in this field.

Keywords: Berginiacilliata, Antioxidant , Phenolics, Flavonoids

INCPS-2024-108 Formononetin from *Glycine max* (L.) Merr) Seeds as Promisıng Organo-protective Intervention in Letrozole-induced Polycystıc Ovarian Syndrome Sprague Dawley Rats

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Polycystic ovarian syndrome is an emerging health problem for females belonging to reproductive age across the globe. Conventional methods of treatment only provide symptomatic relief with many side effects. So to seek alternative treatment options, current study was designed to observe and compare the restorative and protective roles of formononetin (40 mg/Kg.b.w./day) on ovary, uterus, liver and kidneys of PCOS induced (via

letrozole @ 1.0 mg/Kg b.w./day) female Sprague dawley rats (150-200 gm) by keeping cyproterone acetate (1.0 mg/Kg.b.w./day) as positive control. Statistically analyzed results ($p<0.0001$) showed that after treatment of PCOS induced rats with formononetin, there was remarkable restoration of FSH, estradiol and progesterone (3.14±0.98 ml U/mL, 5.8±1.2 pg/dL and 45± 0.01 pg/mL respectively) as compared to positive control (2.5±0.01 mIU/mL, 3.05±0.3 pg/dL and 48±5.2 pg/mL respectively) while there was decrease in the levels of bilirubin and uric acid (0.4±0.01 mg/dL and 2.3±0.7 mg/dL) as compared to positive control (0.9±0.01 mg/dL and 4.7±0.15 mg/dL) respectively. Serum ALT, AST, ALP, urea and creatinine were (67±0.01 IU/L, 255±0.3 IU/L, 315±0.0I IU/L, 41.3±1.5 mg/dL, 1.31±0.25 mg/dL) in experimental group as compared to control (78.3±1.8 IU/L, 134.3±4.5 IU/L, 618±0.0I IU/L, 55±0.01 mg/dL,0.8±0.1 mg/d) respectively. Histological examination experimental group showed restoration of normal ovarian stroma from typical pearl string cystic appearance, with normal hepato-renal tissues. So it is concluded that formononetin may helpful to cure or mange PCOS but more studies are require to establish hepto-renal safety.

Keywords:Polycystic ovarian syndrome, Letrozole, Cyproterone acetate, Formononetin, organo-protective

INCPS-2024-122 In Silico-based Drug Discovery Approach for Abietadiene from *Pinus roxburghii* (L.) Leaves as Anti- frostbite Agent

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Exposure to sub-zero temperatures usually leads to vascular damage causing severe ischemic injury known as frostbite, one of the prominent cold weather injuries that can lead to devastating consequences such as amputation of the extremities. Although rate of amputation due to frostbite has decreased recently due to thrombolytic therapy but this new regimen comes with a price as well which include symptoms such as profuse gastrointestinal bleeding in patients. Thus, there is a need to discover effective treatments with least side effects and more bioavailability rate. In current work, aqueous extract of Pinus roxburghii leaves were checked against dry-ice induced frostbite on plantar surfaces of albino Wistar rats (both genders, 150-200 g) by keeping heparin as control, followed by the computational evaluation of its phytocompounds to prioritize potential anti-

inflammatory and anti-thrombotic compounds against frostbite. Statistically analyzed results of molecular docking showed that among all secondary metabolites of P. roxburghii, abietadiene was most suitable potential ligand against antiplasmin and antithrombin III, which modulated anticoagulant pathway and proved to be a valuable anti-inflammatory and antithrombotic agent for wound healing. These results suggest the wound healing potential of abietadiene especially in case of frost bite which further needs to be validated experimentally.

Keywords: *Pinus roxburghii*; Abietadiene; Antiplasmin and antithrombin III; Wound healing

INCPS-2024-107 Effect of Fatty Acids from Selected Plants on Poultry Protein: In Silico and in Vivo Approaches

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The poultry industry is a significant contributor to global food security, providing a vital source of protein for millions of people worldwide. However, the industry faces challenges in maintaining optimal animal health and productivity, particularly in the face of increasingly prevalent diseases and antibiotic resistance. One promising area of research is the use of plant-derived fatty acids as nutritional supplements, which have shown potential health benefits in various animal species. Despite this, there is a significant research gap in understanding the effects of plant derived fatty acids on poultry protein and their potential applications in animal nutrition. This study has investigated the effects of selected fatty acids on poultry protein by using different tools of bioinformatics and these results has been validated via in vivo approach on the growth and quality of meat of day 1 old broilers (both genders). Among all fatty acids, omega-3 fatty acids have improved meat quality and quantity and with in less time as compared to the control (already commercial poultry feed). The results of this study have provide valuable insights into the potential applications of plant-derived fatty acids in poultry nutrition and may lead to the development of novel nutritional strategies for improving poultry health and productivity, potentially improving poultry health and productivity, reducing reliance on antibiotics in animal feed, developing novel nutritional supplements and feeding strategies, and contributing to global food security and sustainability.

Remote Sensing in Plants

INCPS-2024-82 Assessing Forest Cover Dynamics in the State of Azad Jammu and Kashmir: A Spatio-Temporal Analysis from 1990 io 2020 using Remote Sensing &GIS

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Forest ecosystems are crucial for the sustainability of the Himalayan region owing to immense ecosystem services and ecological functioning. It is vital to monitor the ecosystem health and overall changes in forest cover to ensure environmental sustainability of any region. Remote Sensing technology (RST) and Geographical Information System (GIS) are robust and efficient tools to investigate forest cover change using GIS. Current study aimed to address the critical need for a comprehensive understanding of the afforestation and deforestation dynamics in the state of Azad Jammu and Kashmir (AJK). The research objectives include determining forest cover, assessing vegetation density using Normalized Vegetation Index (NDVI), and analyzing the spatio-temporal changes in AJK's forest cover using ArcGIS 10.8 and ENVI 4.7. In this study, we have used the Landsat data for the detection of forest cover change from 1990 to 2020, using 1990 as a base year. Each satellite image was classified into three land cover categories, and post-classification implemented to analyze and interpret change detections. The GIS analysis has revealed that the Re and Afforestation/deforestation equation for the state of AJK is highly tilted towards deforestation as almost 2 times more area has undergone forest loss over the last 3 decades. The cover of the primary forests of the state have undergone a -11.4% change for 3 decades as compared to <5% increase in Re-Afforested area. GIS analysis also revealed a highly significant increase in the barren land area as well as the built area causing severe forest loss. Historical data suggests that the earthquake of 2005 had immensely devastating impacts on the forest cover of Muzaffarabad division which comprises about 71% of the total state forest. However, the NDVI analysis indicated a significant increase in the private/rural forest cover linked with the socioeconomic transformations in the region. This comprehensive assessment of forest cover dynamics in AJK provides valuable insights for sustainable natural resource management, supports conservation initiatives, and lays the groundwork for evidence-based policy recommendations. The study underscores the importance of balancing development with habitat conservation to ensure sustainability of AJK's forests.

Key words: Western Himalayas, Arc GIS, Forest Cover, Kashmir

Sustainable Agriculture

INCPS-2024-233 Plant Sciences: Unlocking Entrepreneurial Opportunities for a Sustainable Future

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The future of sustainable innovation lies in plant sciences, offering groundbreaking alternatives to petrochemical-free and animal-free products. As the world faces increasing environmental challenges, such as climate change and resource depletion, plant-based technologies provide essential solutions for reducing reliance on non-renewable resources. Plants, as renewable and scalable systems, can be engineered to produce everything from alternative proteins to bio-based materials, eliminating the need for petrochemicals and animal-derived products while minimizing environmental impact.

This shift is essential to meet the United Nations' Sustainable Development Goals (SDGs), particularly SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), and SDG 15 (Life on Land). Furthermore, with global commitments to achieving Net Zero emissions by 2050, plant-based innovations present a critical opportunity for decarbonizing industries and building sustainable economies. Countries like the EU, UK, and US are setting ambitious targets to phase out fossil fuels and support eco-friendly alternatives.

Entrepreneurial ventures in plant sciences, such as developing animal-free proteins and biodegradable materials, are crucial to achieving these goals. By leveraging the potential of plants, we can reduce environmental harm, promote sustainability, and create a more resilient future that meets the needs of both the present and future generations.

Keywords: bio-based, plant-based, Net zero; alternative

INCPS-2024-151 Poultry Feathers Decomposed by UV-Mutated *Bacillus subtilis* with Better N/C Improved Fiber Quality and Chromium Stress Tolerance in Cotton

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In literature, some studies mention the possible potential of Bacillus subtilis (BS) to degrade poultry feathers (PF) and transform it into a biofertilizer. But it is first detailed multidisciplinary research that reports not only physiochemical comparisons of BDP produced from wild BS also revealed its role in cotton growth, fiber quality and chromium stress tolerance. Here improvement in germination percentage, root fresh weight, leaf number and number of branches, chlorophyll a/b ratio, total soluble proteins, amino acids, ball weight, FUI, and fiber elasticity was noted along with decreased Cvt and mean germination time. Hence proved it a potential candidate for biofertilizer production in line with the literature and our hypothesis. As regards UV-mutated BS in comparison with untreated feathers or simple soil with minor variations it improved almost all above mentioned parameters like wild BS. In addition, it got superior in terms of germination index, germination percentage extra lowering of Cvt, a greater increase in shoot fresh weight, root vigor, shoot vigor, root and shoot dry weight, and chlorophyll a/b ratio. This BDP was with better antioxidant production in stressed (chromoium) plants as depicted by lowering MDA and H_2O_2. Hence for a cotton grower BDPs produced by both types of BS may be recommended based on the availability of resources and specialty. However, for scientific studies or for the biofertilizer producers it would be suggested to prefer UV-mutated BS for similar or somewhat similar outcomes when working with other crops or stresses.

Keywords: Bio fertilizer; *Bacillus subtilis*; poultry feathers; cotton; chromium stress

INCPS-2024-07 Exploring Strategies to Enhance Wheat Diversity for Sustainable Agriculture in a Fluctuating Climate

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Wheat is an important staple cereal crop that provides protein and calories to the human population. As the population rises, the global demand for wheat is increasing. Additionally, the wheat crop is susceptible to various environmental abiotic and biotic stresses, including variability in climate such as increasing temperatures, frequent droughts, and floods. This variability is threatening global food security. Each degree of temperature rise reduces wheat production by 6-13%. In this study, we summarize the successful gene transfer between the wild relatives and the use of available genetic diversity to address this challenge. This study includes both traditional and modern strategies to develop climate-resilient wheat varieties that maintain good end-use quality, enhance crop productivity, and meet future needs.

This includes utilizing landraces, which are rich genetic sources of diversity in wheat, and applying various approaches to harness this diversity amid climate change. These approaches include conventional breeding, direct hybridization, backcrossing, and advanced high-throughput phenotyping. Additionally, we explore quantitative trait loci (QTL) mapping, sequencing technology, genome-wide association studies (GWAS), marker-assisted backcrossing (MABC), Next Generation Approaches, Genome Selection (GS), and cogenesis. Hundreds of QTL have been mapped using linkage analysis and GWAS. Insights gained by fine mapping, sequenced genomes, and QTL cloning have resulted in the identification of new genes and a huge number of molecular markers, leading to the development of high-yielding wheat varieties in a changing climate. These cutting-edge technologies accelerate the breeding process and improve the efficiency of breeding programs. The Integration of these strategies to explore new genetic resources, gene discoveries and understand mechanisms of adaptation to climate change ensures sustainable agricultural development in the future.

Keywords: Wheat, Genetic diversity, Climate-resilient, Quantitative trait loci (QTL), Breeding strategies

INCPS-2024-202 Stage Specific Drought Stress in Canola, *Brassica napus* L. Affects Population Dynamics of Aphids and its Yield

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Global rise in temperature exacerbates the threat of water scarcity and subsequently jeopardizing food security. In addition to the climate change, extensive use of groundwater in intensively irrigated crops continuously attenuating the water resources and sustainability of future crop production. Therefore, understanding the response of crops to deficit irrigation strategies is crucial. Canola is an important edible oil crop susceptible to stage specific water stress. Skipping irrigation at crucial stages, might keep crop plants under physiological stress, changing their metabolic profile that might also influence plant-herbivore competition on the struggling plant. In the present study, we assessed effect of water stress on the abundance of most commonly found aphid, *Brevicorynebrassicae*L. on B. napus under field conditions following a randomized complete block design in 2018-2020. We also determined the consequences on chlorophyll contents and yield components of plants under both (stressed and unstressed) conditions. Water stress was given at any of the three phenological stages viz; vegetative, flowering and pod development (treatments) by completely inhibiting irrigation throughout the length of each designated stage and compared with well-watered (unstressed) crop. In terms of preference, our findings suggest that aphid avoid stressed canola plants and prefer

unstressed plants. The relative chlorophyll contents of stressed plants were higher, due to low aphid presence. Despite harboring low aphid number, canola plants stressed at flowering and pod formation stages fail to produce satisfactory yield, clearly indicating canola sensitivity towards water stress at these stages. We conclude that water stress has role in generating aphid preference on canola, irrigation at flowering or pod formation stages is crucial so farmers are suggested not to avoid irrigation at these stages.

INCPS-2024-203 Effects of Wheat Canola Intercropping on Hexapods Density and Diversity

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The rise of monocultures in recent decades has led to increased pest outbreaks and a higher reliance on pesticides. This overuse of chemicals jeopardizes the environment by adversely affecting ecosystem services including biological control. Therefore, it is essential to develop alternative ecosystem-based strategies like crop diversification that promotes biodiversity, which can enhance natural pest suppression. Two experiments, involving wheat-canola (WC) cropping system with wheat as primary crop and canola-wheat (CW) cropping systems with canola as primary crop, were with three replications each having treatment plots including a monocrop, strip crop and an alternate-row intercrop. In WC systems, intercropping of wheat and canola significantly reduced densities of wheat aphids including Sitobionavenae and Schizaphisgraminum, while promoting higher numbers of coccinellids and aphid mummies on wheat plants. Conversely, in CW systems, the highest populations of canola aphids including Lipaphiserysimi, Myzuspersicae, and Brevicorynebrassicae were noted in sole canola crops, with lower densities on canola plants in alternate row treatments. However, natural enemy populations were higher in sole canola compared to canola plants in intercrop, suggesting that the enemy hypothesis may not universally apply. In conclusion, crop diversification practices like intercropping can offer farmers a chance to minimize reliance on chemical pesticides, leading to reduced input costs and fostering sustainable agricultural practices.

INCPS-2024-228 Green-Synthesized Metal Nanoparticles: A Boon for Sustainable Bio- and Agro-Applications

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The green synthesis of metal nanoparticles (NPs) has garnered significant attention due to its eco-friendly and sustainable approach to nanoparticle production. This process utilizes natural sources such as plant extracts, microorganisms, and biocompatible reducing agents, minimizing the use of hazardous chemicals. This work explored the applications of silver nanoparticles as antioxidant, antibacterial and antifungal agent to find their significance in treatment of diseases and prevention of fungal attacks on plants. Silver nanoparticles were synthesized using plant extract as reducing and capping agents. The physicochemical properties of AgNPs were determined using different analytical techniques viz., scanning electron microscopy, X-ray diffraction, and Fourier transform infrared spectrometry. Silver nanoparticles (average size of less than 100 nm) synthesized using plant extracts have shown tremendous effects as antioxidants, antibacterial and antifungal agents. In conclusion, the green synthesis of metal Nanoparticles holds great promise for various biological and agricultural applications. The eco-friendly nature of this approach, coupled with the unique properties of the resulting nanoparticles, positions them as valuable tools for addressing contemporary challenges in healthcare and agriculture while minimizing the impact on the environment. Further research and development in this field will undoubtedly uncover new opportunities and expand the horizons of green-synthesized metal nanoparticles in these critical domains.

Keywords: Nanoparticles; Green synthesis; Agriculture.

Poster Presentations

Agricultural Sciences, Agronomy, Horticulture

INCPS-2024-158 Anthocyanins and Carotenoids Production by Cell Suspension Cultures in Carrot Cultivars

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Carrot is considered as a model crop in tissue culture for better regeneration. Cell suspension cultures are useful to extract plant derived secondary metabolites and obtain biologically important molecules to be used as medicine. This study was aimed at establishing suspension culture of four carrot varieties viz. T-29, Black Carrot, Deep Red and Red Core. Seedlings of these varieties were developed in vitro on MS and B5 media. The hypocotyls of seedlings were cultured for callus induction on MS medium supplemented with 3 mg L^{-1} 2,4-D, 1 mg L^{-1} kinetin and 20 g L^{-1} sucrose under light and dark culture conditions. Plant material was multiplied using nodal cultures. Maximum fresh (2.06 g) and dry weight (0.83 g) of induced calli was noted in cv. T-29 after 30 days of culture on MS media under 16/8 hrs photoperiod compared with B5 media. The proliferating calli were suspended in liquid media and placed on an orbital shaker for the development of suspension cultures. Chlorophyl a, b and total chlorophyll contents were maximum in calli induced in cv. T-29 compared to other cultivars. Cultivar Black Carrot developed maximum anthocyanins in different volumes (25-75 ml) of suspension media and calli weight (1-3 g). However, carotenoid contents were greater in both cvs. T-29 and Black Carrot. Overall micropropagation of cultivars was better on MS medium under light conditions compared to B5 media. Conclusively cells suspensions of cv. T-29 and Black carrot were found rich in carotenoids and anthocyanin production on MS media compared with other varieties. Further research may be focused on refining culture conditions to enhance metabolite yields and exploring industrial applications for these valuable compounds.

INCPS-2024-166 Modern Landscape Leading to Sustainable Urban Environment

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Creation of sustainable environment through modern landscape involves ecological measures and conservation of native Flora and Fauna to promote healthy ecosystem along with preserving the aesthetics. Urban ecology is suffering from severe climate change, which is affecting the economy, efficient resources utilization and human living standards. The idea of pleasing aesthetics of surroundings is getting popular and have proven positive impacts on human mental, emotional and behavioral health. Modern landscape design harmonizes the sustainability of the environment without any artificial input like chemical fertilizers and pesticides while serving the purpose of entertainment. Well-planned and executed landscape design can reduce the carbon footprint and improve air quality. Advanced techniques like vertical gardening, green roofs, permeable paving and energy efficient tools can be used to manage the stormwater, surface runoff, heat island effect and ground water recharge. These landscape designs encourage the use of native species, efficient irrigation system and self-sustainability which provide the food and shelter to fauna. Increased efficient green spaces of a city can improve the socioeconomic factors of urban life. In order to address the life threating challenges like extreme weathers, unsustainable urban environment, food insecurity and degraded living standards, execution of modern landscape is the only way out.

Keywords: Carbon footprint, Vertical gardening, Heat Island effect, Socioeconomic factor

INCPS-2024-267 Effect of *Tamarixaphylla* and *Suaedafruticosa* as Biostimulants on Growth of Wheat

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Bio stimulatory studies explore the positive and negative impact of plants extract on wheat crop growth and yield. This study explores the influence of a bacterial filtrate (BF), a vegetal-derived protein hydro lysate (PH), and a standard synthetic Auxin (SA) on strawberry, exploring their effects on yield, fruit quality, mineral composition and metabolomics of leaves and fruits. Agronomic test revealed that SA and BF considerably enhanced early fruit yield due to their positive influence on flowering and fruit set, while PH treatment favored a gradual and prolonged fruit set, supplementary with an increased shoot biomass and persistent production. The role of bio stimulants of growth of various natures in the production process of spring wheat variety Zlata was studied, depending on nitrogen nutrition conditions, and was carried out under field conditions. The studies found that the greatest effectiveness of the studied drugs was observed under conditions of

optimal provision of nitrogen nutrition to wheat plants. It has been established that the preparations Epin-Extra, Emistim and Hardy increase the efficiency of the integration apparatus of spring wheat plants, which led to the acceptance of large increases in grain weight under conditions of optimal provision of wheat plants with nitrogen nutrition. The experimental involved field preparation planting fertilizer application, irrigation treatments, harvestings, and various growth parameter and measurements. A completely randomized design with two factors seed priming and foliar treatments was employed.The results indicate that significant effects of plant extracts and maxi crop on plant height fresh weight dry weight grain weight and yield in both seed priming and foliar treatments.

Keywords: Biostimulants, plants extracts, sustainable agriculture,priming

INCPS-2024-268 Effect of Aqueous Extracts of *Cassia senna* L. and *Achyranthes aspera* L. on Growth and Yield of Wheat

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The present research work to investigate the effect of aqueous extracts of Sana maki *(Cassia senna* L.) and Puth Kanda (*Achyranthes aspera* L.) on the growth and yield of wheat crop. A randomized complete block design with two factor, seed priming and foliar application. Five concentrations of aqueous extract of each plants prepared i-e 1%,3%,5%,7 and 9%. Seed priming show increased root length, shoot length, fresh root and shoot weight, dry root and shoot weight, increased no. of tillers, no. of grains and spike length of wheat. The foliar spray of these plants applied on wheat. This study show that the plants showed increased root length, shoot length, fresh root and shoot weigh, dry shoot and root weight, number of tillers, number of grains and spike length of wheat at 3%and 5%. Additionally, the result shows that the higher concentration negative effect on plant growth.

Keywords: Biostimulants, plants extracts, sustainable agriculture

INCPS-2024-269 Effect of Aqueous Extracts of *Cenchrus ciliaris* and *Convolvulus prostratus* as Biostimulating agent on Growth of Wheat

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Wheat (Triticum asetivum) is globally used in the human food and used as staple food in all over the world. It is used to make flour and baked food.

Bio-stimulants are artificial or natural substance. This can be employed on land, plants and seeds. These substances alter structural processes and effect the plant development by increasing the tolerance to environmental stresses and enhance grain yield and quality. Fertilizers and pesticides are not included in biostimulants. The object of this work was to examine impact of aqueous extracts of Convolvulus prostratus (hiranbooti) and Cenchrus ciliaris (daman) on the development and productivity of wheat crop. Experiment was conducted in field. Five different concentration (1% ,3% ,5%, 7% and 9%) of plants aqueous extract were used . The plants aqueous extract were applied by two methods . Seed priming methods in which seeds were soaked in plants aqueous extracts for 24 hours and foliar method in which plants aqueous extracts were applied as foliar spray. First foliar application was given to wheat crop after 30 days of sowing and second foliar application was given to wheat crop after 60 days of sowing. Four harvest of priming method was taken after 30, 60, 90 and 150 days interval respectively. Three harvest of foliar method was taken after 60 days, 90 days and 150 days interval respectively. According to results of this research at low concentration of plants aqueous extract stimulate or promote the growth of wheat crop but as the concentration of plants aqueous extract was increased it show the negative effect on the wheat crop and yield. And plants aqueous extract applied by priming method show more growth of wheat crop as compared to foliar method. Convolvulus prostratus aqueous extract shown more growth of wheat crop as compared to Cenchrus ciliaris aqueous extract.

Keywords: Biostimulants, plants extracts, sustainable agriculture

INCPS-2024-270 Phytotoxicity and Uptake of Chlortetracycline in Commonly Grown Vegetables

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Phytotoxicity studies explore the adverse effects of chemical or physical agents on plant growth and ecosystems. Chlortetracycline, an agricultural antibiotic, is a notable phytotoxic agent, and its presence in soil, impact on microbial life, and potential consequences for human health and the environment are subjects of concern. Phytoremediation, a sustainable remediation technique, employs plants to uptake and degrade pollutants. Mustard plants have exhibited promising potential in the phytoremediation of chlortetracycline, while radish and turnip possess nutritional value. Antibiotics employed in animal agriculture serve to prevent and treat diseases, yet their continuous use can facilitate the transmission of drug-resistant bacteria and pose risks to human health. In plant agriculture, the use of antibiotics like chlortetracycline can lead to soil and water contamination, disrupt ecosystems, and contribute to antibiotic resistance. Furthermore, phytotoxicity, which affects plant growth and essential biochemical attributes, can occur. Mitigating these risks requires proper

antibiotic management and disposal, along with the implementation of best agricultural practices. The present study investigated the effects of antibiotic treatment on the growth, germination percentage, seedling emergence rate and energy, total antioxidants, and antibiotic residues of radish and turnip plants. The experimental design involved pre-experimental soil analysis, planting, fertilizer application, irrigation, treatments, harvesting, and various measurements. A completely randomized design with two factors, antibiotic treatment and vegetable species, was employed. Soil analysis results informed fertilizer application, and statistical analysis was conducted using two-way ANOVA. This study contributes valuable insights into the impact of antibiotic treatment on radish and turnip plants.The results indicate significant effects of chlortetracycline on plant height, fresh weight, dry weight, total antioxidant activity, and antibiotic accumulation in both roots and Shoot. Additionally, higher levels of radiation exposure exhibited detrimental effects on plant growth, antioxidant activity, and increased antibiotic accumulation.

Keywords: Phytotoxicity, antioxidant Chlortetracycline, agricultural antibiotic

INCPS-2024-271 Effect of Seed Priming with Aqueous Extracts of *Meliolotus officinalis* and *Heliotropiumstrigosum* on Germination and Growth of Maize

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The primary purpose of the study was to investigate the impact of priming maize (*Zea mays*) seeds with water-based extracts from two wild plants, *Heliotropiumstrigosum* and *Melilotus officinalis* on the growth and yield indices of the maize crop.The experiment on maize seeds were subjected to treatment with plant extracts at concentrations of 1%, 3%, 5%, 7%, and 9%.Three separate harvests were carried out at intervals of 30 days, 60 days, and 107 days after planting to check growth parameters. The physiological parameters of maize e.g shoot fresh weight and root dry weight were measured.The results indicated that different concentrations of plant extracts used for seed priming had a substantial impact on the growth and yield characteristics of maize. The initial harvest, occurs 30 days after planting, the application of a 3% Sinji extract resulted in a 22.08% increase in shoot fresh weight compared to control group. This increase was larger than the 21.76% rise found with the application of a 1% Gorakh Pan extract.The 3% Sinji therapy consistently yielded Concentrations of the extracts 7% and 9% resulted in a decrease in both the fresh weight of shoots and the dry weight of roots, thereby inhibiting their growth. The observations were corroborated using statistical analysis using ANOVA, which produced highly significant p-values (<0.0001) for the effects of treatment, species, and their interactions.This approach promotes sustainable farming practices

while offering a alternative to artificial fertilizers. Both Plant extract concentrations of 1% and 3% were shown to be useful in enhancing growth and yield.

Keywords: Biostimulants, plants extracts, sustainable agriculture

Biochemistry, OMICS, Bioinformatics

INCPS-2024-137 Computational Modeling and Comparative Analysis of *Polyporusumbellatus* (Pers.) Fries Lectin and its Sugar Complex

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*Polyporusumbellatus*may contain bioactive compounds with immunostimulating, anticancer, anti-inflammatory, and hepatoprotective properties. ***Polyporusumbellatus*** is a species of mushroom belonging to the family Polyporaceae.***Polyporusumbellatus*** lectin (PuL)is found in the fruiting body of the ***Polyporusumbellatus*** mushroom. *Polyporusumbellatus* lectin FASTA sequence was retrieved from UniProtKB with a primary sequence length of 354 amino acids and 37 kDa molecular weight. Molecular structure was predicted from SWISS-MODEL by using template 6KBQ showing a sequence identity of 49.85%. PuL predicted model was validated with an ERRAT quality factor of 86% and good values of Ramachandran plot with only two residues in the disallowed region. VERIFY 3D results show that 89.88% of residues averaged a 3D-1D score >= 0.1. The overall structure of the PuL is a V-shaped structure composed of two pseudo-symmetric domains. Each domain displays a β-jellyroll like fold with the two β-sheets consisting of 9 and 13 antiparallel strands, respectively. The two domains are connected by a long loop of 20 amino acids (199–218) and by a disulfide bridge between Cys90 in strand β-6 and Cys253 in strand β-13. Superimposition of PuL with its template *Pleurotus ostreatus* (6KBQ) showed an RMSD value of 0.063 Å. PuL has a unique carbohydrate-binding specificity and Rhamnose was docked to predicted PuL structure and it showed two binding sites with one site in each domain. Divalent cation Ca^{2+} was found important for stable binding to sugars. Site 1 comprises 3 residues along binding energy of -4.5 kcal/mol while site 2 showed the interaction of 3 residues (-2.9 kcal/mol). Site 1 ligand molecule makes 8 H-bonds and site 2 ligand molecule makes 5 H-bonds. The present study aimed to develop novel PuL protein as anti-cancer agents through an *in-silico* analysis approach.

INCPS-2024-156 Bioinformatics-guided Approach for Pollen Allergy Therapy of *Olea europaea* L. Ole e 1 Allergen

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Olive pollen allergy is a striking health concern affecting millions of people worldwide. The Ole e 1 allergen is a significant contributor to cause this allergy where current treatments have limitations. This thesis explores a bioinformatics-guided approach to identify potential therapeutic agents against Ole e 1.UsingUniProt, the Ole e 1 allergen sequence (UniProt ID: P19963) was retrieved, and its 3D structure was predicted via SWISS-MODEL, AlphaFold, Phyre2 and trRosetta. The structure predicted from AlphaFold was selected as reliable based on ERRAT score (90.5512) and Ramachandran plot analysis (110 residues in the most favored region.) The targeted protein was aligned on PyMOL software with other homologs three dimensional predicted structures as superimposition of Ole e 1 with Lig v 1, Fra e 1 and Syr v 1 shown RMSD values as 0.382, 0.378 and 0.365, respectively. A library of 1500 phytochemicals from PubChem was screened using PyRx software, and 10 compounds exhibited favorable docking scores (ranging from -7.5 to -8.1) when bound to Ole e 1. Enoxolone emerged as a top candidate, displaying a high docking score (-8.1) and strong hydrogen bond interactions. Lipinski rule analysis showed 0 violations, indicating good drug-like properties.This research demonstrates the potential of a bioinformatics-guided approach in identifying therapeutic agents against Ole e 1. Enoxolone and other identified compounds warrant further experimental validation to confirm their efficacy and safety as potential treatments for olive pollen allergy.This study contributes to the development of novel therapeutic strategies for pollen allergy therapy and showcases the power of bioinformatics in drug discovery. The findings offer a promising direction for addressing the unmet medical need of olive pollen allergy sufferers.

INCPS-2024-189 *In-silico*Modeling, Molecular Docking and *In-vitro* Antibacterial Activity of Napin Seed Protein from *Eruca sativa* L.

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Eruca sativa seeds contain flavonoids, essential oils and also bioactive compounds. The present study was focused on napin protein which was

isolated and purified from seeds of rocket salad (*E. sativa*). Seeds of *E. sativa* extracted in pH 7 buffer at room temperature and protein profile resolute by Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis (SDS-PAGE). An approximately 15 kDa band of *Eruca sativa*Napin (*Est*N), 2S albumin type was partially purified by ammonium sulfate precipitation at 90% saturation level and characterized on 12% SDS-PAGE under non reduced and reduced form. Physio-chemical properites of *Est*N were calculated through ProtPram. *Est*N was examined under *in-silico*, molecular docking and *in-vitro* analysis for their bioactivity as antimicrobial peptides. Three potential ligand binding sites of *Est*N model were predicted through CASTp. 3D structure *Est*N was examined to predict anti-bacterial screening and for that *in-silico* molecular docking done with two lignads i.e. N-Acetyl-Beta-D-glucosamine and Beta-glucan which shown that *Est*N has free binding energy (ΔG) in the range of -6.9 and -9.7 kcal/mol respectively. For *in-vitro* analysis *Est*N was tested against six bacterial species by using disc diffusion method. In antibacterial activity inhibition zone observed in five bacterial species *(Bacillus subtilis, Xanthomonas oryzae, pseudomonas auroginosa, Staphylococcus aureus* and *Escherichia coli*) and one bacterial *(Pseudomonas syringe)* species did not exhibit the bacterial killing.Three bacterial species *(Bacillus subtilis, Xanthomonas oryzae* and *pseudomonas auroginosa)* exhibited bacterial killing on both concentration (40 and 80µg) while two bacterial species (*Staphylococcus aureus* and *Escherichia coli*) shown inhibition only at 80µg concentration while one specie *(Pseudomonas syringe)* did not show bacterial killing on both concentrations (40 and 80µg). This comprehensive analysis of *Est*N provides key insights about the structure, active site, binding affinity and mode of binding of the substrates.

Key words: Napin, *Eruca sativa*, SDS-PAGE, Anti-bacterial activity, Molecular dockinig

INCPS-2024-222 Crystal Structure of Kunitz-type Trypsin Inhibitor: EntomotoxicEffect of Native and Encapsulated Protein Targeting Gut Trypsin of *Triboliumcastaneum* Herbst

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Trypsin inhibitors are known to act against insect pests by inhibiting proteases of the digestive tract. In this study, we report structural and functional characterization of ~ 19 kDa*Albiziaprocera*Kunitz-type trypsin inhibitor (ApKTI) protein with potential bio-insecticidal applications. Crystal structure of ApKTI protein has been refined to 1.42 Å and molecular structure (8HNR) showed highly beta sheeted conformation including 12 beta sheets, 15 loops and two small alpha helices. Docking between predicted model of *Triboliumcastaneum*trypsin (TcPT) and 8HNR produced a stable complex (11.3 kcal/mol) which reflects the inhibitory potential of ApKTI against insect gut trypsin. Significant mortality was observed in all life stages of *T. castaneum*including egg, larvae, pupae and adults with a 3.0 mg native ApKTI treatment in comparison to negative control. Although standard trypsin inhibitor (*Glycine max* trypsin inhibitors; GmKTI; 3.0 mg) produced maximum reduction against all above life stages; however, a non-significant mortality difference was observed in comparison to 3.0 mg native ApKTI. The study further explores the synthesis and characterization of Graphene (GNPs) and Zinc oxide (ZnONPs) nanoparticles, followed by the optimization of ApKTI and GmKTI loading on both nanoparticles to evaluate their enhanced insecticidal effectiveness. Encapsulated proteins showed significant mortality against *T. castaneum*across all concentrations, with GNPs proving more effective than ZnONPs. Additionally, encapsulated GmKTI produced significant mortality of eggs compared to loaded ApKTI treatments while other life stages were non-significantly affected by two proteins. This research highlights the importance of encapsulated ApKTI protein for eco-friendly pest management strategies.

Key words: Kunitz–type trypsin inhibitor, Crystal structure, Graphene nanoparticles,

INCPS-2024-260 In-silico Analysis of *Morchella conica*Pers. H-type Lectin and GalNAc Complex for Understanding Cancer Therapy

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On a global scale, cancer stands as the second most prevalent cause of mortality, accounting for approximately one-sixth of all deaths. *Morchella conica*Pers. contains several active compounds with immuno-modulatory, anti-cancerous and anti-inflammatory properties. *Morchella conica*H-type lectin (McHL) FASTA sequence; retrieved from UniProtKb, was comprising of 258 amino acids. Molecular structure was predicted from trRosetta via

template based homology modelling and it indicated McHL model as a monomeric protein consisting of three domains. Predicted structure was validated via ERRAT quality factor of 95.88% and Ramachandran plot showed more than 95% residues in favored regions. VERIFY 3D confirmed 100% of residues with a 3D-1D score above 0.2, indicating high structural accuracy and reliability. Superimposition of McHL with its templates 3WMP, 2CCV and 4Q56 showed RMSD values of 1.26, 1.03 and 1.03Å, respectively. McHL was docked with two distinct GalNAc complexes known as Forssman and Tn antigens which have been recognized as cancer epitopes. Docking analysis of McHL indicated that residues Arg167, Glu203, and Gln205 interact with the FORSSMAN antigen, with each residue forming a single hydrogen bond, with a binding affinity of -6.1 kcal/mol. In contrast, the interaction with the Tn antigen involves amino acids Gly94, Ser96, Tyr145, Ser151, and Leu153, where Ser96 forms two hydrogen bonds and the remaining residues form one hydrogen bond along binding affinity of -6.0 kcal/mol. Conserved residues for carbohydrate-binding sites in H-type lectins include aspartate, asparagine, glutamine, arginine, tryptophan, and tyrosine. In the McHL – Forssman antigen complex, two conserved residues (arginine and glutamine) and one variable residue (glutamate) are present, whereas in the McHL – Tn antigen complex, tyrosine is conserved, while the remaining four amino acids fall into the variable group. Our study provides valuable insights into the therapeutic potential of *Morchella conica* H-type lectin by elucidating its molecular interactions with cancer-associated carbohydrate epitopes where binding of McHL with GalNAc complexes present on cancer cells will activate the receptor molecules that triggers downstream signaling pathway including pro-apoptotic signal induction, mitochondrial membrane disruption and activation of caspase cascade that ultimately will lead to programmed cell death.

INCPS-2024-261 Structural Analysis, Molecular Docking and Dynamics of an Entomotoxic Lectin from *Senna tora* (L.) Roxb. Seeds

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Legume lectins are a group of lectins that are derived from leguminous plants, which belong to the family Fabaceae. Lectins are carbohydrate-binding proteins that have the ability to recognize and bind to specific sugar structures. *Senna tora* Lectin (StL) is Concanavalin A (Con A) like lectin family protein and has a strong affinity for α-D-mannose, α-D-glucose and their derivatives. The objective of the study was to understand molecular

basis of structural and functional characterization of legume lectin from *Senna tora* (StL) against chitin molecules potentially targeting the gut epithelium of stored grain insect pest *Triboliumcastaneum*Herbst. In this study, initially the sequence analysis was performed for legume lectin to understand the sequential properties followed by using similarity search, multiple sequence alignment and phylogenetic analysis to identify the closely related protein sequences of StL. UniProtKB retrieved fasta sequence (A0A834STY8) of *S. tora* lectin was consisted of 272 amino acids which was feed to SWISS-MODEL. 3D StL molecular structure was predicted by using the coordinate information of *Ulex* europaeus lectin (1FX5). Predicted model showed homodimer comprising of a mixture of α-helices and β-sheets along β-turns, γ-turns and β-hairpin. Predicted 3D-StL, was subsequently used for interaction studies with three ligands namely N-acetylglucosamine (GlcNAc) and oligomers of chitin (N,N'-diacetylchitobiose and β-N,N',N''-triacetylchitotriose) to find out the best interaction site of StL with chitin molecules. Moreover, the docked complexes were subjected to MD simulation to understand the structural stability, integrity and compactness. Together the results of docking and dynamics of the StL were showing comprehensive analysis on binding affinities of ligands towards binding pocket of StL and provides key insights about the structure, active site, binding affinity and mode of binding of the substrates. Lectins interact with glycans in insects, interfere with insect physiology and affect fecundity, growth, and development, therefore, possess potential insecticidal properties.

INCPS-2024-128 Evolution of Liquid Dense Clusters toward Crystallization Area C, C2.2 Exploring Emergence in Biological Macromolecules Condensates

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Phase separation is a process by which molecules can self-associate to create two compositionally distinct phases from a homogenous solution: a dense phase containing a high concentration of the molecule; and a light phase relatively depleted of the molecule. We discuss the phase behaviour in crystallization of a plant storage protein Napin in solution with coacervating agents. Crystallization from the condensed regime has been observed to follow different mechanisms i.e., crystals grow following a classic nucleation and growth mechanism; the crystallization follows a two-step crystallization mechanism in which crystal growth follows a metastable

liquid-liquid phase separation (LLPS). This study focusses on the two-step crystal growth of napin monitored with Xtal controller confirmed cluster evolution in this regime with time dependent increase in size. After achieving metastable dense liquid phase, the droplet was transfer to crystallization plate. Based on our observations, During the crystal growth, the metastable dense liquid phase seeds the crystal nucleation process. Napin crystallization the nucleation mechanism starting from clusters and from a metastable LLPS. These protein clusters behave as the building blocks for nucleation, while the dense phase acts as a reservoir ensuring constant protein concentration in the dilute phase during crystal growth.

Microbiology and Plant Microbe Interaction

INCPS-2024-79 Microbial Consortium of Cyanobacteria and Arbuscular Mycorrhizal Fungus Enhance the Yield of Wheat Crop

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Plant-associated microbes are essential for improving agricultural productivity. Numerous studies have demonstrated that microorganisms can benefit plants, either in single or consortium forms. Consortium comprised of two or more similar or diverse microorganisms that lead to an additive or synergistic impact on plant. Wheat is a vital staple crop for ensuring food security while its production is significantly affected by various climatic factors, urging essential to find solutions to increase productivity under climate stress. Cyanobacteria exhibit visible impact on crops by providing nitrogen. As a natural root symbiont, arbuscular mycorrhizal fungi (AMF) supply essential inorganic nutrients to host plants, enhancing growth and yield in both stressed and unstressed conditions. The current study aims to examine the effects of single and dual inoculations of AMF and cyanobacteria on wheat crops. Four cyanobacteria strains, isolated and purified from paddy field in Faisalabad, were tested with previously available AMF strain *Funeliformismosseae* in the Microbial Ecology Lab. Colony and cell morphology was analyzed by using light microscopy while biochemical and physiological tests e.g., starch, chlorophyll and carotenoid estimation were done as standard protocols. In addition, growth promoting abilities of four cyanobacterial isolates CRPS1, CRFS1, COS, CRW and AMF were evaluated on wheat crop for various growth parameters in a pot experiment. Plant growth parameters like shoot length, root length, number of tillers, plant fresh and dry weight, spike length and yield were determined. All cyanobacterial and AMF inoculations enhanced the growth of Wheat. However, the combine effect of all cyanobacteria and AMF specially of CRPS1 and AMF showed significantly higher plant growth and yield as compared to the un-inoculated control. The results showed that the combined application of AMF and Cyanobacteria can be used as efficient microbial consortium for wheat production.

Keywords: Wheat, Consortium, AMF

INCPS-2024-187 Characterization of Plant Growth-Promoting Rhizobacteria with Biocontrol Potential against *Rhizoctonia* sp.

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Wheat, a staple crop worldwide, faces severe yield losses due to fungal diseases, particularly *Rhizoctonia* sp., which is threatening food security in Pakistan. Chemical fungicides are widely used to combat these diseases; however, their excessive use has led to environmental degradation and the emergence of resistant fungal strains. Plant growth-promoting rhizobacteria (PGPR) offer a promising, eco-friendly alternative for enhancing plant health and disease resistance. Therefore, this study aimed to explore the potential of PGPR strains isolated from the wheat rhizosphere as biocontrol agents against *Rhizoctonia* sp. A total of 93 bacterial isolates were obtained from different wheat rhizosphere soil samples and screened for various PGPR traits. Of these, 76 produced ammonia, 47 isolates demonstrated chitinase activity, 44 produced siderophores, 43 exhibited cellulase activity, 20 solubilized phosphate, and 51 demonstrated urease activity. However, only one isolate produced indole acetic acid, and none of them showed zinc solubilization ability.In addition to their plant-growth promoting traits, these isolates were further evaluated for their biocontrol potential against *Rhizoctonia* sp. Among these 93 isolates, only 47 exhibited varying degrees of fungal growth inhibition, with 1W10 being the most effective isolate, showing the maximum inhibition of *Rhizoctonia* sp. growth (81.25%). These findings suggest that the wheat rhizosphere harbors diverse PGPR having the potential to serve as both plant growth promoters and biocontrol agents. Further studies are essential to evaluate the efficiency of these isolates in real-world agricultural conditions, offering an eco-friendly solution to combat fungal diseases in wheat production.

INCPS-2024-68 Isolation and Activity Assays of Some Antimicrobial Agents from *Syzygiumaromaticum*L.

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Protein was isolated from *Syzygium aromaticum* floral buds to analyze the antimicrobial activities against different types of gram positive and gram

negative bacteria. Different solvent i.e. acetone, phenol and methanol were employed in this method to ease the extraction of TSP. The treatment was followed by the extraction of antimicrobial protein with the help of buffers i.e. Citrate buffer pH3.0, Acetate buffer pH 5.0, Potassium phosphate buffer pH 7.0, Sodium phosphate buffer pH 6.8 and Carbonate buffer pH10.0 at 4°C. The Bradford's assay and SDS- PAGE revealed that the Potassium phosphate buffer pH 7.0 and Sodium phosphate buffer pH 6.8 yielded maximum quantity of proteins. These isolated TSPs were subjected to antibacterial activity assays in over-lay method in agar plates against one Gram-positive bacterium *Staphylococcus aureus* and three Gram-negative bacteria *Pseudomonas aeruginosa*, *Pseudomonas syringae* and *Escerichia coli*. It was observed that all protein samples were biologically active against all bacterial strains and have produced bacterial growth inhibition zones in the agar plates.

Key Words: Antimicrobial Plants, Antimicrobial Protein, Antimicrobial Peptides, Methanolic extract

Mycology, Plant Pathology, Disease Management

INCPS-2024-157 A Survey- Based Study of Root Rot Diseases of Guar (*Cyamopsis tetragonoloba*) in Sindh

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The identification of soil –borne pathogens play a significant role in agriculture sector. For this study a Survey was conducted to record disease incidence of root rot in Guar. The aims of this study is cost-effective and efficient method for pathogen detection, finding the overall health and productivity of agricultural field. The study area was based on 52 sites of 13 places from five districts of Sindh. i.e., Mirpurkhas, Hyderabad, Tando Allahyar, Sanghar and Karachi. *Fusarium* spp. was the most common destructive root rot fungi found in all survey areas. The colonization percentage of *Fusarium* spp. was recorded between 55 to 100%. Four different species of *Fusarium*; namely *Fusarium solani*, *F. oxysporum*, *F. moniliforme*, *F. semitectum*wereisolated from the sampled areas. Another root infecting fungi *Macrophominaphaseolina*, was found that ranged between 0 – 45 %. The 3rd tested root rot pathogen, *Rhizoctonia solani* was found at its lowest distribution (0 - 30 %) in all governorates on the diseased, survey area. These results showed that *Fusarium*spp. is the most prevalent in the soil of the agricultural field and responsible for the decline of guar crop. In this study, physicochemical properties of soil i.e. soil organic matter, Ec, cation and an-ion showed significant variation and K^+ deficiency was recorded in all sampled areas. Geographical distribution did not influence fungal pathogenicity, as determined by principal component analysis. Our work highlights the potential soil pathogens identification and paves the way for future research to expand the dataset with A.I to incorporate a wider range of pathogenic spp and help in disease management.
Keywords: Root Rot Pathogens, Colonization percentage%, Guar

INCPS-2024-12A Study of Fungal Pathogens in Dhakki Date Palm Trees in Tounsa Shareef, Pakistan

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Date palm trees, vital for their economic, nutritional, and environmental contributions, face significant threats from fungal pathogens, leading to diseases like Bayoud disease, False Smut, and Thielaviopsis disease. These diseases not only diminish yield and quality but can also lead to the death of trees. Understanding and managing these pathogens are crucial for sustaining date palm cultivation. A recent study aimed to identify fungal pathogens affecting Dhakki Dates trees in Punjab, Pakistan. Samples were collected from the M2H orchard, where trees exhibited unusual drying symptoms. The study involved the preparation and analysis of various plant parts, including stem, leaves, fruit, and root. These parts were meticulously washed and sliced, subsequently, the sliced samples were inoculated onto Sabroud dextrose agar (SDA) plates and placed in an incubator set at 30°C for 5 to 7 days to allow fungal growth. Upon observation of different fungal colonies, sub-culturing was conducted to obtain pure cultures and morphological studies. Microscopy examination under a 40x objective lens was done, using Lactophenol cotton blue techniques was performed to study fungal structures. Out of 54 samples 12 were positive for fungal isolation, with a total of 183 fungi identified. Thielaviopsis punctulata emerged as the predominant pathogen, highlighting its significant impact on date palms in the region. Other notable isolates included *Curvularialunata, Alternaria species, Aspergillus species, Fusarium oxysporum, and Graphioliaphoenic*, all contributing to disease incidence. Efforts to manage fungal infections showed potential, with eight out of 27 infected trees recovering after intervention measures. However, five trees required immediate removal to prevent further spread. This study underscores the importance of identifying and managing fungal pathogens in date palm cultivation. Such efforts are crucial for sustaining economic viability, ensuring food security, and preserving environmental sustainability. Moreover, insights gained from this research advance scientific understanding of fungal-plant interactions, informing future strategies for disease control. Moving forward, continued research and proactive management practices are essential to mitigate the impact of fungal diseases on date palm production.

Keywords: Date palm, Pathogen, Bayoud disease, False Smut, Thielaviopsis

INCPS-2024-110 Identification of Microfungi from Different Types of Water Samples Collected from District Bhimber Azad Kashmir

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The current research was focused on micro-fungal assessment of drinking water from District Bhimber, Azad Kashmir (Pakistan) during the year 2023. The samples of water were collected from specific spots from the study area.

For fungal culturing, two different culture media were used for fungal spores' cultivation. One is potato dextrose agar (PDA) and other is nutrients agar (NA) media. The Baiting Technique and Direct Plate Method (DPM) were used for microfungal culturing and identification from aquatic samples. A total of five sources of each drinking water and polluted water of the selected spots were collected and analyzed. These water sources were tap water, pond water, stream water, rain water, well water and industrial effluent polluted water. The findings indicated that 15 different fungal species were isolated frequently from collected samples and it was estimated that most of the isolated species were predominantly human pathogenic. The occurrence of fungal species was identified in tap water samples (TWS) that were counted 11 species. Similarly, 9 species were isolated from pond water (PW) and 8 species were identified from stream water sample (SWS). It was observed that *Penicillium, Aspergillus, Fusarium, Trichoderma* and *Rhizopus* species were the dominant species isolated from drinking water samples. It was noted that TWS of drinking water contained highest frequency of fungal species because it was provided best atmosphere and nutrition for growth and development of the fungal growth. It was also concluded that *Dreschlerahavaiensis*showed maximum CFU value (900 CFU/ml) in TWS.

Keywords: Water Fungi, Azad Kashmir, Paper, Microfungal Isolation, *Trichoderma* and *Rhizopus*

INCPS-2024-111 Responses of Fungal Stresses and Climatic Impact on Growth and Yield of *Cicer Arietinum* in District Bhimber, Azad Kashmir

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The current study was elaborated the responses of microbial stresses and the influence of the climatic factors on the growth and yield of *Cicer arietinum* in District Bhimber, Azad Kashmir. Both abiotic and biotic stresses reduced the production of chickpea. This research was focused on pathogen-induced biotic stresses which mainly included fungal diseases impact on growth and yield of *Cicer arietinum.* The fungal diseases identified from collected samples were Ascochyta Blight, Botrytis Gray Mold, Fusariumwilt and Rhizoctonia root rot. The most dominant fungal species were recognized as *Fusarium salani,Ascochytarabiei, Botrytis cinerea, Rhizoctonia solani*and*Fusarium oxysporum.* Highest infection rate 57.14 % was observed against *Rhizoctonia salani* while minimum infection rate 20.8 % was observed against *Ascochyta rabiei*pathogen. The highest severity rate was recorded 80 % while the minimum severity rate was recorded as 40 %. The yield of the chickpea crop showed negative correlation with sudden climatic variation in the selected study. A shorter crop cycle observed due to shorter phenological stages after sudden higher temperatures. The low

productive/nutrient soils have also negatively influenced on farming when rainfall declines and poor irrigation opportunities. Therefore, it was concluded that both fungal diseases/biotic stresses and drastic chances in climatic/abiotic factors showed negative impact on growth and yield of *Cicer arietinum* crop in the study area. Hence, the crop of *Cicer arietinum* reduced significancy due to fungal stresses and poor climatic factors.

Keywords: Microbial Stresses, Climatic Factors, Fungal Diseases, Biotic Stresses, Abiotic Factors, *Cicer arietinum,* District Bhimber, Azad Kashmir

INCPS-2024-112 Allelopathic Impact of Selected Weeds on Growth and Yield Parameters of Wheat Grown in District Bhimber, Azad Kashmir

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Four weed species like *Chenopodium album, Fumaria indica, Lantana camara* and *Anagallis arvensis* were used to check their allelopathic effects against growth rate of *Triticum aestivum*. All the weed powder treatments indicated significant effects on fresh and dry root and shoot weight of wheat plant. Some treatments exhibited inhibitory effects on seed germination and plant growth, while others showed stimulatory effects. The speed of seed germination varied among the treatments, with some showing faster or slower germination rates compared to the control. Result of this study revealed that higher concentration of weed invitro treatments suppressed the growth of *Triticum aestivum* significantly. The allelopathic effects varied depending on the type and quantity of the weed leaf powder used. These results suggested that the allelopathic effects of weed extracts indicated negative impacts on the seed germination and growth of wheat crop. Hence, many different weed management strategies were recognized in agricultural practices. Further the research was explored the specific mechanisms involved in these allelopathic interactions and assessed the long-term effects on crop productivity.

INCPS-2024-120 Antifungal Activity of *Euphorbia helioscopia*, *Fumaria indica* and *Anagallis arvensis* Subsp. *Foemina* Collected from Sokasan District Bhimber, Azad Kashmir

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The antifungal activity of stem and leaf extracts in different solvents of three medicinal plants were evaluated against four fungi i.e., *Rhizoctonia solani*, *Fusarium oxysporum, Mycosphaerellagraminicola, and Gibberellaavenacea*. The agar well diffusion method and disc diffusion method were used to evaluate the antifungal activity of selected medicinal plants. The *Euphorbia helioscopia* showed a maximum zone of inhibition (ZI) 27mm in methanolic leaf extract, while a maximum ZI of 28mm was also indicated against *Gibberellaavenacea* in methanolic stem extract by agar well diffusion method (AWDM). The *Euphorbia helioscopia* showed a maximum zone of inhibition (ZI) of solvent methanol (29mm) for leaf extract and 27mm ZI for stem extracts against *Gibberellaavenacea*by disc diffusion method (DDM). The *Fumaria indica* leaf and stem crude methanolic extracts indicated maximum ZI 26mm against *Gibberellaavenacea*by agar well diffusion method (AWDM). The plant *Fumaria indica* indicated maximum ZI 30mm for methanolic leaf extract, while ZI of 29mm for methanolic stem extracts against *Gibberellaavenacea* by Disc diffusion method (DDM). The plant *Anagallis arvensis* subsp. *foemina* elaborated a maximum ZI (25mm) against *Mycosphaerellagraminicola for leaf extract in methanol and a maximum zone of inhibition by solvent ethanol (27mm) against Fusarium oxysporum* for stem extract by agar well diffusion method (AWDM). The plant *Anagallis arvensis* subsp. *foemina*also explored maximum ZI 28mm against *Gibberellaavenacea* in ethanolic leaf extract, while maximum ZI 26mm measured against *Mycosphearellagraminicola*after treatment stem extract prepared in distilled water by disc diffusion method (DDM). These findings revealed that the disc diffusion method DDM has shown better antifungal activity as compared to the agar well diffusion method. Although all selected medicinal plants indicated very significant antifungal activity against 4 fungal species. *Fumaria indica* medicinal plant indicated the best antifungal activity against *Gibberellaavenacea* fungi. Therefore, we should focus on the compound isolation from *Fumaria indica* medicinal plant for future targeted fungal species.

Keywords: Antifungal activity, *Euphorbia helioscopia*, *Fumaria indica* and *Anagallis arvensis,* Medicinal plants

INCPS-2024-121 Phytochemical Screening and Antifungal Activity of *Silene Conoidea* Collected from Samahni Azad Kashmir

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This study was conducted to evaluate the effect of distilled water and ethyl ether extracts from silene conoidea leaves, stem and inflorescence on

growth of two pathogens *Aspergillus niger* and *Fusarium oxysporum* prepared from these extract inhibited the growth of the test pathogen and the effect gradually increased with concentration shows the antifungal activity of *S. conoidea* in correspondence to control. The control used was *Streptomycin* and *penicillin.* The present antifungal activity were assessed by following methods i.e. agar well diffusion method and disc diffusion method. The investigation showed that *Silene conoidea* have maximum antifungal potential in distilled water extract with highest zone of inhibition (25.21mm) against *Fusarium oxysporum* and with lowest zone of inhibition (20.01mm) against *Aspergillus niger*, While ethyl ether extract showed highest zone of inhibition (29.84mm) against *Aspergillus niger* and with lowest zone of inhibition (22.05mm) against *Aspergillus niger* and the maximum antifungal potential in distilled water extract with highest zone of inhibition (25.59mm) against *Fusarium oxysporum* and with lowest zone of inhibition (20.10mm) against *Fusarium oxysporum*, While ethyl ether extract showed highest zone of inhibition (29.03mm) against *Aspergillus niger* and with lowest zone of inhibition (22.60mm) against *Fusarium oxysporum*by these methods respectively. The main objective of this study was to conduct phytochemical screening of selected traditionally used medicinal plant *Silene conoidea*. The phytochemical constituents identified were flavonoids, alkaloids, saponins, and proteins. The crude extracts and distilled water and ethyl ether fractions of the extracts showed an activity against the tested strains. The investigation of leaves extract of *S. conoidea* of solvent ethyl ether shows the presence of flavonoids, tannins, alkaloides, and proteins while saponin is absent. The investigation of leaves extract of *S. conoidea* of solvent distilled water shows the presence of saponin, tannins, and proteins while flavonoids and alkaloids are absent.

INCPS-2024-62 *In Vitro* Propagation of Sugarcane Mitigating Effect of Sugarcane White Leaf Disease

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Sugarcane, an economically significant crop used for sugar extraction particularly in Pakistan. Sugarcane white leaf disease (SWLD) is emerging as a devastating threat to sugarcane and industry and causes enormous economic losses. Disease samples were collected from farmers' fields, as well as sugar mills and research farms at multi-locations in province Sindh. Data regarding disease incidence and severity was assessed. The disease incidence varied from 2 to 15% in different areas of the province. *In vitro* culture was also carried out to develop healthy and disease free seed from SWLD. NIA-2012, SPF-234, HSF-240 were utilized as ex-plant source for tissue culture. Tissue culture derived plants were sown in Mirpur Khas and Tando Muhammad

Khan. These locations have substantial SWLD incidence because of the already present vector population in the area and encountered disease prevalence in past. A very low disease incidence (0.0 to 3.0%) was observed in tissue culture derived plants at Mirpur Khas and Tando Muhammad Khan. This observation suggested that the apical meristematic tissue culture of the thin plant tissues resulted in loss of phytoplasma–the causative agent of SWLD. Absence of the causative agent, the progeny population did not carry the disease. Therefore, results have shown that tissue culture derived plants can successfully utilize for SWLD disease mitigation.

Keywords: *In vitro*; Sugarcane white leaf disease; Tissue culture; Mitigation

INCPS-2024-275 Screening of Cucumber Germplasm for Resistance to Cucumber Mosaic Virus, Correlation of Disease with Environmental Factors and its Management Strategies

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Cucumber (*Cucumis sativus*) is an important vegetable crop which belongs to family Cucurbitaceae. It is native of Asian continent and grown in different areas of the world. Cucumber carries minerals such as copper, phosphorus, potassium and magnesium, as well as 14% to 19% of the vitamins K, B and C. Winter is the growing season for cucumbers. Many bacterial, viral and fungal diseases affect it. The most prevalent disease affecting cucumber plants is Cucumber Mosaic Virus which can reduce crop production by 10% to 20%. Cucumber Mosaic Virus is a RNA virus and belongs to genus Cucumovirus and family Bromoviridae. It is spread by several types of aphids. Aphids feed on infected plants for a few minutes during which time the virus spreads to healthy plants. This study is conduct to screen the cucumber germplasm against CMV and its management through chemicals. Among the 11 varieties VRI-3-80A and VRI-6-76E show moderate symptoms and VRI-7-31F show extremely sever infection of disease. No variety was completely immune against the Cucumber Mosaic virus. Among all the treatments Acetamaprid have highest control against the disease and control treatment has lowest control after 1st and 2nd treatment. After 1st and 2nd treatment VRI-3-80A is highly effect by the disease and show sever symptoms. In term of vector population the control plants have maximum number of vectors (10.6) and VRI-5-81B has minimum number of vector population (1.3). Environmental factor is positively co- relate with the disease severity. At maximum temperature (34℃) the disease severity was 49% and at minimum temperature (26℃) the disease severity was 41% recorded. Disease severity was 47% when relative humidity was 18%. In the

results of survey the maximum disease severity was noted in Yazman area and minimum in Bhawalpur area.

Keywords: Cucumber Mosaic virus, Aphids, environmental factor and disease severity

INCPS-2024-276 Evaluation of Berseem Germplasm and Various Chemicals for Management of Stem and Crown Rot Disease and Its Epidemiology

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Berseem (*Trifolium alexandrinum* L.) is one of the most important winter fodder crops and is cultivated as winter annuals in the tropical and subtropical regions of Pakistan. It is grown in irrigated areas on a large scale throughout the country. It is a high-quality green forage and a Nitrogen-fixing legume. It is the major growing cattle fodder in Pakistan. As a winter crop, its play a vital role in providing good quality feed for animals. As a nitrogen fixer its cover the soil and prevents soil erosion. Stem and crown rot disease of berseem is a complex disease that causes severe losses upto 46-60% to the crop. Light brown spots appear on leaves and petioles and crown or basal parts show brown soft rot and white mycelium grow on dead leaves and petioles. The disease was found to be prevailing in the district Faisalabad; thus, the research was conducted for evaluation of different berseem germplasms and to observe the effect of different chemicals on disease in relation to epidemiological factors. Samples were collected from the research area of department of Plant Pathology UAF Faisalabad. The fungus was isolated, purified and morphologically identified. *Sclerotinia sclerotiorum* was found to be present in collected infected samples of stem and crown rot of berseem. Ten different germplasms were collected and underwent screening. Anmol germplasm was observed resistant with a disease incidence of 9.33%. To observe the effect of different chemicals on disease incidence of stem and crown rot of berseem, different treatments were prepared for management. Among used treatments, Topsin-m (Thiophanate methyl) was found most effective against the disease. Effects of different chemicals were examined statistically by using Tuckey HSD at a 5% level of significance. Correlation and Regression analysis were made to find the relation of disease development to environmental factors. For temperature (Max. and Min.), the relationship was found positive, while the relationship for wind speed, relative humidity and rainfall was found to be negative with a disease incidence against stem and crown rot of berseem.

Keywords: Berseem, germplasms, Stem and crown rot and *Sclerotinia sclerotiorum*

INCPS-2024-277 Management of Downy Mildew of Cucumber in Relation to Epidemiological Factors

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Cucumber (Cucumis sativus) which belongs to family Cucurbitaceae, is a significant vegetable crop that is grown all over the world. Downy mildew disease of cucumber is caused by Pseudoperonosporacubensis which reduces yield from 10-40% under favorable environmental conditions. To identify the source of cucumber downy mildew symptoms, nearly ten cucumber germplasm samples were taken from the Ayub Agriculture Research Institute in Faisalabad (AARI) and sown in a greenhouse before being transferred to the field after three weeks. In order to manage downy mildew disease, an experiment was carried out using a randomized complete block design (RCBD). Downy mildew disease on cucumber was treated with various chemicals, particularly with Metalaxyn+mancozeb, Propineb and Mendipropamid. The results suggest that the VRI-5-81B variety responded 38.54% to disease severity, while the VRI-7-31F variety rose 53.89%. In terms of disease incidence, VRI-4-BSR had a minimal disease incidence of 20.55%, whereas VRI2-SK had a disease incidence of 57.84%. VRI-6-76F demonstrated a minimum of 18.34% of disease severity and diversity. VRI-09-SA revealed a maximum disease severity of 39.42%. Disease severity was compared after the first chemical therapy and VRI-7-31F had the lowest disease severity at 13.47%, while VRI-6-76E had the highest at 24.72%. After the second treatment, chemicals reduced symptoms of disease by 28.44%. There was a negative correlation between cucumber disease incidence and downy mildew. Environmental factors such as minimum and maximum temperatures, relative humidity, and rainfall all aided in the spread of the disease. The varieties had a negative correlation with percentage incidence of downy mildew at minimum and maximum temperatures. Rainfall had a significant impact on disease spread since extended leaf wetness was the primary cause of downy mildew disease, with disease severity at 18mm being 25% and at 20mm being 43%.

Keywords: cucumber, downy mildew, disease severity and environmental factors

INCPS-2024-279 Biochar for Nematode Control in Vegetable Crops

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Tomato (*Lycopersicon esculentum* Mill) is a fundamental component of our diet, but it often faces a hidden problem in the soil, root-knot nematodes (Meloidogyne spp.). These tiny worms form galls on tomato roots leading to reduced yields and fruits with inferior quality. Usually, people use chemicals called nematicides to get rid of these worms but these chemicals can harm the environment and even make people sick. So, there's a need to find a better and more sustainable solution. Biochar, a charcoal made from natural byproducts, could be a potential strategy to control nematodes. This study focuses on the utilization of biochar developed from different feedstocks (wheat straw, maize stalks, green waste and sugarcane bagasse) at two different pyrolysis temperatures (300°C and 500°C) to manage root-knot nematodes in tomato. The extracts of these biochars were tested for there nematicidal potential at first but no direct nematicidal activity was found. A pot experiment was launched using a triplicate completely randomized design to test the efficacy of various biochars at different concentrations (1%, 2% and 3% w/w) to combat root-knot nematodes and growth promotion effects. The application of biochar resulted in improved tomato plant growth and a decrease in root-knot nematode development. According to the results, the most effective biochar treatment was sugarcane bagasse biochar (SCB) produced at 300℃, followed by SCB500°C for both enhancing growth and managing nematodes in tomato. However, further investigation is needed to understand the specific mechanisms through which biochar application promotes growth and controls nematodes in tomato. The number of females, galls and egg masses differed for all treatments. The lowest number of galls, egg masses and females were found in 3% sugarcane bagasse pyrolyzed at 300°C treatment and highest results were examined in the positive control. The results show that using biochar is important for managing root-knot nematodes (RKNs) in tomato and other crops.

Photosynthesis and Crop Productivity

INCPS-2024-201 Assessment of Growth, Yield and Some Physiological Attributes of Selected F7 Wheat Lines from a Cross S-24 × Fsd-08

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Wheat (*Triticum aestivum* L.) is the most important cereal crop in the world. It belongs to the most important and diverse family, Poaceae, in the plant kingdom. Production of wheat has gradually declined and is disturbing in developing countries, which are already facing the problem of food storage. There are many strategies to enhance wheat production, but breeding is one of the best solutions to enhance wheat production. Breeding strategies prove successful in producing high yield cultivars of wheat along with better use of nutrition, more salt and drought tolerant and less susceptible to diseases. We can improve the existing genes with better high yield and disease-resistance genes through wheat breeding. To evaluate the different selected F7 lines of wheat, field experiment was designed in which parent wheat cultivars (S-24 and Faisal abad-08) and their 12 selected F7 lines were sown under normal field conditions in the field of Biopark, Bahauddin Zakariya University, Multan, Pakistan. Water and fertilizers were applied to the plants periodically whenever needed. Different growth and yield parameters such as the flag leaf length and width, plant height, number of spikes/plant, the number of tillers/plant, total seed weight (g/plant), 100 seed weight (g), and the number of grains produced/spike. The chlorophyll fluorescence-based technique can detect genetic variation in PSII-related parameters.Significant correlations were observed between photosynthesis-related traits and yield-related traits in wheat. The study focuses mainly on growth and yield while some physiological attributes are also taken at different stages of growth by using photosynQ. Based on the outcomes, L-1, L-4, L-6, and L-15 demonstrated the most favorable growth and are recommended for further research. They exhibited superior performance compared to their selected F7 lines and parent lines in terms of growth and yield characteristics, including a longer flag leaf length (31.4cm), shorter plant height (106.8cm), 100 seed weight of 5.116g, spike yield of 2.805g, number of grains per spike (14.51), and physiological parameters such as quantum yield (0.71), chlorophyll content (52.19), Fo′ (642), Fm′ (3015), and Fv′/Fm′ (0.772).

Keywords: Wheat, growth, yield, physiology, breeding, photosynQ

Phycology, Marine Biology

INCPS-2024-259 Systematic Study of Prokaryotic Blue-Green Algae (Cyanobacteria) Based on Dichotomy of Morphological Characteristics

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The broad group of prokaryotic microbes known as cyanobacteria, or blue-green algae, is essential to many ecosystems. Uncovering their ecological relevance and prospective applications requires an understanding of their taxonomic classification and evolutionary links. In this thesis, prokaryotic blue-green algae are systematically studied, with a focus on the dichotomy of morphological traits as a basis for classification. The study starts with a thorough analysis of the state of the art in cyanobacterial taxonomy, emphasizing the problems with conventional methods and the demand for new categorization techniques. It is suggested that a novel strategy to address these issues and offer a greater knowledge of cyanobacterial variety is the dichotomy of morphological traits. A large number of cyanobacterial samples from various habitats, including freshwater, marine, and terrestrial settings, are included in the study. These samples are put through in-depth morphological evaluations using light, scanning, and transmission microscopy, among other techniques. For each strain, a wide range of morphological traits, including cell size, shape, arrangement, pigmentation, and cellular structures, are recorded. A dichotomous key is created based on the reported morphological characteristics to help identify and categorized cyanobacteria. The key is intended to assist taxonomists and researchers in correctly identifying cyanobacterial species and genera based on their distinctive physical characteristics. Furthermore, the visually based classification system is validated and improved using molecular techniques like DNA sequencing and phylogenetic analysis. A thorough foundation for cyanobacterial taxonomy is created by combining molecular information with morphological traits, allowing for a more reliable and precise categorization. The findings of this study aid in the development of a thorough and trustworthy categorization scheme for prokaryotic blue-green algae. Researchers may identify cyanobacteria with the help of the dichotomy of morphological traits, which also provides vital information about their ecological functions, evolutionary history, and possible biotechnological uses. In the end, this research improves our knowledge of the diversity of cyanobacteria and makes it easier to conserve them and use them sustainably in a variety of applications.

Plant Biotechnology and Genetic Engineering

INCPS-2024-185 Docking-based Therapeutic Analysis of Maize Cysteine Proteinase 1 and LOX-1 Complex Against Atherosclerosis

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Zea mays L. is a cash crop belongs to grass family (Poaceae). The study is primarily focused on sequence analysis, structure prediction, structure validation and molecular docking of Cysteine Proteinase 1 of *Z. mays*. The primary residual sequence of ZmCP was obtained from UniProtKB online server with Accession No B5KVP9. Primary sequence showed 89.3% sequence homology with *Sorghum bicolor* (Accession No. C5WVP4) and 82.9 % with *Setariaviridis* (Accession No. A0A4U6T481). Structure of ZmCP was predicted by online server SWISS-MODEL which used coordinate information of *Ananas comosus* Cysteine Proteinase 1 (PDB ID: 6U7D) as a template which has 42.9 % sequence homology with ZmCP. Predicted ZmCP consists of 310 amino acids in a polypeptide chain and 34 kDa molecular weight. There are 6 sheets; 4 β-hairpins and 10 helices. Predicted structure was validated by ERRAT which showed 88% overall quality factor for ZmCP. Similarly, Ramachandran plot showed 85% with 227 residues in the favored regions. The structure alignment of ZmCP with the template Bromelain of *A. comosus* was performed by PyMOL software. Root Mean Square Deviation was calculated to analyze the structural similarity between aligned structures which indicated highly homologous molecular conformation of both the proteins with RMSD value of 0.134 Å. ZmCP was docked with human Lectin-like oxidized LDL receptor 1 (LOX-1) via ClusPro and it showed low binding energy (-12.7 kcal/mol) along two salt bridges and fourteen hydrogen bonds inside the complex. One salt bridge has been contributed by arg-75 of ZmCP and asp-147 of LOX-1 and second is aided by arg-85 of ZmCP and asp-189 of LOX-1. The main residues contributing for hydrogen development in docked complex are met-45, arg-74, arg-75, glu-78, his-79, thr-83, arg-85, glu-104, asn-139, glu-272, gln-288, arg-292, asn-294 (ZmCP) and asn-139, ser-141, gln-146, asp-147, trp-148, trp-150, his-151, gln-193, ala-194, tyr-197, leu-270 (LOX-1). The structure prediction of ZmCP and its docked complex with LOX-1 is valuable for understanding of atherosclerosis development at first and further anti-atherosclerosis therapy by inhibiting the binding of oxidized LDL with LOX-1 receptor that will reduce the frequency of cardiac arrest.

Keywords: *Zea mays*; Cysteine Proteinase 1; LOX-1; ClusPro; Atherosclerosis

INCPS-2024-05 Epidemiological Analysis of Autism Spectrum Disorder in the Children of District Swabi,KP, Pakistan

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Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by social communication and behavioral impairments. This study aims to evaluate the prevalence of ASD in district Swabi.Aquestionnaire based study were conducted in the month of December 2023 to March 2024.This study aims to evaluate the current understanding to examine the maternal, parental and environmental factors that may increase the risk of Autism Spectrum Disorder. Moreover, it was estimated that psychological interventions in the children can improve specific behaviors such as joint attention, language, and social engagement may affect further development and could reduce symptom severity. Understanding these factors can inform the early intervention and prevention strategies to support the families and individuals affected by Autism Spectrum Disorder.
Keywords: Autism, Prevalence, Factors, Psychological interventions, Prevention strategies

INCPS-2024-288Spatio-temporal Expression of Cry2A Protein in Some Bt-Cotton Varieties and their Comparative Study for Drought Tolerance

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The Cotton (*Gossypium hirsutum* L.) is a very important fiber and cash crop. Its production has been severely reduced because of the environmental constraints including drought stress and insects/pests attack. To control this problem, some sort of resistant and good fiber quality varieties were raised through conventional and molecular breeding approaches. Among these, the transgenic Bt cotton varieties, harboring Bacillus thuringiensis Bt toxin gene, gained much importance exhibiting resistance to the boll worms. In this study, five different transgenic cotton varieties. i.e., CKC-1, CKC-3, CKC-5, CKC-6 and CKC-7 were compared with a non-Bt variety VH-144 for potential of water deficit tolerance by investigating the plant biomass, plant height, number of leaves per plant, photosynthetic pigments, total soluble proteins, total free amino acids, quantum yield, antioxidants (POD, CAT and APX), number of flowers per plant and number of bolls per plant,. Furthermore, the selected Bt varieties were subjected to investigate the spatio-temporal expression of the insecticidal Cry2A

protein through ELISA. The results indicated that the CKC-3 and CKC-6 varieties were found to be relatively better in growth management under water deficit condition whereas the varieties CKC-1 and CKC-5 were screened as poor in drought tolerance. Furthermore, CKC-3 and CKC-7 showed the highest concentration of Cry2A protein as compared to other Bt varieties. The leaves of the Bt cotton plants were found to have the highest level of toxin protein (Cry2A) followed by bolls and flowers. It was concluded that CKC-3 and CKC-6 could be good choice to grow in water deficit area for better crop production.

INCPS-2024-289 Identification and Characterization of Some PGPR Strains Isolated from Some Grasses of Cholistan Desert

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The rhizosphere is the narrow zone of soil in close contact with plant roots. Along with the root exudates, rhizosphere is important for variety of useful microbes particularly bacteria. The rhizospheric bacteria may directly or indirectly help the plants in growth improvement as well as immunity strengthening. Cholistan desert is spread along the Eastern border of Pakistan in Bahawalpur division. There are some wild grasses growing in Cholistan desert which are drought tolerant and open horizons to investigate drought tolerance mechanism. Considering previous reports of the role of PGPR in inducing and/ or strengthening drought tolerance, current study was designed to identify and characterize PGPR in rhizosphere of some wild grasses of Cholistan desert. The bacteria were cultured from collected rhizospheric soil samples on agar media in multiple steps to get the purified bacterial colonies which were subjected to Gram staining, microscopy and 16S-rRNA sequencing for identification. The identified genera included Bacillus, Enterobacter and Exiguobacterium. Twenty bacterial isolates were tested for different plant growth promoting attributes including N, S & Zn solubilization and catalase, siderophores and indole-3 -acetic acid (IAA) production. The results showed that the bacterial isolates possess multiple plant growth promoting traits and can be used as a potential candidate to improve plant production. The isolated strains are being applied to some of the crop and non-crop plants including Wheat, Barley, Rice, Maize, Sorghum, Pearl millet, Sunflower, Safflower, Canola, Chickpea, Tomato, Paprika, Cucurbits, Arabidopsis, Tobacco, Lawn grass and others to investigate their compatibility and functions for plant growth promotion and defense strengthening against various biotic and abiotic stresses. On these grounds, this study will be very helpful in sustainable plant production and agriculture.

Keywords: Cholistan, PGPR, Phosphate solubilization, Rhizosphere,

Plant Ecology and EnvironmentalPollution

INCPS-2024-15 Phytosociological Study of Weeds in (*Saccharum officinarum L.*) Crop Fields of Union Council Bagh, District Jhang, Punjab, Pakistan

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Sugarcane is the most important commercial crop of Pakistan as it is cultivated on large area across the country and also providing raw material for a number of industries. It is extremely important to study the effects of unwanted weeds on crops as they compete for resources such as nutrients available for crops specifically considering sugarcane as they lower crop yield. Their reproductive rates are comparatively high as compared to other plants due rapid seed development and also having allelopathic effects. Current study was done during the months of July and August 2023 to examine their impact on sugarcane crop (*Saccharum officinarum* L.). For sampling purpose, quantitative ecological techniques were used and 60 quadrats of 1m2 were placed randomly in 20 fields of sugarcane. Soil samples were also collected for analysis such as percentage soil organic matter, electrical conductivity, pH, soil textural class (percentage sand, silt and clay), percentage of available phosphorus and potassium etc. Density and cover of weeds in a quadrat were noted during the field survey. Relative density, relative cover, relative frequency and Importance Value Index of weed were calculated. Total 36 weeds were collected and identified from the fields out of which Dactylocteniumaegyptium was dominating weed with highest IVI value, followed by Cynodondactylon and Euphorbia serpens. Our findings will pave a way to build up new environment-friendly weed control methods to increase the crop yield.

Plant Genetics and Breeding

INCPS-2024-182 Characterization of Wheat Genotypes for Some Morphological Traits to Improve Yield

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Genetic improvement is an ongoing process aimed at sustaining wheat production in Pakistan. In this context, efforts have made to evaluate genetically diverse germplasm for various grain yield and its related traits. To fulfill this objective, fourteen genotypes was utilized, namely Dilkash, Akber-19, Fareed-06, Ghazi-19, Johar-16, Fakhar-e-Bakhar, Aas-11, Nawab-21, Subhani, Arooj, Gold-16, Sadiq-21, Meraj-08, and Nishan these genotypes were evaluated in RCBD.The results revealed that the tallest plant height was observed in Dilkash (83.70 cm). Conversely, Subhani exhibited the shortest plant height. The longest peduncle length was observed in Sadiq-21 (18.47 cm). Variety Nishan showed the highest number of spikelet per spike (22.53), followed by Dilkash (22.07) and Gold-16 (21.80). In terms of spike length, Fakhar-e-Bakhar exhibited the longest spike (19.87 cm), followed by Johar-16 (19.73 cm) and Ghazi-19 (16.40 cm), While the shortest spike length was observed in Fareed-06. Dilkash had the largest leaf sheath area (64.22 cm²), followed by Akber-19 (60.60 cm²), whereas Fakhar-e-Bakhar exhibited the smallest leaf sheath area (30.74 cm²). The diverse genotypes crossed in a manner to achieve heterosis and their hybrids perform well against adverse challenges of climate change.

Key words: Wheat, Heterosis, Yield, Morphological traits

INCPS-2024-227 Unravelling the Combining Ability of S-24 and Linxia 06-43 for Agronomic Trait of Spike and Grain Yield in cv. S-24 and cv. Linxia 06-43

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Wheat (*Triticum aestivum*L.)is the most important cereal crop throughout the world. It belongs to most important and diverse family of plant kingdom. Production of wheat has gradually declined and is disturbing in the developing countries, which are already facing the problem of food shortage. For increasing wheat production and to meet future demand breeding is the best method. Through wheat breeding, we can change the existing genome

with a better yield productive genome. The study mainly focuses on yield parameters, although different agronomic and physiological parameters were also taken at different growth stages. In a field experiment; one local cultivar S-24 which is rust susceptible to lodging and Chinese variety Linxia06-43 was grown in the field of Biopark, Bahauddin Zakariya University, Multan. Plants of both cultivars were crossed. Data for photosynthetic pigments and functional activity of PSII and PSI is measured using RIDE.2.0 protocol at the photosynQplatform.In addition, ATP synthase activity was also measured using dark induce relaxation kinetic analysis (DIRK) at the same phenotyping platform. Morphometric and agronomic attributes of yield were also measured. The results showed that from 60 crosses made, 45 seeds were formed. Photosynthetic activity of PSII was higher in S-24 which was positively associated with Fo′ higher in S-24 while ΦPSII, ΦNO, ΦNPQ, NPQt, LEF, and light intensity (PAR) photosynthetic pigment are almost same in both lines qL is higher in S-24. Grain yield in S-24 is greater than Linxia06-43. Hundred seed weight (g) is almost the same in both cultivars. Total seed weight in grams is higher in S-24. Plant height in cm, number of tillers per plant, and number of spikes per plant is higher in S-24.

Keywords: Pakistani and Chinese wheat cultivars, growth, yield, breeding, photosynQ

INCPS-2024-229 Genome-Wide Association Study (GWAS) on Novel Leaf Traits (NLTS) in Wheat

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Wheat (*Triticum aestivum L.)* is a staple crop in Asia and is crucial in nourishing humanity. Regarding food security, wheat is the second most important food crop in the developing world after rice. The changing climate and diminishing water sources require the use of scarce natural water supplies, such as air moisture, for irrigation. Wheat production is threatened by climate variability and extreme climate events, particularly heat waves and drought. Several studies have been conducted on the self-irrigating properties of the wheat plant. This study aimed to find the SNPs associated with Novel Leaf Traits in wheat. This would help in the selection of self-irrigating wheat plants by optimizing leaf architecture and surface properties for precise self-irrigation. Wheat germplasm of 220 genotypes was characterized for Novel Leaf Traits (NLTs) i.e. leaf angle, leaf rolling, grove type, and prickle hairs. The analysis of variance depicted significant

difference among genotypes for NLTs. GWAS was conducted to find the SNPs linked with Novel Leaf Traits to mitigate the water shortage problem. Based on the 37K wheat SNP assay, a genome-wide association study (GWAS) identified 50 stable and significantly associated signals for above mentioned traits. The SNPs were found on chromosomes 2A, 2B, 3A, 4B, 5A, 2D and 7A. Most of the SNPs were found on chromosome 2B. This study establishes the theoretical foundation for future research into the genetic mechanisms underlying wheat novel leaf traits and the efficient breeding of varieties with desired plant architecture through Genomic selection.

Plant Physiology and Stress Physiology

INCPS-2024-169 Effectiveness of exogenous proline through priming in reversing salt damages to growth of wheat (*Triticum aestivum*) plants as well as excised leaves

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Proline modulates the salinity stress along with improving plant growth. An experiment was set up to observe the response of four wheat varieties: S-24, Galaxy-13, Pasban-90 and Sehar-06 to proline (15mM) and salinity (150 and 300 mM) in terms of growth and photosynthetic stability. Proline priming (15 mM) led to an improvement in overall shoot and root growth. Salinity treatments depicted variable response in growth, where S-24 showed no impact, P-90 exhibited reduction and G-13 exhibited improvement. Besides growth, plants were further studied for their PSII stability through OJIP-test. Performance indexes, PIABS and PItot, were considered as indicators of cumulative impact of treatments at PSII. Results indicated slight improvement in PIABS and Fv/Fo (functionality of OEC) in G-13, due to proline treatment in control group contrary to their proline treated saline groups. In all other three varieties, there was uniform response of increased performance indexes (PIABS and PItot) due to proline treatment during salinity, whereas there was a decline in proline treated than control plants. In the second part of experiment, proline primed leaves of two wheat varieties; *S-24* and *G-13*, were excised and tested for their salt (NaCl) susceptibility at low (150 mM), medium (300) and high salt stress (600 mM). Structural stability of PSII was again tested through chlorophyll a fluorescence technique (OJIP-test) after random intervals (4 hrs, 40 hr and 64 hrs). Results indicated successful regulation of all stresses after 4 hours of leaf excision. Proline enhanced the activity of OEC (Fv/Fo) in salinity treated leaves resulting in rapid electron flow in low salinity levels and also the PIABS. However, both Fv/Fo and PIABS decreased at higher salinity levels. Stress induced dissociation of LHCII was observed at later stages (40 and 64 hrs). After 64 hours, the leaves were tested for PSII and PSI efficiency through light curve. Studies revealed that Proline reduced the photochemical damages at higher salinity. Overall, *G-13* was damaged more quickly than *S-24*, exhibiting its lower tolerance potential. Moreover, for low salinity (150 mM), proline can provide long term protection to PSII.

Keywords: Chlorophyll fluorescence, Performance index, proline, OJIP, salinity, excised leaf

INCPS-2024-195 Identification of Mode of Action of Photosynthetic Herbicide, Atrazine, on Wheat (*Triticum aestivum* L.) by Chlorophyll a Fluorescence Analysis and Molecular Docking Study

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Many herbicides applied for weed control inhibit PSII by interrupting the photosynthetic electron transport chain at the level of the D1 protein, through competition with the plastoquinone for the QB site. In the present study, a pot experiment was conducted to observe the effect of PSII-inhibiting herbicide (Atrazine) at six different concentrations (0 µM (control), 0.1, 1, 10, 100, and 1000 µM) on wheat (*Triticum aestivum* L.). We combined OJIP chlorophyll fluorescence kinetic measurements with in-silico analysis. Fluorescence measurements were taken after 24, 48, and 72 hours of herbicidal application but more significant results were observed after 48 hours. A significant reduction in fluorescence measurements was observed at 100 and 1000 µM concentrations of atrazine. To investigate the molecular details of the interaction of atrazine with the D1 and D2 proteins of wheat (*Triticum aestivum* L.), we performed an in-silico analysis. For that purpose, a predicted 3D structure of the D1 protein of wheat was retrieved in PDB format from a protein data bank (PDB) or UniProtKB. The D2 protein of wheat was homology modeled by using SWISS-MODEL, homology modeling, an online server, using the structure of *Arabidopsis thaliana* as a template. Ligand (atrazine) was downloaded from PubChem. When the D1 protein of wheat was docked with atrazine, it was found that atrazine bound with Glu 333 residue at the QB site and when the D2 protein of wheat was docked with atrazine, it was observed that atrazine bound with Val 260 residue at QA. The binding of atrazine with those residues caused the blockage of the electron transport chain and inhibited photosynthesis. This condition was observed when atrazine was applied at 100 and 1000 µM concentrations. Docking was performed by using PyRx, a multiple ligand binding software. Docking results were observed in PyMol and BIOVIA Discovery Studio 2020.

Keywords: Photosynthetic herbicides; atrazine; OJIP, JIP-test; molecular docking

INCPS-2024-194 Influence of Exogenous Application of Omeprazole on Water Status and Photosynthetic Capacity of Maize (*Zea mays* L.) under Drought Stress

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Drought stress hampered maize growth, development, and yield, necessitating novel strategies to increase drought tolerance. Exogenous application of biostimulants at minimal concentration can enhance a plant's abiotic stress tolerance. Recently, omeprazole (PPI) has been reported to enhance N uptake and assimilation in tomato, basil, and corn. The present study aimed to assess the influence of exogenously applied OMP (10 µM) through the rooting medium and as a foliar spray in alleviating adverse effects of drought stress on plant water status, PSII structural stability and functionality, and light reactions in maize. In a pot experiment, two week old maize plants were exogenously treated with OMP (10 µM) through the rooting medium & foliar spray and subjected to drought stress by withholding water for further two weeks. Drought stress reduced growth, RWC, water potential, and osmotic potential. Exogenously applied OMP increased growth and improved plant water status by increasing the accumulation of proteins and amino acids. Drought stress reduced photosynthetic pigments and caused PSII photodamage at the donor and acceptor end of PSII by reducing QY, Fv/Fm, and PI_{ABS}, and increasing Fo, Fj, and Vj. Drought stress also reduced PSII activity by declining Y(II), ETR-II, and increasing NPQ. Exogenous application of OMP improved PSII activity by increasing the photoprotective component of NPQ as indicated by Y(NPQ), NPQt, and Φ_{NPQ}. Exogenous application of OMP decreased ECSt, gH^+, vH^+ through ATP-synthase. Drought stress caused membrane damage through oxidative stress (H_2O_2& MDA), and OMP application reduced the membrane damage by increasing antioxidant enzyme activity (CAT & POD). However, both modes of application of 10 µM OMP (rooting medium & foliar spray) were effective. Yet this improvement was greater through the rooting medium treatment of OMP. It is concluded that OMP application improved the structural and functional activity of PSII, regulation of cyclic electron transport, and photo-protective components of NPQ. Molecular docking between OMP and each of HKT1, PsbA, PsbD, **PIP1-1, PIP1-2,** TIP1-1, nrt2.1, nrt2.2, and NAR of maize showed that OMP interacts with these proteins confirming its role in K uptake, water uptake, NPQ generation, nitrogen use efficiency.

Key Words: Omeprazole, drought, maize, photosynthesis, molecular docking

INCPS-2024-141 Omeprazole Alleviated Adverse Impacts of Drought in Maize (*Zeamays*L.): A Nexus of Dynamics of Water Balance and Photosystem II Activity

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Drought is able to cause biomass reduction, disturbance in water relations as well as in photosynthetic apparatus. Though it has been found that chemical compounds such as omeprazole showed recently good results by promoting biomass, morphological attributes, relative water content, water potential and photosynthetic efficiency. However, mechanism behind the OMP action under drought is unclear. The present study investigates the effect of 10µM omeprazole on two varieties ($D3366^{Tol}$ and $D6619^{Sens}$) of *Zea mays* (maize) subjected to drought after screening. Drought decreased relative water content in both varieties (70% and 62%) while substantially increased osmotic adjustment along with an increase in NPQ and NPQt. However, such effects are different in both varieties. Exogenous application of 10µM OMP increased morphological attributes (shoot /root length, shoot/ root biomass, number of leaves, leaf area), improved water relation related parameters (RWC and water potential) influenced photosynthetic parameters (ϕII, ϕNO, LEF, ECSt, vH+, gH+) under normal and drought conditions in both varieties ($D3366^{Tol}$ and $D6619^{Sens}$). This led to increase maize varieties' growth under drought, such as increase in biomass. These results indicate mitigating effect of omeprazole in $D3366^{Tol}$ and as well as in $D6619^{Sens}$ by increasing morphological, water relations and photosynthetic attributes, reduction in loss of water by boosting water potential of leaf and relative water content (RWC); improving PSII activity when exposed to drought.

INCPS-2024-140 The Battle for survival: Application of FTIR Spectroscopy linked with Physiology in Maize under Drought stress

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Development of drought tolerant hybrids is restricted due to poor knowledge of mechanism behind drought tolerance. The present study was aimed to

investigate the effect of drought on antioxidant response, photosynthetic capacity and mineral nutrient status of maize hybrids. Initially six maize hybrids (D-3464, D-6619, D-4464, D-2468, D-3377, D-3366) have been screened at seedling stage. Selected drought tolerant (3366) and drought sensitive hybrid (6619) (two treatments (0, 1) × 2 hybrids (D-3366 and D-6619)) were further evaluated using growth, biochemical and physiological attributes. Drought significantly reduced relative water content, plant biomass, photosynthesis, and altered accumulation of micro and macro nutrients/ limited uptake of essential macronutrients (N, P, K). Drought induced oxidative stress (H_2O_2, MDA) caused photoinhibition of both donor and acceptor ends of photosystem II. Significant reduction in QY of PSII in hybrid D6619 was mainly due to PSII photodamage. Raw OJIP and double normalised curves of Fo and Fm shows marked changes in fluorescence occurred at O, J, I and P steps only in D6619. Moreover, JIP test has showed decrease in PI_{ABS} of D6619 as compared to that of D3366 which is associated with closed reaction centres Mo, energy fluxes of absorption. ABS/RC, trapping TRo/RC, electron transport ETo/RC and dissipation per reaction centre as heat DI/RC. Fourier transform infrared (FTIR) spectroscopy revealed notable metabolic adjustments, especially in lipids, plastids, proteins, and carbohydrates, indicating biosynthesis of protective compounds such proline in response to drought. Pearson correlation analysis confirmed a strong relationship between drought and the observed physiological and metabolic changes. The findings highlight the potential of FTIR spectroscopy as a non-destructive tool for early detection of drought stress and timely intervention to improve crop resilience and yield. This study highlights the widespread application of FTIR spectroscopy in agricultural research to manage drought stress in crops. Biochemical and physiological attributes suggest greater photodamages to D6619 as compared to that of D3366 which somehow maintained RWC, Biomass, photosynthetic pigments, metabolites and mineral ions around the threshold and protected PSII. The genetic variation revealed among selected maize hybrids could be used in breeding program and high precision crop management.

Keywords: OJIP. Photosystem II. Water use efficiency, Maize, Drought.

INCPS-2024-193 Varietal Screening of Canola (*Brassica napus* L.) and Agronomic and Physiological Responses under Lead Toxicity

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Heavy metals contaminations have not only polluted the agricultural soil but also has hazardous effects on human and wild life. As the complete exclusion of lead (Pb) toxicity from soil is difficult, researchers are working on selecting tolerant varieties that combat against Pb toxicity in the soil.

Keeping the importance of canola, the present investigation was conducted to screen out the canola varieties with different Pb tolerant levels from the available germplasm. A total, 15 varieties (i.e., CON-II and Dunkeld, Super canola, Super raya, Rainbow, CON-III, AARI canola, Cyclone, AC Excel, Legend, Punjab canola, Faisalabad canola, Oscar, Shiralae and Sandal canola) were sown in a hydroponic culture medium at various toxicity levels of Pb, i.e., tap water (no Pb), 0.5, 1.0, 1.5, 2.0 and 2.5 mg Pb/L of solution. The result showed that among the different varieties, CON-II and Dunkeld showed the best germination characteristics, improved chlorophyll contents, antioxidant activity and other growth parameters validated their tolerance. So based on our results CON-II and Dunkeld were observed as tolerant, Super canola, Super raya and Rainbow were found susceptible while remaining as moderate canola varieties against Pb toxicity. Choosing the right canola varieties is important if we want to grow in areas with lead pollution.
Keywords: Heavy metals, Canola, Growth attributes, Antioxidant activity, Chlorophyll contents.

INCPS-2024-152 Improve Tolerance in Barley (*Hordeum vulgare* L.) via Application of Green Synthesized Silicon Nanoparticles under Water Deficit Condition

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Among all the abiotic stress, drought stress is the one which drastically effects plant growth development. To cope with this stress, different kinds of nanoparticles i.e. Silicon nanoparticles (Si Nps) are used that enhance the plant capability to withstand in this stress. The soil filled pot experiment was consist of two (a) Barley (*Hordeum vulgare* L.) varieties i-e Barley-17 and sultan-17 (b) foliar application of Si NPs @ 0, 50,100, 200ppm at vegetative stage. Drought stress affects decreases in root and shoot biomass, relative water content, chlorophyll content. Enzymatic antioxidant such as CAT, POD, APX increases up to some extent. Chlorophyll content such as chlorophyll a, Chlorophyllb, carotenoids and total chlorophyll decreases under drought stress. Spad and quantum yield also decreases under water deficit condition. Proline and amino acids increase under drought stress. Ion analysis results in increases in Na+ ion under drought stress. Yield parameters such as number of tillers, number and length of spike, number and length of spikelet, total seed weight, hundred seeds weight and thousand seed weight decrease under water deficit condition. Treatment of silicon nanoparticles causes increases in all biochemical, physiological, morphological parameter. All regimes of Foliar application of improve biomass production, antioxidant activity, photosynthetic pigments, K content and as well as decrease MDA content, Na content. Moreover, (Si NPs) @ 100ppm promote growth of both varieties significantly.

Keywords: Si NPs, water deficit condition, green pigments, Proline, MDA, Antioxidants

INCPS-2024-63 Influence of Foliar Application of Nanoparticles on cabbage Grown in Activated Biochar Amended Soil under Drought Stress

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The most devastating abiotic stress that has a significant impact on plant growth and output is drought stress. The current study investigated the effects of supplementing biochar and nanoparticles on the physiological, biochemical, and yield characteristics of cabbage grown in two different moisture regimes (100% FC, 70% FC and 70% FC with GNPs) combined with drought stress at vegetative and reproductive stages. The experiment was carried out in the University of the Punjab Lahore's Quaid-e-Azam Campus Botanical Garden in Pakistan. Two amounts of two types of biochar (sugarcane bagasse and acacia wood shaving biochar) amendment in the soil (0 tons per hectare and 5 tons per hectare) were used in the field experiment, which was set up as a split-plot design. During the vegetative and reproductive stages, cabbage plants with 70% field capacity received two foliar spays of green synthesis nanoparticles. The findings demonstrated that biochar and green synthesized nano-particles nanoparticles had a major impact on the physiological (transpiration rate, photosynthetic rate, stomatal conductance and sub-stomatal conductance), and biochemical processes (proline, protein and antioxidant enzyme assays) and yield attributes (head weight, head length, stem length, head size, inner stem length, and width). Green synthesis nanoparticals and activated biochar amendments in soil are the most ecofriendly interventions used in agricultural field for cabbage production.

INCPS-2024-286 Bridging Growth and Sustainability: Biochar's Impact on Yield and Water Dynamics in Diverse Maize Hybrids under Natural Field Conditions

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Water shortage is a major problem for agricultural crop production around the globe it’s a major problem in different regions of the world, it affects plant metabolism, growth, and yield and ultimately leads to significant crop loss. Despite struggles to enhance agriculture production in the world, there always remains a large gap between real and possible yields of food crops. There are numerous types of soil amendments in the world

(organic/inorganic) to increase the soil properties and gain more yield under drought conditions. The addition of biochar to degraded soil has a significant ability to increase crop productivity biochar-based applications can mitigate environmental changes through the storage of carbon in soil. The present research work explored the effect of biochar amended in soil on Chlorophyll a, Chlorophyll b, Total Chlorophyll content, Carotenoids, relative water content, proline, sugar, lipid, protein, Antioxidant, Absolute growth, and economic analysis of three maize varieties under three different regimes. A field experiment was conducted at location 32°38.37'N, 74°9.00'E (Gujrat) to explore the suitable level of activated biochar under different moisture regimes (100% ET_C, 70% ET_C, and 50% ET_C). Field experiments were performed to explore the dynamic effect of biochar-amended soil on maize growth and yield. The following seeds of maize hybrids will be used DK-2088, DK-6317, and YH-5427. The experiment was placed in a split-plot design with three replications. We examine the response of non-amended soil (0 tons ha^{-1}), and biochar-amended soil which was applied at 5 tons ha−1 and 10 tons ha−1. Maize yield gives positive results as compared to the control and enhances the average increase of yield. Furthermore, the preparation of biochar has no negative influence on other environmental factors, such as the cutting of forests, trees, herbs, and shrubs and it also inhibits the modification of agricultural landscapes.

Key words. Biochar, drought, vermicompost, soil composition

INCPS-2024-223 Influence of Sugarcane Industrial Effluent as an Alternate Source of Irrigation on Various Parameters like Growth, Chlorophyll Contents and Antioxidants on Various Canola Varieties

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Irrigation is backbone of life in crops especially if sugarcane industrial effluent is used for irrigation purposes; however, its tricky composition and elevated metal contaminants have a risk of soil and crop contamination So, it is imperative to pay effective approaches to ensure the wise utilization of this resource for cultivation of crop. Dilution is a useful approach to lessen its toxicity, minimizing its contrary impact on health of soil and crops. To resolve this issue the current study is based on the use of the best dilution technique of sugarcane industrial effluent (SW) for the cultivation of canola varieties. A total of 15 canola varieties (i.e., write varieties names) were cultivated at 0%, 20%, 40%, 60%, 80%, and 100% SW. Results showed that at 60% SW;

Faisalabad Canola and Punjab Canola enhanced germination, shoot length, root length, shoot fresh and dry weight, root fresh and dry weight, and chlorophyll contents compared to other treatments and control. AARI Canola and CON-III showed poor growth and chlorophyll contents under 60%SW. Dunkled and Oscar cultivars showed moderate improvement in growth and chlorophyll contents under 60SW. The 60% SW can be recommended for maximum growth benefits in canola cultivars, specifically Faisalabad Canola and Punjab Canola. At 20SW, the root dry weight of Faisalabad Canola increased by 2.7%, while Punjab Canola increased by 3.4%. Canola varieties showed the highest increase in POD (antioxidant) activity compared to the control, with a 55.45% increase, followed by Sandal Canola, with a 43.26% increase. However, additional field-level experiments are required to govern the best cultivars suitable for ideal growth under 80SW and 60SW irrigation conditions.
Key words: Irrigation; Growth attributes; Antioxidants; Dilution technique; Canola

INCPS-2024-114 Interactive Effect of Co- composted Biochar on Ameliorating Drought Stress on Different *Zea mays* Varieties

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Drought stress severely impacts maize production by interfering with plant physiological functions, hindering nutrient and water uptake, resulting in stunted growth and reduced yields. This study investigates the potential of composted biochar (CB) and different maize genotypes to mitigate drought stress effects. CB improves soil aeration, water retention, and nutrient cycling, benefiting plant growth and sequestering carbon due to its porous structure that fosters beneficial microbes. We examined the effects of CB on five maize genotypes (SG2002, RS111, RS999, AH9272, AS376) under varying drought conditions. A completely randomized design was used with four treatments (control, drought stress, CB, and (drought + CB) in four replications. Results showed that under drought stress, maize plant height (~47%), shoot length (~72%), root length (~62%), and fresh weight (~80%) decreased significantly compared to control. The (CB + drought) treatment significantly improved these parameters, with increases in plant height (~32%), shoot length (~100%), root length (~80%), and fresh weight (~125%) compared to drought stress alone. Chlorophyll content also improved significantly with (CB + drought) treatment, showing increases in chlorophyll a (~80%), chlorophyll b (~85%), and total chlorophyll (~83%) compared to drought stress. Soil nutrient availability (P, K, N) and organic matter content were better maintained with CB application under drought stress. Among genotypes, RS111 showed the highest drought tolerance, while RS999 exhibited the most least responses to both drought stress and CB treatment. These findings demonstrate that CB application is an effective

method for mitigating drought stress in maize plants, with potential for improving crop resilience in water-limited environments.

INCPS-2024-33 Growth, Water Relation, and Photosynthesis of Canola (*Brassica napus* L.) as Influenced by Nickel Stress

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Low nickel concentrations are necessary for normal plant growth; however, higher levels reduce plant growth by affecting plant physiological processes such as water status, mineral nutrition, and photosynthesis. To assess up to what extent increasing concentration of Ni negatively affects the plant water status and photosynthesis which translates into poor growth of plants, three-week-old plants of canola (*Brassica napus* L. var. Dunkled) were subjected to different concentrations of nickel (0, 50, 100, 150, 200 ppm) as $NiCl_2$ in half-strength Hoagland's nutrient solution. Growth attributes, water status, and photosynthetic efficiency were recorded after twenty-one days of nickel application. Nickel application in the rooting medium reduced the growth of canola plants, but the maximum reduction in growth was observed in 200-ppm nickel-applied plants. The nickel application reduced water potential, osmotic potential, and turgor potential. The chlorophyll contents and quantum yield of PSII were also decreased significantly by nickel application. Nickel reduced the structural stability of PSII in canola by reducing the JI and IP amplitude and significant changes in L- and K-band. Nickel reduced the PSII activity by decreasing Fm and increasing the relative variable fluorescence at the J step (Vj). The performance index was reduced, and Mo was enhanced at higher nickel concentrations. However, ABS/RC, TRo/RC, and ETo/RC decreased, and DIo/RC was enhanced by 150- and 200-ppm nickel application. These results indicate that PSII activity was reduced by nickel application via reducing the antenna size, electron trapping to QA, and linear electron transport from PSII to PSI while increasing heat dissipation. It is concluded that 150- and 200-ppm nickel had more negative effects on plant growth, water status, and photosynthetic efficiency than lower nickel concentrations.
Keywords: Nickel, Canola, PSII activity, Water Status, Growth

INCPS-2024-13 Abiotic Stress Tolerance in Wheat

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The world population is expected to increase up to 9.7 billion in the year 2050, which stands currently at 7.7 billion. Abiotic stresses viz. drought and

temperature extremes arise when population explosion combines with climate change. Drought and heat are two major abiotic stresses constraining wheat productivity worldwide, causing yield losses of up to 86% and 69%, respectively. Due to continuous increase in the population of Pakistan; it is the need of time to improve the yield of staple food. An experiment was designed in plastic pots (1mx1.5m) under controlled environment in wire netted pot house to study the responses of selected genotypes under drought and high temperature stress. Selected advanced genotypes (SDW-17, SDW-25, DF-1701, DF-1708, DF-1709, DF-1917 and Khirman as a local Check) were sown in plastic pots filled with clay loam soil. The experiment was arranged in completely randomized design (CRD) with three treatments i.e. Control (100% FC), drought (50% FC), high temperature stress (late sowing) and replicated thrice. The genotypes were evaluated on the basis of physiological indices, agronomical traits and water use efficiency. It was observed that genotype DF-1701 exhibited maximum leaf area, NRA, proline and RWC under stress conditions compared to control followed by DF-1708 and SDW-17 respectively. The abiotic stress tolerant genotypes specified in this study may be recommended to wheat breeders to produce stress tolerant genotype
Keywords: wheat, abiotic stress, physiology, water use efficiency

INCPS-2024-147 Influence of Polyvinyl Chloride Microplastics on Growth, Photosynthetic Pigments and Antioxidant enzymes in Wheat (*Triticum aestivum* L.) Crop

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In the present era, the productivity ratio of crops has been reduced due to increased level of plastic pollution worldwide. It can severely affect the growth, photosynthetic pigments and antioxidant capacities. Therefore, a pot trial was conducted to examine the effects of polyvinyl chloride microplastics (PVC MPs) on morphological physiological and biochemical attributes of (*Triticum aestivum*L.) crop under different levels. The experiment was carried out at Botanical garden of BZU Multan, Pakistan. The experimental studies was consist of Wheat varieties (Akbar-19), (Arooj-22) and (Anaj-17) and PVC microplastic @0,50, 100, 200, 400, 600mg/kg of having completely randomized design (CRD) with four replicates of each treatment. Each pot consists of 5kg soil and PVC was mixed with sieved soil before sowing of seeds. Seeds were obtained from Ayub Agriculture Research Institute, Faisalabad-Pakistan. All three varieties of wheat significantly differ from each other under different regimes of soil applied PVC microplastic. The plants which grow in medium containing PVC MPs @600 mg kg^{-1} showed decrease

in biomass production i.e., shoot fresh dry weight, proline content, K^+ ions and spike length, no. of spikes, seed weight plant^{-1}. On the other hand, shoot and root length, chlorophyll content (a, b), quantum yield, H_2O_2 and relative water content (RWC) all these attributes remain unchanged under various regimes of PVC MPs. Antioxidant enzymes (CAT, POD, SOD), total soluble protein, amino acid content of leaves and Na^+ ions also increased via increasing dose of PVC MPs. Finally results showed that PVC MPs effects few attributes significantly but it did not significantly effects on various morpho-physiological and biochemical attributes of wheat crop. It is also assume that, they may have more severe effects on growth of plants if they remain persist in soil for long time.

Keywords: Microplastic, Wheat, physiological, chlorophyll, PVC, Antioxidants, biomass

INCPS-2024-149 Effect of Foliar Fertigation of Silicon on Lipid Peroxidation, Photosynthetic Attributes and Activities of Antioxidant Enzymes under Cadmium Stress on Canola (*Brassica napus* L.) Crop

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In the recent times, the productivity ratio of crops has been reduced due to increased level of heavy metal pollution worldwide. Although Canola (*Brassica napus* L.) crop is regarded as stress tolerant, but shows great genetic variability under Cadmium (Cd) stress. The adverse effects of drought stress could be quenched by exogenous application of Silicon. For this purpose, an experiment was conducted at Bahauddin Zakariya University, Multan -Pakistan. Therefore, a pot trial was conducted to examine the effect of cadmium chloride on morphological, physiological and biochemical attributes of (*Brassica napus* L.) crop under different levels. The experimental studies was consist of (a) Canola varieties, (b) Cadmium chloride @0, 50, 100, 150mg/kg (c) two silicon levels @ 0, 200ppm K_2SiO_3 consist of completely randomized design (CRD) with four replicates of each treatment. Both varieties of canola significantly differ from each other under different regimes of soil applied Cd. The plants which grow in medium containing 150mg kg^{-1} of $CdCl_2$ showed decrease in biomass production, shoot & root length, chlorophyll content, SPAD, quantum yield and relative water content (RWC), amino acid and protein and antioxidant enzymes (CAT, POD,APX) , but proline show antagonistic behavior in response to Cd stress. H2O2, which is regarded as oxidative stress indicator. However, after application of Silicon @200ppm all morphological, physiological and biochemical attributes of both varieties of canola was improved which indicate that the adverse effects of heavy metal stress could be mitigated by foliar application of silicon on canola crop.

INCPS-2024-35 The Integrative Effect of Zinc Oxide-Nanoparticles and Biochar on Turnip (*Brassica napus* L.) and Radish (*Raphanus sativus* L.) under Drought Stress

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Water shortage is a major challenge for sustaining global food security. Using nutrients in the nano-scale formulation including zinc oxide nanoparticles (ZnO-NPs) is a novel fertilization strategy for crops. Biochar is a carbon-based soil amendment that may increase soil porosity and functionality. A study with complete randomization will be carried out three experiments. This study was specifically developed to observe the comparative effects of ZnO-nanoparticles and at diverse concentration levels (0, 50mg/L 100mg/L and 200mg/L) and biochar at different levels (0, 0.5%,1% and 1.5%) that could effectively decrease the injurious effect of drought stress on turnip and radish plants. In experiments on the turnip and radish, drought stress caused a significant reduction in all growth and biochemical attributes, and increased antioxidant enzymatic activity. In a comparison with the conventional ZnO-nanoparticles, the foliar application of 100mg/L ZnO-nanoparticles and application of 0.1% biochar on soil rhizosphere significantly improved plant biomass, antioxidant defense system, secondary metabolites, and photosynthetic pigments in the leaves under drought stress. Based on the collected results, it is recommended that the foliar application of ZnO-nanoparticles and biochar apply on soil rhizosphere under drought stress is helpful in increasing the growth and yield of turnip and radish plants.

INCPS-2024-131 Influence of Foliar Fertigation of Ascorbic Acid on Physio-Biochemical Attributes of Safflower (*Carthamus tinctorius* L.) under Drought Stress Condition

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Drought stress severely inhibits growth and development of plant by disturbing all metabolic functions. In this regard, foliar application of ascorbic acid can be used an approach to lessen the adverse consequences of drought stress to crop plants. Several organic and inorganic compounds such as osmolytes, vitamins and ascorbic acid exogenously applied to enhance tolerance in plants under drought stress conditions. The current research consists of two safflower varieties (AYT-V7 and AYT-V9) with four foliar applications (0, 100, 200 and 300ppm). The soil filled pot experiment was completely randomized design (CRD). Drought stress significantly affected different morphological attributes (biomass accumulations and shoot lengths) and biochemical (chlorophyll contents, total soluble protein contents

and antioxidant enzymes) and ionic contents (root and leaf Na^+ and K^+). The foliar application of ascorbic acid further strengthened the defensesystem which was evident from enhanced activities of antioxidant, thus mitigating the excessive H_2O_2 (ROS) produced under drought stress. The results clearly described that drought stress induced reduction in growth, photosynthetic pigments and yield attributes were reversed through foliar application of ascorbic acid. Among all concentrations of ascorbic acid, the dose 300 ppm alleviated the different physio-biochemical as well as yield traits. Conclusively, foliar application of Ascorbic acid posed a positive effect on overall health of plant especially under drought stressed safflower plants.

INCPS-2024-148 Improving Resistance Against Multiple Abiotic Stresses via Inoculation of Growth Promoting Bacterium *Enterobacter cloacae* on Safflower (*Carthamus tinctorius* L.)

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In the present era, the productivity ratio of crops has been reduced due to increased level of abiotic stress. However, application of *Enterobacter cloacae* as plant growth promoting rhizobia (PGPR)as an alternative for chemical fertilizers is an effective approach to improve plant growth and as well as soil health. Therefore, a soil containing pot trial was conducted to improve the resistance of safflower (*Carthamus tinctorius* L.) crop under abiotic stress (drought, diesel stress and heavy metal stress) condition. The research study was consisting of (a) two varieties of Safflower “SAF-65” and “SAF-111” (b) seed primed with *Enterobacter cloacae* (c) drought stress, diesel stress @ $5mgkg^{-1}$and cadmium (cd) stress@ $75mgkg^{-1}$ The experiment was completely randomized design with four replications. Under various abiotic stress condition, many attributes of both varieties of safflower have been reduced including biomass production, photosynthetic pigments, RWC, quantum yield and total protein content. On the other hand, all stresses enhance production of H2O2 content in both varieties. But the var “SAF-111” performed better as compared to var “SAF-65” under all stress condition. However, among all stresses diesel stress significantly reduced the plant growth and development of both varieties of safflower. Moreover, exogenous application of *PGPR* enhance the morphometric attributes, green pigment concentration, stress related protein and amino acids and also antioxidant enzymes like peroxidase dismutase (POD), Catalase (CAT), ascorbate peroxidase (APX) and reduced H2O2 content to ameliorate oxidative stress in plants. The ion analysis of Na K and cd showed that Na increased under abiotic stresses while K and cd showed reduction under cd, dr and diesel stress. Plants treated with Enterobacter cloaceae showed decreased in Na and Increased in K and cd c ontent. Thus, *Enterobacter*

cloacae improved the resistance against multiple abiotic stresses in safflower.

INCPS-2024-173 Boosting Wheat Growth and Photosynthetic Efficiency with Proline Applied through the Rooting Medium

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Proline, an imino acid known for its osmo-protective properties, plays a crucial role in promoting plant growth under both stress and non-stress conditions. However, the impact of exogenously applied proline on water status, and photosynthetic efficiency in wheat remains underexplored. To address this, a pot experiment was conducted at the Botanic Garden of Bahauddin Zakariya University, Multan, Pakistan. Plastic pots of 10 cm diameters were filled with washed river sand. The study utilized a completely randomized design with one wheat cultivar (Galaxy-13) and five proline concentrations (0, 5, 10, 15, and 20 mM), each with five replications. After germination, five equal sized and equidistantly placed plants were selected for further experimentation. After seven days of germination, wheat plants were given different proline concentrations in half strength Hoagland's nutrient solution through a rooting medium. After three weeks of proline treatment, different growth, biochemical, and photosynthetic attributes including the quantum yield of PSII, total chlorophyll contents (SPAD values), light response curve, and chlorophyll *a* fluorescence (OJIP curve analysis) were measured. Results showed an overall improvement in plant biomass production, quantum yield, total chlorophyll contents (SPAD values), total soluble proteins, proline contents, catalase, and peroxidase activity and chlorophyll *a* fluorescence (OJIP curve analysis). However, the results were more prominent at 10 mM Proline concentration. Antioxidant activity (CAT and POD) was greatly enhanced at 10 mM proline concentration which indicates that proline activates an antioxidant defense mechanism. Exogenous application of proline increases the level of total soluble proteins, total free amino acids, and proline contents. PSII, ETRII, PSI, and ETRI activity was enhanced at 10 mM proline concentration indicating that proline maintained PSII activity by improving the electron transport chain, modulating thylakoid membrane structure, enhancing light-harvesting complex, and reducing photoinhibition. In conclusion, exogenous application of proline, particularly at 10 mM, concentration was found to be the most effective dose for enhancing wheat growth by improving antioxidant defense, protein synthesis, proline accumulation, and photosynthetic efficiency.

Keywords: Growth, PSII activity, Catalase, POD, Proline, Wheat

INCPS-2024-183 Agro-Morphological, Physiological and Yield Related Performances of Sarson (*Brassica campestris* L.) Evaluated for Nickel Stress Resistance

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Nickel (Ni) toxicity poses a significant threat to crop productivity and environmental sustainability, particularly in regions with elevated levels of this heavy metal. In this study, we investigated the agro-morphological, physiological, and yield performances of Sarson (Brassica campestris L.) under nickel stress conditions, with a focus on evaluating the potential of Zinc Oxide (ZnO) nanoparticles in enhancing stress resistance. Mustard (*Brassica campestris* L.) is widely cultivated around the whole World for the production of edible oils and biodiesel fuel. A pot experiment was conducted which consisted of two varieties (Ghobi and Raya Sarson), six treatments (0, 100mg ZnO, 100ppm Ni, 200ppm Ni, 100mg ZnO with 100ppm Ni, 100mg ZnO with 200ppm Ni) and four replicates in completely randomized design. Distinct responses in the agro-morphological and physiological parameters of Sarson plants were exbhited under nickel stress. Morphological traits such as shoot and root length and biomass production significantly decreased, indicative of stress-induced growth inhibition. The effects of nickel contamination on plants include an overall reduction in growth, chlorophyll content, yield attributes (number of flowers, pods, seeds and 100 seed weight) and increase antioxidants (peroxidase, catalase and proline) while increasing nickel stress. Ni stress led to considerable reduction in yield highlighting its adverse effects on crop productivity. Interestingly, the application of ZnO nanoparticles demonstrated a notable mitigation of nickel-induced stress effects in Sarson plants. ZnO nanoparticles effectively enhanced the tolerance mechanisms against nickel stress, as evidenced by improved agro-morphological traits, physiological functions, and yield performances compared to non-treated plants under similar stress conditions. Notably, the varietal differences were observed, with the tolerant variety (Raya Sarson) exhibiting greater resilience to nickel stress compared to its counterpart (Ghobi Sarson). These results underscore the potential of ZnO nanoparticles as a promising strategy for alleviating heavy metal stress, thereby contributing to sustainable agricultural practices and food security in metal-contaminated environments.

INCPS-2024-184 Impact of Salt Stress on Physiology, Biochemical and Yield Attributes on Varieties of Rapeseed (*Brassica napus* L.)

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Salinity is the most problematic abiotic stress that has significant effect on plant growth, physiology and biochemical processes of plant by causing osmotic stress that result in reduced biomass production. This adverse effect of salt stress appears at almost all growth stages including germination, seedling, vegetative and maturity stages. However, tolerance to salt stress at different plant developmental stages varies from species to species. Salt tolerance and yield stability are complex genetic traits that are difficult to establish in crops since salt stress may occur as a catastrophic episode, be imposed continuously or intermittently and become gradually more severe at any stage during development. Rapeseed (*Brassica napus* L.) is relatively salt sensitive crop, therefore the present study was planned with the objective to screen the best salt tolerant variety by simple and efficient technique. The screening experiment consisted of 10 varieties (Sandal canola, Rainbow, Legend, Punjab canola, Dunkled, Oscar, AC Excel, Super canola, Shiralee and Faisal canola), three NaCl treatments (0, 50 and 100 mM). Seeds were sown in plastic trays of (70x50cm). Hoagland solution was applied as nutrient medium. Germination percentage, root and shoot length and root and shoot fresh and dry weights decreased in all varieties with the increase of salt concentration. Shiralee and Super canola showed the highest germination and growth in all parameters while Punjab canola and Oscar showed less germination. These four varieties of rapeseed were selected for adult experiment that consisted of two stages, four varieties, four replicates and four treatments (0, 50, 100 and 150mM) in completely randomized design. After 8 weeks of experiment plants were harvested and different parameters such as fresh and dry weights of stem, root, leaves and petioles, root and shoot length, number of flowers, relative water content (RWC), chlorophyll a & b content, cell membrane injury, proline content, peroxidase (POD), catalase (CAT), Superoxide dismutase (SOD) and total soluble protein were measured. At mature stage number of pods, number of grain per pod, weight of pods per plant and 100 seed weight were measured. AgainShiralee and Super canola performed better in all parameters and can be therefore classified as best salt tolerant varieties.

Keywords: salinity, rapeseed, Superoxide dismutase, Germination percentage, stress tolerance

INCPS-2024-199 Influence of Sugarcane Industrial Effluent as an Alternate Source of Irrigation on Various Parameters like Growth, Chlorophyll Contents and Antioxidants on Various Canola Varieties

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Irrigation is backbone of life in crops especially if sugarcane industrial effluent is used for irrigation purposes; however, its tricky composition and elevated metal contaminants have a risk of soil and crop contamination So, it is imperative to pay effective approaches to ensure the wise utilization of this resource for cultivation of crop. Dilution is a useful approach to lessen its toxicity, minimizing its contrary impact on health of soil and crops. To resolve this issue the current study is based on the use of the best dilution technique of sugarcane industrial effluent (SW) for the cultivation of canola varieties. A total of 15 canola varieties(i.e., write varieties names) were cultivated at 0%, 20%, 40%, 60%, 80%, and 100% SW. Results showed that at 60% SW; Faisalabad Canola and Punjab Canola enhanced germination, shoot length, root length, shoot fresh and dry weight, root fresh and dry weight, and chlorophyll contents compared to other treatments and control. AARI Canola and CON-III showed poor growth and chlorophyll contents under 60%SW. Dunkled and Oscar cultivars showed moderate improvement in growth and chlorophyll contents under 60SW. The 60% SW can be recommended for maximum growth benefits in canola cultivars, specifically Faisalabad Canola and Punjab Canola. At 20SW, the root dry weight of Faisalabad Canola increased by 2.7%, while Punjab Canola increased by 3.4%. Canola varieties showed the highest increase in POD (antioxidant) activity compared to the control, with a 55.45% increase, followed by Sandal Canola, with a 43.26% increase. However, additional field-level experiments are required to govern the best cultivars suitable for ideal growth under 80SW and 60SW irrigation conditions.

INCPS-2024-204 Assessing the Influence of GA3 Seed Priming in Improving Performance of Maize (*Zea mays*) under Moisture Deficit

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(*Zea mays*) often known as maize or Indian corn (or corn in certain other countries), is a grass belonging to the Poaceae that is more reasonable to select for research as a seasonal,growth and native point of veiw. Study aim to look at how different types of maize are affected by GA3 priming and hydro priming at moisture deficit. To find out how long maize seed hydro priming and GA3 priming should last.The purpose of the current experiment was to evaluate whether hydro-priming and GA3 Priming may enhance maize seed germination and primary seedling development.This study aimed to assess the effects of hydro priming and priming with gibberellic acid (GA3) on different drought stress levels. GA3 has been shown to boost germination and enhance seed vigor. Results show that GA3 primed plants

have a high germination rate, which ensures crop settlement, and that GA3 increases plant growth, seed yield, and vigor at the germination stage. On the other hand, GA3 reduces plant production of chlorophyll and has detrimental effects on antioxidant enzymes, CAT, and POD. Two hybrid maize cultivars are employed in the experiment. Data suggests that Sahiwal 2002 has greater growth responses to stress levels than Malka. Additionally, hydropriming responds to various stimuli with improved development in every way. Because of its minimal agricultural risk and ease of application, it can be utilized in agricultural activities. In conclusion, the development of Zea maize plants was significantly improved by the application of 30% GA3 and hydro priming procedures as compared to the control group (unprimed). Growth characteristics were significantly improved by using 30% GA3, a water-soluble polymer. Additionally, presoaking seeds in water, or hydropriming, accelerated germination and improved plant development. The 30% GA3 treatment was shown to be efficient, as seen by the noteworthy decrease in antioxidant levels in Maize plants, which implies a decrease in osmotic stress caused by stress. With less stress and oxidative damage, the plants' growth circumstances were better, as seen by the reduction in antioxidants. These results advance our knowledge of priming strategies and the ways in which they may be used to improve crop growth and stress tolerance. The 30% GA3 treatment was shown to be efficient, as seen by the noteworthy increase in root length with respect to treatment sequence like 30mg GA3 primed plants of both varieties have long root length when it comes with increasing drought stress level control plants have small root length as compare to 2 day stress level plants similarly less than 3 day level stress plants but shoot length work inversely as compare root length. When we increase the stress levels the shoot length decrease respect to control

INCPS-2024-205 Role of Polyethylene Glycol (PEG 6000) Seed Priming in Lessening the Adversarial Influence of Drought in Sunflower (*Helianthus annuus*)

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Drought stress significantly hampers the growth and productivity of sunflower (Helianthus annuus), a vital oilseed crop. This study, conducted at Bahauddin Zakariya University (BZU) Multan, evaluates the effectiveness of seed priming with polyethylene glycol (PEG 6000) in mitigating the adverse effects of drought on sunflower plants. Seed priming involves treating seeds with PEG 6000 solution to enhance their drought tolerance. The experiment utilized a randomized complete block design (RCBD) with various treatments, including different concentrations of PEG 6000 and control groups.

Our results indicated that PEG 6000 seed priming markedly improved the germination rate, and overall growth of sunflower plants under drought

conditions. Primed seeds exhibited enhanced physiological and biochemical responses, including increased chlorophyll concentration, and improved antioxidant enzyme activities compared to non-primed seeds. These improvements suggest that PEG 6000 seed priming enhances the plant's ability to withstand water deficit by maintaining better hydration and reducing oxidative stress.In conclusion, PEG 6000 seed priming emerges as a promising agronomic practice to mitigate drought stress in sunflower varieties. This technique offers a viable approach to sustaining sunflower productivity in arid and semi-arid regions. Further research is recommended to optimize the priming protocol and explore its applicability across different sunflower variety's and varying environmental conditions.

INCPS-2024-207 Effect of Nitrate Ammonium Ratios on Growth and Photosynthetic Capacity of Sunflower (*Helianthus annuus* L.)

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Helianthus annuus (L.) is the most important source of edible oil and fourth-largest oilseed crop in the world. The study aimed to assess the effects of different NO_3^-/ NH_4^+ ratios (80:20, 60:40, 50:50, 40:60 and 20:80) on the physiological and growth parameters of *Helianthus annuus* (L.). The results demonstrated significant variations in plant responses to different nitrogen forms. A higher ammonium ratio 20:80 significantly promotes root length, root fresh weight and root dry weight suggesting that ammonium is particularly effective for enhancing root development. A balanced 50:50 ratio supports the greatest shoot elongation, indicating that equal parts nitrate and ammonium provide the best conditions for shoot growth. The 60:40 NO_3^-/ NH_4^+ ratio may be the most effective for enhancing shoot fresh and dry biomass, which is crucial for overall plant productivity. Higher ammonium ratios (20:80) improved water potential, enhancing water retention, but increased osmotic stress, reflected in more negative turgor potential. Osmotic potential remained relatively stable across treatments. Results showed a significant decrease in Y (II) and Y (I) as light intensity increased, with maximal changes observed at 1420 µmol m^{-2} s^{-1}. Non-photochemical quenching (NPQ) and regulated energy dissipation (Y(NPQ)) increased with light intensity, while non-regulatory energy dissipation (Y(NO)) and donor-end limitation (Y(ND)) also showed marked variations across nitrate/ammonium ratios. These findings suggest that *Helianthus annuus* (L.) plants exhibit differing photo protective mechanisms based on nitrate/ammonium ratios. The findings showed that nitrate/ammonium ratios significantly influenced light absorption (ABS/RC) and energy trapping (TRo/RC). The 60:40 ratio demonstrated optimal performance in light utilization and energy trapping. Electron transport (ETo/RC) slightly

decreased with higher ammonium, while dissipation of excess energy (DIo/RC) increased under these conditions, suggesting stress adaptation mechanisms. The optimal ratio for chlorophyll content in *Helianthus annuus* (L.) appears to be around 60:40, suggesting that a balance between nitrate and ammonium favors efficient nitrogen metabolism and chlorophyll production, contributing to better plant growth and photosynthetic performance. The 20:80 ratio showed the lowest values, indicating excess ammonium may negatively affect chlorophyll and carotenoid synthesis in *Helianthus annuus* (L.).
Keywords: Nitrate Ammonium Ratios, growth, Photosynthetic capacity, *Helianthus annuus* (L.)

INCPS-2024-208 Influence of Phosphorous Deficiency on Functional Activity of PSII and Electron Transport of *Brassica oleracea* var. *botrytis* L.

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Thepresentresearchinvestigatestheinfluence of phosphorous deficiency on functional activity of PSII and electron transport of *Brassica oleracea* var. *botrytis* L. in sand culture. Seeds of Cauliflower (*Brassica oleracea* var. *botrytis* L.) were obtained from Ayub Agricultural Research Institute (AARI), Faisalabad. The experiment was carried out in a wirenet house in the Botanic Gardens of Bahauddin Zakariya University (BZU), Multan, Pakistan, under regular day and light circumstances, with a temperature of 23-9°C day/night and a relative humidity of 60-70%. Phosphorus (P) is a necessary nutrient for plant growth and the second most limiting macronutrient after nitrogen (N). It regulates metabolic pathways, including photosynthesis in chloroplasts. Inadequate P nutrition slows plant maturity and lowers crop output. In this study, a controlled experiment was carried out with five groups of cauliflower plants. Within each group, different concentrations of P (31ppm, 15.5ppm, 3.88ppm, 1.94ppm, 0ppm) were applied weekly to each group by giving half strength Hoagland's nutrient solution. Amendments were made in the concentration of Hoagland's nutrient solution and applied to pants for 3 weeks. Various parameters were analyzed. The results showed that phosphorus deficiency affected overall plant growth and biochemical parameters, electron transport, PSII activity. However, the plants with no phosphorus showed negative effects on plants. Specifically, the plants with 31ppm phosphorus showed increased plant height, leaf area, biomass accumulation, chlorophyll response, QY, SPAD values, concentration of soluble proteins, amino acids, proline, catalase, peroxidase, OJIP, light respose curve, induction curve, induction+relaxation curve and photosynthetic activity. The current study aims to analyze some of the biochemical and physiological features for use as criteria to study the

consequences of phosphorus deficiency, to assess the effects of this deficiency on crop yield globally and to assess photosynthetic activity in plant groups with varying phosphorus concentrations.

Keywords: deficiency, photosynthetic, biomass accumulation, chlorophyll responses.

INCPS-2024-209 Changes in Growth and Macronutrient uptake in *Trigonella corniculate* L. Grown under Rhizospheric Contamination by Microplastics

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Microplastics ubiquitous synthetic polymers, are widely used across the globe. Several industries manufacture various products for their diversified uses, versatility, and cost-effectiveness. The wide use of plastic material resulted in its addition to the environment This study investigates the impact of microplastics on the growth and physiological attributes of *Trigonella corniculata* L., commonly known as fenugreek, a vital plant species with agricultural, medicinal, and leafy vegetable to ensure its suitability for growth. Microplastic (derived from polystyrene finished products) treatments of 50, 100, and 200 mg/kg soil were applied to *Trigonella* plants grown in a wire-net house. Several growth parameters were measured, including shoot fresh weight, shoot dry weight, root fresh weight, root dry weight, shoot length, root length, leaf surface area, and the number of leaves per plant. The results indicated that increasing polystyrene concentrations showed a non-significant impact on measured attributes of *Trigonella* plants. However, the study underscores the importance of understanding the implications of microplastic contamination on agricultural ecosystems, highlighting the need for sustainable practices to mitigate plastic pollution. Furthermore, it emphasizes the significance of *Trigonella corniculata* in Pakistani agriculture and medicine, suggesting avenues for further research to explore its potential resilience to environmental stressors and its pharmacological properties.

Keywords: Microplastic, Polystyrene, and Fenugreek

INCPS-2024-136 A Comparative Study of Two Species of Family Solanaceae under Escalated Fluoride Levels in the Growth Medium

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Fluoride pollution has become a significant environmental concern, affecting various ecological systems, particularly plant life. A pot experiment was conducted in the spring at the Botanic Garden, Bahauddin Zakariya University, Multan, Pakistan to investigate the effects of Fluoride (F) applied in the form of NaF to green chili (*Capsicum annum* L.) and tomato (*Lycopersicum esculentum* L.) plants @ of 10 mg/kg, 20 mg/kg, and 40 mg/kg fluoride salt in the soil along with control plants. F distinctively influences the physicochemical properties of soil and plant growth parameters and seems to induce stress. Growth parameters; fresh and dry biomass, leaf area, and number of leaves per plant significantly reduced both vegetables. Furthermore, the 40 mg/kg level appeared to be most detrimental on green chili and tomato plants. Based on the study, it was concluded that the presence of F in soil can adversely affect plants' metabolic processes, hence reducing growth and yield. The ever-increasing F pollution of arable soil or water can pose serious threats to the ecosystem. The study signified that appropriate measures should to taken by the EPA to address threats to biodiversity of plants for the sake of food safety and security.

INCPS-2024-212 Temporal Variation in Productivity Traits of Two Leafy Vegetables Grown under Independent and Combined Stress of Essential and Non-Essential Growth Elements

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Manganese is an essential micronutrient required at optimal levels for the growth of all crop plants including leafy vegetables because it supports critical physiological processes such as photosynthesis, nutritional balance, and overall plant growth. In contrast, non-essential elements like chromium negatively impact the performance of plant species. When present in the growth medium, this non-essential metal element can hinder the absorption of essential nutrients required for vital processes involved in plant growth. The presence of metal ions disrupts cellular functions, and cause oxidative stress, leading to decreased growth and productivity. This research aimed to assess chromium and manganese's independent and combined effects on two leafy vegetables: spinach (*Spinacia oleracea* L.) and fenugreek (*Trigonella corniculate* L.). Both vegetables are highly valued for their rich nutritional profiles and health benefits. Spinach is a rich source of essential vitamins, minerals, and antioxidants, making it a staple for promoting overall health and preventing chronic diseases. Fenugreek, known for its medicinal properties, is a rich source of fiber, iron, and protein. Various growth parameters (shoot and root fresh and dry weight, number of leaves per

plant, leaf area, shoot and root length, and photosynthetic pigments like chlorophyll and carotenoids were measured in both controlled and treated plants of these vegetables. The results showed that independent and combined applications of chromium and manganese had a differential impact on the growth of the leafy vegetables. Chromium alone (10 mg/kg) reduced shoot and root fresh and dry weight, while manganese when applied singly at 20 mg/kg showed a positive influence on plant growth. The combined ratio of chromium and manganese (5+20 mg/kg) enhanced the growth attributes of both spinach and fenugreek plants. The leaf area was maximized with 10 mg/kg of manganese and at a combined ratio of chromium and manganese (10+20 mg/kg). Photosynthetic pigments (chlorophyll and carotenoids) in both species were the highest with manganese application of 20 mg/kg) and similarly when the ratio of chromium and manganese applied @ 5+20 mg/kg compared to chromium alone. However, the most detrimental impact of the combined levels of the two elements was observed for 10+20 mg/kg. The results of the study indicated that chromium has harmful effects on growth when present in higher concentrations while manganese has potentially resulted in better growth and shown its ability to antagonize chromium when the metal element is present in a lower level. Thus, manganese seemed to have a limited ability to compete with metal ions.

INCPS-2024-213 Evaluating the Effects of GA_3 Seed Priming in Improving the Adverse Effect of Drought in Sunflower (*Helianthus annus*)

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Oil production largely relies on the sunflower crop, with enormous amounts of oil cakes are used as animal feed. As a non-hyperaccumulating plant that also generates biomass, sunflower is a good option for phytoextraction. GA_3 seed priming causes regulating effect in sunflower ,at the same time hydropriming reduces the hazardous effect of drought and impact positively in sunflower growth. A pot experiment (each plastic pot filled with 8kg of clay and soil combination) was directed At the Bio Park of Bahauddin Zakariya University in Multan, we conduct an examination to assess the impact of different priming methods at sunflower under drought stress. In this experiment, the sunflower variety “FH-701 and FH-648” was cultivated with GA_3 priming treatments (10mg) and hydroprimimg treatments at sowing stages to the seeds. Experimental design was completely randomized(CRD) under factorial arrangement with 3 replicates per treatment. Data was collected for various growth and physiological characteristics after 65 days of sowing. Redical and plumule length (centimetres), leaf area index (centimetres), fresh weight and dry weight of the redical (g), fresh and dry weight of the plumule (g), and plant height are growth factors (cm). Photosynthetic pigments such as chlorophyll a and b, chlorophyll ratio, carotenoid, flavonoids, soluble sugar, anthocyanin, as well as yield, Least

Significant Difference (LSD) was used to compare treatments at 5% probability levels. COSTAT software was used to examine the data.

INCPS-2024-214 Modulation of Growth in Newly Developed Germplasm of Cotton (*Gossypium hirsutum*L.) and Maize (*Zea mays*.) Supplemented with Exogenous *Moringa oleifera* L. Foliage Extract

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Natural plant growth substances are widely used to enhance plant productivity under both stress and favorable environmental conditions. Moringa is gaining popularity as a super fertilizer due to its high nutritional value. Agricultural scientists are increasingly interested in moringa because it is a rich source of micro and macronutrients, antioxidants, and growth hormones. Foliar application of moringa leaf extract is highly beneficial for promoting vigorous growth, deeper root development, better seed germination, and improved yields. The present study investigated the growth-enhancing potential of different concentrations (25%, 50%, and 100%) of moringa leaf extract on 8-week-old cotton and maize plants grown in normal conditions. The results showed that growth attributes were significantly enhanced with increasing concentration of moringa leaf extract. The maximum increase in the shoot, root fresh, dry weights, shoot length, root length, and leaf area was found at 25% of the crude extract of moringa leaves. The overall result showed that moringa leaf extract could be a potential source for growth enhancement of crop plants.

INCPS-2024-215 Does Dependent Relationship Between Polystyrene Microplastic Pollution and Early Establishment of *Cicer arientinum*L.

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Chickpea (*Cicer arietinum* L.) is a crucial annual pulse crop and ranks as the world's third-largest food legume. However, polystyrene microplastic pollution negatively impacts most crops. A pot experiment aimed to assess whether the presence of Polystyrene microplastics would affect the growth attributes of chickpea plants. Three chickpea varieties (Bittal-2022, Bittal-2021, Noor-2022) were exposed to three Polystyrene levels (0, 50, 100 mg/kg) by setting up an experiment in a completely randomized design with three replications. Several growth parameters, including shoot fresh and dry weight (g), root fresh and dry weight (g), shoot & root length (cm), number of

compound leaves, number of flowers, number of pods, pod fresh weight (g), pod dry weight (g), seed fresh weight (g), seed dry weight (g), chlorophyll content (mg/g fresh weight), carotenoid content (mg/g fresh weight), and phenolic content (mg/g fresh weight) were estimated. The results declared that increasing polystyrene concentration reduces the morphological, foliage, and photosynthetic pigments (chlorophyll and carotenoids) at 100mg/kg. While the phenolic contents were found maximum at 100 mg/kg polystyrene.

Keywords: *Cicer arietinum*, polystyrene microplastic, photosynthetic pigments

INCPS-2024-217 Osmoregulatory Role of Root Extract of *Glycyrrhiza glabara* L. In *Lagenaria Siceraria* L. Plants Grown under Moderate and Severe Moisture Deficit Conditions

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Drought stress is a critical environmental factor that adversely affects vegetable plants' growth, productivity, and physiological processes. This study investigates the osmoregulatory role of root extract from *Glycyrrhiza glabra* L. (licorice) in *Lagenaria siceraria* L. (bottle gourd) plants subjected to moderate and severe moisture deficit conditions. The experiment was designed to evaluate how the application of licorice root extract influences osmotic adjustment and enhances drought tolerance in bottle gourds. Plants were grown under controlled conditions with varying levels of water stress, and treatments included the application of licorice root extract (25 and 50%). Growth parameters such as plant height, leaf number, root and shoot biomass, and leaf area were meticulously recorded. Additionally, Fo, Fv/Fm, ETRo/RC, QY_{PSII}, photosynthetic pigments (chlorophyll a, chlorophyll b, and carotenoids) plants' physio-chemical responses to drought stress. Results indicated that drought stress significantly reduced plant height, leaf number, and biomass of bottle-gourd plants. Fv/Fm, ETRo/RC, Photosynthetic pigments decreased markedly under severe water deficit, indicating impaired photosynthetic activity. While the applications of 25 and 50% foliar spray of licorice root extract showed a significant increase in growth rate and photosynthetic efficiency.

Keywords: Drought, *Glycyrrhiza glabra, Lagenaria siceraria,* QY_{PSII}

INCPS-2024-150 Risk Assessment of Microplastics (MPs) Pollution Through Defensive Strategies in Sorghum (*Sorghumbicolor* L.)

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Sorghum (*Sorghum bicolor*) is a vital crop for global food security, rural livelihoods, and sustainable agriculture. In this study, we examined the effects of PE on various physiological and biochemical parameters in two plant varieties. The parameters evaluated included chlorophyll content (chlorophyll a, chlorophyll b, and total chlorophyll), carotenoid content, anthocyanin content, scavenging capacity, enzymatic activities (superoxide dismutase, catalase, ascorbate peroxidase, and peroxidase), lipid peroxidation (malondialdehyde content), proline content, and total soluble protein content. Seeds of both plant varieties were subjected to different concentrations of PE (0,250mg,500mgand 1000mg) during priming, with appropriate control groups. After priming, the seeds were germinated under controlled conditions, and the measurements were taken.Our results demonstrated significant variations in the measured parameters among the different PE concentrations and plant varieties. Increasing PE concentrations positively influenced chlorophyll content, carotenoid content, and total soluble protein content in both varieties, indicating improved photosynthetic efficiency and protein synthesis. Additionally, PE treatment enhanced the scavenging capacity and enzymatic activities associated with antioxidant defense, mitigating oxidative damage caused by microplastic stress. These findings highlight the potential of PE as a seed priming agent for enhancing crop performance under microplastic stress. Further investigations into the underlying molecular mechanisms and optimization of PE application are warranted for practical agricultural applications.

Key words: Microplastics (polyethylene),Sorghum varieties

INCPS-2024-220 Exogenous Application of Omeprazole to Induce Drought Tolerance in Maize (*Zea mays* L.)

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In present study, the impact of omeprazole on photosystem-II susceptibility to photoinhibition occurred in the drought stressed plants, was evaluated in both varieties of maize (*Zea mays* L.) i.e., D-6619 and D-3366. For this purpose, a pot experiment was performed at Botanical Garden of Bahauddin Zakariya University (BZU), Multan. The design of experiment was CRD. The pots were arranged in eight sets, one set was used as a control set (0 µM OMP), three sets were used with various concentration of omeprazole treatment (i.e., 10, 20, and 40 µM OMP respectively), while remaining four sets were used under drought stress. One set of drought stressed plants was used without omeprazole treatment, while other three sets of drought stressed plants were used with various concentration of omeprazole

treatment (i.e., 10, 20, and 40 µM OMP respectively). After 21 days of foliar application of omeprazole various parameters were measured, including water relation parameters, morphological parameters, the quantum yield of photosystem-II, relative chlorophyll content (SPAD), fast chlorophyll a fluorescence (OJIP curve analysis), and biomass. Plants biomass, chlorophyll content, quantum yield of photosystem-II, RWC, Fm, Fj, Fi, Fv, Fv/Fm, Fv/Fo, Fm/Fo, Plabs, ΦPo, Ψo declined under drought stress. But this decline was minimum in 10 µM OMP treated plants. While Fo, Vj, ΦDo, and Dio/RC increased under drought stress. It was observed that this increase was minimum in 10 µM OMP treated plants. It was also observed that PS-II of variety D-6619 was more susceptible to photoinhibition than variety D-3366 under drought stress but application of 10 µM OMP increased the drought tolerance in both varieties. This is because of increase in chlorophyll content, reduction in inactivation of reaction centres of PS-II and it also reduce the hindrance in transport of electrons from one electron acceptor to another in electron transport chain.

Keywords: Maize, omeprazole, foliar spray, drought stress

INCPS-2024-221 Impact of Drought on Growth, Photosynthetic Pigments and Chlorophyll Fluorescence of Two Maize (*Zea mays* L.) Varieties

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Drought is a major environmental stressor that significantly impacts the growth and productivity of maize (*Zea mays* L.), a vital staple crop worldwide. This study investigates the effects of drought stress on maize growth, photosynthetic pigments (chlorophyll and carotenoids) and chlorophyll fluorescence, a key indicator of photosynthetic efficiency. Two maize varieties (2266 and DK8148) plants were subjected to drought stress, and various growth parameters, including plant height, and biomass, were measured. In addition, chlorophyll fluorescence was analyzed to assess the functionality of the photosynthetic apparatus under water-deficit conditions. The results revealed a substantial decline in growth metrics, with reduced plant height, leaf area, and overall biomass accumulation under drought stress. Chlorophyll fluorescence analysis indicated a significant reduction in the maximum quantum efficiency of Photosystem II (Fv/Fm), suggesting impaired photosynthetic performance. The decline in fluorescence parameters, particularly in the quantum yield and electron transport rate, underscores the detrimental impact of drought on the photosynthetic machinery, leading to reduced energy capture and conversion efficiency in maize. These findings highlight the sensitivity of maize to drought stress, particularly in terms of growth and photosynthetic efficiency, as reflected by

chlorophyll fluorescence parameters. Understanding these responses is crucial for developing strategies to enhance drought tolerance in maize thereby ensuring sustainable crop production in the face of increasing water scarcity.

INCPS-2024-109 Unlocking the Potential of Co-applied AMF and Plant Meditated Magnesium Nanoparticles on Cauliflower Growth under Salt Stress

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Salinity is one of the major threats to an agriculture production system and limits plant growth and productivity. Arbuscular mycorrhizal fungi (AMF) from a mutualistic association with the majority of land plants and play an important role in stress tolerance. In the present study, effects of mycorrhizal treatments, i.e., single species AMF (Rhizoglomusintraradices), formulated AMF and moringa based MgO NPs and non NPs along with control (nonmycorrhizal) on growth, yield performance, and metabolic changes in cauliflower crop under salinity stress was examined in a completely randomized design with four replications. The results revealed that AMF inoculation mitigated the negative effects of salinity in cauliflower due to higher nutrient uptake, accumulation of compatible osmolytes, and lower cellular leakage of electrolytes which in turn enhanced biomass production, chlorophyll synthesis, yield, and growth attributes. The foliar applications of MgO-NPs substantially enhanced the biomass, root length, and flower height under Cl^- salt but a positive effect was found in improving water content. NPs increased *Brassica oleracea* var. the soluble sugar and protein of the salinity treated plants. The exogenous treatment of MgO-Np reduces the Cl^- uptake while enhances the nutrient (K, Mg and NO_3) content in the plant. Moreover, NPs increased photosynthetic pigments and carotenoid content. It concluded that MgO-NPs and AMF have the potential to improve the growth and floral properties of *Brassica oleracea* var. when cultivated with saline resources.

Keywords: Salt stress, Nanoparticles, AMF and cauliflower plant

INCPS-2024-238 Influence of Potassium Deficiency on Growth, Photosynthetic Efficiency of Potential Oilseed Crop Til (*Sesamum indicum* L.)

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Potassium (K) is an essential macronutrient that is crucial in plant growth, development, and physiological processes, particularly in oilseed crops like

sesame (Sesamum indicum L.). This study aimed to evaluate the influence of potassium deficiency on growth parameters, and photosynthetic efficiency (specifically PSII) in sesame. In this study, two-week-old sesame plants were subjected to varying K levels (0, 1, 2, 3, 4, and 6 mM). Results indicated that moderate to optimum K levels (2 and 3mM) enhanced the growth of sesame plants. Conversely, both very low and very high K levels resulted in decreased growth rates for sesame. Additionally, low K application increased Fo and decreased Fv/Fo, and PI_{abs}, in sesame plants.The decline in PI_{ABS} was associated with a decline in active reaction center density and electron transport efficiency and an increase in heat dissipation. Overall, this study highlights the critical role of potassium in sustaining optimal growth, and photosynthetic activity in sesame, suggesting that adequate K supply is essential for maximizing growth, and photosynthetic activity in this economically important crop.

Keywords: Potassium, Fo, Fv/Fo, *Sesamum indicum*

INCPS-2024-239 Role of Aqueous Infusion of Processed Leaves of *Camelia sinensis* L. in Growth Promotion of *Abelmoschus esculentus* L. Plants after Exposure to Elevated Barium Levels

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Elevated barium (Ba) levels in soil pose a significant threat to plant growth and development, reducing agricultural productivity. *Abelmoschus esculentus* L. (okra), an important crop, is particularly vulnerable to heavy metal stress. To mitigate the adverse effects of barium toxicity, natural plant-based treatments have gained attention. This study explores the potential of an aqueous infusion of processed *Camellia sinensis* L. leaves (green tea) in promoting the growth of two *A. esculentus* L. varieties (Sabzpari and FLIMZY) under elevated barium conditions. Tea, known for its antioxidant and metal-chelating properties, was hypothesized to enhance tolerance to barium-induced stress. Okra plants were exposed to barium concentrations (0, 2.5, 5, and 10 mM) and treated with 1% *C. sinensis* aqueous infusion. Growth parameters such as shoot and root fresh and dry weights, shoot and root lengths, photosynthetic pigments (chlorophyll and carotenoids), and PSII activity were assessed. The results indicated that elevated barium levels did not significantly reduce growth or photosynthetic pigment content in either variety, though the two varieties responded differently. PSII activity (Fo, Fv/Fm, and ETRo/RC) showed nonsignificant results for barium and C. sinensis applications. The variety Sabzpari showed higher Fo values under barium levels which is an indication of damage to the PSII reaction centers. Fv/Fm and ETRo/RC results were found non-significant. Overall results

showed that the application of barium to okra plants showed non-significant results. However, FLIMZY was found more resistant to Ba.

Keywords: Barium, *Abelmoschus esculentus*, *Camellia sinensis*, Fo, Fv/Fm, and ETRo/RC

INCPS-2024-244 Potential of Menthol as Growth Promoting Agent in Some Summer Vegetable Species of the Family Cucurbitaceae under Drought Stress

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Drought stress is a major limiting factor affecting the growth and yield of summer vegetable crops, particularly in the Cucurbitaceae family. Menthol is a bioactive compound with antioxidant and stress-mitigating properties, as a growth-promoting agent under drought conditions.Menthol, a natural organic compound with well-known bioactive properties, has been explored for its potential as a growth-promoting agent in various plant species. This study investigates the effect of menthol application (0, 25 and 50%) on *Praecitrullusfistulosus* L. (tinda) growth and physiological responses under drought stress. The effects on key growth parameters were evaluated, such as shoot, root fresh, and dry weight, RWC (%), QY_{PSII}, and photosynthetic pigments (chlorophyll & carotenoids). Additionally, physiological responses related to drought tolerance, including relative water content (RWC), and chlorophyll fluorescence (OJIP) were assessed. Results indicated that drought stress has significantly decreased the growth attributes, photosynthetic pigments, and QY_{PSII} but menthol application, particularly at 50%, significantly improved plant growth and physiological attributes under drought stress. The overall result declared that menthol application to tinda plants had improved their efficiency under drought stress.

INCPS-2024-245 Ameliorating the Effects of Drought Stress on Morpho-physiological, Antioxidants Activity and Yield Components of Maize through Biostimulants Application

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Maize is third major cereal crop of world and cultivated on large scale for human food and animal feed. However, drought stress is a major threat to the sustainable maize productivity in arid regions. Hence, there is urgent need to explore the mitigation strategies to decrease the adverse effects of drought stress on maize crop and enhance maize productivity under drought stress conditions. In this regard, biostimulants might be environment ecofriendly mitigation strategy to minimize the adverse effects of drought stress on maize crop. Therefore, a consecutive two years field trial was conducted to evaluate the effects of individual and consortia application of biostimulants viz; control, Smoke water, *Trichoderma harzianum*, *Bavaria bassiana*and*Metarhizium anisopliae* on morphophysiological traits, antioxidants activity and yield components of maize crop under well-watered and drought stress conditions. The results of the study indicated the maize crop showed superior response to the consortia of biostimulants as compared with individual biostimulants. However, maize crop exhibited the maximum grain yield (42-51%) and biological yield (37-43%) with the application of consortia of biostimulants including *Trichoderma harzianum*, *Bavaria bassiana* and *Metarhizium anisopliae* that attributed to increased relative water contents (35-41%), stomatal conductance (35-37%), water use efficiency (37-42%), chlorophyll contents (23-27%) and net leaf photosynthetic rate (38-44%) in comparison to control under drought stress conditions. Moreover, the same microbial consortia also led to a significant reduction in malondialdehyde concentration (36-39%) owning to a marked increase in proline contents (43-59%), superoxide dismutase (52-57%) and peroxidase (43-46%) under drought stress conditions. The findings conclude that the consortia application of *Trichoderma harzianum*, *Bavaria bassiana* and *Metarhizium anisopliae*, is the best agricultural practices to alleviate the adverse effects of drought stress on morphophysiological traits, antioxidants activity and enhance the grain yield of the maize crop under drought stress conditions.

INCPS-2024-246 Oxidative Stress Induced by Changing Moisture Content of Soil in *Luffa aegyptiaca*Mill, and Antioxidative Capacity of Tea Leaves using Time Gradient Extraction Method

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Oxidative stress is a complex chemical and physiological phenomenon that accompanies virtually all biotic and abiotic stresses in higher plants and develops as a result of reactive oxygen species (ROS). Impact of soil moisture variation cause oxidative stress in *Luffa aegyptiaca*Mill (Sponge guard) and evaluate the antioxidative capacity of tea leaves. Fluctuations in soil moisture particularly drought which cause the oxidative stress in plant by production of ROS H_2O_2 leading cellular damage. The current study evaluated leaves extract of tea which highly rich in antioxidant enzyme, such as superoxide dismutase (SOD), ascorbate peroxidase (APX), catalase (CAT), glutathione peroxidase (GPX) and flavonoids were analyzed for ROS scavenging ability. Application of tea leaves which help the plant to retain moisture. Experiment was conducted to assess the antioxidant capacity to combat the oxidative stress occur due to drought. Concentration of tea leaves (5g L^{-1} and 10g L^{-1}) extract was given through root media after one week interval to check the growth, photosynthetic pigments, and chlorophyll fluorescence of *Luffa aegyptiaca.* Results indicated that drought stress has decreased the growth and physiological attributes of luffa plants. While application of tea leaves (10g L^{-1}) enhanced the growth attributes i-e shoot, root fresh/dry weight), number of tendrils and tendrils length. Chlorophyll and carotenoids were found maximum under 5g L^{-1}.Additionally, chlorophyll a fluorescence as F_O, PI_{abs} and ETo/RC were also measured. Results declared that Fo was found maximum under drought stress which showed the issue in efficiency of the PSII in luffa plants. PI_{abs}& ETo/RC values were found lower under drought stress while tea leaves application enhanced the mean values for both parameters. This conclude that tea leaves serve as natural source of antioxidant capable of countering oxidative stress in biological system. This research provides insight into the relationship between soil moisture induced oxidative stress and plant resilience.

Keywords:PIabs& ETo/RC, *Luffa aegyptiaca*

INCPS-2024-247 Antioxidative Capacity of Cinnamon Extract in Reducing Adverse Effects of AluminumToxicity in *Cucurbita maxima* L. Plants

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Aluminum (Al) toxicity is a significant abiotic stressor that negatively affects plant growth and physiological functions, particularly in acidic soils. This study investigates the antioxidative capacity of cinnamon bark extract in mitigating the adverse effects of aluminum toxicity on *Cucurbita maximum* L. (pumpkin) plants. Plants were treated with Al (0, 0.05, 0.1 & 0.2g Kg^{-1}) and supplemented with varying concentrations of cinnamon extract (0, 5, 10 & 20%) was foliarly applied to assess its potential protective role. Key growth parameters (Biomass), chlorophyll content, and photosynthetic efficiency, including QY_{PSII} (quantum yield of PSII), Fo (minimum fluorescence), Fv/Fm

(maximum quantum efficiency of PSII), PI_{abs} (performance index), and ETRo/RC (electron transport rate per reaction center), were evaluated. The results demonstrated that aluminum toxicity significantly reduced plant growth, chlorophyll content, and photosynthetic efficiency, with marked declines in QY_{PSII}, Fv/Fm, PI_{abs}, and ETRo/RC, while Fo values increased, indicating damage to PSII. However, plants treated with cinnamon extract showed significant improvements in these parameters. Cinnamon's antioxidative properties helped alleviate oxidative stress, restoring PSII functionality and enhancing plant tolerance to aluminum toxicity. The findings suggest that cinnamon extract could be an effective natural remedy to reduce the harmful effects of aluminum stress on pumpkins, promoting growth and photosynthetic performance.

Keywords: $QY_{PSII,}$ $PI_{abs,}$ Cucurbita maximum, Cinnamon

INCPS-2024-250 Alleviation of metal toxicity by cellulosic and lignin-derived material in a medicinal herb (*Coriandrum sativum* L.) under exceeding levels of Aluminum

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Metal toxicity, particularly aluminum (Al), poses a significant threat to plant growth and development, affecting various physiological and biochemical processes. Coriandrum sativum L. (coriander), a medicinal herb with notable therapeutic value, is highly sensitive to excessive aluminum levels, which impair growth and photosynthetic pigment production. This study investigates the potential of cellulosic and lignin-derived materials as bioremediation to alleviate aluminum toxicity in coriander. The experiment involved treating coriander plants with aluminum stress (0, 50, and 100 mg Kg^{-1}) and applying cellulosic and lignin-based materials (Sawdust) i-e 0, 50, and 100 mg Kg^{-1} to evaluate their effects on plant growth, photosynthetic pigments (chlorophyll and carotenoids). The results revealed that sawdust, at all tested concentrations, showed non-significant effects on plant growth and photosynthetic pigment content (chlorophyll a, chlorophyll b, and carotenoids) under increasing aluminum levels. While aluminum concentrations showed a significant difference in growth and photosynthetic pigment. On the other hand, aluminum along with sawdust application showed a reduction in growth chlorophyll concentrations compared to untreated controls. This suggests that sawdust, as a cellulosic material, may not effectively mitigate aluminum toxicity in coriander under the tested conditions. These findings highlight the need for further exploration of other organic materials or combinations to develop strategies for alleviating metal toxicity in sensitive crops like coriander.

Keywords: Aluminum, Sawdust, Metal toxicity, Photosynthetic pigment

INCPS-2024-252 Effects of Exogenously Applied Proline through Different Modes on Growth and Photosynthesis of Wheat

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In the present study, effects of exogenously applied proline through different modes on growth and photosynthesis of wheat were studied. For this purpose, a pot experiment was performed at the Botanical Garden of Bahauddin Zakariya University (BZU) Multan. The experimental design was CRD with 2 cultivars (galaxy-13 and S-24), four exogenous proline treatments (0 mM without proline, 10 mM root applied proline, 100 mM foliar application, and 15 mM seed priming) two salinity levels (0 mM and 200 mM) and four replicates. After three weeks of germination, physiological attributes were measured including total chlorophyll contents (SPAD), the quantum yield of PSII and rapid light responsive curve. Salinity stress significantly reduced the plant growth and photosynthesis. However, exogenous application of proline improved the growth (fresh and dry weight, shoot and root length) and photosynthesis of wheat plants under saline and non-saline conditions. Proline application by various modes improved photosynthetic efficiency, with significant increase in quantum yield of PSII and total chlorophyll contents. Proline applied plants improved the PSII and PSI activity by improving ETRI, ETRII and cyclic electron transport rate. Salinity significantly decreased the water potential and osmotic potential in both cultivars of wheat under saline conditions. However, proline application enhanced the water potential of both cultivars under saline and non-saline conditions. Cultivar-specific responses were observed, with Galaxy-13 showing increased root length and S-24 exhibiting increased quantum yield of PSII. Salinity induced varying effects on photosynthetic parameters, including decrease in Fv/Fm, Fm and LEF, and increases in ΦNPQ and qL. Exogenous proline application enhanced salinity tolerance in wheat cultivars by improving growth and photosynthetic efficiency, highlighting its potential as a stress-mitigating agent.

INCPS-2024-253 Exploring PGPB Mediated Chromium Detoxification by Antioxidant Defence System in Wheat (*Triticum aestivum* L.)

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Soil contaminated by heavy metals is a major issue of current world due to rapid industrialization. The plant growth promoting rhizobacterial (PGPR) are being utilized to enhance plant growth, development and yield by successful phytoremediation of polluted metal surfaces soils with a considerable decrease in metal contents in edible parts of plants. This trial was design to determine the ameliorative role of PGPR (*Bacillus cereus* and *Bacillus aerius*) on biochemical, physiological and yield of wheat (*Triticum aestivum* L.) varieties (Zincol-2016 and Akbar-2019) grown in 60 mg Kg-1 chromium (Cr: $K_2Cr_2O_7$) contaminated soil. The germination % (54%) was significantly reduced with delayed germination and lengthier mean germination time (53%) under Cr toxicity, while PGPR application enhanced these attributes either under control or Cr stressed plants. A noticeable decline in biomass accumulation (43%); shoot length (39%); number of tillers (50%); spike length (16%), yield per plant (37%) and 1000 grain weight (26%) was observed in wheat plants under stress. The decrease in chlorophyll contents (39%) associated with reduction in absorption and transport of electron through electron transport chain of thylakoid membrane (ABS/RC, ETo/RC, TRo/RC) with a subsequent increase in Mo and Dio/RC resulted in lowered efficiency of PSII (Fv/Fm) in wheat crop grown in contaminated soil with Cr. However, the presence of PGPR in growing media ameliorated the harmful consequences of Cr by stabilizing the integrity of thylakoid membrane (13%) and chlorophyll molecules (31%) either under non-contaminated or Cr polluted soils. Similarly, under Cr stress the PGPR significantly reduced H2O2 (- 44%) synthesis while the actions of antioxidants enzymatic (POD, SOD, CAT, APX and GR) and non-enzymatic (AsA, proline, α-tocopherol and total glutathione) were enhanced that reduced lipid peroxidation (-24%) resulting in better growth and yield. The PGPR inoculation also lowered Cr concentration in roots and leaves (38% and 30%) that were significantly enhance (477% and 136%) in wheat crop grown in Cr polluted soils. Based on the outcome the bacterial strains; *Bacillus cereus* and *B. aerius*effectively ameliorated the toxic effects of Cr and produced a significant enhancement in growth and productivity of both wheat varieties that behaved almost similar to Cr stress and PGPR application.

Key words: Antioxidants, Chromium, Chlorophyll fluorescence, Plant Growth Promoting Rhizobacteria, Total soluble sugars, Translocation factor Cr, Wheat, Yield, α-amylase activity

INCPS-2024-255 Effects of Proline Application through Rooting Medium on Water Status, Photosynthetic Pigments, PSII-activity, and Electron Transport Efficiency of Wheat (*Triticum aestivum* L.) under Salt Stress

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In the present study, the effects of proline application through rooting medium on water status, photosynthetic pigments, PSII activity and electron transport efficiency of two wheat cultivars Galaxy-13 and S-24 were studied. Experimental design was completely randomized including two wheat varieties, Galaxy-13 and S-24, four exogenous treatments of proline, two salinity levels (0 mM proline, 10 mM proline, 200 mM $NaCl^-$, 10 mM proline + 200 mM $NaCl^-$) and four replications. After 21 days of proline and salinity treatments, different parameters were measured. Plant biomass, QY, SPAD, total soluble proteins, total free amino acids increased with the exogenously applied proline (10 mM). Plant biomass, quantum yield and total chlorophyll contents increased in exogenous proline (10 mM) treated plants in both two cultivars (Galaxy-13, S-24) but the results were more profound in S-24 cultivar. However, salinity (200 mM) decreased the photosynthetic rate in both cultivars equally. Total soluble proteins increased in salinity given plants in both cultivars and the level of total free amino acids also increased more prominently in Galaxy-13 cultivar indicating it as a protective mechanism to cope with oxidative damage. Production of Hydrogen peroxide and malondialdehyde elevated in response to salinity exposure particularly in S-24 cultivar. Exogenous proline increased the rate of Fm, Fv/Fm, ϕ NO, vH+ and gH+ while salinity increased Fo level. Salinity caused reduction in the leaf water potential and leaf osmotic potential to a large extent in both cultivars of wheat. However, elevation in leaf turgor potential was observed by the exposure of salinity in both two cultivars. Activity of YII, ERTII, YI and ETRI was enhanced by the exposure of exogenously applied proline. These results were more prominent in S-24 cultivar indicating it as salt tolerant variety and Galaxy-13 as a salt sensitive variety of wheat.

INCPS-2024-256 Effect of Chromium on Growth and Biochemical Attributes of Spinach (*Spinacia oleracea*)

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Chromium is a noxious heavy metal detrimental to plant growth. Long term irrigation of vegetable crops such as spinach with untreated wastewater released from industrial processes cause excessive accumulation of Cr in soil and subsequently into the crop. This study was conducted with the aim to evaluate the effect of Cr on growth and biochemical attributes of spinach,

and to find the toxic level of Cr impairing spinach growth. A pot experiment was performed and seedlings of desi spinach were exposed to five Cr concentrations (0, 25, 50, 75 and 100 µM). Experiment was laid out according to Completely Randomized Design with 3 replications of each treatment having three pots in each replication. Data was collected for root length, shoot length, shoot fresh weight, shoot dry weight, relative chlorophyll content, chlorophyll a, chlorophyll b and total chlorophyll content, electrolyte leakage, Cr concentration in root and shoot, Cr translocation efficiency, relative water content, leaf water potential, and total soluble solids of leaves. Collected data was evaluated statistically through ANOVA and significance was tested by means of Least Significance Difference (LSD) test at probability level of 5%. Results indicated that the application of 100 µM caused significant reduction in chlorophyll a, chlorophyll b, total chlorophyll content, root length, shoot length, shoot fresh weight and relative water content of spinach. At 100 µM concentration of Cr, electrolyte leakage, Cr concentration in shoots, Cr concentration in roots and Cr translocation efficiency were significantly enhanced.

Keywords: Chromium, Biomass, SPAD, Relative water content, water potential, growth Spinach.

INCPS-2024-257 Effect of Biochar on PSI and PSII Activity of *Luffa aegyptiaca* (Sponge gourd) under Drought Stress

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Drought stress is a major environmental constraint causes alteration in physiological and biochemical processes, limited the water uptake through roots, decline in leaf water content and turgor loss in plants leading poor plant water status. It affects the cell turgor, cell enlargement, cell elongation and cell division. Biochar is a carbon-rich material that has capacity to improves soil water retention, improve long term productivity and increase agricultural yield. This study was purposed to evaluate the effect biochar on physiological and biochemical attributes or PSI and PSII activity on luffa aegyptiaca under drought stress. This research was conducted through field experiment in the Botanical Garden of Bahauddin Zakariya University, Multan, Pakistan. The experiment was a completely randomized design with four treatments (control, control + biochar, Drought, and drought + biochar).Biochar is a promising solution to alleviate the negative impacts of drought stress on Luffa aegyptiaca production. Key parameters measured included plant biomass, relative water content, water potential, osmotic potential, the levels of stress indicators such as chlorophyll contents, chlorophyll a fluorescence, proline contents, protein content, amino acid content, antioxidant enzyme activity, ions analysis of sodium, potassium,

calcium, magnesium, zinc and photosignQ parameters (ECSTmAU, ECS-tau, gH+, VH+, Fs, F_o', Θ_2, ΘNPQ, qL, NPQt, ΘNO, Fv'/Fm'). The results demonstrated that biochar application notably improved drought resilience, as evidenced by increased plant biomass and length, improved water retention, quantum yield of PSII, and enhanced biochemical responses compared to drought. Moreover, biochar application changed the ECSTmAU, ECS-tau, F_o', Fv'/Fm', Fs', ΘNO, ΘNPQt, in Luffa aegyptiaca plants indicating changes in PSII and PSI activity. Biochar-induced changes in energy fluxes for absorption, trapping, electron transport, and heat dissipation per reaction center indicated that Luffa had better ability to process absorbed light energy through photosynthetic machinery. Thus, the application of biochar is a promising solution to enhance the growth, root morphology, and physiological characteristics of Luffa plants under drought stress.

Keywords: Biochar effect, Sponge gourd, Water-retention capacity, Biochar, Drought stress, Luffa.

INCPS-2024-23 Growth Improvement in Wheat (*Triticum aestivum* L.) due to Exogenous Proline is Associated with Regulation of Donor End of PSII and Cyclic Electron Transport

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Amino acid proline usually accumulates in plants as an osmoprotectant under normal or stress conditions. Exogenously applied proline can improve plant growth under non-stress or abiotic stress conditions. However, the physiological basis of proline-induced improvement in growth is not known yet. An experiment was conducted to assess proline-induced improvement in growth, photosynthetic efficiency of wheat plants in general, and photosystem II (PSII) structural stability and functional activity, in particular. Ten-day-old wheat (cv. S-24) plants were sprayed with different proline concentrations (0, 100, 200, and 400 mM). Structural stability of PSII (OJIP and JIP-test analysis) and efficiencies of PSII and PSI (through rapid light response curve analysis) were recorded after the 3rd week of proline application. The application of 100 mM proline improved the growth of wheat plants and 400 mM proline application had negative effects on the growth of wheat plants. Chlorophyll content and quantum yield of PSII remained unchanged due to proline application. Proline improved the structural stability of PSII (OJIP) in wheat as indicated by changes in the L-, K- band, J-I, and I-P phases. These results indicate the improvement in energetic connectivity between the antenna and reaction center, and the oxygen-evolving complex (OEC) and reaction center. However, the performance

index and Mo remained the same by proline application. Application of a higher concentration of proline (400 mM) reduced the ABS/RC, TRo/RC, and ETo/RC but DIo/RC, and REo/RC remained unchanged. Proline also increased the functional activities of PSII and PSI, electron transport through PSI (ETRI), and cyclic electron transport (CET), while reducing NPQ. Although 400 mM proline did not change the PSII and PSI, it reduced the electron transport from PSII to PSI, and CET. It is concluded that 100 mM proline improved wheat growth by improving PSII structural stability and functional activity and regulating electron transport via CET. In contrast, the higher dose of proline reduced both linear and cyclic electron transport.

INCPS-2024-153 Impact of Phosphorous Application on Electron Transport Chain rate (OJIP) in Wheat (*Triticum aestivum* L.) and Canola (*Brassica napus* L.)

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Phosphorus (P) is an important macronutrient that plays role in various physiological processes such as photosynthesis. In most of the agricultural soils, only a small fraction is readily available to plants. Phosphate fertilizers are being used to address phosphorus deficiency. However, a major fraction of applied phosphorus becomes locked in the soil, thus optimum dose of phosphate fertilizer should be used. Since phosphate deficiency causes a decline in photosynthesis and growth, it is updated to assess photosynthetic efficiency (specifically Photosystem II) as a non-invasive indicator of plant health. In this study, three weeks old plants of wheat variety Dilkhus-21 and canola variety AARI were subjected to various phosphorus levels (12.5, 25, 32, 62, and 124 mg L^{-1}). Results indicated that moderate to optimal phosphorus levels (25 and 62 mg L^{-1}) enhanced the growth of both wheat and canola plants. Conversely, both very low and very high phosphorus levels resulted in decreased growth rates for Canola. Additionally, low phosphorus application increased Fo and decreased Fv/Fo, and PI_{ABS} in both wheat and canola plants. The decline in PI_{ABS} in both plant species was associated with decline in active reaction center density and electron transport efficiency and an increase in heat dissipation. However, wheat is more efficient for low phosphorous tolerance.

Abbreviations:Fo: Minimum fluorescence of OJIP; **Fv/Fm:** maximum quantum yield of PSII; **PIABS:** Performance index for energy conservation from photon absorbed by PSII antenna to reduction of QB.

INCPS-2024-144 Influence of Aerial Fertigation of Zinc Oxide Nanoparticles on Some Winter Vegetables to Alleviate Drought Stress Condition

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Drought stress significantly affects the plants and decreases the crop yield and productivity all over the world. However, recently, zinc oxide nanoparticles (ZnONPs) have been used as an innovative strategy for crops yield and highlighting the potential as a valuable tool in sustainable agriculture practices to ameliorate drought stress. Hence a field study was planned in the Botanic Garden of Bahauddin Zakariya University Multan to observe the effects of ZnONPs at various concentrations i.e., 0,50,100, 200 & 300ppm on turnip (*Brassica rapa* L.), radish (*Raphanus sativus* L.) and carrot (*Daucus carota* L.) crops under both control and drought stress condition. The experiment was randomized complete block design (RCBD). Results showed that drought stress caused a significant reduction in growth, colored pigments of leaves, and antioxidant system of all these three vegetables. However, aerial application of various regimes of ZnONPs enhance all the vegetables' morpho-physiological and biochemical attributes. Moreover, among various regimes of ZnONPs the dose @100ppm was significantly improved biomass production in terms of shoot and root weight, photosynthetic pigments, enzymatic antioxidants (CAT, POD, APX), non-enzymatic (ascorbic acid, proline) activity, proteins and amino acids content and secondary metabolites (flavonoids and phenolics) under both control and drought stress condition. On the other hand, oxidants (H_2O_2 and MDA) also increased under control and under drought-stress conditions. Data based on results presented that foliar application of ZnONPs, under drought stress is compliant in the enhancement of growth and productivity of turnip, radish, and carrot plants.

INCPS-2024-161 Screening of Wheat Genotypes using Growth and Physiological Attributes at Seedling Stage under Drought Stress

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The implications of shortage of water supply around the globe are becoming worse by every passing day due to the challenges of food production and calamities brought on by climatic changes due to global warming posing negative impacts globally on the grain production, specifically on cereal crops including wheat. Based on previous problem of drought stresses an experiment was conducted in order to determine the selection criteria for drought-tolerant wheat genotypes at the seedling stage considering morphological and photosynthetic pigments. The research was conducted up to seedling stage for 3 replications by applying Completely Randomized

Design (CRD) to check the response of wheat under drought stress conditions. Wheat was grown up to seedling stage and different attributes of morphology and leaf pigments were measured. The recorded data was analyzed by using Statistic 8.1 Software. Results of present study concluded that the shoot length (14.20 cm), their fresh (0.40g) as well as dry weight (0.19 g) decrease with increasing level of drought stress while the root length (9.20 cm) their fresh (0.67 g) as well as dry weight (0.33 g) increase with increasing level of drought stress. Maximum reduction of leaf photosynthetic pigments such as chlorophyll a (2.16 mg g^{-1}), chlorophyll b (6.28 mgg^{-1}), total chlorophyll contents (8.44 mg g-1) and total carotenoids contents (3.17 mgg^{-1}) were noted in treatment where drought stress was applied at the rate of 35% F.C then all others treatment. Among all of the examined wheat varieties the ANAJ genotype of wheat performed better and is considered as drought tolerant.

INCPS-2024-171 Improving Drought Tolerance in Brinjal (*Solanum melongena*) by Foliar Application of Biochar Emission Solution

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Drought stress is a serious threat to sustainable crop production throughout the world especially in arid and semi-arid regions. Biochar has been proposed as a new approach to improve long-term productivity and water use efficiency. The study was purposed to evaluate the potential of biochar in enhancing the physiological and biochemical attributes of drought tolerance in brinjal plants. The study was conducted as a field experiment in the Botanical Garden of Bahauddin Zakariya University, Multan, Pakistan. The experiment was a completely randomized design with four treatments (control, control + biochar, Drought, and drought + biochar) and two biochar doses (0 and 0.5% applied by weight). Drought stress negatively affected the plant growth and photosynthetic efficiency of brinjal while biochar applications alleviated the negative impacts of drought stress. Key parameters measured included plant growth, relative water contents, water potential, and the levels of stress indicators such as chlorophyll contents, chlorophyll a fluorescence, proline contents, protein contents, amino acid contents and antioxidant enzyme activity. The results demonstrated that biochar application notably improved drought resilience, as evidenced by increased plant height, improved water retention, quantum yield of PSII, and enhanced biochemical responses compared to drought. Moreover, biochar application changed the Fo, Fm, Fv/Fo, and -PI_{ABS}, in brinjal plants indicating changes in PSII activity. Biochar-induced changes in energy fluxes for absorption, trapping, electron transport, and heat dissipation per reaction center indicated that Brinjal had better ability to process absorbed light

energy through photosynthetic machinery. These findings suggest that biochar emission solutions could serve as a promising agronomic practice to mitigate drought stress in brinjal cultivation, offering potential benefits for sustainable agriculture in arid regions.

Keywords: Biochar, Crop drought resistance, Water-retention capacity, Biochar, Drought, PI_{ABS}

INCPS-2024-216 Effect of Exogenous Application of Nano-Biochar on Growth and Physiological Responses of Corn (*Zea Mays* L) under Water Stress

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Crop growth and productivity to a greater extent controlled in water limited situation which is termed as drought stress. The utilization of nano-biochar has gained attention as a potential strategy to mitigate adverse effects of water stress on plant growth. Present study investigates the growth performance and mineral nutrient status of corn (*Zea mays* L.) under water stress conditions with application of nano-biochar. Maize is most important cereal whose production is badly affected by drought stress of two maize genotypes (D-3366 and D-6619) with nano-biochar. A randomized experiment is designed with three treatments 0%, 0.5% and 1% of nano-biochar in Botanical garden, Biopark, Bahuddin Zakariya University, Multan under different parameters i.e total chlorophyll content and quantum yield was measured 1% of nano-biochar treatment demonstrated highest values in both verities in control and drought-stressed plants as effected more in D-6619 than D-3366, similarily in drought conditions osmotic and water potential found negative, indicating higher stress, while 1% of nano-biochar control and drought plants maintain higher osmotic and water potentials with greater relative water content. The control plants with 1% of nano biochar exhibited the best growth, but the variety (D-3366) showed better growth. In drought stress a decrease in values of Fj, Fm, Fv and Fm was observed. In D-6619 there is an increase of ratio of Fv/Fo and in D-3366 increase in Pi-Abs value. Values of TRO/RC, ABS/RC Dlo/RC decreased in 3366 and increase in D6619. Ψw and ΦPo were higher in the maize variety (D-6619) than in the control, while in maize variety (D-3366) these two variables were noted lower in concentration as similar trend for Mo. It is concluded that the Maize variety (D-3366) was drought tolerant, while D-6619 drought sensitive. Under drought condition D-3366 displayed more or less tolerantbehavior where D-6619 proved to be drought sensitive having lower values of various physiological parameter.

Keywords: Crop, Growth, Physiological response, Drought Stress, Nano-biochar

INCPS-2024-234 Screening and Selection at All Developmental Stages: A Prerequisite for Optimizing Plant Performance

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Plant salt tolerance is one of the most significant abiotic factors that limit canola crop production. Understanding the mechanisms of response to this stress is critical for developing and producing salt-tolerant genotypes. This research study aims to investigate the importance of genetic diversity in identifying genotypes with a high degree of salt tolerance. Screening of available local/exotic germplasm of a crop for salinity tolerance is one of considerable technique for the economic utilization of salt-affected soils of arid and semi-arid regions. The response of 27 canola (*Brassica napus* L.) cultivars to saline treatments (0, 75, 150/ or 200 m*M* NaCl) was examined at germination, seedling, vegetative and reproductive growth stages. Salt stress caused reducing effect on seed germination, seedling growth, and vegetative growth. Of the 27 canola cultivars, cvs. DGL, Dunkled, Faisal Canola and HOP-9 produced greater fresh and dry biomass, whereas cvs. Ac-Excel, Legend, Oscar and 11CBN-006 were lower in growth attributes. In addition, cvs DGL, Faisal Canola and Shiralee produced maximal seed yield. In the present study, lower Na^+ but higher K^+ content in DGL and Dunkled showed a key mechanism of ion exclusion. With the exception of other canola cvs, Faisal canola showed a positive relationship with Na^+ accumulation suggesting that these cultivars may use mechanisms involved with Na^+ tissue tolerance, such as intracellular compartmentation and increased accumulation of compatible solutes over Na^+ exclusion. Screening and selection for salt tolerance at all growth and developmental stages is prerequisite. As, at germination six canola cultivars such as Rustam canola, Faisal Canola, Cyclone, DGL, Dunkled and CON-III out of 27 were salt tolerant but later on three remained consistently tolerant while others varied in their response to salt stress. It is now evident that selection for salt tolerance made at one growth stage did not tolerate salt stress at the other growth stage due to which selection for salt tolerance should be made at all developmental stages.

INCPS-2024-236 Physio –Anatomical Adaptations among Different Accessions of *Cenchrus ciliaris*L. Collected from Cholistan and Thal Deserts

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Drought-tolerant plants like *Cenchrus ciliaris* L. are excellent sources for exploiting drought-hit areas. Different ecotypes of *Cenchrus ciliaris* L. from 1R Sinawan and Sarai Muhajir (Thal Desert) and Fort Derawer and Bahawalpur (Cholistan Desert) Punjab, Pakistan were subjected to drought stress. Drought reduced the growth, chlorophyll contents, and relative water contents in all accessions while protein and amino acids were increased. The greater reduction in quantum yield of PSII in population from Bahawalpur due to drought stress was due to PSII photodamage. Double normalized differential kinetics indicated adverse effects at the antennae, oxygen-evolving complex, and intersystem electron acceptors in Sarai Muhajir. Moreover, JIPtest analysis showed that drought stress caused a greater decrease in performance index (PIABS) in Sarai Muhajir as compared to that in Bahawalpur, which is associated with an increase in Vj, rate of accumulation of closed reaction centers (Mo), energy fluxes for absorption (ABS/RC), trapping (TRo/RC), electron transport (ETo/ RC), and dissipation of absorbed energy as heat (DIo/RC). Plant anatomical parameters like leaf thickness, epidermal thickness, sclerenchyma thickness, cortical cell area, and metaxylem area were studied. In all populations from different ecological habitats, major anatomical modifications regarding leaves were reduced leaf lamina, well-developed sclerenchyma cells, and increased cuticle thickness under severe drought stress accompanied by a thick epidermal layer for moisture conservation. Likewise, reduced stem, metaxylem, and phloem areas were also noted under drought stress, which played an important role in increasing the plant's capability to cope with drought stress. Based on these anatomical and physiological adaptations observed in all populations under drought, some characteristics are better in populations from the Cholistan desert while some were observed in populations from the Thal desert.

INCPS-2024-237 Assessment of Physiological Basis of Salt Tolerance in *Luffa aegyptica Mill.*

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Food production is the main concerning issue with the continuously increasing population under salinity stress. Experimentation was conducted in the growth room of the Botanical Garden, Bahauddin Zakariya University, Multan. Salt tolerance was assessed in three different varieties of *Luffa aegyptica* (Mill.) at different salt stress levels (0, 60, 120, and 180 mM NaCl). Based on growth attributes and ionic regulation Radhika, Resham, and Advanta-1102 were categorized as salt tolerant, moderate salt tolerant, and sensitive cultivars to salt stress. Results revealed that salt-tolerant cultivars of *L. aegyptica* i.e., Radhika and Resham, had more growth rate than their sensitive variety Advanta-1102 along with a lesser decrease in water

potential but a greater decrease in leaf osmotic potential that resulted in greater turgor potential. Besides these, the accumulation of organic osmolytes like free amino acids, proline contents, ion toxicity through Na^+ exclusion with more K^+ intake, and specific antioxidants in salt-tolerant varieties was also higher. It is suggested that these factors contribute to the salt tolerance of these vegetables. Salt stress decreased the photosynthetic pigments and PSII activity in all cultivars of *L. aegyptica*. Salinity-induced photoinhibition was more in salt sensitive variety and it was mainly due to damage at the donor and acceptor end of PSII. In conclusion, salt-tolerant varieties of *L. aegyptica* including Radhika and Resham had greater ability to withstand salty environments than Advanta-1102. All these factors along with some other parameters such as ECS_t, gH^+, vH^+ and LEF can be used as potential indicators for salt tolerance. It is suggested that assessment of fluorescence-based photosynthetic parameters may help in screening and selection for salt tolerance.

INCPS-2024-241 Response of *Cuscutareflexa*roxb Extract on Barley Crop under Hg Stress

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Barley is an oldest agricultural, early domesticated cereal crop which play important role in human nutrition, animal feed, plant biochemistry and plant biotechnology. A pot experiment was performed to check the effect of growth rate of barley by the application of *Cuscutareflexa*roxb extract and heavy metal Hg. Experiment was performed in Old Botanical Garden at University of Agriculture, Faisalabad. Experiment design was based on CRD with three replications. Two varieties of Barley seeds (Sultan 17 and Joe 17) used which was collected from Ayub Research Institute, Faisalabad. Hg stress (0mM control), and (1mM) applied on two varieties after four week of seedling. Four levels of *Cuscutareflexa*roxb extract (0%, 15%, 45%, 70%) applied as foliar spray after 15 days of stress. 2 to 3 drops of surfactant tween 20 was added in regulator. Morphological, physiological and biochemical characters such as root length, root fresh and dry weight, shoot length, shoot fresh and dry weights, chlorophyll a, b, total chlorophyll, carotenoids, CAT, POD, SOD, total soluble sugar, total soluble protein and total amino acid was determined. Na^+, K^+ and Ca^{2+} concentration was determined by using flame photometer. Correlation was exposed between *Cuscutareflexa*roxb extract and Hg treatment using Co stat software. Data was analyzed for analysis of variance (ANOVA) and least significant method (LSD).

INCPS-2024-47 Flooding and Drought Induced Morphological Response of Soybean (*Glycine max*) Seedlings Grown in Muzaffarabad, Azad Jammu and Kashmir

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Soybean (*Glycine max* L.) is the valuable legume crop, enriched with protein, carbohydrates, and oil. Soybean is cultivated worldwide and adopted to different climatic conditions. The growth and productivity are deleteriously affected by nature's outrage in the form of abiotic stress factors such as flooding and drought. The aim of present study is to profile the effect of alternating water stress periods during the vegetative and reproductive periods on the rate of organ appearance of two genotypes of G. max L. Potted soybean seedlings were subjected to stress treatments. Two varieties with three replicates for both flooding and drought were compared using analysis of variance (ANOVA). Flooding treatment adversely affected the soybean at the reproductive stage rather than at vegetative stage, ultimately reducing the seed yield due to high abortion rate of flowers and pods but favored leaf growth. Whereas, drought stress equally influenced both vegetative and reproductive stages, emergence of nodes initiated during water deficit stress was delayed, whereas flower and pod abortion rate was high. The reproductive phase was shorter under drought. Among both treatments the two genotypes showed slight tolerance towards flooding, but both genotypes were intolerant towards drought stress. The fallouts of the current study unveil that flooding and drought have significant effects on all morphological parameters of soybean.

INCPS-2024-264 Effects of Poultry Manure as an Ecofriendly Soil Fertilizer for Maize (*Zea mays* L.) Crop

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Use of organic fertilizer (poultry manure) instead of chemical fertilizers, could be a best option for future as soil amendments which can also overcome the problem of environmental pollution. The main objective of the current study was the assessment of the effects of poultry manure as a fertilizer on growth and yield of maize crop. Two maize varieties were grown in the field area of The Women University Multan under following ratio of the poultry manure (0%, 0.25%, 0.5%, 0.75%, and 1%). Results shown that in both varieties of maize, increase in fresh and dry biomass were noted with the

increase in poultry manure. Maximum % control values were observed at 1% ratio of poultry manure in both varieties. Percent control values for shoot fresh and dry weight were 278.6, 295.5, 310.5 and 466.1 and for root fresh and dry weight were 326.8, 331.8, 316.7 and 360.3 in both varieties respectively. Relative water content was 109.2 and 102.4 in both varieties respectively at 1% poultry manure. In yield attributes according to % control no. of cob wt./plant (220.4 and 210.5), no. of rows/cob (102.8 and 117.1), length of cob/plant (138.5 and 819.4), 1000 grain wt./plant (137.4 and 140.5) and total yield/plant (195.4 and 225.2931) in both varieties respectively at 1% of poultry manure. Thus it will be recommended that poultry manure could be supportive as an ecofriendly soil amendment and fertilizer which can fulfil the demand for NPK in soil.

INCPS-2024-266 Adaptive Anatomy and Physiology of *WithaniaSomnifera* (L.) DUNAL Under Different Environmental Conditions

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Withaniasomnifera (L.), also known as Ashwagandha or Winter cherry, an evergreen shrub native to Pakistan, India, the Middle East, and certain regions of Africa. This study focused on the collection of plant material from different ecotypes in the Punjab region, including Shadan Lund, Layyah, KotAdu, Jam Pur, Vodor, DG canal, Kala, Chah Jeand Wala, Faisalabad, DG Khan, Jang, and Multan, to investigate morphological and anatomical variations. The collected samples were preserved in a 70% alcohol solution, and freehand sectioning and double staining methods were employed. Microscopic examination using a digital ocular camera facilitated the analysis of various anatomical structures in the roots, stems, and leaves. Morphological and anatomical features were carefully observed and documented. Results indicated that the Jam Pur ecotype exhibited the maximum root epidermal thickness, while the Faisalabad ecotype displayed the largest root radius. Stem characteristics varied significantly among the ecotypes, with the Vodor ecotype exhibiting the highest cortical cell area, Jam Pur ecotype displaying the greatest epidermis thickness, and the Shahdan Lund ecotype showing the thickest sclerenchyma layer. The Vodor and Jang ecotypes had the highest abaxial stomatal area and number of trichomes. In conclusion, alteration of morphological features in various plant parts of *Withaniasomnifera* were linked to changes in environmental factors, thus enabling the successful distribution of this species along in diverse environment.

INCPS-2024-272 Prospective of Medium-Supplemented Thiourea to Attenuate Heat Stress by Improving Growth, Gas Exchange and Mineral Attributes of Maize Hybrids

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Heat stress is a vital environmental issue that affects the growth and development of plants by reducing photosynthesis. In a recent study thiourea application has been validated to improve the stress tolerance in different crops. Towards this exertion, the main objective of this work to elucidate the affective role of medium supplemented thiourea (0.25mM) against heat stress in five maize (*Zea mays*) hybrids sown in spring and autumn seasons. Seeds of hybrids were sown in pots containing 10kg of sand. Fifteen days old plants were subjected to different treatments. Thiourea (0.25mM) was given with nutrient solution whereas open door plexiglass fitted canopies that provided about 7-8^{o}C greater temperature than outside were used to induce heat stress. Heat stress decreased the shoot length, root length, shoot fresh weight, root fresh weight leaf length and leaf area whereas root applications of thiourea mitigate the toxicity of heat stress. Different gas exchange (net photosynthetic rate (P_n), stomatal conductance (g_s) and tranpirational rate (E)) attributes were reduced due to heat stress on the other hand increase was noticed in substomatal CO_2 (Ci) contents in both the seasons Thiourea cope with heat stress and improved the hybrids growth, Pn and gs contents. Thiourea application in the root medium under control and heat stress situation improved the tissue contents of minerals such as N, P, K^+, S, Ca^{2+} and Mg^{2+} that appeared to enhance the root function and its area. Results explored that efficiency of thiourea was more noticeable in spring than in autumn season; whereas hybrids responded differently.

INCPS-2024-283 Photosynthetic Performance Enhanced as an Ameliorative Effect of Ascorbic Acid on *Brassica napus* L. under the Influence of NaCl Stress

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An experiment was performed in order to figure out the control of salinity by seed priming with ascorbic acid of canola (Brassica napus L). Two cultivar of canola Dunkled and Cyclone were used. The arranged experiment was actually in complete randomized design (CRD) with four replicates. Seeds were primed with 100, 200 and 300ppm of ascorbic acid solution for 24 hours. Both primed and non primed of canola cultivar seeds set for

germination and irrigated with four levels of NaCl stress (50,100,150,200mM). Different parameters of growth like length, fresh weight of root and shoot was also measured. Under saline condition it was noticed that length of root and shoot minimized as compared to non- saline condition, but in case of primed seeds it was observed that primed seeds showed better results under both non saline and saline conditions, 300ppm priming with ascorbic acid showed maximum results. It was also observed that assimilation of carbon dioxide and transpiration rate also increased in seed primed plants under saline and non saline conditions. Stomatal conductance and sub stomatal conductance showed maximum increase in primed seeded plants with 300ppm ascorbic acid solution. It was also observed that primed seeds showed better performance under saline condition as compared to non primed seeds. Plant pigment contentlike chlorophyll a, chlororphyll b and total content of choloropyll as well as carotenoids were alsomeasured and it was observed that salinity and priming had significance effect on them. It was observed that priming played important role in the mitigation of salt stress and improves plant growth.
Keywords: Salinity Stress, Crocin, Plant Growth Stimulant, Saffron, Crocus sativus, Turnip

INCPS-2024-285 Improving Resistance Against Cadmium Stress by Foliar Fertigation of Ascorbic Acid on Barley (*Hordeum Vulgare* L.) Plants

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Cadmium (Cd)-contaminated soil is a global issue that might be harmful to both agriculture and the well-being of people. Furthermore, the toxicity of cadmium poses significant challenges to the environment friendly cultivation of food, particularly for agricultural crops such as barley. However, foliar fertigation of ascorbic acid might prove a potent tool to alleviate Cd toxicity in barley. A completely randomized experiment was conducted consisting two barley varieties (Sultan-17 and Jalbiana-21) to study foliar fertigation of AsA modulated improvements in physiochemical attributes under cadmium contamination. Treatments were consisted of varying concentration of cadmium as 0, 50 and 100 mg kg-1 as well as foliar AsA viz. 0,100 and 200 ppm. The effects of cadmium contamination on plants include an overall reduction in biological yield, chlorophyll content, quantum yield and ions homeostasis (K+, Ca2+) while increased uptake of Cd+2 and Na+ ions. Similarly, the contents of total soluble proteins, total free amino acids, lipid peroxidation, H2O2 and the activities of antioxidative enzymes (SOD, POD, CAT, APX and proline) were significantly enhanced under cadmium stress. In addition, foliar fertigation of ascorbic acid produces excellent modulation of growth metrics, yield qualities, chlorophyll content, enzymatic and non-enzymatic antioxidants and synchronized ions uptake. Comparing variation Sultan-17 to variety Jalbiana-21, Sultan-17 appears to be more tolerant. It is concluded from this study that AsA 200 ppm dose not only improved

cadmium tolerance but also upregulated yield metrics which is a step to solve the global problem of malnutrition through bio-fertigation of AsA.

Keywords: Cadmium, Barley, Ascorbic acid, Antioxidant response, Oxidative stress

Plant Taxonomy and Ethnobotany

Morus macroura Miq. &*Morus cathayanaHemsl.*; Two Monophyletic Morus Species Identified and Confirmed by Phenetic and Phylogenetic Analysis in Pakistan

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Morus is a multipurpose plant genus. It is playing a significant role in improving the economy, used for the formation of many important medicines. For the correct and appropriate use of its medicinal benefits, it is indispensable to understand its taxonomic and phylogenetic position. Its taxonomic status always remains complex and disputed. Very little research work has been done on its taxonomic and phylogenetic identification. Many species are still wrongly identified and create problems in any new or existing species identification. Up till now, merely four species have been documented on the basis of their morphological features. In this research work, two monophyletic species M. macroura and M. cathayana have been reported based on morphological and phylogenetic approaches. It is the first detailed study on the phylogenetic analysis of two different Morus species from Pakistan. Complete morphological and phylogenetic analysis based on ITS region has been illustrated and described.
Key words: flora, mulberry, variety, phylogenetic study, taxonomic study, authentic identification

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Sustainable Agriculture

INCPS-2024-160 Nanoparticles as Nanofertilizers: The Key to Unlocking Sustainable Agricultural Productivity

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The quest for sustainable agricultural practices has increasingly highlighted the role of innovative technologies, among which nanoparticles as nano-fertilizers stand out. Nanotechnology can enhance crop yields and nutritional value under various abiotic stress conditions like salinity, drought and heavy metals while minimizing environmental impact. Nanoparticles as well as phyto-nanoparticles offer unique advantages in fertilizer application due to their high surface area-to-volume ratio, which allows for targeted delivery and controlled release of nutrients. This results in improved in various physiological and biochemical attributes like biological yield, nutrient use efficiency, photosynthetic rate, antioxidant activity, colored pigments, and yield attributes in various crops like sunflower, canola, wheat, rice, mung bean and other crops. Additionally, the ability of nanoparticles to interact at the cellular and molecular levels can lead to increased stress tolerance and better soil health. The integration of nano-fertilizers into agricultural systems represents a promising approach to addressing global food security challenges, promoting sustainability, and reducing the ecological footprint of traditional fertilization methods. Future research and development in this field will be crucial for optimizing nano-fertilizer formulations and application strategies to maximize their benefits and ensure their safe use in agriculture.

Keywords: Phyto-nanoparticles, abiotic stresses, global food security

INCPS-2024-126 Sustainable Remediation of Cadmium Contaminated Soil: Boosting Wheat Growth with Magnetic Biochar and Ectoine

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The presence of toxic metals like cadmium (Cd) and lead (Pb) in agricultural soils is a risk to both environmental quality and food safety. It is therefore essential to create efficient methods for remediating these types of soils. In this research, we created iron-modified biochar (MBC), which contains the special qualities of iron and pure biochar (BC). The present research examined how iron-modified (MBC) and pure biochar reduced the harmful effects of Cd in wheat crops (Tritium aestivum L.).The results of this study

demonstrated that 0.25% MBC+EC treatments significantly increased the tiller length, spike fresh weight, shoot initial weight, biomass, root dried weight, and shoot dried weight were, respectively,148.2,53.2,64.2, and 148% in comparison with untreated plants. Further, the 0.25% MBC application increased the amounts of chlorophyll a and b, the pigments involved in photosynthesis, by 43.2, 88.4, 24.9, 32.5, 21.4, and 26.7%, individually. The 0.25% MBC treatment also increased superoxide dismutase (SOD) and catalase (CAT) by 62.4 and 69.2%, respectively, reducing oxidative stress in wheat plants. When compared to the corresponding solo BC treatments, foliar EC further enhanced the rate of growth, nutrients, and antioxidant activities while minimizing oxidative stress. Dosage dependent BC and EC had a combined impact. When BC is present, it can be utilized to increase crop development; however, more research at greater BC concentrations in other crops is required.

INCPS-2024-198 Mitigation of Drought Stress by Foliar Spray of ZnO Nanoparticles in Wheat (*Triticum aestivum*)

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Drought stress is one of the major abiotic factors that affects plant growth and development. This study investigated the drastic effects of drought on the growth, biochemical and physiological characteristics of wheat and the role of foliar application of ZnO nanoparticles treatment in growth improvement and drought stress mitigation in wheat crop. Wheat cultivar, Galaxy-13 was cultivated in pots filled with uniform mixture of soil, sand and garden compost, exposed to 50% of field capacity under drought stress and 100% of field capacity under control conditions. 100ppm ZnO nanoparticles were applied (foliar spray) in control as well as drought stress condition. TheZnO nanoparticles, known for their distinctive physicochemical characteristics, can influence plant metabolism and enhance physio-biochemical and yield attributes. The data revealed a significant increase in fresh and dry weight of shoot and root with the application of ZnO nanoparticles. These NPs also activated the antioxidant defense system and protected the crop from oxidative damage. In short, ZnO nanoparticles improved the development, physiology, and antioxidant defense of plants, thereby mitigating the detrimental effects of drought. It can be concluded that application of ZnO nanoparticles may have potential of growth improvement and reducing the effect of drought stress on wheat (*Triticum aestivum* L.) variety Galaxy-13.

INCPS-2024-226 Assessing the Growth of Rice (*Oryza Sativa* L.) Seedlings under Two Different Levels of Nitrogen using Hydroponic System

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Rice (*Oryza sativa* L.) is the staple food for half of the world's population so the focus on its productivity must be checked. Nitrogen is considered the main nutrient for its growth and improvement. On the other hand, nitrogen used as fertilizer causes environmental damage and loss of economy, but inadequate amount of nitrogen fertilizers also reduces yield and quality of rice production. The experiment was carried out at the Growth Room, Department of Botany, University of Agriculture Faisalabad (UAF). A nursery of 4 rice genotypes was established in plastic trays and these trays were filled with sand. In this study, hydroponic experiment was conducted by using four different varieties i.e., Chinab Basmati (CB), Kala Shah Kaku-133 (KSK-133), Chinab Basmati (CB-300) and Kainat Basmati (KB). To explore the potential of these four different varieties, hoagland's solution was applied to meet the demand of other essential nutrients. In this experiment, two different recommended nitrogen levels; T1 containing 100% recommended nitrogen and T2 containing 50% recommended nitrogen were used as a treatment. The results indicated that by using 100% recommended level of nitrogen showed better results in KB variety. Morphological parameters were also improved in the presence of 100% recommended level of nitrogen i.e., primary root length, primary root diameter, length of lateral root, lateral root diameter, lateral root numbers and density of lateral roots increased as 15.8 cm, 3.8 mm, 10.4 cm, 2.6 mm, 5.0, and 2.72 mg respectively and in 50% it is increased as 13.9 cm, 3.2 mm, 9.8 cm, 3.5 mm, 5.0 and 1.71 mg respectively. Similarly, physiological parameters were also enhanced in the presence of 100% recommended level of nitrogen. Data was analyzed by using STATISTIX 8.1 software and then results were subjected to LSD test at 5% probability level.

INCPS-2024-164 Making the Most of Under-utilized Plant Species to Improve Food Security

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The 21st century presents a growing number of challenges to ensuring food security, including soil degradation, climate change, and limited water resources. These new risks are becoming too much for the limited variety of basic crops that characterize traditional agricultural systems. Diversifying our food sources is essential if we want to strengthen the resilience and sustainability of food systems.The purpose of this study is to investigate how

under-utilized plant species, or those that are frequently disregarded by conventional agriculture, can improve nutritional variety and food security, particularly in communities that are at risk.We carried out a thorough analysis of the literature on underappreciated plant species, paying particular attention to their nutritional profiles, tolerance for different agro-ecological zones, and resistance to pests and environmental stresses. To evaluate the growth performance and yield stability of particular species in various settings, field investigations were conducted. Agro-ecological methods and community-based seed banks were also assessed in order to find scalable approaches for incorporating these species into regional and global food systems.According to our research, a large number of neglected plant species have high nutritional value, are more resilient to drought, and are resistant to pests, which makes them excellent choices for cropping systems diversification. Crop resilience and food security were enhanced in communities that embraced these species. Furthermore, it was found that locally owned seed banks were successful in maintaining plant diversity and advancing food sovereignty.Reusing under-utilized species in agricultural systems presents a viable method to improve food security and strengthen climate change resilience. In order to promote a transition towards more resilient and sustainable food systems, the study emphasizes the necessity of policy frameworks that encourage the cultivation and consumption of a variety of plant species.

Keywords: Food Security, Soil degradation, Climate Change, Agricultural systems, Under-Utilized plants, Conventional agriculture, Crop Resilience.

INCPS-2024-165 Using Plant Genetic Diversity to Create Food Systems Resistant to Climate Change

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A major danger to global food security is the escalating effects of resource constraint, insect outbreaks, and climate change. There is a pressing need to investigate novel approaches for strengthening food systems' resilience because agricultural productivity is under threat. Plant genetic variety offers a potent, but under-utilized, answer to this problem.This study looks into how using plant genetic variety can improve food systems' resilience, production, and ability to adapt, especially when faced with environmental difficulties. In order to assess the value of genetic features from landraces and wild relatives in the breeding of crops resistant to climate change, we carried out case studies in a variety of agro-ecological zones. Cutting-edge biotechnological instruments, such CRISPR and genomic selection, were utilized to expedite the process of breeding. To determine how smallholder farmers will profit from plant genetic resource conservation, socioeconomic evaluations were also carried out. According to the study, applying genetic

diversity can greatly enhance crops' ability to withstand stress, retain their nutritional value, and maintain stable yields. Creative breeding initiatives that included a variety of genetic features showed improved pest resistance and climatic adaptation. Socioeconomic assessments demonstrated that preserving plant genetic diversity lessens reliance on a small number of basic crops and promotes sustainable livelihoods, particularly for smallholder farmers. This study emphasizes how crucial it is to use genetic variety to create food systems that are adaptable to climate change. In a time of environmental instability, cooperation between scientists, decision-makers, and local people is crucial to promoting innovation and guaranteeing food security.

Key words: Global Food Security, Insect outbreak, Climate change, Agricultural Productivity, Resilience Production, Breeding, genomic Selection, Agro-ecological Zones, Socio-economics.

INCPS-2024-280 *Phragmites australis* (Cav.) and *Lemna minor* (L.) biochar: Sustainable Soil amelioration and enhancement of Spinach productivity

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Phragmites australis (Cav.) Trin.exSteud and *Lemna minor* L. are aquatic weeds which are exotic in origin. They can compete native crops, disturbs the habitate dynamics, reduces biodiversity, changes nutrient ratios in wetland ecosystem, oxygen depletion, eutrophication, destroy water quality etc. Valorization of this huge biomass into biochar is a sustainable approach to cope up both environmental and agricultural challenges. Their management through biochar not only mitigates the climate issues by their proper management and utility, sequester carbon, formation of soil ameliorant which provides the agro-benefits. The current study manifests the utility of *Phragmites australis* and *Lemna minor* biomass as a feedstock for pyrolysis at (400, 500 and 600ºC) to design biochars (LMBC400, LMBC500, LMBC600, PABC400, PABC500 and PABC600). These biochars were added as a soil conditioner to estimate productivity of test crop henceforth physicochemical analysis. The results demonstrated that AC, SA, pH, ECe, and FC are proportionate directly to pyrolysis temperature whereas oxygen, hydrogen, nitrogen, volatile contents and bulk density are inversed to pyrolysis temperature. FTIR and SEM visualized the high porosity, alteration of phenolic compounds and surface of biochars. Percentage of nutrients like Mg, Fe, N, Ca, N, P, K and Zn increases by elevating pyrolysis temperature due to unlocking and release under the influence of heat. Soil quality parameters (viz. pH, BD, ECE, WHC, ECe, TDS and SOC) improved in favor of plant growth conditions so yield of test crop increased. So LMBC600 and PABC600 had great potential to ameliorate soil and productivity. It is promising approach to manage this collossal volume of *P. australis* and *L. minor* by green technology by recycling of this bio-waste into worthy product

biochar which is an alternative to chemical fertilizer in agronomical practices which leave eco-toxic footprints and play havoc to environment.
Keywords: Biochar, valorization, amelioration, pyrolysis

INCPS-2024-281 Valorizing Combustible and Compostable Fractions of Municipal Solid Waste to Biochar and Compost as an Alternative to Chemical Fertilizer for Improving Soil Health and Sunflower Yield

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Reduced reliance on synthetic chemical fertilizers necessarily requires using renewable biomaterial-derived soil organic amendments (SOAs) in agriculture for sustained retention of nutrients through improvement in the soil organic matter (SOM). SOM replenishment through SOAs derived from wasted materials could help in its valorization by furthering the sustainability prospects of agronomic crop production systems. In the current study, compost (CP) and biochar (BC) were derived as SOAs from combustible and compostable fractions of municipal solid waste (MSW) for their potential valorization by adding SOAs as potential sustainable sources of nutrients as a replacement of chemical fertilizers (CF) for sunflower crops cultivated in potted soils. The experimental design included quadruplicated soil application of MSW-derived BC and CP in discrete and combined forms, each in three doses (% w:w), viz., low (L), medium (M), and high (H), i.e., BC-L, BC-M, BC-H; CP-L, CP-M, CP-H; and BC + CP-L, BC + CP-M, BC-CP-H. The results showed that, compared to the control (soil only), the sunflower growth and harvestable yield were significantly greater in CP+BC with a medium dose and were comparable to the growth and yield obtained in soils with CF. Sunflower growth in the discrete SOAs remained less than in the combined SOAs (CP+BC) and was attributed to the comprehensive soil health improvement rendered by the applied SOAs. The soil health improvement factors included SOM, CEC, and concentrations of available NPK. The dose-effect comparison of the SOAs showed highly variable trends, i.e., the sunflower growth did not correspond with the increase in dose of the SOAs. It is concluded that the combined application of CP+BC derived from MSW components at a medium dose could act as a potential alternative to CF. The developed approach resulted in MSW valorization, which improved soil health and yielded a better sunflower crop.

INCPS-2024-282 Optimizing Soil and Crop Physiology through Activated Acacia Biochar under varying

Irrigation Regimes and Cultivars for Sustainable Wheat Cultivation

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Wheat, a staple food crop globally, faces the challenges of deficit water resources and the need for sustainable soil management practices. Current research delves into a multifaceted approach to enhance sustainability in wheat cultivation. The pivotal elements of this investigation include the amelioration of varying irrigation regimes (IR) by the integration of activated acacia biochar (AAB) as a soil amendment over diverse wheat cultivars. A field study was conducted in the botanical garden, University of the Punjab, Lahore. Experiment consisted of RCBD with split-split-plot design comprising three AAB levels (0T AAB, 5T AAB, & 10TAAB), three cultivars (Dilkash. Akbar, & FSD-08) cultivated under five IR levels (100%, 80%, 70%, 60%, & 50%). Data observed included soil analysis (pH, Ec, water holding capacity, organic matter, %C, %N, Porosity, and pore size), plant growth, morpho-physiology, biochemical and yield attributes. Statistical analysis of data collected showed that reduction in IR, negatively affected plant growth and yield but when amended with 10T AAB, improved plant growth and yield was observed with ameliorated biochemical attributes. Among cultivars, Dilkash proved to be the best for maximum yield followed by FSD-08 and Akbar respectively. Maximum yield enhancement (11.8, 10.9, and 9.2 times for Dilkash-2020, Akbar-19 and Faisalabad-08 respectively) with 10T AAB was observed in 70% IR as compared to other IR levels followed by 5T AAB. Improved soil attributes with enhanced plant growth were observed under biochar amendment. plant growth Hence, AAB enhanced wheat production under water deficit conditions by improving soil properties, drought tolerance, and yield attributes.

INCPS-2024-293 Alleviation of Lead Stress on Wheat (*Triticum aestivum* L.) through the Application of Biochar Via Regulating the Morpho-Physiological and Antioxidant Defence Mechanisms

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Abstract: Crops are continually challenged by several abiotic stressors that are present in the field. It is important to have a sustainable strategy for reducing crop stress. This study looked at the protective effects of biochar on wheat crops that were also under heavy metal (Pb) stress. After the wheat had been germinated for two weeks, metal stress was applied. Three level of heavy metals were applied to plants (0 mg/kg, 50mg/kg and 100mg/kg). Three levels of biochar were applied on wheat for amelioration of heavy

metal stress (0%, 1.5% and 3%). Pb uptake and translocation affected both physiological and biochemical attributes of wheat. Lead stresses reduced biomass accumulation in wheat. Biochar, however, enhanced biomass production in stressed wheat varieties compared to unamended soil (control). Biochar increased chlorophyll content, total soluble proteins and amino acids. Under the heavy metal stress, proline buildup was more evident. Level of H_2O_2, POD, MDA, CAT and APX, were determined increasing under heavy metal stress. In comparison to the control, the adjustments elevated their concentrations much more. Micronutrients were also determined (Ca, K and Na). K and Ca level were increased and Na ions were decreased by application of biochar. Pb accumulation in wheat crop was more under stress. Application of biochar alone at 3% typically decreased Pb absorption by wheat when compared to other biochar concentrations when compared to other soil amendments. In a stressed wheat crop, biochar increased biomass and osmolyte production while reducing Pb absorption.

Keywords: Wheat, Biochar, Lead stress, Antioxidant Defense Mechanism, Ion Homeostasis

Supplementary

INCPS-2024-294 Effects of PGPR Inoculation on Growth of Pearl Millet Grown Under Salt Stress

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Environmental conditions around the plants are continuously changing. These changes are directly linked to the growth, health and yield of plants. This work was carried out with aim to find out the effects of PGPR inoculation on the growth of Pearl Millet (Pennisetum glaucum L.) grown under salt stress. Seeds of four different varieties of Pearl Millet (HP-50 Red, HP-50 Blue, HP-50 Yellow and PL-101) were subjected to seed priming with Bacillus subtilis, a previously isolated and identified potential PGPR strain. Sowing of seeds and seedling growth was carried out under optimal conditions. After four weeks of germination, root inoculation of PGPR was done and plants were exposed to salt stress (200mM). Harvesting was done before the yielding stage of plants. Morphological attributes (shoot/root length, shoot/root fresh weight, shoot/root dry weight and leaf area), physiological assessment (chlorophyll contents and quantum yield) and biochemical analysis (total free amino acids, antioxidant activity and analysis of Na+ & K+ ions) were performed. Plants showed improved morphological growth even under salt stress when treated with PGPR strain. An increase in chlorophyll contents and quantum yield was observed. Biochemical factors were also improved under salt stress with PGPR treatment as compared to untreated saline plants. Improved amino acids amount, lower catalase and peroxidase activity was found in PGPR treated plants. Ion analysis showed improvement in K+ concentration and lowering of Na+ concentration with PGPR treatment. This study supported the hypothesis that the application of plant growth promoting rhizo-bacteria strain alleviates the drastic effects of salinity on pearl millet. So plants with PGPR treatment exhibited better growth even under salt stress. Thus it may has significant application in the sustainable agriculture.

INCPS-2024-295 Physiological survival strategies in maize (*Zea mays*) under drought stress

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The research was conducted to check the photosynthetic activity of two maize *(Zea mays* L.) hybrids under drought/water-stressed conditions. Two maize hybrids D-6619,D-3366 were used in the study. Maize plants were grown in Wirenet House of Bahauddin Zakariya University, Multan. Drought was initiated when plants were two weeks old. Drought was imposed by withholding water from the plants for a period of one week Control plants were watered three times a week. Chlorophyll fluorescence measurements were taken with a MultispeQ. The 2nd and 3rd fully open trifoliate leaves were selected for measurements and were taken at the same time each day. Maize varieties differed in their responses to photosynthesis under drought conditions. PhiII, PhiNPQ and PhiNO were both affected by stress, with drought stressed exhibiting increased PhiNPQ. The low PhiII for drought stressed plants was mostly caused by photosystem II photoinhibition.In contrast, in drought-stressed plants both dissipation as heat through the qE response and photoinhibition contributed to this decreased PhiII.ThePhiNO signal corresponded well with observed drought as well as yield. Apparentlydrought susceptible hybrid exhibited the greatest decline in PhiNO.

INCPS-2024-296Biochar in mitigating adverse impacts of drought on maize (Zea mays)

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Drought stress poses a significant threat to global crop production, making it imperative to explore sustainable solutions for enhancing plant resilience under water-limited conditions. This study investigated the effects of Nano-biochar application on the growth of corn (*Zea mays* L.) in response to varying levels of water stress. The experiment comprised different treatment groups that were randomly organized and were applied varying concentrations of nano-biochar as 0%, 0.5%, 1% and 1.5% incorporated into the soil. The findings revealed positive impact of Nano-biochar in mitigating the adverse impacts of drought stress on corn plants. The root and shoot fresh biomass significantly increased when 1% biochar was incorporated into the soil, surpassing the outcomes observed at other biochar concentrations. Simultaneously, water potential was higher at the 1% biochar concentration in the soil. The photosynthetic parameters, including the quantum yield of PSII and SPAD values, were greater in maize plants under

both control and drought conditions when 1% biochar was introduced into the soil. Furthermore, various OJIP parameters exhibited positive responses to the presence of 1% biochar in the soil, indicating enhanced plant health and increased photosynthetic efficiency. These findings collectively showed that addition of 1% biochar in soil improved the plant growth and physiological performance. Drought stress reduced the growth of maize plants. This growth reduction in maize due to drought stress was positively associated with the decrease in leaf water potential, photosynthetic pigment and PSII photodamage. Addition of Nano-biochar improved the growth of maize plants. However, addition of 1% Nano-biochar was most effective dose. These findings suggest that biochar application can be a valuable component of sustainable agricultural practices aimed at improving crop performance and resource management in a changing climate.

INCPS-2024-297 Estimation of Ciprofloxacin Phytotoxicity in Some Winter Vegetables

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Plant growth and development can be adversely affected by a range of chemical and physical agents, known as phytotoxins. The phytotoxicity of a substance reflects its capacity to cause harm to plants, which can be expressed as physical damage, for example scorching, or chemical damage, such as disruption of metabolic processes. Ciprofloxacin is an antibiotic drug used to treat a variety of bacterial infections. It has been used in some agricultural settings, and it is possible for the drug to accumulate in plants, such as vegetables. This can be dangerous if people consume these vegetables, as ciprofloxacin has been known to cause serious side effects. Therefore, it is important to investigate the uptake of ciprofloxacin in vegetables to better understand the potential effects on human health. Objective of this study was the evaluation of the Role of five levels of Ciprofloxacin on Radish & Turnip Growth and Yield in a CRD with two factors. Antibiotic treatments were applied to the soil at the time of planting. The CIP treatments were 0, 2, 4, 6 and 8 mg/Kg. During the experiment, it was discovered phytotoxicity and uptake of Ciprofloxacin in commonly grown vegetables" found evidence of phytotoxicity and uptake of Ciprofloxacin in the tested vegetables. The results indicate potential adverse effects on plant health and the potential for Ciprofloxacin to be absorbed by commonly grown vegetables. These findings underscore the importance of considering the environmental impact of pharmaceuticals and the need for further research on the potential risks associated with the presence of Ciprofloxacin in agricultural systems.

An analysis of the Palynomorphs obtained from woody plants inhabited in Tehsil Pakpattan, Punjab, Pakistan

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The present study is carried out to assess the palynomorphic characterization of woody plants of Tehsil Pakpattan, Punjab, Pakistan, by using Light and Scanning Electron Microscopy. A total of 65 species of woody plant's pollen from 24 families were collected. There are a total of 65 dicotyledonous. To characterize these palynomorph, the shape, size, ornamentation, and aperture of the pollen were examined. Most of the pollen are prolate spheroidal as in Carissa macrocarpa, Alstoniascholaris, Fernandoaadenophylla etc and oblate spheroidal as in Jacaranda mimosifolia, Euphorbia Milii, Cassia javanica etc. Suboblate pollen present in Euphorbia cotinifoliaand sub prolate pollen present in Bauhinia purpurea.

The smallest pollen is of Psidium gujava which P/E ratio is 76.4µm. The largest pollen is Bauhinia purpurea which P/E ratio is 117µm. Hibiscus syriacus has maximum polar length and equatorial diameter which is 12.06±0.15µm and 11.87±0.12µm respectively. Psidium gujava has minimum polar length and equatorial diameter which is 0.32±0.01µm and 0.42±0.01µm. Maximum colpi length present in Abelmoschus esculentus which is 16±3.93µm. Maximum colpi width present in Bauhinia purpurea which is 19.6±0.51µm. Minimum colpi length present in Parkinsonia aculeate which is 2.7±1.20µm. Minimum colpi width present in Lantana camara which is 0.75±0.38µm. Maximum pori length present in Abutilon mauritianum which is 21.7±0.44µm. Maximum pori width present in Bauhinia purpurea which is 13.5±1.64µm. Minimum pori length present in Durantaerecta which is 0.67±1.14µm. Minimum pori width present in 0.9±0.36µm. Maximum exine thickness present in 3.1±1.47µm. Minimum exine thickness present in Malpighia glabra which is 0.5±0.33µm.

Major pollen types have been identified on the basis of aperture and tectum. There is great variation among the aperture of the studied plants i.e. porate, colpate, colporate, tricolpate, tricolporate, pentaporate, monocolporate, tetracolpate, tetracolporate, hexacolporate, hexacolpate, pentacolptae, dicolporate and inaperturate. Different type of tectum ranging from reticulate, perfortae, scabrate, verrucate, echinate, psilate, microreticulate, perforate to rugulate and granulate, crotanoid, striate, lacunate. On the basis of aperture and tectum types, the pollen are recognized i.e. porate, colpate and colporate.

Genetic Diversity Assessmentin Exotic Germplasmof Wheat (*Triticumaestivum*L.) using Multivariate Analysis

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Abstract: Wheat (*Trium aestivum* L.) is an important staple food crop in Gramineae family and is widely grown worldwide. Food security is a major problem in fast growing world population, thereby, it is necessary to develop high-yielding wheat varieties.Genetic diversity is a pre-requisite to breed high-yielding wheat cultivars. We have used Line × tester approach coupled with multivariate analysis to study genetic diversity by evaluating morphological, physiological and yield-related agronomic traits in wheat genotypes. Five spring wheat genotypes; CB-35, CB-212, CB-214, CB-219, and Mairaj-8 as a female parent and two male parent lines; Local landrace-1 and Local landrace-2 were employed with 10 F_1 and 10 F_2 crosses and data was recorded to evaluate the diversity in wheat genotypes. Principal component analysis revealed variation of PC1 (33.05%) and PC2 (20.46%) at X and Y axis respectively. Multivariate analysis like cluster analysis grouped 27 genotypes into four clusters which shows the presence of considerable variation. Plant height and yield per plant shows negative significant correlation among genotypes. Correlation study and variation level among genotypes provides insight for exploitation and preservation of genetic resources. Based on the PCA and other multivariate analysis results of our study best performing lines with desirable characters can be recommended for future breeding programs.

Keywords: wheat, line into tester analysis, principal component analysis

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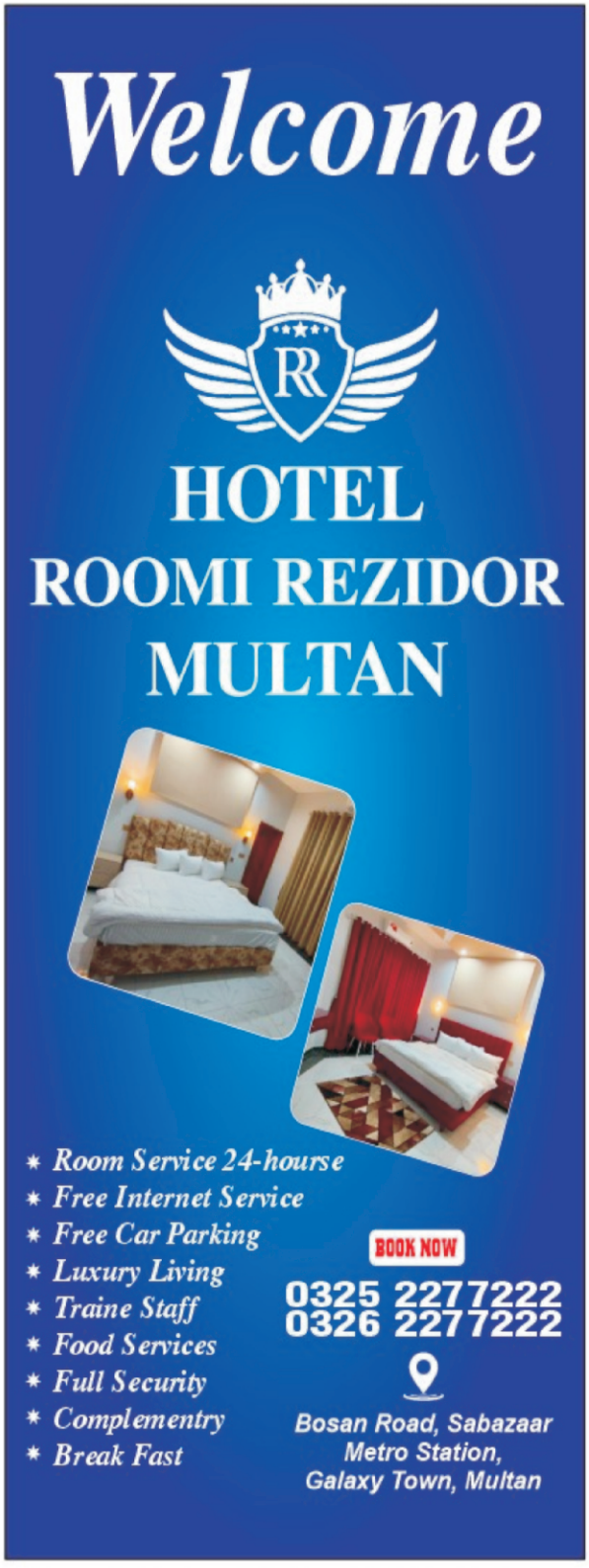

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