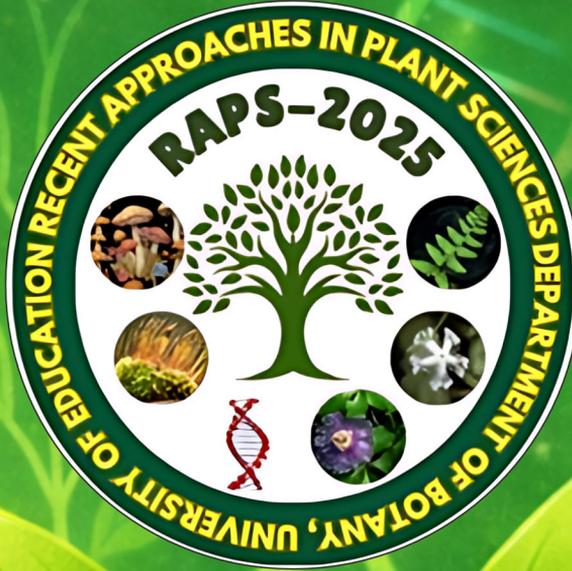


# E-BOOK OF ABSTRACTS



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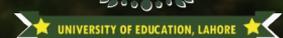
*“Innovative technologies for global  
challenges and a sustainable future”*

**RAPS-2025**

November 12–13, 2025

**ORGANIZED BY**

Department of Botany,  
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**ISBN: 978-969-8040-64-2**

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*3<sup>rd</sup> International Conference on Recent Approaches in Plant Sciences  
(RAPS-2025)*

*November 12-13, 2025*

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E-Published by

**Pakistan Scientific and Technological  
Information Centre, (PASTIC), Islamabad**

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**Prof. Dr. Aqif Anwar Chaudhry**

Vice Chancellor

### **Patron**

**Prof. Dr. Mohammad Alam Saeed**

Pro-Vice Chancellor

### **Conference Chair**

**Prof. Dr. Abrar Hussain**

Chairperson, Department of Botany

### **Conference Secretary**

**Dr. Zahra Noreen**

Associate Professor of Botany, Botany Division of Science & Technology

### **Focal Persons**

Prof. Dr. Ghulam Mujtaba Shah, UOH, Hazara, KP

Prof. Dr. Mushtaq Ahmad, QAU, Islamabad

Prof. Dr. Rahmatullah Qureshi, UAAR, Rawalpindi, Punjab

Prof. Dr. Shakil Ahmed, PU, Lahore, Punjab

Prof. Dr. Habib-ur-Rehman Athar, BZU, Multan, Punjab

Prof. Dr. Saadullah Khan Leghari, GU, DGKhan, Punjab

Prof. Dr. Naeem Iqbal, GCUF, Faisalabad, Punjab

Prof. Dr. Aamir Ali, UOS, Sargodha, Punjab

Prof. Dr. Muhammad Iqbal, GCUF, Faisalabad, Punjab

Prof. Dr. Tehreema Iftikhar, GCU, Lahore, Punjab

Prof. Dr. Zubaida Yousaf, LCWU, Lahore, Punjab

Prof. Dr. Nargis Naz, IUB, Bahawalpur, Punjab

Prof. Dr. Kafeel Ahmad, BGNU, Nankana, Punjab

Prof. Dr. Hamayun Shaheen, UAJK, Muzaffarabad, AJK

Prof. Dr. Muhammad Naveed, UCP, Punjab

Prof. Dr. Ijaz Ahmad Khan, AUP, Peshawar, Khyber Pakhtunkhwa

Prof. Dr. Jamal-U-Din Mangi, UOS, Jamshoro, Sindh

Dr. Farooq Ahmad, UAF, Faisalabad, Punjab

Dr. Fahim Arshad, UO, Okara, Punjab

Dr. Sumera Anwar, GCWUF, Faisalabad, Punjab

Dr. Khawaja Shafique Ahmad, UPR, Rawalakot, AJK

Dr. Syed Zeeshan Haider, UOL, Punjab

Dr. Rehana Sardar, Emerson University, Multan, Punjab

Dr. Muhammad Shareef, Unniversity of Narowal, Punjab

Dr. Zahid Ullah, University of Sawat, KP

Dr. Qamar Abbas, KIU, Gilgit Baltistan

Dr. Tahira Mengal, SBKWU, Quetta, Balochistan

## **INTRODUCTION**

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3<sup>rd</sup> International Conference (Physical & Online) on Recent Approaches in Plant Sciences (RAPS-2025) will provide opportunities for researchers to present their work around the globe. The aim of this conference is to bring together leading academic scientists and researchers to exchange their experiences on all aspects of plant sciences. It will be an interdisciplinary platform for researchers, educators and industrialists to present and discuss the recent innovations as well as the challenges encountered and solutions adopted in diverse fields of plant sciences.

Conference Themes are as follows: Biodiversity & Conservation, Economic Botany & Natural Products, Environmental Science, Horticulture, Mycology & Plant Pathology, Pharmacology, Plant Anatomy, Plant Genomics, Plant Nanotechnology, Plant Taxonomy & Systematics, Plant Biotechnology, Plant Physiology, Plant Ecology, Plant Molecular Biology, Plant Cell & Tissue Culture and AI in Plant Sciences

## **ABOUT ORGANIZER**

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The University of Education was established in 2002 as the highest seat of learning in teacher education with clear goals and objectives of producing quality teachers of international standards. Among other related objective sset before the UE, some are to: Bring quality change in education focusing on teacher education. Promote governance, leadership and management skills among educational managers. Promote teaching and learning innovations. Develop human resource for educational institutions and other areas of high social and economic need and to establish linkages with national and international educational institutions and the society.

The Division of Science and Technology started functioning in 2004 with minimum teaching faculty and academic programs. However, main bulk of teaching staff was inducted after wards and at present maximum teaching faculty is performing its duties in the Division. Division of Science & Technology has been offering diversity of academic programs to cater the needs and demands of percentage and to equip the students with current scientific technology. In its nascent phase, the Division offered two programs; however, currently it is offering undergraduate 10 programs and graduate 05 programs in morning and evening shifts in the field of Natural Sciences and Information Technology. Currently, Department of Botany is offering BS, MS (Morn. /Even.), PhD (Morn.) programs with different areas of specialization.

## **PREFACE**

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The 3<sup>rd</sup> International Conference on Recent Approaches in Plant Sciences (RAPS-2025) will be held on 12-13 November 2025 at Department of Botany, Division of Science and Technology, University of Education, Lahore. The theme of Conference includes i.e., Biodiversity & Conservation, Economic Botany & Natural Products, Environmental Science, Horticulture, Mycology & Plant Pathology, Pharmacology, Plant Anatomy, Plant Genomics, Plant Nanotechnology, Plant Taxonomy & Systematics, Plant Biotechnology, Plant Physiology, Plant Ecology, Plant Molecular Biology, Plant Cell & Tissue Culture and allied fields. The conference has accepted more than 200 papers to be presented in the conference with more than 600 participants from different national and international academic institutes. The papers offered in this proceeding are expected to pay in stimulating new perceptions in talking to promote scientific research in Pakistan. The main objective of RAPS-2025 is to find new ways for research and development in the field of science. We hope that you will find this 3<sup>rd</sup> International Conference on Recent Approaches in Plant Sciences (RAPS-2025) perceptively inspiring and that the RAPS-2025 is a prestigious event organized with a motivation to provide an international platform for the scientist and scholars around the world to share their research findings in the various research fields.

**Dr. Zahra Noreen**  
**Conference Secretary**

## **ACKNOWLEDGEMENT**

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It is our pleasure to welcome you to the 3<sup>rd</sup> International Conference on the Recent Approaches on Plant Sciences (RAPS-2025). We thank the authors for giving the content of the program in the form of poster and oral presentations. We are also grateful to the keynote speakers from academia, industries and research centers. These valuable speeches will guide us to a superior appreciative in the field of Science and Technology. We also thankful to Pakistan Science Foundation (PSF), Higher Education Commission (HEC), Punjab Higher Education Commission (PHEC) and all other sponsors. We are thankful to all organizers, who worked hard day and night in order to make this event successful.

## **MESSAGE FROM VICE CHANCELLOR**

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University of Education is a multi-campus-based University; you will find us in Attock, Lahore, Faisalabad, Jauhrabad, Vehari, Multan and Dera Gazi Khan. With our core education and research thrust areas of Science and Technology, Management and Administrative Science, Education, Arts & Social Sciences and Islamic & Oriental Learning, University of Education offers a versatile learning and research ecosystem to all stake holders (at BS, MS and PhD levels). Our Business Incubation Centre and Youth Development remain engaged in providing essential grooming and mentorship to future entrepreneurs. Today, University of Education is well poised to respond to local and global needs. With our vision of ensuring academic excellence, focusing on translational research and development, promoting Internationalization, engagement of all stakeholders and social service, enhancing the student experience and ensuring broad-field sustainability, we look towards the future with optimism – cognizant of our strengths.

This conference is a step towards achieving our vision of becoming a world-class academic and research institution to produce human capital with a first-class mentality. This conference will be a good initiative for the University of Education and international universities to exchange knowledge and skills in the field of Botany and allied fields. We are looking forward to finding solutions and modern trends in Botany to contribute towards global needs. It is a great pleasure to welcome all presenters and participants in this conference from all over the world. A warm welcome to all of you.

Let us Connect to Deliver.

**Prof. Dr. Aqif Anwar Chaudhry**

## ABOUT PASTIC

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Pakistan Scientific & Technological Information Centre (PASTIC) is a subsidiary organization of Pakistan Science Foundation (PSF), under the umbrella of Ministry of Science and Technology (MoST). PASTIC is a specialized premier organization in the field of S&T information handling and dissemination responsible for catering to information needs of R&D and industrial community across the country. The PASTIC National

Centre is housed at Quaid-e-Azam University Campus, Islamabad having a network of 6 Sub-Centres at Karachi, Lahore, Peshawar, Quetta, Faisalabad and Muzaffarabad.

To begin with PASTIC supported research community across the country when S&T research infrastructure in Pakistan was at a nascent stage and provided facilities including supply of scientific and technical documents, abstracts and indexes, bibliographies, translations, patent information and patent indexes, science reference library service, technological information transfer service, dissemination of computer-based information services, reprographic and publication services.

For further details visit: [www.pastic.gov.pk](http://www.pastic.gov.pk)

### **PASTIC Objectives**

- Development of National Scientific & Technological Information (STI) resources (databases)
- Dissemination of Scientific & Technological Information through contemporary reference information tools
- Collaboration & Cooperation with institutional libraries/repositories for resource sharing
- Promotion of R&D based industrial development
- Printing of S&T/R&D Publications
- Capacity Building of researchers, information professionals, innovators & entrepreneurs
- Development of collaborations with national and international information networks

### **PASTIC Functions**

#### **S&T Publications**

- *Technology Roundup*: Publish bi-monthly bulletin by repackaging of latest global Trade and Technology information.
- *Abstract Books of Conferences*: PASTIC supports publication/printing of Abstract Books of Conferences organized by various S&T universities (on request).

### **PASTIC Online databases**

- *Pakistan Science Abstracts (PSA)*: Abstracts of research published in Pakistani S&T Journals & Conference Proceedings etc.
- *National Digital Archive (NDA)*: Full text digital repository of National Journals
- *PakCat*: Union Online Public Access Catalogue (OPAC) of books available in Scientific & Technological Libraries of Pakistan
- *Digital Repository of Indigenous S&T literature*
- *Directory of Scientific Periodicals of Pakistan*: An index of scientific periodicals (e.g., Journals, Magazines etc.) published in Pakistan.
- Database of R&D Projects executed in Pakistan
- Database of Books published by Pakistani authors
- National Scientists Directory (NSD)
- Industry related databases (e.g., Industries, Industrial challenges etc.)

### **Promotion of Commercializable Technologies & Industrial Products**

Organize STEM and IT Expo for promotion of local R&D, SMEs, technologies/products/services, as well as empowering youth and general public on new and faster ways of delivering and accessing information.

### **National Science Reference Library Facility**

A state-of-the-art Traditional Library facilitating the researcher through following services: Reference & Referral Services; Reader Service; Internet Service, Journal Listings; Photocopying & Scanning Services.

### **Skill Development/Capacity Building**

Organize Seminars/Workshops /Trainings/ for capacity building of:

- Young Researchers on Data analysis, Reference Management etc.
- Women Entrepreneurs on E-marketing&E-business skills
- Library Professionals on Library automation & digitization
- Journal Publisher/Editors on E-Journal management & publishing
- Researchers and Innovators on Intellectual Property Rights, Media Information Literacy

## **INTERNATIONAL INVITED SPEAKERS**

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### **Chang-Lin Zhao**

Prof. Dr. Changlin Zhao, a distinguished mycologist and fungal taxonomist, currently serving as Professor of Mycology at Southwest Forestry University, China. Prof. Zhao earned his Ph.D. in Mycology from Beijing Forestry University. As part of his doctoral training, he pursued a joint research program at Harvard University (USA.) In 2025, he was awarded a Chinese Scholarship Council (CSC) fellowship as a Visiting Scientist at the Helmholtz Centre for Infection Research, Germany. Prof. Zhao's research focuses on taxonomy of wood rotting and medicinal fungi. His scholarly impact is reflected in his over 4,000 citations, an H-index of 26, and an i10-index exceeding 100, underscoring his significant contributions to fungal systematics. Prof. Zhao has received several honors, including the Thousand Talents Program Award (2019), Teaching Achievement Awards from Southwest Forestry University, and the Excellent Doctoral Thesis Award from Beijing Forestry University.

### **Fethi Ahmet Ozdemi**

Prof. Dr. Özdemir is a faculty member in the Department of Molecular Biology and Genetics at the Faculty of Science and Arts, Bingol University in Bingol, Türkiye. He is actively involved in academic and research activities within his department. His work is associated with various scholarly publications and research projects in molecular biology and genetics, contributing to the scientific community at Bingol University. His role encompasses both teaching and research responsibilities, supporting the academic mission of the Faculty of Science and Arts at Bingol University. This department is known for promoting advanced studies and research in molecular biology and genetics fields, offering educational programs and conducting scientific investigations.

### **Ruhangiz Mammadova**

Dr. Ruhangiz Mammadova, also known as Ruhangiz Bakhtiyar gizi Mammadova, is a distinguished Azerbaijani biologist and researcher affiliated with the Genetic Resources Institute of the Azerbaijan National Academy of Sciences (ANAS). She holds a Ph.D. in Biology and serves as an Associate Professor, contributing significantly to the field of plant genetics and breeding. Dr. Mammadova's work primarily focuses on the genetic diversity, inheritance patterns, and breeding of technical and forage crops, with special emphasis on cotton and grape varieties native to Azerbaijan. Her department at ANAS has been instrumental in developing new crop genotypes, including improved cotton varieties such as Karabakh-11, Zafar, Barakat, and Alakbari, which have enhanced agricultural productivity in the region. In addition to her research, Dr. Mammadova has played an active role in international scientific collaborations and conferences, serving on organizing committees and presenting on topics such as genetic resources and diversity of cotton (*Gossypium* spp.) in Azerbaijan. She is also recognized as a Fulbright alumna, reflecting her global academic engagement and leadership in advancing agricultural science. Her numerous publications on plant genetics and breeding

underscore her dedication to improving crop resilience and genetic potential. Through her scientific and academic achievements, Dr. Ruhangiz Mammadova has established herself as a leading figure in Azerbaijan's agricultural research, bridging traditional breeding practices with modern genetic approaches to support sustainable crop development.

### **James J. DeDecker**

Dr. James J. DeDecker is the Director of Michigan State University's Upper Peninsula Research and Extension Center, where he connects research, education, and the community to boost sustainable agriculture in Michigan's Upper Peninsula. With a focus on soil health, integrated pest management, and the human side of farming, he's a go-to expert for growers looking to improve profitability and environmental stewardship. His research focuses on sustainable agriculture, soil health, and farmer decision-making. He has authored several publications addressing climate resilience and participatory research in agriculture.

### **Xiaoli Sun**

Dr. Xiaoli Sun currently as Professor at College of Agronomy, Heilongjiang Bayi Agricultural University. She does research in Botany, Genetics and Molecular Biology. Her particular research domain is plant molecular responses to abiotic stresses (e.g., salt- alkaline stress, cold stress) in germplasm, transcriptome & miRNA/mRNA regulatory networks, gene-function analysis in crops such as rice, soybean, and industrial hemp.

### **Yuliya Byzova**

She works as professor in M. Kozybaev North Kazakhstan University at International campus. She is an associate professor and head of department. She holds a masters degree in chemistry and describe a journal publication as Master of Chemistry lecture at university her research focus on materials science applications in road engineering investigating modified bitumen composition, surfactant system, and surface properties of binders. 2022-2024, she has been contributing author on multiple studies published in the *Chemical journals of Kazakhstan*.

### **Zeliha Selamoglu**

Prof. Dr. Zeliha Selamoglu working as a professor in the field of medical biology at Nigde Omer Halisdemir university in Nigde, Turkey. She also Head of Department of medical biology within the faculty of medicine at same university. She earned her PhD in biology from Inonu university. She is associate member of society for experimental biology and medicine and also member of European Association for cancer research. She serves as an Editorial board member for several scientific journals. She recognizes as an expert and invited a keynote speaker at international conference such as international conference on applied zoology (ICAZ-2024). Her research interest includes natural product, Apitherapy, Antioxidant, Biochemical analysis, molecular biology, Ecotoxicology and Biomedical sciences.

**Prof. Dr. Wenlong Xu**

Wenlong Xu is a researcher at the Institute of Agricultural Resources and Environment, Jiangsu Academy of Agricultural Sciences. His work focuses on agriculture sciences, e.g., “soil nutrient cycling, sustainable crop production, and agro-environmental modeling”. He has authored many peer-reviewed papers, contributed to various book chapters, and presented his findings at many national and international conferences. In addition to his research, Xu collaborates and serves as a reviewer for several agricultural science journals.

## **NATIONAL INVITED SPEAKERS**

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### **Prof. Dr. Mushtaq Ahmad (T.I)**

Academician Professor Dr. Mushtaq Ahmad TWAS, PIFI-CAS and PAS fellow is renowned world Top Medicinal Plants, Traditional Chinese medicine, Agro-biologist and Director of Sino-Pak Biodiversity Research Centre for Agro-Biological Resources and impact of Climate change on ecosystem, Department of Plant Sciences, Quaid-i-Azam University, Islamabad, Pakistan. He is Honorary Distinguished professor in China and Uzbekistan. He is author of 997 articles (citations  $\pm$ 24000, H-index 77, i10-index 456) including 60 international books and book chapters. He has successfully supervised/produced 47 PhDs & Post Doctorates, 180 M.Phil./M.Sc./BS research scholars He is recipient of highest Civil Award of Pakistan (Tamgha-e-Imtiaz), High Foreign talent award by China, International Scientist Award by Uzbekistan, fellow of TWAS by UNESCO, fellow PIFI- Chinese Academy of Sciences, Fellow Pakistan Academy of Sciences (PAS) and is the Member & Awardee of international bodies i.e., Chairman Silkroad Biohealth Agricultural Industrial Alliance Alliance, China, IUCN, IBPES, Association of federation of biotechnologists Asia Japan, Flora of Pan Himalaya- China, PAS, TWAS, PIFI- CAS, NAS, TUBITAK, MEVLANA, HEC, PBS, BSP.

### **Prof. Dr. Abdul Rehman Khan Niazi**

Prof. Dr. Abdul Rehman Khan Niazi, from Department of Botany, University of the Punjab, Lahore who is an eminent mycologist with an exceptional academic and research career spanning over two decades, Prof. Niazi has made remarkable contributions to fungal taxonomy and biodiversity. In recent years, he has expanded the scope of his research toward applied mycology, exploring the ecological, industrial, and biotechnological potential of fungi, thereby bridging classical taxonomy with practical applications in science and society. During his research carrier, Dr. Niazi authored more than 200 over research papers, in reputed national and international journals. He has honor to introduce over 50 new fungal species from various ecological regions of the country. In addition to his taxonomic expertise, Prof. Niazi won serval research projects funded by national and international organizations focusing on fungal biodiversity, ecosystem roles of macrofungi, and their potential applications. His contributions have been instrumental in strengthening fungal systematics research and mentoring the next generation of mycologists in Pakistan.

### **Prof. Dr. Amjad Hameed**

Prof. Dr. Amjad Hameed, Deputy Chief Scientist and Professor at NIAB-C (PIEAS), Pakistan Atomic Energy Commission, Faisalabad, Pakistan. Prof. Hameed is a distinguished plant molecular biologist and biochemist with more than two decades of experience in research, teaching, and scientific leadership. His expertise lies in molecular characterization, marker-assisted breeding, and the development of stress-resilient crop varieties, areas in which he has made transformative contributions to agricultural biotechnology in Pakistan. He has

authored over 177 peer-reviewed publications with a cumulative impact factor exceeding 310, more than 6,100 citations, and an H-index of 40, reflecting his exceptional scientific impact. As Investigator prof Hameed led more than 19 national and international funded projects—Among his many honors, he is a recipient of the PAEC Gold Medal (2013) and multiple Research Productivity Awards. His outstanding leadership and mentorship are reflected in his supervision of more than 100 graduate students at PhD, MPhil, and MSc levels.

### **Prof. Dr. Shehzad Basra**

Dr. Shahzad Basra is a retired professor of physiology who has made a lasting impact across agriculture, nutrition, and community development. With a distinguished career that includes serving as a visiting professor at the University of California, USA, and leading the Department of Crop Physiology and later the Department of Agronomy at the University of Agriculture Faisalabad (UAF), he pioneered research on *Moringa oleifera* as a natural source of zeatin. Under his guidance, the Alternate Crops Lab introduced seven new crops to Pakistan—including moringa, quinoa, chia, amaranth, foxtail millet, and buckwheat—and secured approvals for varieties such as UAF-Q7 quinoa (2019) and Chia 1 (2023). Beyond the laboratory, Dr. Basra is a social mobilizer who promotes healthy lifestyles, superfoods, multigrain and gluten-free flours, and agri-tourism through hundreds of festivals and educational programs. His environmental initiatives include planting an 18-km “jungle” along the Jhung Branch Canal, and his extensive media presence—spanning YouTube, Facebook, TikTok, Instagram, and Twitter—reaches millions, sharing expertise on nutrition, fitness, and sustainable agriculture.

### **Dr. Khawaja Shafique Ahmad**

Dr. Shafique Ahmad is working as an Associate Professor in the Department of Botany, University of Poonch Rawalakot, Rawalakot, Jammu & Kashmir, Pakistan. His research group is composed of an interdisciplinary team of scientists who are passionate about environmental science research with a particular focus on investigating the complex interactions between plants and their environment. His research group study plant physiological and biogeochemical responses under abiotic stresses (i.e., cold, heavy metals, salt and temperature stress) to natural environmental variation and to global and regional environmental changes in natural ecosystems, with emphasis on fundamental aspects of plant growth, structural and physiological responses to environmental stress and climate change, and production of secondary metabolites. The group has also been interested in synthesis of metals and their oxide nanoparticles and their application in agriculture, medicine and environment. In addition to this, he is also interested in ethnopharmacological research which involves plant toxicity in livestock and traditional societies that incorporate wild plants into their daily life and takes the ethnobotanical approach to drug discovery.

## **Prof. Dr. Tehmina Anjum**

Prof. Dr. Tehmina Anjum was awarded PhD degree in 2007 on topic “Phenolic Allelochemicals of Sunflower as Natural Herbicides for Weed Management in Wheat”. Dr. Anjum joined Department of Plant Pathology (formerly Department of Mycology & Plant Pathology) in University of the Punjab as lecturer in 2004. Later she completed two postdocs, one in School of Agriculture, Food and Wine, Adelaide University Australia on “Characterization of mycotoxins from *pyrenophora teres* in the development of net blotch disease of barley” in 2009 and second on “Mode of action of Cyanamide – A known plant allelochemical”, in International Agro-Biological Resources and Allelopathy Lab, Tokyo University of Agriculture and Technology, Fuchu Campus, Tokyo, Japan in 2011. Dr. Anjum has won Charles Wallace Trust (British council) visiting fellowship to UK 2003; E.L. Rice Award 2005; Endeavour research fellowship 2009; Matsumae Research Fellowship 2011 and Women Super Achiever Award by Hawks Youth Vision HYV Foundation in 2023. Dr. Anjum joined as Professor in 2018 in same department. After Upgradation of the Institute of Agricultural Sciences to the Faculty of Agricultural Sciences, Dr. Tehmina Anjum became first Chairperson of the Department of Plant Pathology. Her main area of research is “Integrated Plant Disease Management”. Till today, Dr. Anjum has successfully supervised 15 PhD students who worked on various topics of Mycotoxin degradation, plant growth promoting bacteria, green nanotechnology, edible coatings, allelopathy and bioactive coated fertilizers.

## **Dr. Hammad Majeed**

Dr. Hammad Majeed has 26 years of experience in both industry and academia. He currently serves as the Head of the Chemistry Department and ORIC at UMT Sialkot Campus, and as the Manager of Innovation and Commercialization at UMT Lahore, Pakistan. He also works as an industrial consultant and trainer in intelligent manufacturing for multiple industries worldwide, specializing in climate change mitigation, Industry 6.0, resource optimization, cost reduction, industrial feasibility planning, and entrepreneurship for various government and non-government sectors. In this role he oversees both teaching and research, steering projects that bridge academia with industrial needs, such as the renovation of basic chemistry labs, establishment of advanced synthesis and characterization facilities, and the launch of an international chemical society in Pakistan. His professional journey includes more than two decades in the industrial sector, where he has worked across textiles, sugar, paints, paper, construction, and food industries, handling sales, marketing, and the commissioning of industrial plants. He brings those hands-on industry insight into the classroom, mentoring Ph.D. and M.Phil. students and acting as an industrial consultant for numerous firms. Dr. Majeed’s scholarly output is impressive: 8 peer-reviewed papers, 12 additional publications, 4 review articles, 2 book chapters, and a book manuscript in preparation, complemented by 5 patents and several industrial projects funded nationally and internationally. His work has earned him awards such as the DICE-VIC 2019 runner-up prize and a certificate

of appreciation from the Vice-Chancellor of UAF for completing his Ph.D. in six semesters. Beyond research and administration, he is an active speaker at national and international conferences, a member of dramatic and literary clubs, and a committed social mobilizer who promotes science education and industry-academia linkages.

### **Dr. Sajid Sandhu**

Dr. Sajid Sandhu is a professional agriculturist recognized for his contributions to the field of agricultural sciences in Pakistan. His work primarily focuses on crop improvement, sustainable farming practices, and agricultural innovation aimed at enhancing productivity and resource efficiency. As an academic and researcher, he has been associated with various agricultural research institutions and universities, where he has contributed to projects on plant breeding, agronomy, and soil management. His efforts are directed toward improving crop resilience under changing climatic conditions, promoting eco-friendly agricultural practices, and advancing scientific knowledge to support the farmer community. Dr. Sajid Sandhu is a dynamic social entrepreneur and community leader whose work bridges interfaith dialogue, human-rights advocacy, and sustainable agriculture. With a background in business management (MBA, University of the East, Manila) and extensive experience running non-profits, he has turned his passion for rural development into a vibrant agri-tourism movement that showcases Pakistan’s agricultural heritage while empowering local farmers. He is Founder, Interfaith League Against Poverty (I-LAP) – integrated farm-based workshops and farm-stay experiences that link urban visitors with rural producers. He organized Peace Museum & Rural Outreach – organized farm tours and cultural festivals that attract thousands of visitors each year, promoting cross-community understanding through shared meals and traditional farming practices. He is running Agri-Tourism Events – spearheaded events such as the “Harvest Festival” and “Mango & Heritage Trails,” drawing participants from across the country and abroad. He Advocate for Sustainable Practices – works with local cooperatives to introduce organic methods, value-added products, and eco-friendly tourism packages that benefit both the environment and the local economy.

### **Prof. Dr. Kafeel Ahmad**

A seasoned academic and researcher, Prof. Kafeel Ahmad serves as a senior faculty member at the University of Sargodha. With a strong background in his discipline—spanning teaching, research, and community outreach—he brings decades of experience to UOS’s vibrant academic community. His work focuses on [briefly mention field if known, e.g., “innovative agricultural practices” or “structural engineering”], and he’s known for mentoring students, leading research projects, and contributing to the university’s outreach initiatives. At UOS, Prof. Kafeel Ahmad is actively involved in both undergraduate and postgraduate programs, supervising theses, and collaborating on interdisciplinary research that addresses local and national challenges. His dedication to academic excellence and student development makes him a respected figure among peers and learners alike.

### **Dr. Qamar Abbas**

Dr. Qamar abbas is an established academic researcher and an assistant professor at the Department of Biological Sciences, Karakoram International University (KIU), in Gilgit, Pakistan, whose expertise lies in the field of ethnobotany, phytochemistry and phytosociology. His research primarily focuses on documenting the rich and traditional uses of medicinal plants within the Gilgit-Baltistan region's indigenous communities, while also conducting chemical and ecological assessments of these flora to support biodiversity conservation efforts. Dr. Qamar abbas includes significant publication such as Medicinal plants of Turmic Valley (Central Karakoram National Park), Gilgit Baltistan, Pakistan". He also serves in administrative capacities as being Provost of KIU and actively participates in various national and international conference contributing to academic community through his work on natural drug discovery, plant taxonomy, and sustainable resource management.

### **Prof. Dr. Shabnum Shaheen**

Prof. Dr. Shabnum Shaheen is a leading plant scientist whose career spans teaching, research, and mentorship at Lahore College for Women University (LCWU). After earning her Ph.D. in Plant Sciences from Quaid-i-Azam University, Islamabad (2010) and completing a post-doctoral fellowship in Malaysia (2016), she joined LCWU, where she has built an impressive publication record—over 300 research articles, books, book chapters and conference abstracts, including 15 authored books with international and national publishers. Her work has been recognized with gold medals at an International Conference of Botany and from Idara Farogh-e-Taleem & the Federal Minister for Kashmir Affairs, and she has successfully led an HEC-funded project that resulted in a published book. In addition to serving as a reviewer for several reputable journals and sitting on numerous international scientific editorial boards, Prof. Shaheen has supervised 9 Ph.D., 60 M.S. and 40 B.S. students, and is currently guiding 5 Ph.D. and 4 M.S. candidates. Her contributions continue to shape plant science research and education in Pakistan and beyond.

### **Dr. Jamal U Din Mangi**

Dr. Jamal U Din Mangi holds a Ph.D. from the University of Sindh, Pakistan (2004) and is a faculty member at the University of Sindh, Jamshoro. His research profile includes a Research Interest Score of 189, over 200 citations, and an h-index of 6, reflecting a solid impact in his field.

### **Dr. Muhammad Shareef**

Dr. Muhammad Shareef received PhD degree from the Chinese Academy of Sciences China in 2018 as an awardee of CAS-TWAS President's fellowship program. His specialization is in Ecology/Ecophysiological studies of plants with key research focus on drought, temperature stress, and nutrient cycling. He earned a Distinguished International Researcher award of 2019 from the state key laboratory of desert & oasis ecology research, Chinese Academy of Sciences, China, and also an outstanding International PhD graduate Award of 2018 from

Chinese Academy of Sciences Xinjiang Branch, China. So far, he has published 30 research articles as principal as well as contributing author with H-index 17 and i10-index of 23. Currently since 4 years, he is serving as an Assistant Professor and HOD in the Department of Botany, University of Narowal, Pakistan.

### **Prof. Dr. Hassan Sher (SAARC Gold Medalist)**

Dr. Hassan Sher is widely recognized for his remarkable contributions to plant sciences, biodiversity conservation, and mountain ecosystem research. With an extensive record of impactful publications, he has played a vital role in promoting sustainable development and scientific innovation in Pakistan's northern regions. As Vice Chancellor, he continues to lead with excellence, dedication, and a forward-looking vision fostering research, education, and collaboration at both national and international levels.

### **Prof. Dr. Abdul Qayyum Rao**

Dr. Abdul Qayyum Rao working as Professor at CEMB and Heading Plant Biotechnology Section. He has more than 22 years of working experience in plant molecular Biology. He is active member of cotton variety development and commercialization at CEMB, He has three patents granted. He received various prestigious awards like Best Researcher award of scientist working on Cotton by ICAC, PAS gold medal and HEC Best Researcher award 2024.

### **Prof. Dr. Bushra Rashid**

Dr. Rashid is a distinguished plant biotechnologist whose pioneering work in cotton genetic transformation has significantly contributed to the development of pest- and herbicide-resistant cotton varieties, strengthening Pakistan's agricultural biotechnology. Her expertise extends to molecular genetics, plant tissue culture, and gene expression studies, with impactful research addressing challenges in crop improvement and stress tolerance. She has authored valuable scientific publications and book chapters, and has represented Pakistan in international trainings and workshops in the USA and beyond. With her vision for sustainable agricultural innovation and her dedication to advancing molecular biology research, she continues to be a role model for young scientists.

### **Prof. Dr. Muhammad Naveed**

Prof. Dr. Muhammad Naveed is a globally acclaimed academic and researcher, ranked among the top 2% scientists worldwide by Stanford University and Elsevier. He earned his Ph.D. in Biotechnology (Bioinformatics) from Quaid-i-Azam University, Islamabad, and completed a postdoctoral fellowship in Bioinformatics at Jiangsu University, China. A recipient of both the HEC Indigenous and IRSIP scholarships, he was named Best Ph.D. (IRSIP) Scholar of the Year (2013) and honored as a Distinguished Alumnus of QAU (2017). In 2025, he was selected for the prestigious HEC Pak-Sri Lanka Faculty Exchange Program Award. From 2022 to 2025, he served as Head of the Department of Biotechnology at the University of Central Punjab (UCP), where he continues as

a senior faculty member. His research focuses on Bioinformatics, Molecular Biotechnology, Nano-informatics, vaccine development, and computational drug design for infectious diseases. Prof. Naveed has authored 304 peer-reviewed research articles, with a cumulative impact factor of 4412.48, over 20,950 citations, and an H-index of 42. His scholarly output also includes one authored book, six book chapters, and six patent filings. As a mentor, he has supervised more than 90 MSc, 80 MPhil, and 2 Ph.D. students. In recognition of his outstanding contributions, he has received numerous honors, including the Prof. A.R. Shakoori Gold Medal (2025) and the Researcher of the Year Award from the UoG (2016) and UCP (2018, 2019, and 2021-22). Prof. Naveed continues to lead advancements in life sciences through high-impact research, translational innovation, and strategic academic leadership

### **Prof. Dr. Tahir Mehmood**

Dr. Tahir Mehmood working as Professor of Microbiology and Molecular Genetics at the Institute of Microbiology and Molecular Genetics, University of the Punjab, Lahore, Pakistan. He earned my PhD degree in Molecular Cell Biology and Biochemistry from the Institute of Genetics and Molecular and Cellular Biology (IGBMC), University of Strasbourg, Strasbourg France in 2012. He has around 19 years of experience in teaching and research at the university level inland and abroad, having had a first-class academic career. The main area of his research interests includes: To isolate and characterize plant-based drugs/bioactive peptides/nutraceuticals, biotransformation, industrial uses Enzymes production, biofuels and accesses the chemical toxicity etc. Nutra-Pharmaceutical with potential medication as anti-cancer, anti-diabetes, other pharmacological activities and product development with value addition. In addition to teaching and research, he has supervised 15 MSc/BS, 75 MPhil, and 6 PhD students, with three PhD and four MPhil students currently working under his supervision. Over 125 research papers have been published in highly reputed journals, with an aggregate impact factor of over 320 and over 2550 google scholar citations (h-index=25, i10-index=68). In addition, 15 book chapters and two practical books for BS/MSc have been published by internationally renowned publishers. Currently, he is working on a research project entitled “Designing lignocellulose-derived enzyme cocktail as a robust biocatalytic system for detergent applications” the project funded from HEC under TDF. It’s worth 14 million. In the year 2024, he have completed one project as Co-PI entitled “Safety and quality assessment of loose milk in Pakistan “the worth 18 million of Pakistani rupees.



# ABSTRACTS



**RAPS-25-01: Climate Smart Plantation in western borders of Pakistan through promoting Grapes Cultivation in Pakistan**

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Grape (*Vitis vinifera* L.) is economically the most important fruit crop grown in the world. It is native to the Mediterranean region and can withstand varied conditions. We aimed to find out suitable grape varieties, soil and micro climatic conditions for propagation and extension in semi-arid subtropical and dry temperate Mountainous valleys of the Hindu-Himalayan Range. A total of one hundred thirteen soil samples were collected at a depth of 0.3 m. Soil tests i.e., pH, electrical conductivity, soil micro and macro nutrients/elements like sodium, nickel, iron, cadmium, calcium, chromium, lead, potassium, manganese, zinc, magnesium and copper, were analyzed using Atomic Absorption Spectrophotometry technique and other standard protocols. Three demonstration plots were developed based on climatic and edaphic factors. The grape varieties were distributed among the local community and farmers of Ex-FATA regions. The morphological data of different grape varieties were taken, including Plants Height, Flag Leaf Area and Internodes Length in centimeter. Grapes fruit data were recorded and analyzed at all three demonstration plots. It included the assessment of vitamin C (ascorbic acid), reducing and non-reducing sugars, pH, electrical conductivity, iron, sodium, zinc, copper, calcium and magnesium concentrations. Grape biochemical contents were also determined that includes sugar contents, salicylic acid, indole-3-acetic acid, total phenolic & flavonoid contents, total antioxidant capacity and 2,2-diphenyl-1-picryl-hydrazyl free radical scavenging assay. All the collected data were statistically analyzed using Pearson correlation, Analysis of Variance (ANOVA), Regression Analysis, Canonical Correspondence Analysis (CCA) and Structural Equation Modeling (SEM). The successfully grown grape varieties were identified as Crimson Seedless, Alpanso, Superior, Tarkaya Tarikalyn, Red Globe Seedless, Thomson Seedless, Flame Seedless, Oval Red and Round Black (each with 100% survival rate) followed by NARC-Black (92.85% survival), King Ruby (83.33% survival), Perlette (76.47 % survival), Sultania-C (66.67% survival), Early Green Seedless (50% survival) and Autumn Royle (20% survival). The structural equation modeling revealed that the climate, soil, and plant height significantly affect grape plant survival and fruit production..

**Keywords:** Grape varieties, Dry Ecological Zones, Climate Smart Agriculture

## **RAPS-25-02: Two Bacillus strains remodulate metabolomic profile to protect Pea plants against Fusarium wilt disease**

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Plant growth-promoting beneficial microbes are extensively studied to protect plants against diseases. In this study, it was attempted to manage Fusarium wilt disease of Pea plants using two Bacillus strains (*Bacillus aryabhatai* strain Z-48 and *B. cereus* strain Z-53) either alone or in a synthetic consortium. Pea plants were grown in potting mix drenched with bacterial strains and inoculated with the Fusarium oxysporum. The application of a synthetic consortium of both Bacillus strains (Z-48 + Z-53) significantly suppressed Fusarium wilt disease up to 54.3%. In addition to protection against Fusarium wilt, both bacterial strains showed significantly higher growth of plants both in the presence and absence of the wilt pathogen. Likewise, the application of the Bacillus consortium significantly increased the time-course accumulation of defence-related enzymes (PO, PPO, PAL), and photosynthetic pigments (Chlorophyll and carotenoid contents) in Pea plants. The LC/MS-based non-targeted metabolite profiling indicated that the Fusarium wilt pathogen negatively affected the metabolites in Pea plants belonging to different classes. Whereas, soil-drenched application of a Bacillus consortium (Z-48 + Z-53) in Pea plants caused an ameliorative effect for different metabolites in pea plants subsequently challenged with the wilt pathogen. The PCA analysis of the obtained data clearly separated Pea plants based on the application of the wilt pathogen and the Bacillus consortium. The multivariate analysis showed strong relationships between treatment effect and different metabolites, including phenylalanine, ursolic acid, and glycerol-3-phosphocholine. These findings unveil the intricate beneficial interplay between this synthetic consortium of Bacillus strains and Pea plants in the context of Fusarium wilt management and plant growth promotion. This study also proved the potential of this synthetic consortium to be applicable in the field for sustainable farming.

**Keywords:** Bacillus; Synthetic consortium; Fusarium wilt; Induced resistance; Growth promotion.

**RAPS-25-:03 Heat shock protein gene: the molecular solution to heat stress in crop plants**

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Heat is one of the major stresses causing threat to food security issue in Pakistan. Pakistan is among top ten countries suffering from severe climatic challenges. Genetic improvement of local cotton is important for tolerance against heat and other abiotic stresses. A local cotton cultivar was genetically transformed with heat shock protein gene (*AsHSP70*) revealed 1.9% transformation efficiency and evaluated under heat stress. Cell electrolyte leakage was 39.83 $\mu$ s/cm and 63.43 $\mu$ s/cm in transgenic plants and control plants respectively. Relative conductivity (4.05%) was correlated with the membrane stability index (97.19%) in the transgenic plants while it is 7.28% when the membrane stability index is 90.19% in the control plants. Membrane injury in the control plants was 19 to 52% but that was 15.6 to 29% in transgenic plants over the time of exposure to heat stress. Significant variation in chlorophyll content and osmoprotectants such as proline and soluble sugar content was observed in control as compared to the transgenic plants which showed the heat tolerance mechanism is induced in the transgenic plants. PCR amplified 1800bp fragment of *AsHSP70* in genomic DNA of transgenic plants. Activity of polyamine oxidase induced the mRNA expression of *AsHSP70* in transgenic plants from 1.02 to 9.58 fold as the duration of heat stress was increased from 30min to 3h. mRNA expression of *AsHSP70* was relatively higher the transgenic leaf tissues as compared to the root and stem under combined stress of heat/drought. Performance of transgenic plants was better in the field for number of bolls, their weight and the open bolls with the cotton lint. FISH analyses detected the single copy of transgene in transgenic plant material. Analyses of transgenic progeny may lead the selection of pure lines to be used in breeding program for cotton improvement.

**RAPS-25-04: Sustainable Future via Innovative Techniques in Plant Sciences Along Belt and Road Partnership China - Pakistan**

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Biodiversity is the foundation of human survival, sustainable development, and ecological resilience. Over the past decade, the Pakistan–China Belt and Road Partnership has created new opportunities to mobilize biodiversity resources for green growth, carbon neutrality, and cultural inheritance. This wisdom-driven collaboration integrates AI-powered digital transformation, new energy transitions, and sustainable utilization of natural resources to achieve ecological civilization and economic prosperity. This talk will highlight the role of biodiversity resources—including food crops, medicinal plants, and underutilized wild species—in addressing global challenges of food security, renewable energy, and health. Special emphasis will be placed on evergreen biomass and evergreen energy crops, which hold promise for continuous biomass supply, biofuel production, and carbon sequestration, ensuring both ecological stability and industrial innovation. The sustainable utilization of medicinal plants will also be explored, demonstrating their value for healthcare, biotechnology, and cultural heritage preservation along the Belt and Road. By showcasing a decade of Pakistan– China cooperation, this presentation will emphasize how biodiversity conservation and resource utilization can be harmonized with AI-driven smart agriculture, low-carbon energy systems, and ecological restoration. The integration of new energy, biodiversity resources, and cultural inheritance not only contributes to carbon neutrality but also fosters a green future, rooted in the shared wisdom of both nations. This vision positions the Belt and Road Alliance as a model for sustainable development, biodiversity protection, and global ecological partnership.

### **RAPS-25-05: Microclonal Propagation of Medicinal Plants and Production of Biologically Active Extracts**

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Developing innovative methods for *in vitro* microclonal propagation of medicinal plants is crucial, as climate change, drought, and plant extinction make this essential. Producing high-quality plant materials is crucial for applications in agriculture, medicine, and environmental protection, and the extraction of biologically active compounds and their pharmacological applications is a necessity of our time.

### **RAPS-25-06: Effect of Salicylic acid on *In Vitro* Cultures of *Lantana camara* L.**

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*Lantana camara* is a widely used medicinal plant and a reservoir of various bioactive pharmacologically important compounds. The current investigation aimed to develop an efficient protocol for the establishment of *in vitro* shoots and callus cultures of *L. camara* to assess the effect of SA on callus culture. MS medium supplemented with 35.2  $\mu\text{M}$  BAP was best for shoot multiplication with  $2.3 \pm 0.28$  and  $2.0 \pm 0.35$  shoots for shoot tip and nodal explants, respectively, and 4.6  $\mu\text{M}$  Kin was best at shoot elongation resulting in  $6.05 \pm 0.28$  and  $7.92 \pm 0.79$  cm long shoots for the two explants, correspondingly. The highest number of roots per plant ( $3.80 \pm 0.59$ ) was obtained with 7.5  $\mu\text{M}$  IBA. Embryogenic calli resulted in light-incubated cultures. For leaf explants, highest frequency of callus induction (90%) and biomass ( $0.41 \pm 0.04$  g) were obtained at 5.4  $\mu\text{M}$  NAA + 0.88  $\mu\text{M}$  BAP. For internodal explants, the phytohormone combination of 5  $\mu\text{M}$  BAP + 1  $\mu\text{M}$  NAA + 1  $\mu\text{M}$  2, 4-D was best for callus induction (90%), while 40  $\mu\text{M}$  NAA + 4  $\mu\text{M}$  BAP proved best for callus proliferation ( $2.01 \pm 0.09$  g). In dark incubation, 40  $\mu\text{M}$  NAA + 4  $\mu\text{M}$  BAP and 5.4  $\mu\text{M}$  NAA + 0.88  $\mu\text{M}$  BAP were found best for callus induction and proliferation from leaf and internodal explants, respectively. For elicitation response, MS medium fortified with 5.4  $\mu\text{M}$  NAA + 0.88  $\mu\text{M}$  BAP and low SA concentration (125  $\mu\text{M}$ ) favoured callus biomass accumulation more in dark incubation than light.

**RAPS-25-07: Expression Study of Newcastle Virus Gene in Chloroplast Vector Coumarin-rich Extract of *calotropis procera* L. is Effective in Controlling *fusarium* wilt in *Cicer arietinum* L.**

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Fungicides are commonly applied to overcome *Fusarium* wilt, caused by *Fusarium oxysporum*, in chickpea. However, the practice raises serious concerns for human health and the environment. Phyto-priming provides an eco-friendly alternative. To find the effective phyto-priming agent, the crude (methanol) and fractionated (*n*-hexane, dichloromethane-DCM, ethyl acetate-EtOAc, acetone-Ace and methanol) extracts of leaves of *Calotropis procera* L. were tested against the fungus in the current study under *in vitro* and *in vivo* conditions. All the tested concentrations, *i.e.*, 0.5%, 2%, 3.5%, 5% and 6.5% of crude extracts, significantly controlled *F. oxysporum* growth, with complete suppression observed at 5% concentration. The EtOAc and Ace organic fractions have completely inhibited fungal growth at a concentration of 0.6%. The chickpea seeds were phyto-primed with the extracts showing best antifungal potential to check their phytotoxicity and disease control in the seedlings. The highest fresh weight (0.8 g), dry weight (0.41 g), root elongation percentage (71.75%), seed germination index (71.75), radicle length (8.83 cm), and plumule length (1.88 cm) were noted for EtOAc-0.6%. The same fraction produced least disease incidence percentages in petri- plate (0%) and soil (41.7%) setups and least disease severity percentages in petri-plate (0%) and soil (42%) setups during *in vivo* study. Presence of alkaloids, terpenoids, flavonoids, tannins, coumarins, phenolics, glycosides, steroids, volatile oils, proteins and carbohydrates in the crude extract was confirmed. The quantification of metabolites of organic fractions show that EtOAc fraction possessed highest phenolic (32.74674 µg/mg), saponin (9651.811 µg/mg) and tannin (25716.54 µg/mg) contents, and second highest flavonoid (1840.687 µg/mg) content. LC-ESI-MS revealed coumarins as the major component in the EtOAc fraction, followed by flavonoids and alkaloids, etc. The highest contents were observed for 7-Hydroxy-4-(methoxymethyl) coumarin (100%), and bergapten (76.36%), which might be responsible for withstanding *Fusarium* wilt and better growth in chickpea seedlings treated with EtOAc-0.6% of *C. procera*.

**Keywords** :7-Hydroxy-4-(methoxymethyl)coumarin, Bergapten, *Fusarium* wilt, LC-ESI-MS, *Calotropis procera*

**RAPS-25-08: Phytotherapeutic Emulsions in Dermatology: A Non-Invasive In- Vivo Approach Using Plant Based Actives in Treating Dermatological Disorders**

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Dermatological disorders such as eczema present a therapeutic challenge due to the adverse effects linked with prolonged use of conventional treatments such as corticosteroids. This study aimed to formulate and evaluate phytotherapeutic emulsions using *Curcuma longa*, *Ocimum sanctum*, and *Matricaria chamomilla* extracts for their potential in treating inflammatory skin conditions. This quantitative study included in- vitro and in-vivo evaluations over a 12-week period. Ethanolic plant extracts were screened for phytochemicals and assessed for antioxidant activity using DPPH assay and antimicrobial efficacy against *Staphylococcus aureus* via disc diffusion method. Stable water-in-oil emulsions having 4% extract were formulated and evaluated for pH, viscosity, and stability under controlled conditions (8°C, 25°C, 40°C, 40°C+75% RH). The in-vivo study involved non-invasive testing on human volunteers, measuring erythema, melanin, sebum, hydration, and elasticity using bioengineering probes. *Ocimum sanctum* exhibited the highest antioxidant activity (91.09%), followed by *Curcuma longa* (81.98%) and *Matricaria chamomilla* (72.63%). All showed significant antimicrobial activity. The formulations remained stable across all tested parameters. In-vivo application led to statistically significant improvements ( $p < 0.05$ ) in skin hydration and elasticity, with reductions in melanin, erythema, and sebum levels compared to base formulations. Phytotherapeutic emulsions containing *Curcuma longa*, *Ocimum sanctum*, and *Matricaria chamomilla* extracts were effective, stable, and well tolerated, showing significant improvement in dermatological parameters and potential as non-steroidal alternatives for skin disorder management.

**Keywords:** Plant Extracts, Phytotherapeutic Emulsions, Non-invasive in-vivo evaluation, Eczema, Skin Disorders

**RAPS-25-09: First report of *Chrysomyxa woroninii* (Spruce bud rust) on Himalayan spruce from Pakistan using Electron Microscopy and DNA Barcoding Techniques**

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During a survey of rust fungi from the alpine and temperate regions of northern Pakistan, particularly the floristically rich high-altitude site of Fairy Meadows (Gilgit Baltistan, 3,300 m a.s.l.), *Chrysomyxa woroninii* was collected parasitizing needles of *Picea smithiana* (Himalayan spruce). The species was identified based on detailed morpho-anatomical characteristics, scanning electron microscopy (SEM) observations, and molecular analyses, and is reported here as a new record for Pakistan. The integration of SEM micrographs with molecular data improved species resolution and demonstrated the taxonomic value of combining traditional morphology with modern molecular approaches for accurate rust fungi identification. Members of *Chrysomyxa* (Coleosporiaceae, Pucciniales) are obligate biotrophic pathogens responsible for foliar infections in coniferous hosts, often leading to premature needle drop and substantial economic losses in forest ecosystems. *Picea smithiana*, an ecologically and economically important conifer native to the Himalayas, also holds considerable medicinal significance. Therefore, accurate identification of the rust fungus infecting this valuable species is a critical first step toward developing effective management and control strategies against the pathogen. This study also extends the known geographic distribution of *Chrysomyxa* to the western Himalayas of Pakistan and emphasizes Fairy Meadows as a potential hotspot for unexplored rust diversity.

**Keywords:** *Picea smithiana*, rust fungi, Fairy Meadows, electron microscopy, DNA barcoding, new record, alpine mycobiota, Pakistan

**RAPS-25-10: 28-Homobrassinolide Primed Seed Improved Lead Stress Tolerance in *Brassica rappa* L. through Modulation of Physio-Biochemical Attributes and Nutrient Uptake**

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Brassinosteroids (BRs) persuade a variety of physiological reactions and alleviate a different biotic and abiotic stressors. Turnip seedlings were grown with the goal of further exploring and expanding their function in plants under abiotic stress, particularly under heavy metal toxicity (Lead stress). This study's objective was to ascertain the role of applied 28-homobrassinolide (HBL) in the reduction of lead (Pb) stress in turnip plants. Turnip seeds treated with 1  $\mu$ M, 5  $\mu$ M, and 10  $\mu$ M HBL were grown-up in Pb- contaminated soil (300 mg kg<sup>-1</sup>). Lead accumulation reduces biomass, growth attributes, and various biochemical parameters, as well as increasing proline content. Seed germination, gas exchange characteristics, root growth, and shoot growth were all enhanced by HBL treatment. Furthermore, lead-stressed seedlings had decreased total soluble protein concentrations, photosynthetic pigment, nutritional and content of phenol. Nonetheless, HBL increased chlorophyll a and chlorophyll b levels in plant treatments, resulting in increased photosynthesis. As a result, seeds treated with HBL2 (5 $\mu$ M L<sup>-1</sup>) had higher nutritional content (Mg<sup>+2</sup>, Zn<sup>+2</sup>, Na<sup>+2</sup>, K<sup>+1</sup>). HBL2-treated seedlings had higher DPPH and metal tolerance indexes. This led to the conclusion that HBL2 effectively reduced Pb toxicity and improved resistance in lead-contaminated soil.

**Keywords:** 2,2-diphenylpicrylhydrazyl (DPPH), Lead, Seed Priming, 28-homobrassinolide

**RAPS-25-11: Taxonomic and Functional Diversity of Rhizosphere-Associated Fungi in *Abies pindrow* (Himalayan Fir)**

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Fungal communities associated with *Abies pindrow* (Himalayan fir) play a pivotal role in sustaining forest ecosystem functioning through complex ecological interactions. Ectomycorrhizal (ECM) fungi enhance nutrient acquisition and host fitness, while non-ECM groups such as endophytes and saprotrophs contribute to root resilience and nutrient cycling. Despite their ecological importance, the diversity and taxonomic structure of *Abies* rhizosphere-associated fungi in the Himalayan region remain poorly characterized. This study aimed to analyze the fungal diversity and taxonomic composition of *A. pindrow* microbiomes and to compare the dominant fungal orders and their relative abundances. Root samples were collected from multiple forest sites, followed by DNA extraction, ITS region amplification, and high-throughput sequencing. Operational taxonomic units (OTUs) were clustered at 97% similarity, taxonomically assigned using UNITE and NCBI databases, and visualized through phylogenetic and abundance analyses. Phylogenetic trees revealed distinct clades corresponding to several fungal orders. Pezizales emerged as the dominant group, representing typical ECM symbionts. Chaetothiales were frequent and likely correspond to dark septate endophytes, while Eurotiales and Onygenales indicated saprotrophic members involved in organic matter decomposition. Diversity indices (Shannon and Simpson) reflected high fungal richness and evenness across samples. These findings demonstrate that *A. pindrow* roots harbor a functionally diverse fungal assemblage encompassing symbiotic, endophytic, and decomposer guilds. The study underscores the ecological significance of these fungal groups in maintaining nutrient dynamics in temperate Himalayan forests and highlights the need for further molecular and functional characterization of underexplored taxa.

**Keywords:** FA, novel symbiotic association, AHLs-producing *Sinorhizobium meliloti*, *Alysicarpus bupleurifolius*.

**RAPS-25-12: A Novel symbiotic association of AHLs-Producing  
*Sinorhizobium meliloti* with *Alysicarpus bupleurifolius***

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Bacteria use quorum sensing to coordinate their populations locally. It can also occur among unrelated species, regulating various processes at a community level. Bacteria sense their quorum strength through signaling molecules called auto-inducers. The study reports a novel symbiotic relationship between *S. meliloti* and *Alysicarpus bupleurifolius*. We isolated *Sinorhizobium meliloti* (PCC21) from root nodules of the wild legume species *Alysicarpus bupleurifolius* and characterized its AHL (Acyl homoserine lactone) diversity. The TLC and HPLC-MS/MS profiles showed a wide range of AHLs, from short-chain C4-HSL to long-chain C12-HSL, indicating the possible presence of more than one synthase system in *S. meliloti* PCC21. This bacterial strain producing diverse AHL molecules offers an opportunity to explore the complex genetics behind AHL production in *S. meliloti*. Additionally, we introduced the WsPr vector, which contains the DGC (Diguanilate cyclase) gene from *Pseudomonas aeruginosa*, and observed a reduction in exopolysaccharide (EPS) production in *S. meliloti* PCC21. unctional guilds, ITS rDNA sequencing, Operational taxonomic units (OTUs)

## **RAPS-25-13: AI Driven Additive Manufacturing in Food and Plant Systems in Industry 6.0 and 7.0**

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The transition to Industry 6.0 represents a paradigm in which decentralised, AI cognitive, autonomous manufacturing ecosystems integrate seamlessly with sustainable value chains and bio inspired systems. Recent literature positions Industry 6.0 as moving beyond mass customisation into fully cognitive, human machine symbiotic, risk monitored, real time adaptive production systems. Within this context, the coupling of AI with additive manufacturing (AM) technologies offers transformative potential for two often separate domains i.e. food industries and applied botany. In the food manufacturing sector, AI adoption in 2024 to 25 is reported in around 70 % of firms, yielding average line efficiency gains of 20 % and machine downtime reductions of 30 to 35 %. Concurrently, the global 3D food printing market (a subset of AM) is projected to expand from USD around 296.7 million in 2023 to USD around 2.26 billion by 2030 (34.2 % CAGR). In applied botany, AI driven phenotyping, trait prediction and generative modelling accelerate breeding and resource use efficiency. These developments, illustrating how AI enabled AM workflows can be embedded within Industry 6.0 frameworks to produce scalable, customisable food sector components (tailored nutritional forms, personalised packaging, edible structure printing etc.) and innovative plant system applications (biomimetic scaffolds, precision printed carriers for bio stimulators, synthetic leaf inspired geometries etc.). Key considerations should include material formulation optimisation (PLA, PETG in food contact AM), process parameter modelling via ML/AI (recent work on neurosymbolic AI predicting AM part strength) and sustainability metrics (material waste reduction, energy efficiency gains in AM). We need to work on practical deployment challenges (safety/regulation in food contact AM, botanical material compatibility, data integration across bio digital ecosystems) and propose a roadmap aligning with SDG 1, 2, 3, 6, 9, 12, 13, 14, 15 & 17. The objective of the talk is to chart a strategic path for researchers and industry leaders to integrate AI and AM under the Industry 6.0 umbrella for resilient, bio integrated food and plant-based manufacturing ecosystems. Keywords: Industry 6.0 and 7.0; Artificial Intelligence in Additive Manufacturing; 3D Food Printing; Applied Botany & Bio Printed Systems; Sustainable Manufacturing & SDG Integration; Human Machine Symbiosis and Cognitive Production.

## **RAPS-25-14: Weeds Management through Allelopathy and Food Security in Pakistan: Challenges and Sustainable Solution**

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Weeds are a major threat to agricultural productivity and food security in Pakistan, competing with crops for essential resources such as light, water, and nutrients, while also harboring pests and diseases. Traditional survival mechanisms among plants, including biochemical interactions with neighbouring herbs, highlight the concept of allelopathy—a natural process where plants release chemicals that influence the growth and survival of others. Allelopathy, recognized as early as 370 BC, has gained attention as a potential tool for weed management in modern agricultural systems. In Pakistan, ineffective weed control practices, herbicide resistance, and the impacts of climate change continue to alter weed dynamics, posing significant challenges to sustainable crop production. Conventional approaches, such as manual weeding and reliance on chemical herbicides, are limited by rising labour costs, environmental concerns, and increasing resistance in weed populations. Consequently, sustainable and integrated solutions are urgently required. Integrated Weed Management (IWM) offers a holistic approach by combining biological control through allelopathy, crop rotation, cover cropping, precision agriculture, and the development of herbicide-resistant varieties. These strategies emphasize reducing dependency on synthetic chemicals while promoting ecological balance. Furthermore, farmer education, supportive policies, and enhanced investment in agricultural research are critical for the adoption and long-term success of IWM practices. By embracing comprehensive, eco-friendly weed management strategies use of allelopathy in crop production, Pakistan can minimize crop losses, enhance agricultural productivity, and strengthen national food security. Sustainable weed control is therefore not only an agronomic necessity but also a cornerstone of ensuring future food stability in the country.

**Keywords:** Weed management, Allelopathy, Food security, Integrated Weed Management (IWM), Sustainable agriculture, Pakistan

## **RAPS-25-15: Dry Leaves and Plant twigs Compost's effect on the Growth and Yield of Brinjal (*Solanum melongena* L.)**

Muhammad Imran

Management of agricultural waste like dry leaves and plant twigs has become very important for controlling soil health and for environmental waste management. Composting of the plant twigs and the dry leaves turns them into useful organic fertilizers that is a good source of carbon and other essential nutrients. These nutrients increase soil fertility and structure with providing a sustainable natural alternative to the chemical fertilizers that decrease the soil fertility efficiently. The study was done to demonstrate the effects of the compost which is prepared from dry leaves and plant twigs on growth and yield performance of the brinjal. The compost was prepared by using mixture of the dry leaves and plant twigs. Different methods were applied, including no compost(controlled),25%, 50% and 75% compost introduction into the soil. Brinjal seeds were grown in controlled field conditions,and parameters as height, leave numbers , fruit yield and nutrients of soil were measured through the whole growing season. Statistical data was also conducted to demonstrate the importance of treatment of the effects on growth and yield of Brinjal. Result demonstrated that application of compost greatly increase brinjal growth as compared to controlled conditions. 50% compost treatment gave the best results, plant height, leaf area, fruit size and yield were significantly improved. Soil nutrients and organic matter content also increased with increase in compost level, showing its importance as organic fertilizer. Future research can be done on exploring long term field trials, and microbial activity determination and interaction of compost with bio-fertilizers to increase brinjal productivity and soil fertility.

**Keywords:** Dry leaves compost, Plant residue, Brinjal growth, Soil nutrients, Organic fertilizers.

## **RAPS-25-16: Using Green Silver Nanoparticles to Combat Plant Pathogens: A Sustainable Antifungal Strategy**

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Fungal diseases significantly impact global crop production, causing major yield losses and contaminating food and feed with mycotoxins. This infection hampers agricultural output and renders food unsafe and unsellable. Currently, chemical fungicides are the primary management method, but their long-term overuse raises concerns about environmental pollution, toxicity to non-target species, and the development of resistance among pathogen strains. As a result, eco-friendly alternatives are deemed more promising for sustainable disease management in agriculture. Though research on antifungal agents continues, silver nanoparticles (AgNPs) have gained attention due to their broad antimicrobial activity, stability, and lower likelihood of resistance development. This study details a green chemistry synthesis of AgNPs, utilizing bioactive compounds from medicinal plant leaves for reduction and stabilization. This eco-friendly approach minimizes or eliminates hazardous chemicals, enhancing nanoparticle biocompatibility and effectiveness. The antifungal activity of the biosynthesized AgNPs was tested against various phytopathogenic fungi through *in vitro* methods like disc diffusion and agar well diffusion, showing significant fungal growth inhibition. Further validation in greenhouse trials demonstrated that foliar application of AgNPs controlled fungal pathogens with over 80% effectiveness—outperforming AgNO<sub>3</sub> and traditional fungicides. These findings suggest biosynthesized AgNPs are promising, sustainable alternatives to synthetic fungicides, capable of controlling plant pathogens while reducing environmental impact and resistance issues. Future developments like field trials, toxicity evaluations, and formulation improvements could pave the way for integrating AgNP-based nano-fungicides into sustainable crop protection practices.

**Keywords:** Nanoparticles; Green synthesis; Nanoparticles; nano-fungicide

**RAPS-25-17: Climate Change Effects on Leaf and Seed Yield of Lettuce (*Lactuca sativa* L.) Genotypes across Variable Sowing Dates in Punjab, Pakistan**

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A four-year field study (2020–21 to 2023–24) was carried out at the Vegetable Research Institute, Ayub Agricultural Research Institute, Faisalabad, to evaluate the effects of climate change on the fresh-leaf and seed yield of four lettuce genotypes—Green Check, VRIL-0203, VRIL-0204 and VRIL-0205—sown on five different dates from late September to early December. The study aimed the effects of temperature variation, nursery duration and transplanting time on vegetative and reproductive performance and selection of heat tolerant and climate resilient lettuce genotype for sustainable lettuce production. Nursery periods ranged from 21 to 50 days, becoming shorter under higher early-autumn temperatures, which produced weaker seedlings and reduced field establishment. Moderate temperature during nursery (26–29 °C) and at vegetative growth stage (13–17 °C minimum) during 2020–21 resulted in vigorous transplants and the highest leaf and seed yields, identifying the most favorable season. In contrast, 2022–23 proved to be inferior due to extreme spring temperatures exceeding 37 °C that induced premature bolting, shortened seed filling and markedly reduced both leaf and seed yield. Among genotypes, VRIL-0205 consistently performed best, exhibiting superior heat tolerance, yield stability and climate resilience. VRIL-0204 despite of high productivity was unacceptable due to its bitterness. Among different sowing windows, the second sowing (1–15 October) with transplanting during 8–30 November was most productive for both leaf and seed yield. Concisely, the sowing during first fortnight of October with transplanting 8–20 November ensured strong canopy growth and delayed bolting favored fresh-leaf production whereas, for seed production, sowing between 15 October and 5 November with transplanting 22 November to 12 December synchronized flowering and seed filling with favorable temperature regimes. Hence, the breeding for heat-tolerant genotypes, rising protected nurseries, use of mulch and precise irrigation during seed filling is strongly essential to sustain lettuce productivity under future climatic challenges in Punjab.

**Keywords:** Climate change; Lettuce; sowing time; Leaf yield; Seed yield.

**RAPS-25-18: Effect of Gamma Amino Butyric Acid on Quinoa  
(*Chenopodium Quinoa* Willd.) Under Salinity Stress**

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The major environmental problem is soil salinity which affects plant nourishment and development and limits plant productivity. Soil salinity leads to decline in crop production around the globe. The quinoa plant, *Chenopodium quinoa* Willd., is a member of family *Amaranthaceae* is a halophyte with high nutritional value. Gamma Amino Butyric Acid is plant growth regulator that reduces the effects of abiotic stress, especially salt-stress. GABA promotes physiological and biochemical processes of plants. This research conducted for the effects of Gamma Amino Butyric Acid on morpho-physiochemical attributes of four varieties of quinoa JQH1, JQH2, JQH3 and Q30 under salinity stress. A sand culture experiment was done in the wire house. Experimental design was Completely Randomized Design (CRD) that had three replicates. The pot method used to check the effects of GABA on germination, growth, morphological, physiochemical and yield attributes of the plant. Based on the results, GABA at 2mM<sup>-1</sup> concentration play important role in improving some of the morphological, physiochemical, and yield attributes of quinoa under 300mM salt stress. There was decrease in overall growth of plant under salt stress in all varieties. Foliar application of GABA improves the plants growth and yield attributes in both control and stress conditions. GABA treatment was evidenced as effective application to grow quinoa under salt stress. According to statistical analysis and comparison of graphs results showed that quinoa has great potential to grow under salt stress and results are improved with exogenous application of GABA. However, JQH1 showed better growth as compared to other three varieties of quinoa JQH2, JQH3 and Q30. So, quinoa can be used as salt tolerant crop and yield, improved with exogenous use of GABA to achieve desirable production.

**Keywords:** Soil salinity, GABA, Quinoa, Salt stress tolerance, Growth regulator

## **RAPS-25-19: Potato Dry Peels Mediated Amelioration of Salinity Stress in Multiple Sunflower Hybrids**

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Soil salinization, a major consequence of climatic fluctuations, severely impairs crop productivity by disrupting plant growth, biochemical, and physiological processes. Potato peels, a bio-waste product, contain potent bioactive compounds, particularly phenolics and antioxidants, that can mitigate the effects of abiotic stress. However, their contribution to the regulation of photosynthetic pigments, antioxidant defense, reactive oxygen species (ROS) metabolism, and ion balance during salinity conditions is largely unidentified in the hybrids of sunflower (*Helianthus annuus* L.). Five hybrids (FH-741, FH-780, FH-793, FH-800, and FH-804) were examined by treating them to 150mM NaCl stress, followed by treatment with potato dry peels. Salinity significantly inhibited plant growth, relative water content, pigment concentration, and nutrient uptake, and caused excessive Na<sup>+</sup> accumulation and oxidative stress, as revealed by high malondialdehyde (MDA) and hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) levels. Even though salt stress marginally increased the antioxidant and osmolyte activity, potato peel application additionally enhanced the defense mechanisms and inhibited oxidative damage, and enhanced physiological performance. The treated plants had increased relative water content, enhanced photosynthetic pigments, and recovered mineral uptake, which eventually increased growth, especially in the hybrids FH-780 and FH-800. These findings reveal the ability of Potato Dry Peels to sustain the salinity tolerance of sunflower by modulating key mechanisms, thereby representing a sustainable approach to mitigating salt stress in agricultural systems

**Key words:** Climate Change, Salinity, Potato Dry Peels, Sunflower Hybrids

## **RAPS-25-20: Investigating Eco-Friendly Nanoparticle Approach for the Management of Fusarium Wilt with Reduced Synthetic Pesticide Dependency**

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Tomato as a perishable crop has become a successful model plant to investigate the initiation of defense pathways after exposure to disease agents which act as a trigger for resistance mechanisms. The current investigation was aimed at the green synthesis of nanoparticles to induce resistance in tomato plants against fusarium wilt. Green synthesized nanoparticles i.e., MA-AgNPs, CF-CuONPs and BC-IONPs were characterized and used to investigate the in vitro and in vivo antifungal activity at various concentrations. In-vitro antifungal potential of all three types of nanoparticles expressively inhibited mycelial growth and spore germination of *Fusarium oxysporum* f.sp. *lycopersici* in a dose-dependent manner. The highest percentage inhibition in mycelial radial growth ( $96.8 \pm 0.23\%$ ) and decline in spore germination rate (4.67%) was observed at 140  $\mu\text{g/mL}$  of MA-AgNPs in contrast to the control and fungicide treatment. Monographs of the scanning electron microscope revealed the ultrastructural changes in fungal hyphae. DCFH-DA fluorescence revealed ROS accumulation in fungal mycelium by showing strong green colour after treatment with NPs however, insignificant to very weak fluorescence was observed in control samples. Each type of nanoparticle was further characterized to get information about wavelength range, functional nature, crystallographic structure, size, shape and stability. The microwave- assisted MA-AgNPs showed a peak at 434 nm by using 5 mL of *M. azedarach* leaf extract and 2.5 mM of  $\text{AgNO}_3$  solution at pH 8, exposed to 30 s of microwave irradiations. MA-AgNPs indicated stability even after six months. Spherical shaped nanoparticles ranged from 12–46 nm were confirmed by X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM) analysis. MA-AgNPs indicates the negative zeta potential of -22.3 mV. In addition, uptake of these nanoparticles did not show any visible sign of toxicity on plant yield and productivity. The metal concentration checked in edible parts was found in permissible limits.

**Keywords:** nanotechnology, nanoparticles, nanopesticides, plant pathology

**RAPS-25-21: Unveiling the Diversity, Culturability, and Preliminary Cultivation Trials of *Morchella* Species from Kaghan Valley, Pakistan.**

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*Morchella* species, commonly known as morels, are seasonal ascomycetous mushrooms highly valued for their nutritional and medicinal benefits and high market demand. During a survey of morels in the Kaghan Valley, Pakistan, 50 specimens of the genus *Morchella* were collected. Macro-, micro-, and molecular analyses identified nine distinct species: *M. palazonii*, *M. galilaea*, *M. crassipes*, *M. tridentina*, *M. semilibera*, *M. vulgaris*, *M. eohespera*, *M. pakistanica*, and *M. conica*. Among these, *M. semilibera*, *M. vulgaris*, and *M. eohespera* are reported for the first time from Kaghan Valley, enriching Pakistan's edible mushroom diversity. Two species, *M. palazonii* and *M. crassipes*, were selected for cultivation trials, as morel cultivation remains limited worldwide, with only a few species grown commercially in China and the USA. Five nutrient agar media were tested at various temperatures to evaluate culturability. Pine Extract Agar (PEA) proved the most effective for both species. *M. crassipes* exhibited notable sclerotia formation on PEA and MEA, while *M. palazonii* did not form sclerotia on any medium. Optimal growth temperatures were 20°C for *M. crassipes* and 25°C for *M. palazonii*. Spawn production was tested on sorghum, wheat, and barley grains. *M. palazonii* showed rapid mycelial growth on sorghum, whereas *M. crassipes* performed best on wheat, with visible sclerotia in all trials. Reproductive potential was evaluated using exogenous nutritious bag technology with soil-based substrates supplemented with lignocellulosic residues. Both species showed excellent spawn running on soil mixed with pine needles. Notably, *M. crassipes* produced a single fruiting body on soil+ pine needles substrate at 20°C and 90% humidity.

**RAPS-25-22: Integrative Application of Melatonin, Copper Nanoparticles, and *Bacillus velezensis* Enhances Chili Resilience against Anthracnose and Micro plastic Stress: An Eco-Innovative Approach for Climate-Smart Agriculture**

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Climate-induced biotic and abiotic stresses increasingly threaten global food security, fungal diseases and emerging microplastic pollution posing serious risks to sustainable crop production. This study introduces an eco-innovative approach integrating melatonin (MT; 100  $\mu$ M), copper nanoparticles (CuNPs; 75 mg L<sup>-1</sup>), and *Bacillus velezensis* (10<sup>8</sup> CFU mL<sup>-1</sup>) (collectively termed MCB) to mitigate anthracnose disease caused by *Colletotrichum capsici* in chili under microplastic (MP) stress. The synergistic MCB treatment significantly suppressed fungal growth by disrupting pathogen membrane integrity and reducing disease severity. Concurrently, it restored plant physiological and biochemical performance impaired by MP and pathogen stress. MCB application enhanced chlorophyll and photosynthetic efficiency, regulated hormonal balance, upregulated defense-related genes, and boosted antioxidant and lignin biosynthesis while minimizing oxidative damage. Moreover, suppressed mineral nutrition and secondary metabolite synthesis were markedly improved. The findings highlight a novel, climate-resilient strategy that merges biomolecular signaling, microbial biocontrol, and nanotechnology for sustainable crop protection under complex environmental pressures. This integrative framework aligns with climate-smart and resource-efficient agriculture to strengthen food system resilience in vulnerable regions. Keywords: micro plastics, sustainability, microbial biocontrol, climate resilience

**RAPS-25-23: 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 H<sub>2</sub>O<sub>2</sub> 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*.

**Keywords:** Salicylic acid, Jasmonic acid, synergistic effect, Gene expression, *Spodoptera frugiperda*

**RAPS-25-24: Integrative Morphological and Molecular Characterization of *Marasmius pseudojasminodorus* (Marasmiaceae) from Lahore, Pakistan**

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The genus *Marasmius* (Marasmiaceae) represents one of the most species-rich lineages of saprotrophic agarics, widely distributed and commonly abundant in leaf-litter and decomposing plant debris worldwide. *Marasmius pseudojasminodorus* (Marasmiaceae) was collected from a graveyard locality in Lahore, Punjab, Pakistan. An integrated morphological and molecular characterization was performed, combining detailed macroscopic and microscopic observations with phylogenetic analyses of the nuclear ribosomal internal transcribed spacer region (nrITS). Macromorphologically, basidiomata were small to medium with a striate, rugulose pileus (brown-orange to copper-red), white, subdistant lamellae, and a slender, wiry stipe. Specimens occurred solitary to scattered on leaf litter and decomposing organic matter during the post- monsoon season. Measurements of basidiospores, basidia, and cystidia were recorded and compared with type material and published descriptions. Phylogenetic analyses of nrITS sequences placed the specimens within *Marasmius* section *Sicci* and supported their conspecificity with *M. pseudojasminodorus*. Voucher specimens and nrITS sequences are archived as reference material for future studies. These records document the confirmed occurrence of *M. pseudojasminodorus* in the Lahore region and underscore the value of combined morphological and molecular approaches for accurate identification in marasmioid fungi. The dataset provides a reference for regional mycologists and contributes baseline biodiversity records for urban ecosystems; continued surveys and expanded molecular sampling will clarify local distribution and ecological preferences.

**Keywords:** *Marasmius pseudojasminodorus*; Marasmius; Marasmiaceae; Morphology; nrITS; Molecular phylogeny; Urban biodiversity.

**RAPS-25-25: Production and Purification of Extracellular Laccase from *Amylosporus sp.* and its Application in Azo Dye Decolorization**

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This study reports *Amylosporus succulentus*, a relatively underexplored white-rot fungus, as a novel source of laccase enzyme with significant potential for azo dye decolorization. The mushroom sample was collected from decaying log in a moist, shaded area. Phylogenetic analysis confirmed its identity as *A. succulentus*. Pure cultures were maintained on potato dextrose agar and used for enzyme production through liquid state fermentation in Kirk and Tien's medium. Laccase production was first confirmed using a guaiacol plate assay, and its activity was later measured on spectrophotometer at 470 nm against guaiacol. Optimization of physical and chemical parameters under liquid-state fermentation indicated that laccase production peaked on the 6th day of incubation at 35 °C, pH 5 with glucose, ammonium sulfate and wheat straw as optimal carbon and nitrogen sources. Laccase was further purified by ammonium sulphate precipitation, dialysis and ion exchange chromatography. SDS PAGE showed its molecular weight as 60KDa. The laccase enzyme was tested on azo dye Congo red under optimal conditions, achieving 78% decolorization. Laccase from *Amylosporus succulentus* exhibited a strong dye decolorization potential and stability across a broad range of temperature and pH levels for up to 12 days, indicating its potential for sustainable applications in bioremediation.

**Keywords:** *Amylosporus succulentus*; Laccase enzyme; Liquid state fermentation; Purification; Dye decolorization

## **RAPS-25-26: Salicylic Acid-Induced Modulation of Morphological and Biochemical Responses in *Brassica napus* L. under Cadmium Stress**

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Heavy metal pollution, particularly cadmium (Cd), poses a growing threat to sustainable agriculture and food safety. Among toxic metals, Cd is highly mobile, non-biodegradable, and easily accumulated in crop tissues, leading to oxidative damage, photosynthetic inhibition, and yield decline. *Brassica napus* L. (oilseed rape), a vital oilseed crop in Pakistan, is especially susceptible to Cd toxicity due to its high nutrient uptake potential and shallow root system. Even moderate Cd exposure disrupts chlorophyll synthesis, decreases root elongation, and induces oxidative stress through excessive reactive oxygen species (ROS) formation. The present study aimed to evaluate the mitigating effect of salicylic acid (SA) on the morphological and biochemical attributes of *B. napus* under Cd-induced stress. A greenhouse pot experiment was conducted with three Cd levels (100, 200, and 300 mg kg<sup>-1</sup>) applied alone or in combination with SA at 10 and 15 mg kg<sup>-1</sup>. After 15 days of germination, growth and biochemical parameters were recorded. Results revealed that increasing Cd concentrations caused a 25–50 % reduction in germination, 44–97 % decline in root biomass, and a marked decrease in shoot growth compared with control plants. Cd stress also enhanced the activity of antioxidant enzymes catalase (CAT), peroxidase (POX), and polyphenol oxidase (PPO) by approximately 3-fold ( $\approx 273$  %), indicating severe oxidative stress. Conversely, the exogenous application of SA significantly alleviated Cd toxicity. SA-treated plants exhibited 70–100 % germination, a twofold increase in root and shoot growth, and a 50 % reduction in oxidative enzyme activity compared with Cd-stressed plants. Furthermore, SA application improved the tolerance index (TI) by 70–90 %, reflecting enhanced physiological resilience. Plants receiving both SA and Cd treatments maintained better chlorophyll content, membrane stability, and visible health compared to Cd-only treatments. In conclusion, salicylic acid effectively mitigates Cd-induced morpho-biochemical damage in *B. napus* by regulating the antioxidant defense system, maintaining redox homeostasis, and promoting growth recovery. SA thus represents a cost-effective and eco-friendly approach for improving heavy metal tolerance and sustaining oilseed productivity in contaminated soils.

**Keywords:** *Brassica napus*, cadmium toxicity, salicylic acid, antioxidant enzymes, morphological attributes.

**RAPS-25-27: Integrated Application of PGPR and Iron Oxide Nanoparticles to Mitigate Drought Stress in *Pisum sativum* L.**

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Drought is a major environmental constraint that severely limits plant growth and yield. This study evaluated the combined effect of plant growth-promoting rhizobacteria (PGPR) and iron oxide nanoparticles on mitigating drought stress in *Pisum sativum* L. A pot experiment was conducted using a completely randomized design with three replicates, where drought stress was imposed by maintaining 50% field capacity. The bacterial suspension (80 ml) was inoculated into the soil, and seedlings were sprayed with iron oxide nanoparticles (50mg/l). The results showed that growth, physiological, and yield parameters were significantly decreased under drought stress. However, combined PGPR and iron oxide nanoparticle treatments enhanced biomass accumulation and photosynthetic efficiency of *P. sativum*. Antioxidant enzymes (peroxidase, superoxide dismutase, and ascorbate peroxidase), total soluble protein and proline contents also improved, while malondialdehyde (MDA) and hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) levels declined. It was concluded that PGPR and iron oxide nanoparticles can potentially mitigate the deleterious impacts of drought stress. In contrast to PGPR and iron oxide nanoparticles, ferric chloride produced the least effective response. Overall, PGPR and iron oxide nanoparticles synergistically improved drought tolerance and productivity of *P. sativum* under water deficit conditions.

**Keywords:** abiotic stress; growth; *Providencia vermicola*; sustainable agriculture

**RAPS-25-28: Synergistic Effects of Pseudomonas and Silver Nanoparticles to Mitigate Cadmium Toxicity in Wheat (*Triticum aestivum* L.)**

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Cadmium (Cd) is a toxic heavy metal that severely limits plant growth and agricultural productivity by disrupting key physiological and biochemical processes. This study assessed the role of silver nanoparticles (AgNPs) and plant growth-promoting rhizobacteria (PGPR) in alleviating Cd-induced stress in two wheat (*Triticum aestivum* L.) varieties, Sehar-2006 and Faisalabad-2008. Plants were grown under Cd stress (0, 1 mM, 2 mM) and treated with AgNPs (25 mg/L, 50 mg/L) and PGPR ( $5 \times 10^8$  CFU/g), individually and in combination. Cadmium exposure led to significant reductions in root and shoot length, fresh and dry biomass, and chlorophyll and carotenoid contents. Moreover, gas exchange parameters, antioxidant enzyme activities (SOD, POD, CAT, APX), and biochemical markers such as total soluble sugars, total free amino acids, proline, and total soluble proteins were adversely affected. Essential nutrient uptake (N, P, K) also declined under Cd stress. However, the application of AgNPs and PGPR, particularly when used together, significantly mitigated these negative effects. Treated plants showed notable improvements in growth, photosynthetic efficiency, antioxidant defense, and nutrient accumulation, indicating enhanced tolerance to cadmium toxicity. These results suggest that the combined use of AgNPs and PGPR is an effective strategy for improving wheat growth under cadmium stress, offering a promising approach for sustainable crop production in contaminated soils.

**Key words:** Wheat, Silver, rhizobacteria, Reactive oxygen species, Total soluble sugars

## **RAPS-25-29: Safeguarding Cotton plants from American bollworm using NPV technology**

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American bollworm (*Helicoverpa armigera* Hübner) is a major key pest that is destroying cotton crops worldwide, causing significant yield losses and threatening sustainable agriculture. The excessive and prolonged use of chemical insecticides to control this pest has led to resistance development and ecological imbalances. This study aimed to evaluate the insecticidal efficacy of a native isolate of *Spodoptera litura* nucleopolyhedrovirus (SpltNPV) and five commonly used insecticides, i.e., chlorantraniliprole, emamectin benzoate, bifenthrin, spinosad and chlorpyrifos, against second-instar larvae of *H. armigera*. All treatments were tested at four quantitative levels, and mortality data were analyzed using ANOVA ( $P < 0.05$ ), confirming a significant effect of treatments with a good model fit ( $\chi^2$  test,  $P > 0.05$ ). SpltNPV, chlorantraniliprole, emamectin benzoate and bifenthrin achieved  $> 50\%$  mortality and were categorized as effective, whereas spinosad and chlorpyrifos were less effective ( $< 50\%$  mortality after 72 h). Synergistic evaluation showed that SpltNPV combined with chlorantraniliprole (6:4 ratio) yielded the highest co-toxicity factor (35.90) and a synergistic index of 1.85. Enzymatic assays revealed no significant changes ( $P > 0.05$ ) in the activity of carboxyl esterases (CarE), glutathione S-transferases (GST), cytochrome P450 (CYP450) or acetylcholine esterases (AChE) following exposure to SpltNPV or combination treatments. These results suggest that SpltNPV is not targeted by the insect's detoxification pathways and can effectively integrate with selective insecticides, especially chlorantraniliprole.

**RAPS-25-30: 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:** alkaline stress, cytochrome, GsCYP82C4

## **RAPS-25-31: Response of Fiber and Floral Hemp under Different Water Regimes**

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Hemp (*Cannabis sativa* L.), is a multipurpose crop belongs to family Cannabaceae. Hemp, containing less than 0.3%  $\Delta^9$ -tetrahydrocannabinol (THC), is primarily cultivated for its fiber, seeds and medicinal properties. Present study was conducted to assess the effects of different water regimes i.e., 80%, 60%, and 40% field capacity regarded as FC80, FC60, and FC40 in two fiber i.e., *K-Jinma* and *K-Shama* and two floral i.e., *Auto-Tune* and *Auto-Pivot* type hemp cultivars. Data was recorded 15 and 30 days after water treatments (for fiber type), and 21 and 35 days after flowering (DAF) for floral type. Results revealed that different water levels affected differently to both hemp types. Plant height and stem diameter were substantially reduced at both 15 and 30 DAT whereas the root dry weight was significantly reduced at 30 DAT at FC40 as compared to FC80 for both fiber cultivars. Moreover, both types flower earlier at FC40 than FC60 and FC80 whereas non-retted yield was found statistically similar at all water levels. Interestingly, both fiber types were found non-complaint regarding THC contents (>0.3%) at all water levels. Regarding floral types, root dry weight, floral clusters per plant and floral yield was substantially reduced at FC40 than FC80 whereas the cannabidiol (CBD) and THC contents were remained statistically similar at all water levels for both cultivars. The cannabigerol (CBG) contents were statistically similar for *Auto-pivot* across all water levels, while reduced significantly at FC60 and FC40 for *Auto-tune* at 35 DAF. Overall, among all water levels, FC40 was found limiting regarding yield aspects, however CBD and THC were remained statistically similar at all water levels. Future studies should explore optimized irrigation strategies to improve productivity and cannabinoid yield in both hemp types within THC compliance.

**Keywords:** cannabidiol; floral yield; fiber, root dry weight  $\Delta^9$ -tetrahydrocannabinol

## **RAPS-25-32: Expression study of Newcastle virus gene in Chloroplast Vector**

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Newcastle Disease (ND) being a pathogenic viral sickness has resulted in a massive financial loss to fowl all around the world. Pakistan suffered a lack of Rs. 6 billion because of the outbreak of this lethal virus lower back in 2012. The available vaccines have been found to be insufficient owing to the least efficacy against local strain, multiple dosage requirement, and low reactivity in hot climates. In the current study, an attempt was made to develop an algae-based vaccine that is the most effective, cheaper, stable, and high-yielding vaccine against NDV genotype VII to fight deadly poultry infection. HN gene cloned in the chloroplast expression vector (pSRSapI) was taken from CEMB, repository. The recombinant plasmid HN-PSRSapI was transformed into an E. coli TOP10 host. The amplification of the HN gene size 2.1Kb by using gene-specific primers confirmed the successful transformation of the chloroplast expression vector (pSRSapI) into E. coli TOP10 host. Further confirmation of recombinant plasmid HN-PSRSapI was done by using restriction digestion Hind III site. The elution of fragment size 2.4Kb (2.1kb actual gene size 300bp vector having enzyme for digestion= 2.4Kb gene size) further confirm the transformation of recombinant plasmid HN- PSRSapI and presence of HN gene. After transformation molecular weight and quantity HN gene was determined by using western blotting. The resolution of protein size 69KDa in sodium dodecyl sulfate-polyacrylamide denaturing gel electrophoresis (SDS- PAGE) confirm the size of protein produced by HN gene. Chloroplast vector with maximum expression protein will be transformed in algae *C. reinhardtii* to produce edible vaccine.

**RAPS-25-33: Use of Geographical Information Techniques and Statistical Analysis: to Access Flora and Quality of Soil in Kinnaird College, Lahore**

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The distribution of vegetation species and soil characteristics play a fundamental role in controlling local biodiversity and ecological processes in small areas, such as educational campuses. At Kinnaird College for Women, an environmental survey was conducted to record the presence of plant species and investigate the basic chemical properties of soils in different areas of the campus. The primary aim was to create a map using Geographic Information System (GIS) software, specifically ArcMap, with coordinates obtained from GPS. This mapping facilitates a visual representation of the locations of plant species within the campus. Soil samples were collected from distinct zones surrounding the college. Standard digestion procedures and pH testing were performed to analyze the acidity or alkalinity of the soil samples. Focusing on these two variables, the soil analysis served as a crucial standard for comparing the chemical conditions that can affect plant growth and diversity. By integrating GIS-based mapping with soil data, this study enhances our understanding of the interaction between vegetation and soil characteristics at a micro-ecological level. The significance of this research lies in its interdisciplinary approach, merging spatial technology with environmental science to document and assess the natural features present in an urban educational environment. This baseline data not only facilitates future monitoring of biodiversity and ecological planning but also promotes sustainable landscaping. The study illustrates the application of GIS in botanical research and provides a reproducible model for similar evaluations in other institutions.

**RAPS-25-34: Impact of Various Plant Growth Regulators on *In Vitro* Callogenesis in *Solanum melongena***

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*Solanum melongena*, an important species of the Solanaceae family, is cultivated in several areas of the Pakistan. This study aim to examine the impact of certain plant growth regulators (PGRs) like NAA, BAP, KIN, IAA and GA3, on the induction of *in vitro* callus in *Solanum melongena*. These PGRs were introduced to the MS at various concentrations of (0.1, 0.2, 0.3, 0.4 and 0.5mg/L), individually or in combination. That is, NAA remained at 0.5mg/L together with BAP, and KIN remained at 0.5 mg/L together with IAA. The highest callus formation was recorded at 0.5mg/L for both NAA and KIN. In contrast, BAP (0.3-0.5mg/L) was best forming active callogenesis, IAA supported moderate callus initiation, and GA3 showed moderate callus production at higher concentrations. Of the explant type used, cotyledonary node and nodal segments responded much better, allowing callus initiation in 7-15 days followed by the emergence of shoots in 18-22 days. These results highlight the unique significance of optimizing PGR levels to achieve the maximum *in vitro* regenerative potential of *Solanum melongena*.

### **RAPS-25-35: Propagation of *Stevia Rebaudiana Bertoni* by Using Different PGRs Under *In Vitro* Condition**

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This thesis investigated the influence of different concentrations of GA3 and IBA on the morphological parameters of in vitro cultivated *Stevia* plants. Multiplication of plants involved culturing apical parts and nodes on MS basal media, followed by sub culturing on treatment media with nine different combinations of PGRs. After 15 and 30 days of growth, measurements were taken for shoot length, root length, number of leaves, number of nodes, dry weight, wet weight and total length. Results showed that IBA positively affected leaf and node development with treatment T4 (1.0 ml IBA) demonstrating the highest number of leaves and nodes after 15 days and treatment T3 (0.5 ml IBA) showing the highest number of leaves and nodes after 30 days. Results revealed that treatment T4 (1.0 ml IBA) yielded the maximum number of leaves and nodes after 15 days, treatment T3 (0.5 ml IBA) demonstrated the maximum number of leaves and nodes, whereas the control treatment (T0) without added hormones showed the minimum number of leaves and nodes. Regarding shoot length, root length and total length, treatment T3 (0.5 ml IBA) yielded the maximum shoot length, whereas treatment T1, 0.5 ml GA3, showed the minimum shoot length. The maximum root length was observed in treatment T3 with 0.5 ml IBA, while the minimum root length was observed in treatment T1 with 0.5 ml GA3. Treatment T3 resulted in the maximum total length of *Stevia* plants, while treatment T1 exhibited the minimum total length. In terms of wet weight and dry weight, treatment T3 (0.5 ml IBA) displayed the maximum wet weight and dry weight, whereas treatment T5 (0.5 ml GA3 and 0.5 ml IBA) showed the minimum wet weight and dry weight. Overall, these findings provided valuable insights into the effects of GA3 and IBA concentrations on the morphological parameters of in vitro grown *Stevia* plants. The findings highlight the potential for optimizing the growth and development of *Stevia* plants through the judicious use of specific hormone combinations, offering promising prospects for their cultivation under field conditions.

**Keywords;** *Stevia* plant In vitro cultivation, Plant Growth Regulators

**RAPS-25-36: Effect of Pseudomonas on Physiological and Biochemical Attributes of Canola (*Brassica napus L.*) under Cadmium Stress**

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Cadmium (Cd) pollution presents a great threat to crop productivity and food safety because it is phytotoxic and affects plant development, physiology, and biochemical processes. This research examines the influence of *Pseudomonas* spp. on reducing the deleterious effects of cadmium stress on two canola varieties, Punjab Canola and Faisal Canola (*Brassica napus L.*). The experiment tested a set of morphological, physiological, and biochemical parameters under cadmium stress conditions (15 ppm and 30 ppm) with and without bacterial inoculation at two different doses. The results indicated that cadmium stress exposure resulted in the reduction of important growth parameters of canola genotypes, such as shoot and root growth and overall biomass. Physiological traits such as photosynthesis rate, stomatal conductance, transpiration rate, and chlorophyll content were also inhibited. Biochemical indicators such as proline content, total soluble sugars, proteins, and activity of antioxidant enzymes revealed significant stress-induced fluctuations, indicating the functioning of stress response mechanisms. However, inoculation with *Pseudomonas* greatly ameliorated the harmful impacts of cadmium, especially at high concentrations. Bacterial treatment improved nutrient uptake (nitrogen, phosphorus, and potassium), enhanced photosynthesis efficiency, and regularly normalized biochemical indicators. Punjab Canola was observed to bear a better adaptive response than Faisal Canola, and this reflects genotype-specific tolerance supported by microbial interaction. Overall, the current study underscored the utility of *Pseudomonas* as a biological agent for enhancing heavy metal stress tolerance in plants. The findings suggest potential applications in sustainable agriculture, particularly in places with soil contamination problems. The employment of plant growth-promoting bacteria (PGPB) such as *Pseudomonas* offers a viable alternative for soil reconditioning and the amelioration of crop yield reduction under conditions of environmental stress.

**Keywords:** *Pseudomonas*, stomatal conductance, transpiration rate, Canola

### **RAPS-25-37: Exogenous Nano-Zinc Sulfide Mitigate Cadmium Stress in Maize (*Zea mays* L.)**

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Zinc sulfide nanoparticles (nZnS) were prepared by co-precipitation method to assess its potential in mitigating cadmium (Cd) toxicity in maize (*Zea mays* L.). For this purpose, the nZnS was exogenously applied (0 and 50 mg/L) to Cd-stressed (0 and 1 mM CdCl<sub>2</sub>) maize plants and changes in growth, physiological and biochemical traits were studied. Exposure to Cd reduced Zn contents in shoot which was recovered in response to nZnS treatments. Moreover, the nZnS also promoted recovery in total chlorophyll, soluble proteins and phenolic contents ultimately contributing to growth recovery under Cd stress. In addition, the root zone nZnS treatments also enhanced shoot Cd fraction by 44% which can be explained based on the potential synergistic effects likely due to Cd/Zn homeostasis supported by sulfur supply. Above all, our results indicated that nZnS could improve maize tolerance to Cd stress through regulation of heavy metal detoxification pathways.

**Keywords:** Cadmium; Heavy metals; Maize; Phytoremediation; Zinc sulfide; Nanoparticles

**RAPS-25-38: Ethnobotanical Study, Phytochemistry and Phytosociological Study of the Vegetation from Sadpara Valley of District Skardu, Gilgit-Baltistan**

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The present study, conducted from 2023 to 2024 in Sadpara and Deosai valleys of Skardu, Baltistan, offers a comprehensive exploration of floristic diversity, phytosociological attributes, and bioassays involving two specific plant species: *Aconitum heterophyllum* from the Ranunculaceae family and *Arnebia euchroma* from the Boraginaceae family. In Sadpara valley, documented 141 plant species, spanning 109 genera and 49 families. These species encompassed herbs, shrubs, and trees. The Asteraceae family emerged as the most prominent, boasting 18 species, followed closely by the Rosaceae family with 13 species. Notably, both the Ranunculaceae and Polygonaceae families were well-represented, each with 8 species. Additionally, there were 7 species from the Fabaceae and Lamiaceae families, while Brassicaceae, Caryophyllaceae, and Salicaceae each featured 5 species. The traditional knowledge acquired from the local community revealed the diverse uses of different plant parts for treating various health issues, with whole plants, flowers, leaves, roots, fruits, stems, seeds, and branches featuring prominently. These were employed through different methods, including decoctions, pastes, and powders, to address ailments such as fever, cough, asthma, digestive disorders, stomach pain, and heart disease. Phytosociological studies revealed the most dominant species in Deosai valley, where *Leontopodium alpinum* (17.98 IVI), *Aconitum heterophyllum* (15.15 IVI), and *Nepeta discolor* (12.66 IVI) took the top positions. In Sadpara valley, *Juniperus excelsa* (66.35 IVI), *Eleagnus angustifolia* (55.78 IVI), and *Hippophae rhamnoides* (23.61 IVI) emerged as the primary species. Furthermore, the study included bioassays that examined the antibacterial, antifungal, and antioxidant properties of *Aconitum heterophyllum* and *Arnebia euchroma*. *Aconitum heterophyllum* exhibited noteworthy antibacterial activity, with the highest inhibition against *Staphylococcus aureus* (57%) and reasonable inhibition against *E. coli* (45%), *Bacillus subtilis* (38%), and *Pseudomonas aeruginosa* (23%). In contrast, it did not show significant inhibition against *Salmonella typhi*. *Arnebia euchroma* also displayed substantial antibacterial activity, with a 62% inhibition against *E. coli* and 51% against *Staphylococcus aureus*. In antifungal assays, *Aconitum heterophyllum* demonstrated strong inhibition, with the highest percentage (50%) against *Fusarium lini*, followed by 47% inhibition against *Aspergillus fumigatus*, 45% against *Aspergillus niger*, 33% against *Microsporum canis*, and 28% against *Candida glabrata*. *Arnebia euchroma* exhibited remarkable

antifungal activity, with 58% inhibition against *Fusarium lini*, 51% against *Microsporium canis*, and 47% against *Aspergillus niger*. This comprehensive study provides a valuable baseline for understanding the rich plant diversity in the region, the ethnobotanical practices of the local community, and the promising medicinal properties of *Aconitum heterophyllum* and *Arnebia euchroma*. It underscores the importance of conservation efforts to preserve these botanical treasures for future generations through sustainable utilization.

### **RAPS-25-39: Influence of Fresh and Dried *Avena fatuva* Leaf Extracts on Various Wheat Cultivars**

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Plant invasions pose a significant threat to global biodiversity and economic sustainability. Allelopathy is recognized as a crucial mechanism through which these invasive plants adversely affect native flora and fauna. This study aimed to investigate the effects of fresh and dry leaf aqueous extracts of *Avena fatua* on two wheat varieties. Two wheat varieties (Ujala and Arooj, referred to as WV I and WV II, respectively) were selected to assess the impact of *A. fatua* on germination and growth parameters. Mature, healthy fresh leaves of *A. fatua* were collected, and solutions of 25% and 50% concentrations were prepared. For the dry leaf solutions, leaves were air-dried at room temperature in the shade, and similar concentrations were prepared. Ten sterilized, viable seeds per petri plate were randomly placed, and the prepared leaf solutions (25% and 50%) were added to the plates. Distilled water was used as the control treatment. Data on germination and growth parameters were recorded. Significant reductions ( $p < 0.05$ ) in germination, plumule, and radicle growth were observed with increasing extract concentrations. The dry leaf extract caused more inhibition (50%) in all parameters compared to the fresh leaf extract. The results indicate the inhibitory effects of crofton weed leaf extracts, likely due to allelopathic compounds in the leaves, which may act independently or in combination to inhibit plant growth. Wheat variety Ujala showed higher tolerance to the allelopathic effects of *A. fatua* leaf extracts, making it more resilient to allelopathic stress. Future research should explore the potential use of *A. fatua* leaf extracts in sustainable weed management strategies and evaluate their broader ecological impacts under field conditions.

**Key words:** Aqueous extract, Germination, Growth, Inhibition, rice Wheat varieties.

## **RAPS-25-40: CRISPR-Cas9–Mediated Genome Editing of Potato for Trait Improvement, Biofortification, and Disease Resistance**

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Potato (*Solanum tuberosum*) is a globally important staple crop that faces challenges related to post-harvest quality, nutritional deficiencies, and disease susceptibility. This study employs CRISPR/Cas9 genome editing to enhance a local potato cultivar across three major dimensions—trait improvement, biofortification, and disease resistance. To improve storage and processing quality, the vacuolar invertase (VInv) gene was knocked down using dual sgRNAs, achieving 11.7% transformation efficiency and 25.6% overall editing efficacy. Edited lines (B4 and T12) exhibited a 90–99-fold reduction in VInv transcript levels, leading to a fivefold decrease in reducing sugars following cold storage. This marks the first successful mitigation of cold-induced sweetening in Pakistani potato cultivars, substantially improving chip processing quality. Nutritional enhancement was achieved through targeted biofortification of provitamin A and vitamin D pathways. A multiplexed CRISPR/Cas9 approach against  $\beta$ -carotene hydroxylase (BCH) enhanced provitamin A content, with 15% transformation efficiency, 92% indel efficacy, and 89-fold transcript reduction. HPLC confirmed a fourfold increase in  $\beta$ -carotene levels (0.11–0.36 mg/mL vs. 0.09 mg/mL in controls). In parallel, knockout of sterol delta-7-reductase (SD7R) achieved transformation efficiencies of 19.6% and 27.2% with 89–98% downregulation, suggesting elevated 7-dehydrocholesterol accumulation and potential vitamin D3 enhancement. For disease resistance, CRISPR-mediated disruption of susceptibility genes provided promising outcomes. Knockout of DMR6 and ERF3 yielded 10.7% transformation efficiency and up to 340-fold reduction in DMR6 expression, indicating potential resistance to *Phytophthora infestans* (late blight). Editing of CYP94A2 and NAC103 enhanced cutin and suberin biosynthesis to counter *Streptomyces scabies* (common scab), with 29% transformation efficiency. Pathogen characterization identified virulent *Streptomyces* isolates for future bioassay validation. Collectively, these genome-edited potato lines display improved storage stability, enhanced nutritional profiles, and potential disease resistance while maintaining physiological performance. The work demonstrates CRISPR/Cas9's precision and versatility in way forward towards development of potato varieties with reduced post-harvest losses and improved disease resistance and nutritional attributes.

**Key Words:** Genome Editing; Potato; Biofortification; Disease, Cold Induced sweetening.

### **RAPS-25-41: Genome Editing for Food and Nutritional Security**

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CRISPR-based genome editing offers a precise approach for improving crop traits critical to agriculture. In this study, CRISPR technology was employed to enhance grain quality in rice by targeting genes involved in starch biosynthesis and grain composition. Edited lines exhibited improved nutritional profiles and cooking characteristics. In canola, targeted modification of the *acetolactate synthase (ALS)* gene conferred resistance to ALS-inhibiting herbicides, enabling more effective weed control. Furthermore, rice lines tolerant to heavy metals were developed through editing of genes involved in metal uptake and detoxification pathways. These results demonstrate the potential of CRISPR to generate crop varieties with improved grain quality, herbicide resistance, and tolerance to environmental stressors, contributing to sustainable crop production.

**Keywords:** CRISPR genome editing; Rice grain quality; Herbicide resistance; ALS gene; Heavy metal tolerance

**RAPS-25-42: Unlocking the Protective Potential of Melatonin against Cadmium Stress in Fennel (*Foeniculum vulgare* L.)**

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Fennel (*Foeniculum vulgare* L.), a member of the Apiaceae family, is an important oilseed crop valued for its high-quality edible oil and protein-rich residue used in animal feed. Although fennel shows moderate tolerance to heavy metal stress, excessive concentrations of soluble metals severely impair its growth and yield, particularly in arid and semi-arid regions. In recent years, the productivity of fennel has declined due to increasing heavy metal contamination. Various cost-effective and eco-friendly strategies have been explored to alleviate such environmental stresses, including the use of plant growth regulators. Among these, melatonin (MT), a naturally occurring plant hormone, plays a crucial role in enhancing plant tolerance by promoting flowering, improving nutrient uptake, stimulating photosynthesis, and regulating enzymatic activity. A pot experiment was conducted in the Department of Botany, Baghdad-ul- Jadeed Campus, The Islamia University of Bahawalpur, to evaluate the influence of foliar-applied melatonin on two fennel varieties exposed to cadmium nitrate stress. Seeds of the CIDS and AARI varieties were obtained from the Ayyub Agricultural Research Institute, Faisalabad. Two cadmium levels (0 and 100  $\mu\text{M}$  Cd (NO<sub>3</sub>)<sub>2</sub>) and three melatonin concentrations (0, 15, and 30  $\mu\text{M}$ ) were applied in a completely randomized design with three replicates. Cadmium stress significantly reduced root and shoot growth, biomass, and photosynthetic pigments. However, melatonin treatments mitigated these adverse effects by enhancing both enzymatic (POD, SOD, CAT) and non-enzymatic antioxidant defenses and improving K<sup>+</sup> and Ca<sup>2+</sup> uptake. Overall, melatonin application effectively minimized the toxic impact of cadmium and promoted fennel growth and physiology. The CIDS variety outperformed AARI, while the 15  $\mu\text{M}$  melatonin treatment proved most effective in reducing heavy metal toxicity.

**Keywords:** Fennel, Melatonin, Cadmium, Antioxidants, Ions

**RAPS-25-43: Rutin, A Dual Molecule That Enhances Drought Tolerance and Reduces Oxidative Stress in Soybean Via a Complex Phytohormonal Pathway**

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The study aims to highlight cutting-edge research and transformative innovations in plant sciences that address climate resilience, food security and sustainable development goals. One of the primary abiotic stresses that has worsened because of population growth and climate change is drought. One promising strategy involves the use of bioactive compounds like Rutin (Rut), a natural flavonoid known to promote plant development and enhance antioxidant activity. This research explored the impacts of Rutin in soybean plants under drought conditions. Rutin concentration was optimized through seed priming, showing improvements in fresh biomass, total length, and stem thickness compared to both negative and positive controls. 8 treatments with PEG 6000 concentrations of 20%, 40%, and 60%, with or without Rut, were evaluated over 21 days. Results indicated that Rut + PEG treatments significantly enhanced seedling growth compared to PEG-only treatments. SOD, APX, and CAT antioxidant enzyme activity also increased in rutin-treated plants, including spectral indices suggesting improved redox balance under stress conditions, and ABA levels showed significant reductions in rutin-treated plants. Overall, the combination of Rut and PEG improved soybean drought tolerance and seedling development, emphasizing the possibilities of applying exogenous rutin in a sustainable way to mitigate drought stress effects to enhance crop performance.

**Keywords:** Rutin, drought stress, soybean, seed priming, ROS, antioxidants, ABA.

## **RAPS-25-44: Role of Fulvic acid, Seaweed Extract and Plant Based Amino Acids in Enhancing Yield and Quality of Cabbage**

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Biostimulants have emerged as sustainable alternatives to synthetic agrochemicals for improving crop productivity and metabolic efficiency. This study evaluated the effects of foliar application of fulvic acid (FA), brown algal extract (BAE), and plant-based amino acids (AA) on the growth, physiological, biochemical, and metabolic responses of cabbage under a completely randomized design (CRD). All treatments significantly improved plant yield compared to the control, with AA producing the greatest enhancement in morphological and physiological traits. FA application notably elevated protein synthesis, antioxidant enzyme activity, and chlorophyll accumulation, indicating its role in enhancing cellular metabolism. The application of GC-MS-based metabolic profiling gave a complex and accurate overview of changes in biochemicals that were produced by each biostimulant, and individual metabolites that were related to improved growth and quality of plants could be identified. Results revealed that metabolic processes were altered due to FA, BAE, and AA treatment, which makes this study unique because it can correlate physiological reactions with biochemical indications. The mechanism of action of biostimulants at a molecular level, which was contrasted with standard agronomic analysis and increased the strength and innovation of the results. Shelf-life evaluation showed that post-harvest quality was maintained longer in AA-treated plants, with greener, firmer, and more compact heads, followed by BAE, while control heads decayed rapidly. FA-treated plants recorded the highest crude protein (24.73%), ash (11.06%), and fats (4.55%); AA treatment led to maximum crude fiber (24.68%), while BAE-treated plants showed the highest nitrogen-free extract (NFE) (45.42%). Overall, the foliar application of FA, BAE, and AA not only improved the growth and biochemical quality of cabbage but also modulated its metabolome, demonstrating their potential and sustainable tools for metabolic enhancement in vegetable production.

**Keywords:** fulvic acid; seaweed extract; plant-based amino acids; biostimulants; metabolomics profiling; sustainable agriculture.

**RAPS-25-45: *Acanthophyllum squarrosum* Boiss.: A  
Phytochemical Reservoir with The Antimicrobial and  
Pharmacological Potential**

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*Acanthophyllum squarrosum* Boiss. is an ethnomedicinal plant, rich in triterpenoid saponins, and traditionally used for gastrointestinal disorders, urinary problems, as cleansing, and foaming agents in medicinal and industrial applications. This study provides a phytochemical and pharmacological evaluation of a methanolic (MeOH) extract from aerial parts of *Acanthophyllum squarrosum*. FTIR spectroscopy confirmed the presence of functional groups indicative to alcohols, phenols, alkanes, esters, and aromatic moieties, demonstrating the existence of bioactive metabolites within the extract. GC-MS profiling revealed 35-phytoconstituents, with 4-O-methylmannose (31.08%), and oleic acid (19.12%) as the major components. Phytochemical quantification revealed high total phenolic content (172.8 mg GAE/g), and total flavonoid content (134.4 µg QE/mg). The MeOH extract demonstrated significant in- vitro antioxidant capacity across multiple assays (TAC, TRP, DPPH, ABTS, and metal- chelation). Furthermore, it exhibited notable enzyme inhibition activity against alpha- amylase (antidiabetic), lipase (anti-obesity), and urease (anti-ulcer) assays. Antimicrobial evaluation revealed broad-spectrum antibacterial activity, which was more potent than its antifungal effects. These comprehensive results validate the traditional uses of *A. Squarrosum* and underscore its potential for bioactivity-guided isolation of novel therapeutic

**Keywords:** *Acanthophyllum squarrosum*; Antimicrobial Activity; FTIR spectroscopy; GC-MS profiling and Pharmacological potential.

**RAPS-25-46: *Lycium RIN* negatively modulate the biosynthesis of kukoamine A in hairy roots through decreasing thermospermine synthase expression**

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Root bark (*Lycium* cortex) of *Lycium* contains 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 Solanaceae fruit ripening. However, the role of RIN in the biosynthetic pathway of KuA in *Lycium* remains 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 *Lycium RIN*, increased the contents of both KuA and KuB in *L. chinense* hairy 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 *Lycium* species.

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

**RAPS-25-47: Genome Wide Identification and Expression Analysis of Kinase Proteins in Land Plants and their Expression in *Gossypium hirsutum* under Salt Stress**

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The kinase proteins are a superfamily in plants and are involved in diverse biological and molecular functions for the better adaptation of land plants. The current study aims to provide a comprehensive structural evolutionary study of kinases in land plants, with an environmental stress-responsive study in angiosperms. The study identified a total of 49,611 genes in 32 land plants across mosses, bryophytes, lycophytes, gymnosperms, and angiosperms. All identified genes were classified into 26 major classes (I-XXVI) based on domain architectures e.g. protein-kinase tyrosine (Pkt), leucine-rich repeat (LRR), LRR-protein kinases (LRR-Pk), LRR-Pk tyrosine kinases (LRR-Pkt), and protein kinase (Pk) and the X domain representing other than the listed domains. RNA-seq based expression profiling under biotic and abiotic stresses and in various plant tissue of *Arabidopsis thaliana* (*Ath*), *Glycine max* (*Gma*), *Gossypium hirsutum* (*Ghi*), *Zea mays* (*Zma*) and *Oryza sativa* (*Osa*) highlighted potential OGs including OG12, OG35 and OG44 showing response in all plants. Furthermore, upregulation of *OG12\_LR\_GhPk08* in *Ghi* under both biotic, (e.g., *Xanthomonas citri*) and abiotic (e.g., salt, heat, and cold) stress, as well as in specific tissues like roots and seedlings, suggest a potential role in stress responses. Molecular docking analysis demonstrated the preferential binding of ATP to *Ghi* kinase proteins, indicating their conserved phosphorylation mechanisms. Furthermore, SNP and InDel analyses in salt-resistant (*Mac7*) and salt-susceptible (*Coker 312*) cotton genotypes revealed genetic variations potentially linked to differential stress responses. Moreover, the qRT-PCR based expression analysis of two genes (*Gohir.D08G10000*; *OG12\_LR\_GhPk08*, *Gohir.D05G155340*; *OG35\_Pk\_GhPk02*) out of three, demonstrated significant contribution under salt stress in *Mac7* and *Coker312* genotype cottons. Thus, the study provides a deep insight into diversity and functional responses of kinase genes in land plants, particularly in cotton leading to future research on kinase studies.

**Keywords:** Kinase, Cotton, Abiotic Stress, Evolution, Expression, Domain, Molecular Docking

**RAPS-25-48: Endophytic Effect of *Aspergillus* Species in Combination with Entomopathogenic Silica Nano-Pesticides on the Growth, Development and Pest Management of Cabbage (*Brassica oleracea* var. *capitata*)**

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Cabbage (*Brassica oleracea* var. *capitata*) is one of the most extensively used Brassica vegetables all over the world because of its affordability, accessibility and various health benefits. Cabbage production is at risk due to presence of plant insect pests that attack at different growth stages. Due to the toxic effect on human health, the environment and resistance issues, there is a need to develop eco-friendly safe tactics that include entomopathogenic fungi as an alternative. The current study was carried out to estimate the potential impact of *Beauvaria bassiana*, *Metarhizium anisopliae* based silica nanoparticles (Si NPs) and *Aspergillus* species on the morphological and biochemical parameters of the Cabbage pests. The pot experiment was conducted using the Complete Randomized Design. The interaction of *Beauvaria bassiana* and *Metarhizium anisopliae* uses silicon nanoparticles (Si NPs) with *Aspergillus* specie was studied in this research. In the experiment different treatment was applied to cabbage plant to manage the pest control and for better growth of plant. The best result were seen when *Beauvaria bassiana* and *Metarhizium anisopliae* uses silicon nanoparticles (Si NPs) with *Aspergillus* species were used as a combined treatment. The mortality rates increased due to the combined treatment of *Beauvaria bassiana* and *Metarhizium anisopliae* uses silicon nanoparticles (Si NPs) were used with *Aspergillus nomius*. Moreover, the effect of these fungi was studied to know the morphological assessments, enhancement in growth traits and biochemical parameters such as protein and carbohydrate contents. In addition, stimulation in proline and antioxidant enzyme activity and malondialdehyde content was observed after fungal infection. When parameters were examined (Met+Bav)NPs+Asp.sp > (Met+Bav)NPs > Bav NPs > Met NPs > Asp.sp > Control this trend of treatments were seen. A two-way analysis of completely randomized (ANOVA) and Tukey's HSD test was used to assess the significance of difference between treatments. The COSTAT software (2005) was applied.

**Keywords:** Aphids, *Aspergillus nomius*, *Beauvaria bassiana* silica nanoparticles, *Metarhizium anisopliae* silica nanoparticles, Diamondback moth

**RAPS-25-49: New and Noteworthy *Boletales* spp. from Himalayan forests of Pakistan**

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*Boletes* represent a distinctive group of mushroom-forming fungi characterized by a spongy hymenium composed of tubular structures beneath the pileus. They are primarily classified within the order *Boletales*, which encompasses over 1,300 species distributed across 16 families. Species delimitation within this group is often challenging due to intergradational color variations and pronounced phenotypic plasticity. The internal transcribed spacer (ITS) region of the nuclear ribosomal RNA gene has been widely accepted as a universal DNA barcode for fungal identification. Among the regions of the ribosomal cistron, ITS provides the highest resolution for distinguishing among a broad range of fungi, displaying the most distinct barcode gap between intra- and interspecific variations. In addition to ITS, other molecular markers such as the 28S nuclear ribosomal large subunit RNA gene (LSU) are frequently employed for comprehensive fungal characterization. During a field survey conducted in Himalayan forests across various regions of Khyber Pakhtunkhwa Province, several *Boletales* specimens were collected, examined morphologically and anatomically, and subjected to molecular phylogenetic analyses using multiple genetic markers. The identified taxa belong to the families *Boletaceae*, *Gomphidiaceae* and *Suillaceae*.

Keywords: *Boletus*, *Gomphidius*, Himalayan, phylogeny, *Suillus*, taxonomy

**RAPS-25-50: *Volvariella brunnea*: Molecular systematics of a novel species from Punjab, Pakistan**

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Genus *Volvariella* Spegazzini, typified by *V. argentina* Speg., is characterized by the presence of a volva, absence of an annulus, free lamellae, pink spore print, and an inverted hymenophoral trama. Species of this genus are typically saprotrophic, occurring on decaying wood, leaf litter, compost, and other organic substrates, where they play an essential role in nutrient recycling and ecosystem functioning. During recent mycological surveys in Village Bhasin and Talwara Par, Punjab, Pakistan, a novel species, *Volvariella brunnea*, was collected. It was subsequently described using an integrative taxonomic framework combining both morphological and molecular data. Detailed macro- and micromorphological observations were conducted to distinguish it from previously described *Volvariella* species. *Volvariella brunnea* is characterized by a dark reddish-brown centrally depressed pileus, radially fibrillose surface, pinkish lamellae, globose to obovoid basidiospores, utriform, fusiform to lageniform cheilocystidia, and central stipe with a sheathing membrane-type volva. Molecular phylogenetic analysis based on the internal transcribed spacer (ITS) region supported its placement as a distinct lineage within *Volvariella*. Previously, only 12 species of this genus have been reported from Pakistan. The discovery of *V. brunnea* contributes significantly to the growing knowledge of fungal diversity in South Asia and highlights the ecological richness of underexplored habitats in Pakistan. This study reinforces the critical role of integrative taxonomy in resolving fungal systematics and suggests that further surveys in the region may yield additional undescribed taxa. The findings underscore the need for continued documentation and conservation of fungal biodiversity in Pakistan's unique ecosystems.

**Keywords:** Lahore; ITS; phylogenetic analyses; fungal diversity; taxonomy

**RAPS-25-51: Improving nitrogen uptake and metabolism coupled physiology of cotton with reduced leaching losses on sandy soil of desert**

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Poor nitrogen recovery due to extreme leaching losses in sandy soils results in reduced cellular nitrogen and eventually low physiological activity and yield formation. The objective of this experiment was to compare the nitrate concentration in cotton rootzone, leaching to uptake ratio, activity of N-metabolizing enzymes, and physiology of cotton yield under various application techniques in a desert ecosystem. The study was conducted on southern oasis of the Taklamakan desert, China and the treatments included a control (C), conventional top dressing before water flooding (CTD), fertigation by drip irrigation (FD), and urea side drilling in the mud after flooding (SDM). Results explicated that SDM and FD techniques resulted in 4-fold and 3-fold, respectively, higher retention of nitrate in 0–60 cm top layer of the soil than CTD; the later had the most accumulation in 60–120 cm zone of the soil profile. Eventually, the greater nitrate retention in 0–60 cm with SDM corresponded to 6% and 41% higher uptake in cotton plants than with FD and CTD, respectively. This enhanced nitrogen uptake under SDM upregulated the enzymatic activity of nitrate reductase by 4.5% over FD and 15.5% over CTD, while the activity of nitrite reductase improved by 1.5% and 13% over FD and CTD, respectively. Consequently, the rate of photosynthesis, sugars accumulation, vegetative growth, and yielding traits greatly improved with a confirmation of their linear relationship with N-recovery and its metabolism. In contrast, the highest N-leaching of 165 kg N ha<sup>-1</sup> occurred in CTD plots, being 61% and 70% higher than FD and SDM, respectively. Together, the results suggest SDM technique for minimizing N-leaching with greater uptake and constructive metabolism on the leaching prone sand of desert farmland where water availability is not a big concern.

**RAPS-25-52: Ethno-medicinal Diversity of Pakistan: Challenges for Conservation and A Gateway to Future Therapeutics**

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Pakistan possesses a remarkable ethnomedicinal wealth, reflecting centuries of traditional knowledge and a unique biodiversity shaped by diverse ecological zones. Indigenous communities across the country rely on a wide array of medicinal plants and remedies for primary healthcare, representing an invaluable cultural and biological resource. However, this heritage faces growing threats from overharvesting, habitat degradation, climate change, and insufficient documentation, leading to the gradual erosion of traditional knowledge systems. Ensuring the sustainable utilization of ethnomedicinal resources and the preservation of indigenous practices remains a pressing challenge. At the same time, Pakistan's ethnomedicinal flora represents a gateway to future opportunities. Systematic research can unlock bioactive compounds with therapeutic promise, while collaboration with local communities can ensure ethical benefit-sharing and strengthen conservation efforts. Furthermore, sustainable use of medicinal plants holds significant economic potential, contributing to rural livelihoods and the development of herbal industries. This talk emphasizes that safeguarding Pakistan's ethnomedicinal diversity requires an interdisciplinary approach that integrates ethnobotany, conservation biology, pharmacology, and policy. By bridging traditional knowledge with modern science, Pakistan can preserve its irreplaceable cultural legacy while providing novel contributions to global healthcare and wellness initiatives.

## **RAPS-25-53: Palynological Study of some members of family Leguminosae from Lahore, Pakistan**

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In this investigation ten (10) plant species belonging to seven (7) different genera of family Leguminosae were collected from different areas of Lahore, Pakistan. Family Leguminosae is generally recognized as pea family or bean family. It is very diverse and economically very important family of flowering plants which may be perennial or annual herbs, shrubs or trees. This family is divided into 3 sub families. These sub- families include Caesalpinoideaceae, Papilionoideae and Mimosoideae. Three plant species (Cassia, Caesalpinia and Bauhinia) belong to family Caesalpinoideae and 2 species belonging to each family Papilionoideae (Millettia and Sophora) and Mimosoideae (Acacia and Albizia). Palynological features like pollen shape, size, morphology, diameter such as colpus length and width were examined in this study and their pollen diameter in both equatorial and polar view was measured. All species have tri- colporate pollen except Albizia julibrissin which had tetra-colporate pollen. Colpus length of examined species ranged from 58um (Bauhinia purpurea) to 13um (Albizia julibrissin) while colpus width ranged from 19um (Bauhinia purpurea) to 1um (Albizia julibrissin). Shape of pollen grain was prolate to sub prolate, spheroidal, sub spheroidal or semi-rounded in some species. Exine ornamentation was found to be microreticulate in seven (7) species while other 4 species (Acacia modesta, Caesalpinia pulcherrima Bauhinia purpurea, and Millettia ovalifolia) exhibited reticulate to intra-reticulate ornamentation. All of these palynological characteristic features were used to form a dichotomous key

**Keywords:** Palynological features, tetra-colporate, exine ornamentation, reticulate

## **RAPS-25-54: Mitigation of Drought Stress in Spinach (*Spinacia oleracea* L.) Through Organic Waste Materials and Beneficial Rhizobacteria**

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Spinach (*Spinacia oleracea* L.) is a highly nutritious leafy vegetable of the family Amaranthaceae that plays an important role in strengthening the immune system. However, it is extremely susceptible to drought stress, which severely limits its growth and productivity. Although inorganic fertilizers can improve plant growth, their adverse environmental impacts necessitate the use of sustainable alternatives. This study was conducted to evaluate the effect of organic waste materials in combination with rhizobacteria on the growth and physiology of spinach under drought conditions. Organic wastes (egg shells and potato peels) were applied as cost-effective organic fertilizers, while *Bacillus megaterium* was used as a plant growth-promoting rhizobacterium. Two drought levels (0% and 50% field capacity) were maintained using a completely randomized design (CRD) with three replicates. The combined application of organic waste materials and rhizobacteria significantly improved morphological, physiological, and biochemical parameters of spinach compared to individual treatments. Physiological attributes such as chlorophyll and relative water content showed variable responses, while biochemical traits exhibited notable improvement. The results indicate that integrating organic waste materials with beneficial microbes effectively mitigates drought-induced stress and enhances spinach growth. This eco-friendly approach can be extended to other crops for sustainable agriculture.

**Keywords:** Spinach; Drought; Rhizobacteria; Organic waste material; Physiological traits

**RAPS-25-55: Endophytic PGPR Strain AF-56: A bio-inoculant for restoring soil vitality and combating chemical pollution.**

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With intensified agricultural practices driving soil degradation and undermining soil health, the use of microbial inoculants, such as beneficial microorganisms, offers a potent strategy for restoring soil fertility and functionality. To address this, microbial inoculants have emerged as a promising strategy. This study isolated and characterized a potent plant root-associated beneficial bacterium, *Citrobacter freundii* AF-56, from soil of a completely unexplored area of subdivision Dhirkot, AJK. AF-56 exhibited multiple plant growth-promoting traits, including IAA production ( $22.67\mu\text{gmL}^{-1}$ ), nitrogenase activity ( $31.68\mu\text{gmL}^{-1}$ ), and phosphorus solubilization ( $41.4\mu\text{gmL}^{-1}$ ) showing significant decrease in pH (from 7 to 4.74) due to the production of oxalic acid, malic acid and gluconic acid. It also demonstrated metabolic diversity, antibiotic resistance, and antagonistic activity against *Fusarium oxysporum*. Inoculation with AF-56 significantly enhanced sunflower growth in hydroponic, sterilized soil, and field conditions along with yield, and oil content. Moreover, AF-56 was able to colonize sunflower roots forming a biofilm like structure; documented through *yfp*-labelling by confocal laser scanning microscopy as well as through immunogold labeling coupled with transmission electron microscope. This study highlights the potential of *Citrobacter freundii* AF-56 as a biofertilizer candidate, offering a sustainable solution to enhance sunflower yield while reducing chemical fertilizer application and mitigating pollution crises. The findings of this study contribute to the development of eco-friendly agricultural practices.

**Keywords:** Microbial Inoculants, N<sub>2</sub> Fixation, Colonization potential, Sustainability.

**RAPS-25-56: Unveiling hidden fungal diversity: two new *Cystolepiota* species (*Agaricaceae*, *Agaricales*) from Northern Pakistan**

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Fungal diversity in Pakistan remains poorly documented, with many taxa yet to be discovered or recorded. Recent mycological surveys conducted in the moist temperate Himalayan forests of northern Pakistan have revealed two significant taxa of the genus *Cystolepiota* (*Agaricaceae*, *Basidiomycota*). Species of *Cystolepiota* are diminutive lepiotaceous fungi with a cosmopolitan distribution. Approximately 45 species have been described worldwide; however, only a single species has previously been reported from Pakistan based solely on morphological characteristics, as documented in *Fungi of Pakistan*. The genus was established by Singer and Digilio to accommodate small lepiotaceous fungi characterized by epithelioid squamules and inamyloid, non- dextrinoid basidiospores. Two novel species belonging to the genus *Cystolepiota* are described in this study, integrating detailed morphological examination with molecular phylogenetic analysis of the internal transcribed spacer (ITS) region of ribosomal DNA. These discoveries significantly enrich the understanding of *Cystolepiota* diversity and contribute to the growing knowledge of Pakistan's underexplored mycobiota. They emphasize the importance of integrating morphological and molecular approaches in fungal taxonomy and highlight the urgent need for continued field surveys to document macrofungal diversity in the region's diverse forest ecosystems. Such studies are essential for elucidating fungal biogeography, ecology, and conservation in Pakistan.

**Keywords:** ecology, forests, lepiotaceous fungi, underexplored

**RAPS-25-57: Impact of Priming with Iron Oxide Nanoparticles on the Growth and Yield attributes of Chickpea (*cicer arietinum* L.) under Salt stress**

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Salinity is one of the major abiotic stresses with salinized areas expanding steadily due to both natural processes and human activities. In Pakistan, soil salinization has become a major constraint, leading to significant declines in crop productivity. Micronutrients delivered in the form of nanoparticles (NPs) are emerging as innovative bio-stimulants that enhance plant growth and stress tolerance. Among various synthesis methods, green synthesis of nanoparticles offers an eco-friendly and cost-effective alternative, aligning with sustainable agricultural practices. The present study investigated the role of iron-oxide nanoparticles (IONPs) to mitigate the negative effects of salinity on chickpea plant. A pot experiment was conducted in completely randomized design with different levels of NaCl (0mM, 25mM, 50mM, 75mM, 100mM) and different concentrations of IONPs (0ppm, 50ppm, 100ppm, and 150ppm) were used alone and in combinations as treatments. Iron oxide nanoparticles were synthesized from fig fruit extract. Chickpea seeds primed with various concentrations of iron oxide nanoparticle were sown in soil and after two weeks of germination salt stress was applied. The results showed that increasing salinity levels significantly decreased the plant growth parameters (shoot and root fresh weight, shoot and root dry weight, shoot and root length and numbers of leaves per plant), biochemical parameters (photosynthetic pigments, total soluble proteins, and total sugar content) and yield parameters (numbers of pods per plant, number of seeds per plant and weight of seeds per plant). However, plants primed with all the concentrations of IONPs except 150ppm showed improved growth in all the studied parameters in both stressed and non-stressed plants. The highest improvement in all parameters of chickpea was seen under 100ppm as compared to all other treatments. So, it was concluded that the seed priming with IONPs has the potential to mitigate salinity stress in chickpea plant. Further field study is necessary to confirm the consistency, environmental safety, and economic feasibility of IONPs application on a broader scale, even though the results under controlled conditions are encouraging.

**Keywords:** Salinity stress, Chick pea, Sustainable crop production, Abiotic stress tolerance, Nanotechnology in agriculture

**RAPS-25-58: New and noteworthy species in *Agaricales* from coniferous dominating forests of Swat District, Khyber Pakhtunkhwa, Pakistan**

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The order *Agaricales* comprises the typical gilled mushrooms, characterized by a distinct pileus and stipe with lamellae on the underside, where basidiospores are produced. Members of this order exhibit diverse ecological roles, including saprophytic, mycorrhizal, and parasitic lifestyles. Globally, *Agaricales* is represented by 31 families, 146 genera, and approximately 602 species. During recent mycological surveys conducted in the coniferous forests of Swat District, Khyber Pakhtunkhwa, Pakistan, several basidiomata belonging to *Agaricales* were collected and examined. The specimens were characterized using detailed morphological and anatomical features, complemented by molecular analyses based on the internal transcribed spacer (ITS) region of nuclear ribosomal DNA. Among these collections, unidentified species of *Candolleomyces*, *Crinipellis*, and *Inocybe*, as well as a new record of *Peckorumyces umbonatus*, were identified. Notably, *P. umbonatus* represents the first report of the genus *Peckorumyces* from Pakistan and marks only the second known global occurrence of this species. These findings highlight the rich and unexplored fungal diversity of the coniferous forests of Swat District and underscore the importance of integrative taxonomic approaches combining morphology and molecular data for documenting and understanding the mycobiota of Pakistan.

**Keywords:** new species, nrDNA, phylogeny, taxonomy

**RAPS-25-59: Organic Soil Amendments and Plant Growth-Promoting Rhizobacteria Improve Antioxidant Enzymes and Physiochemical Parameters in *Brassica juncea* (L.) Czern. under Salinity Stress**

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Soil salinity is a major abiotic stress severely limiting the productivity of *Brassica juncea* (Indian mustard) which is an important oilseed crop. This study investigated a sustainable approach to mitigate salt stress by integrating organic waste amendments with plant growth-promoting rhizobacteria (PGPR). A pot experiment was conducted with *Brassica juncea* plants subjected to salinity stress (150 mM NaCl). Treatments included the application of composted organic waste (20 g peels powder + 20 g eggshells), a specific PGPR strain (30 ml) and their combination. The findings demonstrated that the combined application of organic amendment and PGPR inoculation significantly enhanced plant growth, biomass and chlorophyll content compared to controls under salinity. Furthermore, the synergistic treatment effectively reduced oxidative stress by bolstering the activity of antioxidant enzymes, improved osmotic adjustment and by also increase proline accumulation. These results underscore the potential of integrating organic waste recycling and microbial inoculation as a powerful, eco-friendly strategy to enhance salinity tolerance in *Brassica juncea*, contributing to improve crop resilience and sustainable agriculture in saline-affected regions.

**Keywords:** salt tolerance; abiotic stress; sustainable agriculture; PGPR; organic amendment; mustard.

**RAPS-25-60: Comparative Role of Schiff-base Zinc Complex and Zinc Nanoparticles in Pea (*Pisum sativum* L.) Under Drought Stress**

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One of the serious environmental stresses that have negative impact over the crop productivity is drought. The main consequences of drought on food crops are the modifications in physiological, morphological characteristics and related biochemical cascades. Pea (*Pisum sativum* L.) is very essential crop to grow across the globe for its nutritional value, but pea has threat to loss its yield and quality in the most prevalent condition of drought worldwide. The present research investigated the effects of drought and the foliar application of ZnO nanoparticles, Schiff-base and Schiff-base zinc complex on two varieties (Matoor and 2009) of pea. This experiment was performed in completely randomized design with 3 replicates. Both varieties were grown in plastic pots filled with soil under the control and stress conditions and were also exposed to the foliar application of ZnO NPs (150 mg/L), Schiff-base zinc complex (150+10 mg/L) and Schiff-base (10 mg/L). During experimentation positive results were found in terms of growth and productivity under the foliar treatments in both varieties. Antioxidant enzymes were also boosted under the drought stress as well as by the foliar chemical treatments, while H<sub>2</sub>O<sub>2</sub>, MDA and RMP were reduced. The work is aimed to be helpful for farmers, researchers and traders in future to grow pea crop under water deficit conditions with foliar application of above -mentioned chemicals.

**Key words:** *Pisum sativum*; drought; ZnO NPs; schiff-base zinc complex

**RAPS-25-61: Effect of nitrogen and phosphorus fertilizer application on physiological and biochemical traits of wheat (*Triticum aestivum* L.) under saline conditions**

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Salinity is a major challenge for wheat (*Triticum aestivum* L.) cultivation, significantly reducing plant growth and yield. This study explored how nitrogen (N) and phosphorus (P) fertilizer could help two wheat varieties, Dilkash and Akbar, cope with saline soil conditions. A controlled pot experiment was carried out in a greenhouse using seven different fertilizer treatments: control, DAP+UREA, NEM.P+UREA, NP+UREA, DAP+CAN, NEM.P+CAN, and NP+CAN. The experiment focused on plant growth traits (e.g., height, root length, and biomass), physiological traits (e.g., chlorophyll content, photosynthesis rate, and stomatal conductance), yield traits (spike weight and grain number per spike), and antioxidant enzyme activity (CAT, POD, SOD, and APX). The findings revealed that applying N and P fertilizers greatly improved plant performance under saline stress. Treatments with NP+UREA and DAP+CAN stood out, increasing plant height by 23–28%, root length by 18–22%, and overall biomass by 30–35% compared to untreated controls. Among the two varieties, Akbar responded better to fertilization, showing 15–20% higher improvements than Dilkash. CAN-based fertilizers (NP+CAN and NEM.P+CAN) were particularly effective in maintaining higher chlorophyll a and carotenoid levels, which helped support photosynthesis under stress. Akbar also demonstrated better gas exchange, with significantly higher stomatal conductance and transpiration rates. Grain yield showed a major boost with CAN-based treatments, showing a 40–45% increase. The activity of antioxidant enzymes also rose by 35–40%, suggesting stronger internal stress defenses. The interaction between fertilizer types and wheat varieties was statistically significant, indicating the importance of matching fertilizer strategies to specific genotypes. In summary, applying the right combinations of N and P, especially those using CAN, can help wheat plants better withstand salinity by improving growth, physiology, and stress tolerance. The Akbar variety showed stronger resilience, highlighting the need for both smart fertilization and careful variety selection for farming in saline soils. Further research in field conditions is recommended to confirm these results and better understand the biological mechanisms behind these responses.

**Key words:** Nitrogen, Phosphorus, wheat, Dilkash, Akbar, yield

**RAPS-25-62: Alleviating the Toxic Effect of Salinity Stress on Maize (*Zea Mays* L.) by *Pseudomonas* Application**

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This study was conducted to evaluate the ability of bacteria (*Pseudomonas*) to alleviate salt stress toxicity in maize (*Zea mays* L.). First phase of the study was to screen the different varieties of maize under different salinity levels. Two varieties were selected one tolerant (5427YH) and other sensitive (sweet corn). By using these selected varieties further experiment was performed to check the effect of *pseudomonas* to mitigate the effect of salinity on plant growth. As salinity is one of the most serious factor that negatively affects crops in semi-arid and arid regions by disrupting the physiological and bio chemical mechanism in maize. Salinity stress become the cause of decline in photosynthetic capacity, reduce the enzymatic anti-oxidant activities and also yield of crop. In addition, inoculated plants showed increased activity of superoxide dismutase (SOD), catalase (CAT), and the activity of peroxidase (POD), which greatly promoted the plant growth during salt induced stress. Under this study physiological and bio chemical attributes were collected to assess the effect of salinity and its amelioration by the application of bacteria. It was indicated, salinity stress reduced the growth and alter the physiological and biochemical mechanism. Application of *pseudomonas* mitigated the effect of salinity and enhanced the growth of maize. Over all it was observed that bacteria (*Pseudomonas*) strains may ameliorate the toxic effect of salt in maize. It can be recommended to enhance the agriculture productivity in salt effected soil.

**Keywords:** Maize, bacteria, yield, enzymatic anti-oxidant, stress toxicity

**RAPS-25-63: Growth-Stimulating Activity of Flavonoids Extracts of the Buds of Balsamic Poplar *Populus balsamifera***

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Currently, the task of accelerating the development of alternative plant protection measures is urgent, which is associated with the worsening environmental situation, the desire to reduce pollution of agricultural landscapes and obtain agricultural products with minimal use of agrochemicals. Poplar extract is a plant growth stimulant due to the presence of saturated and unsaturated fatty acids, lipids, phenolic and polyphenolic compounds, amino acids, essential oils, vitamins that provide a stable growth-stimulating effect. The aim is to evaluate the stimulating activity of extracts of the buds of poplar balsamic *Populus balsamifera* on flax seed productivity. *Objectives:* to isolate the amount of flavonoids from balsamic poplar; to establish the growth-stimulating activity of balsamic poplar kidney extract in relation to flax seeds. *Methodology and scientific approaches:* the method of obtaining the proposed extract of balsamic poplar includes the use of balsamic poplar buds, air drying, grinding, extraction with 90% ethanol in a Soxhlet apparatus, filtration and evaporation until the desired product is obtained. *The results and conclusions obtained:* the results of studying the growth-stimulating activity of extracts of balsamic poplar *Populus balsamifera* showed high seed productivity of flax in the control group; the reproduction conditions had a positive effect on flax yield.

**Keywords:** flavonoids, *Populus balsamifera*, growth-stimulating activity, flax seeds, extract.

## **RAPS-25-64: Iron Nanoparticle-Induced Modulation of Salinity Tolerance in *Capsicum annuum* L.**

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Salinity is a growing global concern and has become a major constraint, leading to significant declines in crop productivity. Micronutrients delivered in the form of nanoparticles are emerging as innovative bio-stimulants that enhance plant growth and stress tolerance. Therefore, the current experiment was carried out to analyze the impact of iron oxide nanoparticles (FeO-NPs) on growth and yield of *Capsicum annuum* L. FeO-NPs were synthesized using cucumber peel extract and characterized using DLS, UV-visible spectroscopy, FTIR, XRD and SEM. The pot experiment was laid out in completely randomized design comprising of four levels of NaCl (0, 50, 100, 150 mM) and three concentrations of FeO-NPs (100, 200 ppm, 300 ppm) alone and in combinations as treatments. The results indicated a gradual decrease in growth (shoot and root length, shoot and root fresh and dry weight, as well as no. of leaves/plant), biochemical parameters (photosynthetic pigments, total soluble protein and total soluble sugars content) and yield (fruit length, fruit diameter, number of fruits/plant and weight of fruit/plant) of chillies with increasing levels of salt. The highest decrease was recorded at 150mM salinity level. However, foliar application of FeO-NPs improved all the above mentioned growth, biochemical and yield parameters when applied alone and in combination. In addition, FeO-NPs reduced oxidative stress by increasing antioxidants and reducing MDA and H<sub>2</sub>O<sub>2</sub>. So, it was concluded that the application of FeO-NPs has the potential to mitigate salinity stress in chillies. Further field study is necessary to confirm the consistency, environmental safety, and economic feasibility of FeO-NPs application on a broader scale, even though the results under controlled conditions are encouraging.

**Keywords:** Salinity, FeO nanoparticles, Chillies, growth and yield

**RAPS-25-65: A new species of *Russula*, identified in *R. subsect. Amoeninae* from Pakistan, based on morphology, microscopy and phylogeny**

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During a mycological survey conducted in Swat District, Khyber Pakhtunkhwa, Pakistan, a novel taxon belonging to the genus *Russula* was collected and identified. The taxon is characterized by a dry, reddish-purple to dark purple pileus, off-white to pale yellow adnexed lamellae without purplish margins, and a distinct pink fibrillose stipe. Microscopic observations revealed subglobose to broadly ellipsoid, amyloid basidiospores ( $5.7\text{--}7.1 \times 4.9\text{--}5.8 \mu\text{m}$ ) with prominent warts forming reticulate or chain-like patterns, clavate to fusoid cheilocystidia, and subulate to lageniform hyphal terminations. Molecular analyses based on the internal transcribed spacer (ITS) region of nuclear ribosomal DNA confirmed its distinct phylogenetic position within the genus. The combined evidence from morphological, microscopic, and molecular data supports its recognition as a new species within *Russula*. This discovery enriches the taxonomic knowledge of the genus and highlights the ecological significance of northern Pakistan, particularly the Swat region, as a hotspot for fungal diversity. The study underscores the need for continued integrative taxonomic research to document and conserve the region's rich and underexplored fungal flora.

**Keywords:** fungal diversity, ITS, new species, phylogeny, Swat

## **RAPS-25-66: CRISPR-Cas9 Mediated Precision Genome Editing for Enhanced Disease Resistance in Chickpea**

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Chickpea (*Cicer arietinum* L.) is a vital legume crop, providing a rich source of plant-based protein and contributing significantly to global food security. However, challenges such as abiotic stresses (drought, salinity) and biotic stresses (pests and diseases) hinder its production, particularly in regions most affected by climate change. Genome editing technologies, particularly CRISPR-Cas9, offer promising solutions for improving chickpea by targeting specific genes associated with stress tolerance and yield improvement. Our recent work using CRISPR-Cas9 to edit genes in chickpea that are critical for improving abiotic stress tolerance, such as drought and salinity resistance, as well as genes involved in nitrogen fixation and disease resistance. We focused on identifying key target genes within the chickpea genome, and by utilizing protoplast transformation and *Agrobacterium*-mediated transformation, we successfully introduced CRISPR-Cas9 constructs to generate targeted mutations in these genes. Preliminary results indicate that gene editing in critical pathways, such as those involved in osmotic regulation, ROS scavenging, and protein synthesis during stress conditions, has resulted in chickpea plants with enhanced tolerance to water stress, improved root development, and better survival rates under salinity conditions. These edited plants also exhibited increased yield potential under controlled conditions, suggesting a potential for application in field-based environments. Furthermore, this research discusses the optimization of CRISPR-Cas9 delivery methods, including the efficient use of *Agrobacterium* transformation in chickpea, which has been historically challenging due to the plant's recalcitrant nature.

**RAPS-25-67: Exogenous Thiamine Application Enhances Drought Tolerance in Carrot (*Daucus carota* L.) by Modulating Antioxidant Defense and Osmotic Adjustment Mechanisms**

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Drought is a major abiotic stress that adversely affects plant growth, physiology, and productivity, especially in water-scarce regions. Carrot (*Daucus carota* L.), a nutritionally valuable root crop, is particularly vulnerable to water deficits, which reduce biomass and affect biochemical balance. This study aimed to evaluate the role of thiamine (vitamin B1) in improving drought tolerance in two carrot varieties F1 Hybrid Red and T-29 under controlled conditions. For control plants 50% field capacity was maintained throughout the experiment. Similarly, 25% field capacity was considered as drought stress and both the control and drought stressed plants were treated with three concentration of thiamine (0, 100, and 150 mg/L) via foliar spray. Growth, physiological, and biochemical parameters were assessed, including root and shoot biomass, chlorophyll content, photosynthetic activity, osmolyte accumulation, and antioxidant enzyme activity. The results revealed that thiamine significantly enhanced drought tolerance in both varieties, with the 150 mg/L treatment being most effective. Under drought stress, thiamine application improved root and shoot length, leaf number, fresh and dry biomass, and restored chlorophyll a and b levels. Biochemical analysis indicated increased proline and sugar accumulation, reduced lipid peroxidation, and enhanced activities of catalase, peroxidase, and superoxide dismutase. Among the varieties, T-29 showed greater resilience and responsiveness to thiamine treatment under water-deficit conditions. The study concludes that thiamine foliar application mitigates the physiological and oxidative impacts of drought in carrot by improving water status, antioxidant defense, and metabolic stability. These findings offer a promising, low-cost strategy for enhancing carrot production in drought-prone environments and contribute to the development of sustainable crop management practices.

**Keywords:** antioxidant defense, carrot, drought, osmotic adjustment, proline, thiamine.

**RAPS-25-68:- Exploring the potential role of ironoxide nanoparticles for mitigating the lead chloride induced oxidative stress in wheat (*Triticum aestivum* L)**

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This study was conducted to determine the effect of iron oxide nanoparticles (FeO NPs) to decrease lead chloride stress on wheat (*aestivum Triticum* L.). Two wheat varieties, Akbar 2019 and Arooj 2022 were used under different levels of lead chloride (0.5 mM and 2 mM) stress. The foliar applications of FeO NPs (50 mg/L and 100 mg/L) were applied on wheat and it was observed that morpho-physiological and biochemical parameters enhanced under lead chloride stress by the application of FeO NPs. The NP treatments also improved antioxidant enzyme activities, including catalase (CAT) activities and superoxide dismutase (SOD) and minimized the effect of oxidative stress. The statistical results confirmed that NP treatments had a remarkable positive effect on the plants. In conclusion, FeO NPs reduced the negative effects of lead chloride stress on wheat and could be a strategy to increase crop productivity on metal-contaminated soils. Future recommendations are to investigate the longer-term effects of the FeO NPs to use other forms of nanomaterial to improve wheat resistance.

**Keywords:** Iron oxide nanoparticles, Akbar 2019 and Arooj 2022, catalase, superoxide dismutase

**RAPS-25-69: Chitosan-Zinc nanocomposites foliar application alleviate chromium toxicity in *Spinacia oleracea* via modulating chlorophyll fluorescence, gas exchange, antioxidant defense and metal uptake**

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Heavy metal pollution has become a global issue, and it has adversely affected agriculture. In this study a three factorial completely, randomized design experiment was formulated to assess the effects of Cr stress on growth and physio-biochemical attributes of spinach (*Spinacia oleracea* L.). Chitosan-zinc nanocomposites (CTS-Zn NCs) at 50 and 100 mg L<sup>-1</sup> were applied via foliar spray to examine their ameliorative role against Cr toxicity in spinach plants. While Cr stress was applied at concentration of 125 and 250 µM using K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> salt along with Hoagland's nutrient solution. Results showed that Cr stress severely impacted growth, physiological and biochemical attributes. However foliar application CTS-Zn NCs treatment improved all the morphological attributes in control as well as Cr stress plants. There was a slight change in chlorophyll *a* & *b* content of spinach under Cr stress. Foliar spray of CTS-Zn NCs treatment slightly improved the *a* & *b* content in both control and stressed plants. Conversely, stress markers (relative membrane permeability, malondialdehyde and hydrogen peroxide), antioxidant enzymes and secondary metabolites (total phenolics and proline content) were increased under Cr stress. Applications of CTS-Zn NCs treatment decreased the stress markers but increased the activity of antioxidant enzymes and synthesis of secondary metabolites. Cr stress also decreased efficiency of photosystem II ( $\Phi$  PSII), chlorophyll fluorescence, photosynthesis rate, transpiration rate and stomatal conductance. However, it increased intercellular CO<sub>2</sub> level in the leaves. CTS-Zn NCs application successfully mitigated these adverse effects and significantly improved chlorophyll fluorescence, gas exchange and related attributes under Cr stress conditions. These findings suggest that use of CTS-Zn NCs could be a promising approach to alleviate heavy metals stress in plant.

**Keywords:** Abiotic stresses; Chitosan; Fluorescence; Gas exchange; Nanocomposites; Secondary metabolites

## **RAPS-25-70: Screening the Antioxidant and Antivenom Potential of Secondary Metabolites of *Delonix regia***

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To maintain sustainable means for the treatment of human ailments based on plant derived natural products, the present study aims to support United Nations SDGs 3 and 12 by utilizing a well-known therapeutic plant, *Delonix regia* (DR). The plant constitutes a diverse range of phytochemical compounds, that contribute to its antioxidant, antimicrobial and anti-inflammatory properties but the relationship of secondary metabolites with regards to the neutralization of snake venom remains unexplored. The research outlined here was designed to alleviate this caveat. The study was conducted by isolating secondary metabolites of the pod shells through reflux using methanol as solvent. However, with regards to the seeds, defatting was performed initially, using hexane followed by extraction with methanol. Partial purification of the crude extracts was achieved using solvent-solvent extraction technique to yield fractionated layers (FLs). The percentage yields obtained for FLs of the pods were in the order of: 1.40% (hexane layer), 1.59% (dichloromethane layer), 4.14% (ethylacetate layer), 11.91% (butanol layer) and 52.25% (aqueous layer). The methanolic extract of seeds yielded FLs as 4.00% (hexane layer), 3.55% (DCM layer), 10.22% (ethylacetate layer), 5.77% (butanol layer) and 55.55% (aqueous layer). Chemical tests were performed for the qualitative analysis of secondary metabolites. The results demonstrated the presence of tannins, saponins, flavonoids, triterpenes, and alkaloids in both tissues of the plant. Furthermore, antioxidant activity was investigated by the H<sub>2</sub>O<sub>2</sub> Scavenging Assay while antiophidic activity was assessed by the Venom Neutralization Assay. The findings of the study offer insight into the impact of antioxidant potential and the uninvestigated antivenom activity of the wide range of secondary metabolites of DR.

Keywords: *Delonix regia*; secondary metabolites; antioxidant; anti-venom

**RAPS-25-71: *In Vitro* Micropropagation of *Zingiber officinale* Roscoe**

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*Zingiber officinale* Roscoe. (ginger) is a major crop with significant economic and medicinal value. Pakistan, being the fifth largest importer, brings in around 81,000 metric tons of ginger annually, worth about 112 million USD. To enhance ginger production, tissue culture techniques present a promising alternative to traditional propagation methods. The research was carried out to create an optimized protocol of tissue culture of ginger, with an emphasis on enhancing shoot multiplication, promoting root development, and successfully acclimatizing plantlets. Several explants were inoculated in diverse (MS) media i.e., Murashige and Skoog containing plant growth regulator including cytokinin (BAP and Kin) and auxins (NAA and 2, 4-D) to assess their impact on shoot initiation, proliferation, and callus formation. The results showed that 2 milligrams per liter nutrient medium was the most effective for initiating and multiplying shoots,. The plantlets that were rooted in vitro achieved survival rate with 95% when acclimatized under *ex-vitro* conditions. The optimal potting medium for acclimatization was found to be a blend of peat, husk and soil.

**RAPS-25-72: Unveiling Molecular Interactions Between *S. lycopersicum* RDR1 and ToLCNDV AV2/AV3 Proteins Through Docking Analysis.**

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Tomato leaf curl New Delhi virus (ToLCNDV) is a highly prevalent and destructive bipartite begomovirus that infects a wide range of plant species across three continents, raising global concerns. It is particularly prevalent in Asia and the Asian isolates are better adapted to tomato plants than Mediterranean isolates. In our initial analysis of ToLCNDV DNA-A sequences, it was observed that several Asian isolates have an additional open reading frame, referred to as AV3, whereas most of the Mediterranean isolates lack it. AV3 is the least characterized ORF that starts in the upstream region of AV2 and overlaps with it but in a different reading frame. To comprehend the potential role of AV3 protein in ToLCNDV infection, an in-silico study was conducted to investigate the interaction of AV2 and AV3 with *Solanum lycopersicum*-encoded RNA- dependent RNA polymerase 1 (RDR1). Both AV2 (112 amino acids in length) and AV3 (128 amino acids in length) proteins shared just 14 common amino acids, and their 3D structure showed the least resemblance. The results demonstrated that AV2 forms a more stable and robust binding with RDR1 compared to AV3. Nonetheless, the AV3-RDR1 complex had a higher binding energy ( $-59.64 \text{ kJ mol}^{-1}$ ) and a smaller size (6 nm). The other protein-protein interaction attributes inferred for the AV2-RDR1 and AV3-RDR1 complexes exhibited some fundamental similarities; however, the AV2-RDR1 complex showed better interacting/docking attributes than the AV3-RDR1 complex. Although AV2 and AV3 docked differentially to RDR1 at the same site, they both interacted with some common residues, including E825, D877, K880, K881, and E884. This suggests a shared pathway employed by both AV2 and AV3 to suppress host plant defense, or it may be a strategy of dual deception to evade host defense. Conclusively, this study revealed that AV3 exhibited a strong interaction with RDR1. AV3 may potentially establish a robust in vivo interaction with RDR1 to suppress host plant defense, providing speculative insights into why Asian isolates of ToLCNDV are better adapted to tomato plants than Mediterranean isolates.

Keywords: Host defense; begomovirus; Tomato leaf curl New Delhi Virus (ToLCNDV); Precoat protein.

**RAPS-25-73: Plants: A Vital Source of Nutraceuticals, Functional Foods, Challenges of Safety and Delivery Issues to Nutra-Pharmaceutical Industry**

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Plants are an essential source of nutraceuticals and functional foods since they are abundant in bioactive substances such as vitamins, minerals, dietary fibre, carotenoids, and polyphenols. With the new developments in the area of optimal nutrition, now there is greater interest in the use of functional food and nutraceuticals. Nutraceutical is an isolated or concentrated part of a naturally occurring nutrient-rich food and is sold in the medicinal form such as tablets, capsule and ampule etc. They contain substances which are not traditionally recognized as nutrients but have positive physiological effects against chronic diseases. Different countries designate nutraceuticals in different terms such as medical foods, designer foods, functional foods phytochemical, and natural health supplements. The physiological and medicinal health functions of nutraceuticals can be attributed to wide array of bioactives and high-value components such as carotenoids, biopeptides, dietary fiber, essential fatty acids, flavonoids, isothiocyanates plant stanols/phytosterols, polyols, prebiotics/probiotics, phytoestrogens, soy protein and sulfides/thiols etc. They are being used to cure various ailments, prolong life expectancy, prevent chronic diseases (diabetes, cancer, viral diseases, etc.), promote health, slow down the ageing process, support the body's structure or functioning, and influence gene expression. Nutraceuticals mainly contain plant based bioactive compounds so called secondary metabolites with medicinal value WHO has recognized the potential of nutraceuticals as a safer, targeted and effective remedies against several common diseases including *obesity*, *hypertension*, cancer, diabetes, viral infections and cardiovascular disorders etc., however there is prompt need to elucidate mechanisms of action of these valuable products at molecular level. The present lecture mainly focuses on the concept, classification, and potential medicinal and therapeutic applications of different marketable nutraceuticals along with highlighting the current trends, challenges and future prospects of nutra-pharmaceutical industry.

**Keywords:** Nutraceuticals, supplements, phytochemical, functional food, nutragenomics, Nutra-Pharmaceutical Industry

## **RAPS-25-74: A Versatile Plant for Health and Sustainability: The Amaranth**

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Amaranth (*Amaranthus* spp.) is recognized for its exceptional nutritional profile and diverse health-promoting properties. The amaranth plant, originating from Central and South America, holds historical significance as a staple food for ancient civilizations like the Aztecs and Inca. Widely cultivated today across tropical and subtropical regions globally, including Africa, Asia, and North America, it belongs to the Amaranthaceae family and comprises approximately 60 species. Known for its adaptability, amaranth thrives in various soil and climatic conditions, contributing significantly to agriculture as both a crop and a nutrient-dense food source. The amaranth plant is renowned for its diverse chemical composition and array of bioactive compounds, particularly in its seeds. Amaranth is especially beneficial for individuals with celiac disease or gluten sensitivity because it is naturally free of gluten. It functions as a high-quality protein source for individuals following vegetarian and vegan diets, as it provides a complete profile of all essential amino acids necessary for human physiological function and health maintenance. The plant's significant fiber content aids in digestive health by encouraging regular bowel movements and supporting a balanced gut microbiome. Moreover, amaranth contains phytosterols and antioxidants that help lower cholesterol levels and reduce the risk of heart disease. Amaranth's bioactive components encompass phenolic acids and flavonoids with potent antioxidant properties, shielding cells from oxidative stress induced by free radicals and reducing the risk of chronic diseases. This study explores the diverse health benefits of amaranth in depth, highlighting its potential to enhance well-being through its nutrient-rich composition.

**Keywords:** Amaranth plant; bioactivity; health benefits

## **RAPS-25-75: Seed Priming with Rutin on Seed Germination metrics in Rice**

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Climate change and the increasing frequency of drought events continue to threaten global rice (*Oryza sativa* L.) Production, undermining food security. Enhancing drought tolerance through low-costs, sustainable methods is therefore critical. This study evaluated the potential of rutin priming to enhance drought stress tolerance in the Korean rice cultivar 'Jin Baek'. Rutin, a natural flavonoid with strong antioxidant and anti-lipid peroxidation properties, was hypothesized to improve early seedling growth and metabolic adaptation under stress conditions. An in vitro experiment was conducted using six treatments: a control and five concentrations of rutin (0.01, 0.1, 0.5, and 1.0 mM). Seeds were primed for four hours, incubated at 28–30°C for seven days, and assessed for germination metrics, seedling growth, and metabolic changes. Data were analyzed under a Completely Randomized Design (CRD) using ANOVA and Duncan's Multiple Range Test (DMRT) at  $\alpha = 0.05$ . Results revealed that rutin significantly enhanced germination percentage, seedling vigor, and metabolic activity relative to the control. The 0.1–0.5 mM rutin treatments promoted optimal root and shoot development, while 1.0 mM rutin yielded the highest germination rate (100%) but slightly decreased dry biomass. Rutin-primed seeds exhibited elevated glucose, mannitol, citric acid, and succinic acid concentrations, indicating improved energy metabolism and osmoprotection. Additionally, increased amino acids particularly  $\gamma$ -aminobutyric acid (GABA), valine, and leucine suggested enhanced protein synthesis and antioxidant defense mechanism. Overall, rutin seed priming markedly improved early seedling performance and stress tolerance in rice, with 0.5 mM identified as the most effective concentration. The findings demonstrate rutin's potential as a bio-stimulant for sustainable crop improvement and drought resilience in rice and other cereals.

**Keywords:** Rutin; seed priming; *Oryza sativa*; drought stress tolerance; metabolic modulation.

**RAPS-25-76: Eco-physiological Adaptive strategies of *Prosopis cineraria* (L.) in Response to diverse edaphic habitats of Cholistan Desert, Pakistan.**

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Salt stress is a significant environmental issue that harmfully affects plant growth and metabolism. Physiological and biochemical responses to salt stress of *Prosopis cineraria* (L.) remain unclear in natural habitats. This study evaluated Eco-physiological and biochemical adaptive strategies in *P. cineraria* in different edaphic habitats of the Cholistan Desert. Three edaphic habitats (sand dune = SD, sandy plain = SP, saline area = SA) of the Cholistan deserts were selected, each with three sub-sites as replicates. For the ecological study, five randomly positioned 10m×10m quadrats were taken at each selected site. Physicochemical results revealed that at SD, EC was 9.4 dS m<sup>-1</sup>, pH was 7.5, and OM was 0.78%. At SP, EC increased to 157.7%, pH to 9.33%, and OM to 20%. The Na<sup>+</sup> concentration at SD was 1650.8 mg L<sup>-1</sup>, but in SA, it increased by 200.8% compared to SD. The physiological attributes of the plant were significantly modified in a high-saline area, as chlorophyll a and b declined considerably by 34.26% and 54.32%, respectively, at SA related to SD. Total soluble proteins, free amino acids, soluble sugars, proline, and root tissue contents of Na<sup>+</sup>, K<sup>+</sup>, Ca<sup>2+</sup>, and Cl<sup>-</sup> increased at SA. In wild populations, these physiological changes appear to be crucial for enhanced survival in the arid saline desert environment. *P. cineraria* was identified in all edaphic habitats and showed ecological dominance at the saline area in the Cholistan Desert, indicating its adaptability to the salty environment.

**Keywords:** *Prosopis cineraria*; adaptation; salinity stress; physiology; chlorophyll; Cholistan desert.

## **RAPS-25-77: Taxonomic and Phylogenetic Study of Mushrooms of Kharmang Valley, Gilgit Baltistan**

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The Kharmang Valley (34 ° 58' 0" North and 76 ° 14' 0" East) is a newly established district of Gilgit-Baltistan (GB). It is situated at one of the elevated northeastern Indo- Pak borders. Covering an area of 7183 square kilometers and situated at elevations ranging from 2262 to 5638 meters above sea level, it is approximately at 35.3° N latitude and 76.5° E longitude. This study presents a morpho-anatomical and phylogenetic analysis of mushrooms from the unexplored Kharmang Valley in Gilgit- Baltistan, a region known for its rich fungal diversity. Mushroom samples were collected and identified through both microscopic examination and molecular analysis of the ITS-rDNA region. The research successfully documents nine species, including *Paxillus ammoniavirescens*, *Coprinopsis atramentaria*, *Laetiporus sulphureus*, *Fomes fomentarius*, *Lepiota cristata*, *Coprinus comatus* and *Morchella* species. A significant finding is the first recorded occurrence of "*Paxillus ammoniavirescens*" in Pakistan. Its identification was confirmed by a 99% sequence match via NCBI BLAST and supported by high bootstrap values in the phylogenetic tree, which clustered our specimen with known "*P. ammoniavirescens*" sequences. Additionally, species such as *Coprinopsis atramentaria*, *Laetiporus sulphureus*, *Fomes fomentarius*, *Lepiota cristata*, *Coprinus comatus* and *Morchella* are reported for the first time from Kharmang Valley. The findings provide critical taxonomic and phylogenetic data, highlighting the unique mycobiota of the region. This study not only advances understanding of fungal phylogeny but also lays a foundation for future mycological research in Pakistan.

**Keywords:** Kharmang Valley; *Paxillus*, *Coprinopsis*; *Morchella*; Phylogenetic Analysis.

## **RAPS-25-78: Unlocking Drought Resilience in Wheat: The Physio-biochemical Basis of Melatonin Seed Priming**

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Melatonin (N-acetyl-5-methoxytryptamine), an indoleamine derived from tryptophan, functions as a potent antioxidant and signaling molecule in plants. It regulates key morpho-physiological processes, including seed germination, photosynthetic efficiency, and biomass production, and is critically involved in mediating abiotic stress responses. Drought stress severely impairs plant growth by disrupting physiological and biochemical functions. Seed priming with phytohormones has emerged as a viable and efficient strategy to enhance crop drought resilience. This study investigated the efficacy of melatonin seed priming in mitigating severe drought stress in two wheat cultivars. Seeds were treated with varying melatonin concentrations (0 to 5 mg L<sup>-1</sup>). The results demonstrated that priming with an optimal concentration of 2 mg L<sup>-1</sup> melatonin significantly alleviated drought-induced damage. This treatment markedly improved germination rates by over 33% and enhanced relative water content by more than 13% in both cultivars. Furthermore, melatonin pre-treatment at this concentration substantially increased fresh and dry biomass, leaf area, and photosynthetic pigment levels. It also promoted the accumulation of osmolytes, including proline and soluble sugars, while reducing oxidative stress markers like malondialdehyde and hydrogen peroxide through the upregulation of antioxidant enzymes (superoxide dismutase, peroxidase, catalase) and metabolites. Under non-stress conditions, a lower melatonin concentration of 1 mg L<sup>-1</sup> was most effective in improving growth. The findings indicate that melatonin seed priming bolsters drought tolerance primarily by enhancing the antioxidant defense system, leading to reactive oxygen species scavenging and improved physiological performance.

**Keywords:** Melatonin; Seed Priming; Crop Resilience; Antioxidant Defense; Osmoprotectants.

## **RAPS-25-79: Phytochemical Composition and Pharmacological Potential of *Citrullus colocynthis* (L.) Schrad from Naseerabad, Balochistan, Pakistan**

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*Citrullus colocynthis* (L.) Schrad, commonly known as bitter apple, is a medicinal plant belonging to the family Cucurbitaceae. Traditionally used across Asia and Africa, it is valued for its therapeutic properties against a range of ailments, including gastrointestinal, hepatic, and inflammatory disorders. The plant is rich in bioactive compounds such as alkaloids, flavonoids, tannins, and phenols, which contribute to its reported antioxidant, anti-inflammatory, and antimicrobial activities. This study aimed to investigate the phytochemical, antimicrobial and proximate analysis of *Citrullus Colocynthis* (L.) Schard. collected from Naseerabad Balochistan. This current study is designed to perform the quantitative analysis of nutritional composition and Antimicrobial analysis of *Citrullus Colocynthis* (L.) Schard from Balochistan. We investigated the nutritional and pharmacological composition of *Citrullus Colocynthis* (L.) Schard. This aid in understanding the value in the health benefits, as food value and medicinal applications. The moisture content of *Citrullus Colocynthis* (L.) Schard was recorded as 83% whereas ash content was 20.7%. Phytochemical analysis confirmed the presence of alkaloids, tannins, terpenoids, and flavonoids in the *Citrullus Colocynthis* (L.) Schard. The proximate analysis demonstrated notable percentage of protein, oil, carbohydrates, and dietary fiber. The fruit demonstrated notable antimicrobial effects, supporting its traditional use as a therapeutic agent. *Citrullus colocynthis* possesses a rich phytochemical and nutritional profile, with significant antimicrobial activity supporting its traditional medicinal uses. These findings suggest its potential as a source of bioactive compounds, warranting further pharmacological and clinical investigations.

**Keywords:** *Citrullus colocynthis*; Phytochemical composition; Antimicrobial activity; Nutritional analysis

**RAPS-25-80: Assessment of Heavy Metal Enrichment and Contamination Gradient in Roadside Soil and Vegetation of N-70 Highway Corridor, From Karamdad Qureshi to Dera Ghazi Khan, Pakistan**

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Road dust is one of the main sources of environmental pollution in urban areas. Long-term environmental pollution can be caused by automobiles emission (heavy metals). In methodology, the roadside soil and plant samples were taken from four sites along N-70 National Highway from Karamdad Qureshi to Dera Ghazi Khan. Samples were digested and analyzed for heavy metal content through atomic absorption spectrophotometry (ASS). The content of heavy metals at four sites were as follows in descending order Cd > Cr > Cu > Ni > Pb. Results showed the content of Cd was found to be highest among all metals which is more than 2 folds in plants species of *Albizi lebbeck* in December at site (C) and *Delbergia sisso* in October at site (C). Pb was lowest content which was 27% in *Calotropis gigantea* in September at site (B). The roadside soil is polluted mainly by Cd more than 3-fold in *Vachellia nilotica* in December at site (B). Cr was the second most abundant metal along the roadside in plants and soil. The chromium concentration was observed more than 1 folds in October at site (B). In *Euclayptus hybrida*, Ni was the slightly lower along the road and the concentration was 15% in month of December at site (D). Pb was lowest content which was 11% in *Conocarpus lancifolius* in September at site (B). These findings highlight the significance of monitoring and deliberate environmental management to reduce heavy metal contamination on Pakistan's roadways. The uneven forms of contamination that show complicated nature of pollution and their impact on our ecosystems and health. By relating plant-based remediation technologies with difficult environmental management. It may work towards minimizing heavy metal contamination and preserving both our environment and our communities.

**Keywords:** Vehicular emissions; bioaccumulation; toxicity; metal content; abiotic stress; spectrometer.

## **RAPS-25-81: Production of Bio Enzymes from Organic Waste and its Impact on Spinach (*spinacia oleracea* L.) Performance**

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The rapid increase in population and urbanization is one of the causes of significant enrichment of organic waste worldwide. Therefore, this study was conducted for organic waste management by using fruits and vegetables peels for the formation of bio enzymes. Bio enzymes produced from fruits and vegetables peel also play an important role by enhancing plants growth which act as natural fertilizers. In this study, prepared bio enzymes was used to inspect its impact on spinach (*Spinacia oleracea* L.). Bio enzymes was extracted through enzymatic hydrolysis from peels of fruits and vegetables such as orange, peas and cauliflower. The extracted bio enzymes applied to Spinach plant under natural conditions to assess their effects on growth and yield parameters of Spinach (*Spinacia oleracea* L.) by using randomized complete block design consist of 13 treatments. Results showed the significant impact of BOCPZ on vegetative growth like plant height (98 % increase compared to control) leaf area, length, number of leaves (45% increase compared to control), plant fresh weight (48% increase as compared to Control) and chlorophyll content (50% as compared to T1). Antioxidant analysis also indicates significant impact on spinach SOD (28%), POD (50%), CAT (66%) compared to control. In addition, significant protease, amylase and lipase activity have been found in BOPZ, BCPZ, BPPZ and BOCPZ between 6-7 pH. Whereas biological and economical yield showed a non-significant impact on all treatments. The manufacturing of bio enzymes from fruit and vegetable peels offers effective strategy for the better development of plants as they are chemical free and natural fertilizers.

**Keywords:** Bio enzymes; biological yield; fruits and vegetable peels; spinach

## **RAPS-25-82: Investigating Ethnobotanical Aspects and Habitat Patterns in Dera Ghazi Khan, Punjab, Pakistan**

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The present study refers to the ethno-phytological observation between the human cultures and plants. This study documented the traditional uses of ethnobotanical plants used by the indigenous communities. Ethnobotanical field trips were conducted along Dera Ghazi Khan for data collection from November 2024 to January 2025. Semi-structured interviews were conducted to collect the data. Altogether, 80 plant species were documented. Quantitative indices such as Relative Frequency of Citation (RFC), Fidelity Level (FL) were used to evaluate the cultural importance of ethnobotanical taxa. The Fabaceae family was dominant with 11 species followed by Poaceae (7 species) and Malvaceae (5 species). Plants were collected from various habitats. The Leaves (26 species) were frequently utilized plant parts followed by seeds (15 species), flowers and fruits (9 species) each. Among the crude drug formulation, powdered form was dominant with 39 medications, followed by infusion (27 medications) and decoction (25 medications). Maximum medicinal taxa were used to cure dermal ailments (22 species), followed by abdominal disorders (21 species) and gastrointestinal disorders (19 species). The RFC of the documented species were recorded from 0.254 to 0.03. The highest RFC of *Pennisetum glaucum* was 0.254. The FL of recorded species ranged from 100% to 16.6%. The highest FL of *Vitis vinifera* was 100%. The study concluded that the value of current ethnobotanical knowledge was significantly impacted by variety of factors, including outmigration, urbanization, younger generation lack of interest, and the use of allopathic treatments. These results support concrete initiatives to preserve the ethnobotanical plants and related knowledge of the region under study.

**Keywords:** Ethnomedicinal plants; indigenous knowledge; phytotherapy; relative frequency citation; traditional medicines

## **RAPS-25-83: Exploring the Bio-Preservative Potential of Garlic and Ginger Extracts on Bitter Gourd (*Momordica charantia* L.)**

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Bitter gourds (*Momordica charantia* L.) are extremely degradable fruits they face great damage, which leads to huge post-harvest losses. The current research explored the how ethanolic extract of garlic (*Allium sativum*) and ethanolic extract of ginger (*Zingiber officinale*) contributed in prolonging the shelf life and in boosting the fruit quality of bitter gourds while storage. The extracts were obtained by using ethanol as a solvent and applied to bitter gourds by using immersion method. Alterations in Physicochemical characteristics encompassing loss in length and weight, change in color, shrinkage, sensory evaluation, total chlorophyll content (TCC), reducing sugar (RS), total protein content (TPC), catalase (CAT), peroxidase (POX) activities were checked periodically during the process of storage at optimal ambient conditions. Results showed that those bitter gourds that were treated with ethanolic extract of garlic and ethanolic extract of ginger showed significant ( $P < 0.05$ ) improvement in their shelf life as compared to those that were treated with distilled water only. Retention, firmness and mushiness was highly observed in bitter gourds during storage that were treated with the ethanolic extract of garlic and ethanolic extract of ginger. Results also revealed that less dose of ethanolic extract of garlic and ethanolic extract of ginger extracts having concentration among (0.1%, 0.2%, 0.3%) exhibit minute morphological changes in bitter gourd, less shrinkage and less discoloration was observed in those bitter gourds that were treated with less doses of ethanolic extract of garlic and ethanolic extract of ginger. The pattern in decline of weight in bitter gourds that were treated with ethanolic extracts of garlic and ginger was Garlic 0.4% < Ginger 0.4% < Garlic 0.2 % < Ginger 0.2 % < Garlic 0.3 % < Ginger 0.1% = water < Garlic 0.5 % < Ginger 0.4 % < Garlic 0.1% < Ginger 0.3%. Moreover, Mass liquid chromatography - mass spectrometry (LC- MS) analysis of ethanolic extract of garlic and ethanolic extract of ginger indicated that possible antifungal compounds like Dihydroxydrocinnamic acid, Ergosterol, and Pentacosanoic acid exhibit more antifungal properties and antimicrobial attributes presence of such compounds declined the growth of fungi and other microbes. Further research vindicates to illuminate the mechanism underlying the effects examined and optimize the application methods for execution on commercial level. This research is very important in formulation of eco - friendly and viable strategies to overcome post-harvest loss for agricultural revolution.

**Keywords:** Bio-preservation; garlic extract; ginger extract; bitter gourd (*Momordica charantia* L.); natural preservatives; antimicrobial activity; shelf-life enhancement; phytochemicals.

## **RAPS-25-84: Evaluating the Effects of Seed Priming Techniques on Germination and Seedling Growth in *Ipomoea hederacea***

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Seed priming is a simple, cost-effective, and eco-friendly technique that enhances seed germination and early seedling growth. In this study two priming methods, hydropriming and osmopriming were applied to evaluate their impact on the germination and growth of *Ipomoea hederacea* (ivy-leaved morning glory) seeds. Numerous studies have highlighted the selected plant horticultural significance, emphasizing its ornamental appeal, effectiveness in erosion control, and potential use as green manure. The experiment was conducted under greenhouse and laboratory conditions. The root, stem and leaf seedling length and seed germination (%) in petri dishes and pot were evaluated according to standard protocol. Seeds were soaked for different period i.e 6h, 12h and 18h for hydropriming treatments. The 18-hour treatment produced the best results in terms of seedling growth and germination rate. Osmopriming was performed using potassium phosphate ( $K_3PO_4$ ) at different concentrations: 0.5%, 1.0%, and 1.5%. A significant increase in growth rate and germination was observed at the 1.5% concentration in the pot experiment. The maximum and minimum seedling root lengths  $7.5 \pm 0.06$  cm and  $3.9 \pm 0.04$  cm were recorded at 1.5%  $K_3PO_4$  and in the control group, respectively, in the pot experiment. Similarly, the highest and lowest stem lengths  $14.36 \pm 0.08$  cm and  $2.3 \pm 0.01$  cm were also noted under the same treatments. Leaf length followed the same trend, with the highest value ( $3.9 \pm 0.04$  cm) observed at 18 hours and the lowest ( $0.09 \pm 0.01$  cm) in the control group. The highest fresh weight ( $1.4 \pm 0.02$  g) and the lowest dry weight ( $0.01 \pm 0.001$  g) were recorded in the 1.5% potassium phosphate treatment and the control group, respectively, across both pot and Petri dish experiments. Compared to unprimed seeds (control). These results underscore the effectiveness of seed priming as a low-cost, practical approach for improving crop establishment and productivity. The findings support its potential integration into modern agriculture for more sustainable and efficient farming practices.

**Keywords:** Priming techniques; crop productivity; farming practice

## **RAPS-25-85: Environmental Monitoring of Heavy Metal Pollutants in Roadside Flora, Dera Ghazi Khan to Jampur**

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The vehicular emission is the vital source of heavy metals contamination in roadside soils and vegetation, posing the different environmental and ecological risks. Among the various forms of pollution, air pollution is considered the most detrimental, with vehicular emissions being a major contributing factor. The vehicular emission (heavy metals) accumulate in the biosphere through both natural processes and anthropogenic activities. This study assessed the concentrations of heavy metals like lead (Pb), cadmium (Cd), chromium (Cr), nickel (Ni) and copper (Cu) in soil and selected plants. Both the soil and plants samples were collected from four high-traffic sites along the Indus Highway (N-55) from Dera Ghazi Khan to Jampur, from September to December. These samples were digested and analyzed using atomic absorption spectrophotometry (AAS). The results revealed elevated heavy metal concentrations in both soil and vegetation, with peak accumulations observed in November, followed by a slight decrease in December. Among the studied plants, *Suaeda fruticosa* showed the highest Pb (2.78 mg/kg) uptake. *Conocarpus erectus* showed the highest metal uptake, particularly for Cr (2.85 mg/kg), Ni (2.86 mg/kg) and Cu (2.48 mg/kg). Whereas the maximum concentration of Cadmium (2.16 mg/kg) was uptake by *Ziziphus mauritiana*. The *Prosopis juliflora* also showed significant contamination. Soil metal concentrations followed the order: Ni > Cr > Pb > Cu > Cd, with Site A (Paigan) and Site D (Jampur) recording the highest metals levels. The findings highlight the persistent deposition of heavy metals due to vehicular emissions, emphasizing the need for mitigation strategies to reduce environmental and health risks in high traffic zones.

**Keywords:** Toxicity; metal toxicity; vehicular emission; abiotic stress; spectrophotometer.

## **RAPS-25-86: Green Synthesis of Magnetic Iron Oxide Nanoparticles Using Green Tea Waste Extract for Environmental Applications**

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Magnetic iron oxide nanoparticles have drawn great attention because of their distinctive nature and inimitable magnetic properties. The traditional synthesis techniques of magnetic Fe<sub>3</sub>O<sub>4</sub> Nps usually rely on utilizing harsh chemicals and harmful reducing agents, which raises environmental concerns and safety problems. To counter these problems, the present study concentrates on the green synthesis process for the preparation of magnetic iron oxide nanoparticles by utilizing *Camellia sinensis* (green tea) waste extract. The richness of phytochemicals, including polyphenols, flavonoids, alkaloids, tannins, and vitamins, makes green tea waste a natural, suitable reducing and stabilizing agent for the preparation of magnetic nanoparticles. The preparation process utilizes the ferrous sulfate and ferric chloride solutions along with the green tea waste extract. The immediate change in colour is produced by mixing the solutions of ferrous sulfate (FeSO<sub>4</sub>) and ferric chloride (FeCl<sub>3</sub>) with the waste extract. The mixing of waste extract with the salt solutions reduces the Fe<sup>3+</sup> and Fe<sup>2+</sup> ions for the formation of iron oxide (Fe<sub>3</sub>O<sub>4</sub>) nanoparticles. The pH was maintained at 11 using NaOH. The development of magnetic nanoparticles was initially confirmed by the change in the colour of the solution and their attraction towards a magnet. The nanoparticles were collected and dried to obtain them in a fine powder form. The prepared nanoparticles were further characterized by using SEM, FTIR, XRD and UV-VIS spectroscopy to understand their morphology, structure and stability. This green synthesis approach contributes to a simple, cost-effective and eco-friendly way of producing magnetic nanoparticles, which can further be applied for wastewater purification, environmental remediation, etc.

**Keywords:** Green synthesis; magnetic nanoparticles; green tea waste; eco-friendly; water purification

## **RAPS-25-87: Ameliorative Role of *Galium asperifolium* Extracts in Hyperglycemia-Associated Cognitive Decline Induced by Streptozotocin**

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Both types of diabetes (type 1 and type 2) at a later stage are often accompanied by memory deficits, primarily due to oxidative stress, chronic inflammation, and insulin resistance, along with other additional health concerns. A novel investigation aimed to explore the hypoglycemic and neuroprotective potential of *Galium asperifolium* three extracts in a streptozotocin (STZ) induced diabetic model. In the current study male BALB/c mice were randomly divided into six different groups i.e. 1) The control 2) STZ (90mg/kg) 3) STZ (90mg/kg) plus crude extract (30mg/kg) 4) STZ (90mg/kg) plus ethyl acetate extract (30mg/kg) 5) STZ (90mg/kg) plus chloroform extract (30mg/kg) and 6) STZ (90mg/kg) plus Metformin (100mg/kg). A single dose of STZ was given, followed by extract administration intraperitoneally on alternate days for 3 weeks. Biochemical parameters, oxidative stress markers, inflammatory mediators, and cognitive functions were assessed using glucometer, antioxidant assays, spatial memory tests (Morris Water Maze and Y-Maze), and western blot analysis. GC-MS analysis was performed to identify key phytoconstituents. The findings indicate that all three extracts of *Galium asperifolium* significantly reduced STZ-induced blood glucose level, improved lipid profiles, and restored antioxidant enzyme levels. Notably, the extracts enhanced antioxidant enzymes such as Catalase (CAT), Superoxide Dismutase (SOD), peroxidase (POD), and Gpx (glutathione) and reduced Lipid Peroxidation (LPO) activity while inhibiting p-JNK and TNF- $\alpha$  expression, and subsequently increasing p-IRS to reduce insulin resistance. Behavioral tests revealed improvement in both short- and long-term memory. GC-MS identified phytol as a predominant compound, with known neuroprotective properties. In summary, *Galium asperifolium* extracts exhibit promising hypoglycemic and neuroprotective potential likely through their antioxidant and anti-inflammatory actions. These findings support its potential as a natural therapeutic agent for managing diabetes-associated cognitive dysfunction.

Keywords: Streptozotocin; hyperglycemia; p-JNK, TNF- $\alpha$ , insulin resistance

**RAPS-25-88: Wastewater Pollution Reduction through Biaxially Oriented Polypropylene Sorption Assemblies for Irrigating *Tagetes erecta* L.**

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Untreated wastewater used for the irrigation of plants threatens the health of both plants and soil. limit the ability to purify wastewater before recycling into irrigation due operational, maintenance, and infrastructure limitations. This study was conducted to present a convenient, economical, and eco-friendly wastewater treatment technique. Untreated wastewater samples from Hudiara drain near Mohlenwal village, Lahore were passed through sorption assemblies prepared by fabricating non-biodegradable propylene solid waste in a combined unit. The monitoring of TDS, fecal coliform, EC, resistance, oxidation reduction potential, ammonium-based nitrogen load and pH will compare the pollutant load at pre- and post-sorption stages. *Tagetes erecta* L. was irrigated with the treated wastewater to observe the impact of both treated and untreated wastewater on its morphological development. The pollutant load was reduced considerably in treated wastewater as compared to untreated wastewater through sorption assemblies. Biaxially orientated horizontal assemblies of propylene filters reduced TDS, FC, EC, ORP, pH, resistivity, salts and ammonium ions. Vertical propylene assemblies reduced resistance, ammonium ions, pH, TDS, FC, EC and ORP. Unlike the pollution load in untreated wastewater, the pollution drops in mixed assembly that is combined biaxially horizontal and vertical alignment contained TDS, FC, EC, resistance, ORP, salts, pH, and ammonium ions. Relatively low concentrations of heavy metals in *Tagetes erecta* L. collected biomass showed that the burden in the treated wastewater had reduced below permissible limits. Following the pattern  $Pb > Cr > Cd > Co$ , the concentrations of Pb, Co, Cd, and Cr decreased by 66%, 70%, 67%, and 72%, respectively. This study concludes that the physiosorption of polypropylene-based solid waste was sufficient for the treatment of mixed wastewater to an extent that the levels of heavy metals and other hazardous contaminants decreased below the allowable limits.

**Keywords:** Heavy metal reduction; physiosorption; polypropylene sorbent; *Tagetes erecta* L.; wastewater treatment.

**RAPS-25-89: Integrative Microscopy and Multigene Phylogenetic Inference Revealed *Inocybe khalidii* (Inocybaceae, Agaricales), a new ectomycorrhizal fungus from Pakistan**

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The family Inocybaceae represents an ecologically important lineage of ectomycorrhizal fungi with a cosmopolitan distribution across temperate and tropical forest ecosystems. Members of this family form symbiotic associations with a wide range of host plants and play crucial roles in nutrient cycling and forest health. Despite their ecological significance, the diversity of Inocybaceae remains poorly documented in many regions, including Pakistan. During systematic investigations of the macrofungal diversity of northern Pakistan, we discovered a novel taxon of the genus *Inocybe*, here described as *Inocybe khalidii*. The new species was identified through a combination of detailed morphological characterization and multigene phylogenetic analyses using nrITS, nrLSU, and tef1 sequences. Phylogenetic inference placed *I. khalidii* as a distinct and strongly supported lineage within the genus, showing close affinities with related taxa reported from Mexico, Japan, and the USA. Morphologically, *I. khalidii* is distinguished by its vivid orange, subglabrous pileus, large broadly ellipsoid basidiospores, and the near absence of caulocystidia. The discovery of *Inocybe khalidii* highlights the importance of continued exploration of under-investigated regions such as Pakistan, which remain reservoirs of undescribed fungal diversity. This study not only contributes to a better understanding of the systematics and biogeography of *Inocybe* but also provides insights into the global distribution patterns of ectomycorrhizal fungi. Our findings emphasize the urgent need for expanded taxonomic and molecular research on fungal groups in South Asia.

**Keywords:** Agaricales; Basidiomycota; Fungal Diversity; New species; South Asia

**RAPS-25-90: New and noteworthy *Inocybe* species (*Agaricales*, *Inocybaceae*) from Abbottabad District, Khyber Pakhtunkhwa, Pakistan**

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During recent mycological surveys conducted in the forested areas of the Abbottabad District, Khyber Pakhtunkhwa, Pakistan, several basidiomata belonging to the genus *Inocybe* were collected and examined. *Inocybe* is a species-rich genus comprising around 1000 described taxa worldwide. To date, approximately thirty species have been reported from Pakistan, indicating that the genus remains under documented in the country. The present study aims to enhance understanding of its diversity in Abbottabad district of Pakistan. Members of *Inocybe* are characterized by distinctively shaped basidiospores and the presence of cystidia, with stipe pruinosity determined by metuloid caulocystidia distribution. Morphological and microscopic analyses led to the identification of one species new to science, distinguished by its honey-yellow fibrillose pileus, nodulose spores, thin-walled cystidia, and variable presence of metuloid caulocystidia. Additionally, *I. laetior* is reported for the first time from Pakistan, identified by its honey-to olive-brown pileus, salmon- to flesh-colored stipe with a white base, and smooth, amygdaliform basidiospores. This species is previously known from United State, thereby extending its known geographic range. Another smooth-spored species, *I. subhimalayanensis*, previously recorded from the country, was also confirmed for the first time from Abbottabad District. These findings contribute to the growing knowledge of fungal diversity in Pakistan and highlight the need for continued exploration and taxonomic revision of agaricoid fungi in the region.

**Keywords:** Fungal diversity; *Inocybe*; new species; Pakistan; taxonomy.

**RAPS-25-91: Identification of *Orobancha minor* Parasitism using Hyperspectral Remote Sensing in Red Clover Cropping Systems.**

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Red clover (*Trifolium pratense* L.) is an important seed crop grown in Western Oregon. It is also the preferred host of small broomrape, *Orobancha minor* Sm. Small broomrape seeds found in red clover seed lots can lead to their rejection. A study was conducted to assess if parasitized red clover plants could be identified based on their spectral profiles. Leaf spectra were collected with a spectroradiometer from parasitized and non-parasitized plants grown in greenhouse and field studies. Spectral match/no match analysis was conducted using Mahalanobis (M-distance) between parasitized and non-parasitized plants. Principal component analysis (PCA) and independent t-tests were conducted to extract spectral regions that could be used to identify broomrape parasitism. Match analysis detected *O. minor* parasitism in 100% and 92% of the spectra in greenhouse and field plants (M-distance of >3), respectively. Greenhouse plants had higher M-distance values (range 6-36) compared to field plants (range 0-11) indicating more spectrally distinct characteristics in greenhouse grown plants. PCA captured 88% (PC1=0.54; PC2=0.34) and 83% (PC1=0.58; PC2=0.25) of the total variance between parasitized and non-parasitized plants from the greenhouse and field, respectively. Two spectral bands, containing 70 wavelengths within the green (529-582 nm) and red-edge (697-712 nm) regions were identified as common spectral regions in greenhouse and field grown parasitized red clover plants. The study demonstrates the potential for spectral discrimination of *O. minor* parasitism in red clover, but further analysis is needed to refine the spectral wavelengths and improve detection for timely control measures.

**Keywords:** Parasitic weeds; small broomrape; discrimination; field spectroscopy; seed production

**RAPS-25-92: Restoration of Soil Fertily and Enhancement of Mazie Yeild in Eucalyptus- afftetced Soil through Geosorbents**

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Soil health is essential for maintaining crop yield and the growth of eucalyptus (*Eucalyptus camaldulensis*) plantation is becoming more widely acknowledge as a danger to nearby agricultural soils because of nutrient depletion and allelopathic effects. For the production of maize (*Zea mays* L.), these types of soil degradation is a significant obstacle since it lowers growth and yield. Based on the hypothesis that biochar based geosorbents amendments, might lessen the deleterious effects of eucalyptus soils on maize productivity. This study sought to determine whether eucalyptus-influenced soils had an impact on maize performance and biochar may enhance the physicochemical characteristics of soil. The experiment was conducted in District Karak, Khyber Pakhtunkhawa, using a completely randomized design with three treatments: control soil, eucalyptus soil amended with 1% biochar and eucalyptus soil. The growth and yield characteristics of maize and the pH, electrical conductivity, organic matter, nitrogen and texture of the soils were measured. Maize plant height, root length and leaf area index, cob weight, cob length and grain yield (6.04 ton/ha) were all reduced by eucalyptus soil, but these parameters were enhanced particularly yield (11.89 ton/ha) by peanut husks biochar at higher pyrolysis temperature (600°C). Better structure and nutrient retention were indicated by increase in soil pH (7.38), organic matter (1.207%), nitrogen (1.0603%) and clay content (83%) and decrease in sand and silt. According to this study, biochar successfully reduces the allelopathic stress caused by eucalyptus, promoting sustainable maize production. Long term field trails with a variety of soils and crops should be investigated in future research.

**Keywords:** Eucalyptus affected soil; geosorbents; restoration soil fertility; maize production; sustainable agriculture

**RAPS-25-93: Role of high-density polyethylene components of urban solid waste in reducing wastewater irrigation–borne stress in *Dahlia pinnata* Cav.**

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In developing nations, wastewater that has been untreated is a source of significant danger to both plants and soil. This study examined the ability of High-Density Polyethylene (HDPE) components recycled from municipal solid waste to reduce wastewater-derived stress in *Dahlia pinnata* Cav. The HDPE assemblies were purpose- designed and deployed in vertical, horizontal, or mixed configurations. The treated wastewater was collected from the Hudiara drain in the city of Lahore. Concentrations of Heavy Metals (Cd, Cr, Pb, and Co) were determined using acid digestion followed by Atomic Absorption Spectrophotometry and physicochemical properties were analyzed before and after treatment as per APHA standards. Plant growth traits for both wet and dry weight, height, stem length, and leaf count were measured to evaluate the effectiveness of treatment. The results indicated that treated wastewater via HDPE assembly contained significantly reduced concentrations of heavy metals and organic contaminants. Accordingly, plants treated with HDPE indicated significantly improved plant growth with the greatest fresh ( $10.9 \pm 00.79\text{g}$ ) and dry weight ( $0.49 \pm 0.11\text{ g}$ ); and maximum height ( $35 \pm 3.7\text{ cm}$ ), stem length ( $14 \pm 2.9\text{ cm}$ ), and leaf number ( $9 \pm 0.8$ ), while plants that were exposed to untreated wastewater, displayed stunted growth, decreased leaf area, and chlorosis. Vertical assembly achieved the best soil remediation, effectively reducing lead, cobalt, chromium, and cadmium concentrations to a near-safe level. HDPE-based assemblies promote a sustainable and scalable way for treating wastewater enabling safer reuse in agriculture and supporting environmental conservation.

**Keywords:** *Dahlia pinnata*; environmental remediation; heavy metals; physisorption assembly; sustainable agriculture

**RAPS-25-94: Integrative Taxonomy Reveals A New Genus Within Clitocybaceae from Changa Manga Forest, Pakistan**

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Fungal diversity remains vastly underexplored, particularly in tropical and subtropical forests. During a survey of macrofungi in the Changa Manga Forest, Pakistan, several specimens were collected that could not be assigned to any known genus within the *Clitocybaceae*. The updated classification of *Clitocybaceae* currently recognizes six genera: *Collybia*, *Lepista*, *Clitocybe*, *Dendrocollybia*, *Singerocybe*, and *Pseudolyophyllum*. Detailed morphological investigations and ITS-based phylogenetic analysis revealed that these specimens form a distinct and well-supported lineage, independent from all recognized genera of the family. The basidiomata of the newly proposed genus are medium-sized, featuring a convex to plane, white to cream, smooth, and non-hygrophanous pileus, unlike the often colored, hygrophanous, or pruinose pilei characteristic of *Lepista*. The lamellae are adnate to decurrent, whereas in *Lepista* they vary from adnate to sinuate or weakly decurrent. The stipe is centrally positioned hollow, and lacks both annulus and volva, in contrast to the solid or stuffed stipe typical of *Lepista*. Cystidia are polymorphic and well-developed, a feature absent in *Lepista*. The basidiospores are ellipsoid to ovoid, smooth, thin-walled, and non-cyanophilic, differing from the verruculose, thick-walled, and distinctly cyanophilic spores of *Lepista*. The spore deposit is white to cream rather than pale pinkish buff as in *Lepista*. Basidia are clavate to broadly clavate and mostly 4-spored, but unlike *Lepista*, the basidial walls are non-cyanophilic. Based on combined morphological and molecular evidence, we propose a new genus within the family *Clitocybaceae* from Pakistan.

**Keywords:** Fungal diversity; ITS; new genus; morphology; phylogeny

## **RAPS-25-95: Effectiveness of Rhizobacteria for Growth Promotion of Pea (*Pisum sativum*) under Drought Condition**

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Drought stress is a major abiotic factor constraining global crop productivity. This study investigates the efficacy of plant growth-promoting rhizobacteria (PGPR), specifically *Bacillus subtilis* and *Pseudomonas fluorescens*, applied individually and as a consortium, to enhance drought tolerance in pea (*Pisum sativum* L.) plants. The study combined in vitro and in vivo approaches. Pea seedlings were subjected to drought stress (simulated by 20% and 40% PEG concentrations) in bioassays. The impact of individual PGPR strains and their consortium on germination and seedling growth was quantified. An in vivo pot experiment evaluated their effect on mature pea plant morphology (Plant height, number of leaves, number of nodes, internode length, fresh and dry weight ) and key physiological and biochemical parameters (membrane stability index, chlorophyll a, chlorophyll b, carotenoid, phenols, reducing sugar, protein, peroxidase and catalase) under drought conditions. Drought stress significantly inhibited germination and seedling development in vitro. PGPR inoculation markedly reversed these effects, with the consortium showing superior efficacy, increasing germination by up to 233% and radical dry weight by 464% at 20% drought similarly under 40% stress consortium significantly restored growth enhancing radical and plumule length by up to 257% and 225% respectively,. Biochemically, drought stress elevated protein content and defense enzyme activities (PO, PPO, PAL). Inoculation with *B. subtilis* and *P. fluorescens*, especially the consortium, modulated this stress response, maintaining higher relative water content, chlorophyll stability, and reducing the need for extreme enzymatic defense activation. The results demonstrate that a consortium of *B. subtilis* and *P. fluorescens* is a highly effective strategy for mitigating drought stress in peas. The consortium outperformed individual strains by enhancing morphological growth and stabilizing physiological and biochemical status, positioning it as a promising bio- inoculant for sustainable agriculture in water-limited environments.

**Keywords:** Drought stress; abiotic stress mitigation; peas; rhizobacteria (PGPR); biostimulants

## **RAPS-25-96: Exogenous gamma amino butyric acid (GABA) induced salinity tolerance by modulating morpho-anatomical features in wheat**

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Gamma amino butyric acid (GABA) is an important four carbon, non-protein amino acid that regulates plant growth under stress conditions. Our study investigated the effect of exogenous GABA application on morpho-anatomical traits and growth of wheat cultivars i.e., FSD-08 and ANAJ-17 under salinity stress. The experimental treatments comprised of two salinity levels i.e., 0 and 120mM NaCl and four levels of GABA i.e., 0, 1, 2 and 3mM. Results revealed that GABA application improved the plant height (3.22 %, 6.58%), shoot fresh weight (17.4%, 18.5%), shoot dry weight (15.2 %, 22.6%), root dry weight (3.67%, 3.79%), root length (9.18%, 4.76%), shoot length (2.80%, 8.46%), leaf area (26.6%, 3.01%), awn length (14.7%, 6.7%), number of leaves and roots (5.89%, 13.6% and 8.1%, 2.32%) for ANAJ-17 and FSD-08, respectively. GABA induced anatomical modifications in term of stem radius, epidermal thickness, sclerenchyma thickness, phloem cell area, root cortical thickness, cortical cell area, endodermal thickness, endodermal cell area, and pith radius were increased (7.53%, 21.1%, 63.3%, 61.4%, 9.30%, 7.30%, 7.69%, 7.31% and 11.7%) for ANAJ-17 at 2mM and (14.6%, 18.5%, 26.7%, 62.1%, 25.9%, 37.4%, 33.1%, 45.5% and 41.7%) for FSD-08 at 3mM under saline conditions. Exogenous application of GABA reduces the presence of reactive oxygen species (ROS), regulates stomatal aperture, enhances photosynthesis, activates antioxidant enzymes and upregulates genes in wheat under salt stress. Overall, exogenous GABA application modulate ion homeostasis to improv the performance of wheat plants under saline conditions.

**Keywords:** Anatomy, GABA, Growth, Salinity, ANAJ-17, FSD-08

**RAPS-25-97: Development of Biogenic Nano-Based Formulations for Increased Callogenesis in *Curcuma Longa***

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Turmeric has attracted a significant amount of interest in recent years due to its strong antimicrobial properties. The tissue culture of turmeric is preferred to obtain disease-free, highest number of plantlets with good uniform chemistry. However, there is a need to increase the speed of the whole process to meet the growing demand for planting materials and to save time and resources. Iron oxide nanoparticles (Fe<sub>3</sub>O<sub>4</sub> NPs) showed ipositive effects on callus initiation time, proliferation rate, percent root response, shoot engh, percent rooting, and number of roots per explant. Highest callus induction, i.e., 80%, was recorded in cultures that were grown in the presence of 15 mg/L of Fe<sub>3</sub>O<sub>4</sub> NPs. Callus initiated earlier in culture tubes that received green synthesized iron nanoparticles in a concentration between 10–15 mg/L. Biofabricated nanoparticles were characterized for their size, physiochemical, and optical properties through UV–Vis spectroscopy, FTIR, XRD, and SEM. Curcuminoids profiling was performed by implementing LC-MS that revealed increased quantities in plantlets grown in nano-supplemented media when compared to the control.

**Keywords:** Nanotechnology; turmeric; curcuminoids; Fe<sub>3</sub>O<sub>4</sub> nanoparticles; antimicrobial

## **RAPS-25-98: Ecological implications of microplastic pollution in soils**

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Microplastic pollution has emerged as a pervasive contaminant in terrestrial ecosystems, particularly soils. Sources of soil microplastics include agricultural practices such as wastewater irrigation, the use of plastic mulching films, sewage sludge application and atmospheric deposition. Due to their persistence, small size, and high surface area-to- volume ratio, microplastics can interact with soil minerals, organic matter and various chemical pollutants, thereby altering soil physicochemical properties. These changes can influence nutrient cycling, water retention and soil structure. Additionally, microplastics can adsorb and transport heavy metals and persistent organic pollutants, enhancing their bioavailability or altering their mobility. Ecologically, microplastic contamination may impair plant germination, root growth, and nutrient uptake, while also affecting soil microbial diversity, and enzymatic activities. Soil fauna, such as earthworms and nematodes, are susceptible to ingestion of microplastics, potentially leading to reduced reproduction, impaired mobility, and altered feeding behavior. The cascading effects on soil biodiversity and function may compromise ecosystem services such as carbon sequestration, water purification, and sustainable food production. While research on microplastics in marine environments is relatively advanced, terrestrial systems remain understudied particularly in terms of long-term fate, interactions with co contaminants, and trophic transfer within soil food webs. Addressing microplastic pollution in soils requires interdisciplinary approaches, integrating environmental monitoring, ecotoxicological studies, and policy measures aimed at reducing plastic input into terrestrial systems. This presentation highlights the current knowledge on the occurrence, sources, and ecological consequences of soil microplastic pollution, highlighting urgent research gaps and the need for sustainable management strategies.

**Keywords:** Plastics; soil pollution; risk assessment; wastewater

## **RAPS-25-99: Evaluation of Selected Elements in Guava (*Psidium guajava*) Fruit**

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Guava is a tropical fruit said to have originated from southern Mexico and Central America it belongs to a Myrtaceae family. Guava (*psidium guajava*.L) is an important fruit crop as it grown throughout the tropical and subtropical parts of Pakistan due to its a hard nature and wider adaptability. Guava is a climate fruit that molds quickly and is extremely perishable and has a shelf life of just 2-3 days at room temperature. Trace elements are found in the structural makeup of all living things and play an important role in biological processes. Guava samples (China gold, Desi guava, Choti surahi, Bari surahi) were randomly collected in 2021 from sewage-irrigated fields on Haroon Abad, Bahawalnagar, Punjab. The collected guava samples washed and then collected into small pieces, separating the seeds and pulp by using knife. Then samples were sun dried and then placed in an oven at 100 °C, make a fine powder by using commercial blender and stored in polythene bag. Then make a wet digestion and prepared the standards for different trace elements i.e., Ca, Fe, Mg, Na, Zn, K, Co, Cr, Cu, Mn and Cd. Samples were individually tested and evaluated in duplicate. Data were collected as mean  $\pm$  SD, one-way variance analysis (ANOVA) ( $p < 0.05$ ) and Correlation among different trace elements. The decreasing trend of average metal levels in the different guava fruits revealed following order  $Ca > Fe > Mg > Na > Zn > K > Co > Cr > Cu > Mn > Cd$ . Maximum concentrations of Mg were observed in Desi Guava, Ca, K, Fe, Zn, Mn, Coin Choti Surahi, Cr in Bari Surahi and Na, Cu, Cd were observed in China Gold. Correlation analysis revealed that very strong positive correlations were noted for following pairs; Ca-Mn ( $r = 0.526$ ), Ca-Cr ( $r = 0.807$ ), Mg-K ( $r = 0.553$ ), Mg-Cr ( $r = 0.523$ ), Na-Cu ( $r = 0.557$ ), K-Fe ( $r = 0.600$ ), Zn-Cu ( $r = 0.529$ ) and Co-Mn ( $r = 0.507$ ). Correlation study indicated mutual relationship among the essential and toxic trace metals Ca, Mg and Na with Cr, K and Cu. Correlation study indicated mutual relationship among the essential and toxic trace metals Ca, Mg and Na with Cr, K and Cu.

**Keywords:** Trace elements; Guava; AAS; statistical analysis

**RAPS-25-100: First Report of *Russula pseudoamoenicolor* from Shawar Valley, Swat District, Pakistan.**

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*Russula* is one of the most conspicuous gill mushroom groups among Basidiomycetes that forms ectomycorrhizal association with diverse groups of plants. This study investigated a *Russula* species from Shawar Valley, Swat District, Khyber Pakhtunkhwa Province, Pakistan. Specimen was examined based on macroscopic and microscopic features and the molecular phylogenetic analyses based on the nuclear ribosomal internal transcribed spacer region (nrITS). Both the morphoanatomical and molecular phylogenetic analyses confirms the species identity as *Russula pseudoamoenicolor* (from subsect. *Amoeninae*), with lightly depressed to depressed, pale purplish pink to dark purplish-red pileus with undate margins, adnate, close to crowded and pale yellow to light yellow lamellae, pale purplish pink to moderate purplish pink and clavate to ventricose shaped stipe, globose to sub globose basidiospores, fusoid to ventricose pleurocystidia and fusoid cheilocystidia. This study reports the first record of *Russula pseudoamoenicolor* from Shawar Valley. The findings highlight the diversity of macrofungi in this region and emphasizes the need for further surveys to record and preserve its fungal wealth, as many species may still remain undiscovered. Exploring such fungi not only improves our understanding of biodiversity and fungal ecology but can also provide insights into their potential roles in forest health, ecosystem functioning, and possible applications in food, medicine, and biotechnology.

## **RAPS-25-101: Impact Of Leaf Growth Stages On Lemon Grass Essential Oil Composition, Bioactivity And Toxicity Analysis For Drug Designing Using Computational Methods**

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Lemongrass (*Cymbopogon citratus*) essential oil plays a crucial role in managing digestion, blood cholesterol levels, inflammation, and the immune system. This study aimed determine the optimum leaf development stage for extracting essential oil enriched with therapeutic phytochemicals such as citral,  $\beta$ -myrcene, and perillaldehyde. In lemongrass, essential oil is produced by glandular trichomes. Microscopic analysis revealed the presence of capitate-stalked trichomes on the abaxial epidermis of the leaves. GC-MS analysis identified key phytochemicals such as citral and  $\beta$  myrcene in significant amounts across all leaf growth stages, with essential oil yields of 52.03% (lag phase), 64.26% (log phase), and 69.27% (stationary phase). Antioxidant activity was evaluated at 50  $\mu$ L/mL, with the highest value (84.42  $\pm$  0.03%) observed in the lag phase. Total phenolic content was also highest in the lag phase (1123.61  $\pm$  16.71  $\mu$ g GAE/g), whereas total antioxidant capacity reached its maximum in the stationary phase (0.7  $\pm$  0.15). The stationary phase exhibited the highest anti-inflammatory potential (82.12  $\pm$  0.04%). Both the stationary and lag phases demonstrated the highest antidiabetic potential compared to the commercial drug sitagliptinmetformin. The stationary phase exhibited the highest biofilm inhibitory potential against *S. aureus* (38.78  $\pm$  0.12%) and *R. solanacearum* (91.00  $\pm$  0.07%), while the lag phase showed the strongest inhibition against *X. oryzae* (89.57  $\pm$  0.01%). GC-MS analysis identified citral,  $\beta$  myrcene, and perillaldehyde. Toxicity assessments declared these compounds within safety range. Protein-protein interaction linked these phytochemicals to 44 genes associated with oxidative stress and infectious diseases. TNF, AKT1, and EGFR, among the top 10 genes identified by degree score. Hence *C.citratus* could be a significant source of citral, beta-myrcene and peril-aldehyde to cope with certain diseases and substitute synthetic perilous drugs.

**Keywords:** Beta myrcene, Citral, Cymbopogon, nutritional, pharmacology, phytochemical

**RAPS-25-102: Seed Priming Ameliorates Saline Stress by Inducing Physiological Changes and Improving Antioxidant Defence System in Spinach**

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Spinach (*Spinacia oleracea* L.), widely cultivated leafy vegetable of family Amaranthaceae, can experience salt stress which alters seed germination and plant's physiological and biochemical processes. Seed priming is an effective method to reduce negative impact of salt stress. However, few studies compared the impact of priming agents in spinach under salt stress conditions. In present study, we quantified the role of different priming agents including hydropriming, salicylic acid (1 mM), CaCl<sub>2</sub> (50 mM) and KNO<sub>3</sub> (1%) in spinach seed germination and plant growth under salt (100 mM NaCl) stress conditions. Plants exposed to salt stress showed severe decline in seed germination, seedling vigor index, number of leaves, leaf area, fresh and dry weight of leaves and roots, chlorophyll and carotenoid content, relative water content, electrolyte leakage, and increase in H<sub>2</sub>O<sub>2</sub> and MDA content. Different priming treatments alleviated the germination inhibition caused by salt stress to varying degrees, and 50 mM CaCl<sub>2</sub> and 1% KNO<sub>3</sub> were the most effective treatments. The CaCl<sub>2</sub> and KNO<sub>3</sub> primed seedlings showed improved superoxide dismutase and catalase activities in roots and leaves resulting reduced H<sub>2</sub>O<sub>2</sub> and MDA content and electrolyte leakage which improved membrane stability index in roots, root length, root and leaves dry weight, and chlorophyll a, b and total chlorophyll content. These results support the hypothesis that priming of seeds induces physiological changes in the plants, which ensures seed germination and plant growth under saline stress conditions.

**Keywords:** *Spinacia oleracea*, salt stress; hydropriming; halopriming; antioxidant enzymatic activity

**RAPS-25-103: First report of *Agaricus violaceopunctatus* from Jandiala Village, Punjab, Pakistan**

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*Agaricus* species are ecologically significant, yet their diversity remains poorly documented from underexplored regions like Pakistan. Samples were collected from different locations of Jandiala village, Punjab, Pakistan, followed by morphological examination based on macroscopic and microscopic features. Phylogenetic analysis was conducted based on ITS region of nrDNA. Both morphoanatomical and phylogenetic results confirmed the species identity as *Agaricus violaceopunctatus* (sect. *Minores*), with a unique pileus covered with bright violet squamules that are dense at disc becoming sparser towards the margins on creamy whitish background, convex to broadly convex pileus. Basidiospores were ellipsoid measuring,  $5-6.7 \times 3.1-4.5 \mu\text{m}$ , with a prominent apiculus. Basidia were narrowly clavate sometimes bisporic frequently tetrasporic. Cystidia were clavate to broadly clavate. Phylogenetic inference based on nrITS sequence strongly confirms the placement of this specimen within *A. violaceopunctatus*, having close affinity to holotype sequence. This study reports the first record of *Agaricus violaceopunctatus* from Jandiala village district Lahore. This study enhances the knowledge of Pakistan's fungal diversity and emphasizes the importance of exploring underexplored region.

**Keywords:** Basidiomycota; fungi; phylogeny; systematics; taxonomy.

**RAPS-25-104: Changes in Linear and Cyclic Electron Transport  
Due to Proline Application in Wheat (*Triticum Aestivum* L.)  
Cultivars Under Salinity Stress**

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The salinity induced reduction in growth and yield is mainly associated with changes in different physiological and biochemical processes, especially photosynthesis. These may be through activation of antioxidants or accumulation of osmo-protectants like proline. Proline is an important osmo-protectant and appears to play a major role in conferring resistance to salinity stress by mediating osmotic adjustment and/or protecting cellular structures such as PSII from oxidative stress generated in chloroplast. Present study explains up to what extent exogenously applied proline protects PSII functional activity from salt-induced toxicity in wheat cultivars differing in degree of salt tolerance. For this purpose, seven wheat cultivars used to analyze the changes in linear and cyclic electron transport of both photosystems. Salt stress caused the photo-inhibition of most PS-II in most cultivars. Salt stress induced reduction in quantum yield of PS-II and ETR-II was maximum in wheat cultivars Galaxy- 13, Pasban-90 and Millat-11 while reverse was true in S-24 and Faisalabad-08. Salt stress increased the NPQ in all wheat cultivars except Inqilab-91. However, 100 mM proline improved the efficiency of PS-II and ETR-II in leaves of salt stressed plants of all wheat cultivars. While it did not affect on NPQ in all cultivars of wheat, except Galaxy-13 where exogenous proline application increased it at high light intensity which was associated with increase in regulated protective component of NPQ. Efficiency and electron transport through PSI in all wheat cultivars was also reduced due to salt stress. This efficiency of PSI was reduced due to its donor and acceptor end limitation. Salinity stress caused reduction in both efficiency and electron transport chain through PSI due to acceptor end limitation of PSI in cultivar Galaxy-13, Millat-11 and S-24 while in others due to donor end limitation. Exogenous application of proline reduced the acceptor end limitation in Galaxy-13 and Millat-11 and donor end limitation in Saher-06, Galaxy-13 and Pasban-90 under saline condition. Overall, exogenous application of proline improved the photosynthetic performance in salt sensitive cultivar Galaxy-13 through increased the quantum yield of PSII, ETRII and NPQ. It also increased the quantum yield and ETR through the PSI by reducing the acceptor end limitation.

Keywords: Rapid light curve; compatible solute; foliar spray; salinity tolerance

## **RAPS-25-105: Bench-side to Bed-side Approach: A novel, natural remedy to treat Cardiometabolic Syndrome**

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*Berberis brandisiana* Ahrendt (Ishkeen, Shugloo) belongs to Berberidaceae family is dicotyledonous shrub traditionally used in various disorders like diabetes, arthritis, kidney stones, liver problems, wounds, infections, tumors, leucorrhoea, swellings. It is enriched with alkaloids, phenolics and flavonoids like berbamine, berberine, chlorogenic acid, gallic acid, quercetin, *p*- coumaric acid, ferulic acid, benzoic acid, *m*- coumaric acid. Its efficacy in preventing high fructose diet-induced diabetes has not yet been assessed. This study aims to investigate potential efficacy of HMEBB by using high fructose diet (HFR-Diet) fed diabetic rats. Male Wister rats were given high fructose diet (60%) for 8 weeks and oral doses of HMEBB (150 and 300 mg/kg) were administered for 6 weeks. After 14<sup>th</sup> weeks of study, HMEBB (150 and 300 mg/kg) treated groups exhibited significant decrease in FBG level, modified serum albumin, lipid profile and uric acid levels and significantly ( $p < 0.001$ ) modulated HbA1c, serum insulin, uric acid, eNOS, bilirubin level, lipid profile, electrolytes level as compared to only HFR-Diet exposed diabetic rats. Moreover, HMEBB (150 and 300 mg/kg) treated animals demonstrated cellular architecture preservation by modulation of TNF-  $\alpha$ , IL-6, adiponectin, leptin and levels of SOD, CAT and MDA significantly improved. Tissue architecture of pancreas, liver, kidney, heart and aorta was restored in histopathological study. Whereas, HMEBB (150 and 300 mg/kg) revealed up regulation of candidate genes thus exhibited notable results in treatment of diabetes, dyslipidemia and declined inflammation in HFR-Diet fed diabetic rats.

Keywords: *Berberis brandisiana*; adipokines; glucose transporter- 5; ketohexokinase, molecular docking.

**RAPS-25-106: Phytoremediation potential and ecophysiological responses of *Pistia stratiotes* L. for removal of cadmium and lead from polluted water: a viable option for agricultural resilience**

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Water bodies that are adversely affected due to heavy metal pollution are rendered unsafe both for drinking and irrigation purposes. Hydrophytes such as *Pistia stratiotes* L. (water lettuce) have tremendous remediation potential for heavy metals (HMs). However, studies on ecophysiological responses along with heavy metal tolerance to dose-dependent cadmium (Cd) and lead (Pb) are scant. This research evaluated the bioremediation potential and ecophysiological responses of *P. stratiotes* L. (water lettuce) by treating plants to varying CdCl<sub>2</sub> and PbCl<sub>2</sub> concentrations. Growth, morpho-anatomical and mitigation to stress responses in *P. stratiotes* L. were studied to understand phytoremediation strategy. The physico-chemical water analyses showed that heavy metal concentration directly affected pH, total dissolved solids, and electrical conductivity. The uptake of Cd and Pb in *P. stratiotes* L. roots was much higher (62 and 82% respectively) than in leaves at 15 mg L<sup>-1</sup>. Plants treated with (5 mg L<sup>-1</sup>) Pb and Cd maintained growth and physiological parameters due to enhanced activity of peroxidase and catalase enzymes and higher total phenols as well as leaf proline. Metal phytotoxicity was more pronounced at 15 mg L<sup>-1</sup> than at low and moderate concentrations of Cd and Pb in *P. stratiotes* L. Plants exposed to 5 and 15 mg L<sup>-1</sup> Pb showed reductions in chlorophyll compared to control plants. Similarly, the concentration of chlorophyll b was reduced by 64% and carotenoid content by 43% in plants treated with 15 mg L<sup>-1</sup> Pb compared to the control plants. Plants showed decreased aerenchyma, parenchyma, vascular tissues, and trichome length under increasing Cd and Pb concentrations. The sustainable strategies of water lettuce to adapt and mitigate metal contamination could serve in ecological restoration and decontamination of water bodies for environmental safety.

**Keywords** Water pollution · Heavy metal pollution · Leaf anatomy · Phytoremediation Water lettuce · Decontamination

## **RAPS-25-107: Effect of Climate Change on Biodiversity of Caspian Sea**

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Caspian Sea has big impact on climate and economy of regions located on coastal zones. The Caspian Sea often described as world's largest lake and sometimes referred to as a full-fledged sea. The flora and fauna of the Caspian Sea are rich in endemic species. Regulation of the Caspian rivers, illegal fishing and over-fishing, sea level changes, pollution, introduced species and climate changes are major negative factors on the biodiversity of the Caspian Sea. Ecological situation also affects biodiversity of wetlands connected to Caspian Sea. Gizilagaj Bay is one of the important wetland with rich biodiversity of flora and fauna. Over the centuries, Caspian Sea levels have changed in synchrony with the estimated discharge of the Volga, which in turn depends on rainfall levels in its vast catchment basin. The last short-term sea-level cycle started with a sea-level fall of 3 m (10 ft) from 1929 to 1977, followed by a rise of 3 m (10 ft) from 1977 until 1995. Such a significant change had a negative impact on its flora and fauna. Plant and animal life soon cover recently formed islands and turns them into an important component of onshore ecosystems. Loss of island status almost always has a negative impact on inhabitants of former island because the territory becomes more available for predators and people. This leads to reduction of the biodiversity of the island. Fishing along with other factors resulted in the complete loss of some species of fish and Cyclostomata. In the 1920-40's typical commercial species were Caspian lamprey, Volga shad, Caspian trout, Caspian inconnu. The total catch of these species was about 80 thousand tonnes. The magnitude of fossil fuel extraction and transport activity in the Caspian also poses a risk to the environment. The island of Vulf off Baku, for example, has suffered ecological damage as a result of the petrochemical industry; this has significantly decreased the number of species of marine birds in the area. Pollution is a significant threat to the biodiversity of the Caspian. The sources of pollution are industrial, agricultural and accidental discharges and sewage. The main flow of pollution comes from Volga. The Volga input contains discharges from other sources that did not accumulate in reservoirs and its delta. The Volga discharges are comparable with oil field and industrial discharge from the Baku and Sumgait facilities and with the Kura discharge. The highest level of pollution was observed in late 1980's. The most typical toxicants in the Caspian are petroleum hydrocarbons, heavy metals, phenol, surfactants, chloral-organic pesticides. Measures for protection of biodiversity and water ecosystems: Including both big and small Gizilagaj bays were added to the Ramsar List of Wetlands of International Importance, Mainly as

Waterfowl habitats. Within the project of Rich basins annually 6- 7 million baby fish are released annually. Hircan forests located mostly on coastal zone of Caspian Sea added to UNESCO World Heritage list in September 2023. Hircan forests have big significance and first natural area in Azerbaijan to achieve this status. "My Clean Country" Initiative activities conducted in over 20 regions and cities. In 2023: 42,522 meters of synthetic netting and in 2024 36,900 meters of synthetic netting was removed so far. This project is ongoing. Along with outlined projects also programs on ecological education are conducted by The Ministry of Ecology and Natural Resources and other related organizations.

### **RAPS-25-108: Assessing the impact of deashed biochar on alleviating salinity stress in *Pisum sativum***

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One of the most common environmental stressors is salinity it significantly affects the plants ability to uptake water and nutrients in turn is a major constraint to agricultural productivity. It creates an ionic imbalance that has many deleterious effects, including inhibited cell division, decreased photosynthesis, and premature senescence. This issue is especially acute in arid and semi-arid regions, where salinity accumulation is exacerbated by saline irrigation and high evapotranspiration rates. Therefore, sustainable methods for salinity control and maintaining crop productivity are needed to mitigate this problem. Biochar which is created during biomass pyrolysis and has a porous structure and high surface area is considered a potential means to alleviate salinity stress in soils owing to its positive impact on soil water retention, nutrient availability, and microbial action. More recently a highly purified version of biochar deashed biochar (DABC) was developed through ash removal enhancing its properties to regulate salinity stress. Herein the role of DABC in alleviating salinity stress in pea plants (*Pisum sativum* L.) salt sensitive legumes is reported. A completely randomized design pot experiment was performed on different DABC levels (0.5%, 1% & 1.5%) salt-stressed and non-stressed plants. As a result 1.5% DABC significantly enhanced shoot and root biomass possibly due to increased water use efficiency, absorption, and resting of several ions. Results show that DABC increased both net photosynthetic efficiency and chlorophyll concentration pointing towards the salinity decreased effects of photosynthesis and increased growth and vitality. Such results suggest that DABC is an ecofriendly soil amendment for alleviating salinity stress in pea plants. Field trials and a more comprehensive understanding of the underlying mechanisms are needed to confirm longer term benefits for soil health and crop productivity.

**Keywords:** Pea plant; biochar; salinity stress



## **RAPS-25-109: Evaluating the impact of GA3 and EDTA chelated moringa biochar on lady finger cultivate under nickel stress conditions**

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Nickel as a heavy metal, accumulates in soils due to natural and anthropogenic activities, resulting in inhibit seed germination, reduced growth and diminished yield, which are responses to physiochemical dysfunctional behavior. In order to examine the morphological, physiological, and biochemical responses of Ladyfinger (*Abelmoschus esculentus*) subjected to varying levels of Ni stress, an experiment was conducted at the Rahim Yar Khan Campus of The Islamia University of Bahawalpur. Gibberellic acid (GA3) is a potent phytohormone that is part of the tetracyclic diterpenoid family, playing an essential role in the germination of seeds and other elements of plant development, water absorption, signaling and the alleviation of seed dormancy. Moringa biochar (BC), a carbon enriched material made by pyrolysing organic materials like moringa leaves, can improve soil structure, microbial activity and nutrient retention. Because of its well-established capacity to enhance quality of soil and alleviate metal stress, biochar was selected as a remedial agent. The comprehensive investigation of morpho-physiological characteristics and biochemical reactions in a controlled laboratory setting offers significant knowledge about the possible advantages of these therapies. Three repetitions set up in a completely randomized design (CRD), where each sample of soil, weighing 5kg, was exposed to different concentrations of nickel (0 and 50ppm/kg), GA, with two levels (Oppm and 10ppm) and biochar (0.5% and 1%w/w basis). Thirty-six ladyfinger plant pots were raised under twelve different treatment combinations under Ni stress conditions. The simultaneous use of GA3 and 1% moringa biochar notably improved various parameters such as shoot fresh and dry biomass (9.54g & 1.09g), root fresh and dry biomass (1.68g & 0.3g), chlorophyll a (0.608mg/g), chlorophyll b (1.742mg/g), and total chlorophyll (2.351mg/g), seed germination rate (15.34%), total soluble protein (1.6 mg/g FW), along with reduction in total Ni (3.7 µg/g), Superoxide Dismutase (11.06 U/mg Protein), Peroxidase (16.49 U/mg Protein), Catalase (30.57 U/mg Protein), Ascorbate Peroxidase (35.63 U/mg Protein), phenolics (0.96 µg/g FW), flavonoids (2.25 µg/g FW), lycopene (159 µg/g), free proline (7.4 µmol/g FW) and MDA (1.05 nmol/mg Protein) across 50ppm Ni stress level contrast to the 50ppm Ni stress control group. The combined influence of GA, and BC resulted in optimal levels of total Ni, malondialdehyde (MDA) and flavonoids suggesting an enhancement in tolerance and a reduction of the negative impacts of Ni stress on growth of plant. The enhanced soil's resilience to heavy metal toxicity demonstrated how well BC and GA, may support ladyfinger growth. Gibberellic acid and EDTA chelated moringa biochar are found to be an efficient way to reduce nickel-induced stress in ladyfinger, offering a promising path toward sustainable farming methods. Ladyfinger stress caused

by nickel can be effectively reduced by using moringa biochar and gibberellic acid, indicating a promising alternative for sustainable farming practices.

**Keywords:** Nickel; GA3; EDTA; chelated; moringa; biochar; lady finger

### **RAPS-25-110: In-Silico Screening of Anti-Cancer Natural Compounds Targeting NF- $\kappa$ B as Identification of Potential Therapeutic Inhibitor**

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Cancer has become one of the leading causes of fatality worldwide. NF- $\kappa$ B (Nuclearfactor-kappa B) is an important factor for inflammation and immune response and its aberrant activation or irregular behavior leads to tumor cell proliferation and suppression of apoptosis giving rise to cancer development. This study investigates to identify the anti-cancerous lead molecules against NF- $\kappa$ B bound to DNA (PDB ID: 1A3Q) through virtual screening of 1574 anti-cancerous natural compounds taken from NPACT data base. All the compounds were docked against 1A3Q using PyRx and top ten molecules were selected for further study of ADMET analysis using ADMETlab3.0 and Protox 3.0. The top three natural compounds showed their stability against NF- $\kappa$ B depending upon their high GI absorption, less toxicity and high binding affinities. However, one of these compounds (PubChem ID: 21600009) promises the drug-like characteristics against cancer with binding affinity -8.7 kcal/mol as compared to other two molecules. Subsequently, the top compound selected from these analyses was taken to GROMACS 2022.4 to observe its dynamics and stability with the receptor molecule. The simulation was performed using the CHARMM36 force-field and TIP3P water model. To further validate the compound's viability as a drug, DFT analysis using B3LYP functional and 6-31G (d,p) basis set in Gaussian 9.0 was carried out to evaluate its electronic properties. These comparative studies highlight the potential drug candidate against cancer and further experimental validation of compounds is warranted to confirm their stability and biological efficacy.

**Keywords:** NF- $\kappa$ B (Nuclear factor-kappa B); NPACT; NF- $\kappa$ B inhibitor; computational screening; molecular docking; ADMET analysis; molecular dynamics (md) simulation; dft analysis.

**RAPS-25-111: Environmental Determinants of Algal Diversity and Community Structure in Relation to Water Quality Across Different Regions of Lahore.**

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Algae, ranging from microalgae to large seaweeds, comprise a diverse group of autotrophic organisms that play a crucial role in supporting ecological stability, nutrient cycling, and oxygen production in Earth's ecosystems. This study aims to identify different types of algae based on their morphological characteristics and to explore the relationship between biological diversity and the physicochemical properties of water in various regions of Lahore. Ecologically diverse habitats were selected based on location, aesthetic qualities, pollution levels, and human activities. Samples were collected from Kinnaird College, the Military Accounts area, WASA channels, Bagriyan Pond, and a canal in Lahore. A microscopic examination was conducted to identify the various algal specimens, resulting in the identification of three phyla, which belong to 14 orders, 14 families, and 14 genera. Among these, Ulnaria is a newly reported genera from Lahore, Pakistan among identified taxa. Chlorophyta (green algae) was the dominant phylum among those identified samples, with Spirogyra and diatoms being the most prevalent genera in the studied habitats. Some genera, such as Nostoc and Ulva, were represented by only one or two individuals in the selected areas. The WASA and canal waters exhibited the highest algal diversity. The findings of this study indicate that Lahore is a rich source of green algae and an ideal location for their cultivation. The research emphasizes the importance of algae in ecological monitoring and their potential applications in biotechnology.

**Keywords:** Algal diversity; ecological monitoring; chlorophyta

## **RAPS-25-112: Ameliorative Role of *Galium asperifolium* Extracts in Hyperglycemia-Associated Cognitive Decline Induced by Streptozotocin**

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Both types of diabetes (type 1 and type 2) at a later stage are often accompanied by memory deficits, primarily due to oxidative stress, chronic inflammation, and insulin resistance, along with other additional health concerns. A novel investigation aimed to explore the hypoglycemic and neuroprotective potential of *Galium asperifolium* three extracts in a streptozotocin (STZ) induced diabetic model. In the current study male BALB/c mice were randomly divided into six different groups i.e. 1) The control 2) STZ (90mg/kg) 3) STZ (90mg/kg) plus crude extract (30mg/kg) 4) STZ (90mg/kg) plus ethyl acetate extract (30mg/kg) 5) STZ (90mg/kg) plus chloroform extract (30mg/kg) and 6) STZ (90mg/kg) plus Metformin (100mg/kg). A single dose of STZ was given, followed by extract administration intraperitoneally on alternate days for 3 weeks. Biochemical parameters, oxidative stress markers, inflammatory mediators, and cognitive functions were assessed using glucometer, antioxidant assays, spatial memory tests (Morris Water Maze and Y-Maze), and western blot analysis. GC-MS analysis was performed to identify key phytoconstituents. The findings indicate that all three extracts of *Galium asperifolium* significantly reduced STZ-induced blood glucose level, improved lipid profiles, and restored antioxidant enzyme levels. Notably, the extracts enhanced antioxidant enzymes such as Catalase (CAT), Superoxide Dismutase (SOD), peroxidase (POD), and Gpx (glutathione) and reduced Lipid Peroxidation (LPO) activity while inhibiting p-JNK and TNF- $\alpha$  expression, and subsequently increasing p-IRS to reduce insulin resistance. Behavioral tests revealed improvement in both short- and long-term memory. GC-MS identified phytol as a predominant compound, with known neuroprotective properties. In summary, *Galium asperifolium* extracts exhibit promising hypoglycemic and neuroprotective potential likely through their antioxidant and anti-inflammatory actions. These findings support its potential as a natural therapeutic agent for managing diabetes-associated cognitive dysfunction.

**Key Words:** Streptozotocin, Hyperglycemia, p-JNK, TNF- $\alpha$ , Insulin Resistance

### **RAPS-25-113: Assessment of Kitchen and Laundry Greywater on Wheat Performance. Water Saving Strategy**

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Water scarcity is increasing worldwide due to climate change, rising population, and food demand. Greywater reuse is considered a sustainable way to save freshwater. This study tested the effects of kitchen greywater (KGW) and laundry greywater (LGW) on two wheat varieties, Abdul Sattar (ABS) and Dilkash (DIK), in pot experiments at Dera Ghazi Khan, Pakistan. Seven irrigation treatments were applied: tap water (control), 50%, 75%, and 100% KGW, and 50%, 75%, and 100% LGW. Laboratory tests showed that greywater contained higher salts and organic matter than tap water. Most growth traits, including plant height, leaf number, and biomass, were not significantly different among treatments. However, 50% KGW improved root length and fresh weight in ABS, while 75% LGW enhanced root growth in DIK at the seedling stage. At the reproductive stage, ABS produced the highest fresh weight under 75% KGW, while DIK gave the maximum grain yield (44.66 grains/spike) under 50% KGW, the only significant yield result. Biochemical responses showed that greywater increased proline and soluble sugars, indicating stress adaptation, while chlorophyll decreased slightly and peroxidase activity remained unchanged. The findings suggest that diluted greywater (50% KGW or LGW) can be used for wheat irrigation without major yield loss, but long-term risks from salts and detergents should be studied further.

**Keywords:** Antioxidant enzymes; proline; relative water content; waste water

**RAPS-25-114: Fast-track development of climate smart crops through genomics and marker assisted Innovative Technologies**

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Technological advances in sequencing and applications of bioinformatics tools have led to breakthroughs in crop genetic improvement. Genome-wide association studies (GWAS) leading to genomic prediction became possible after sequencing of reference genomes in many crops. Marker Assisted Breeding (MA) dramatically reduces the time required to identify crop genotypes with desired trait (s) and targeted transfer and pyramiding of genes with high precision. Fast-track MAB is need of the time to develop climate smart crop varieties that can survive attacks caused by several pathogens at once while also surviving in unfavorable environments along with good grain yield and quality. MAB has been an inexorable part of modern crop breeding programs with a long list of success stories. Practical examples of MAB for disease resistance genes (blight *Ph-3*, *ToMV* and *TYLCV* resistance *Tm-2<sup>2</sup>*, *Ty2* and *Ty3*), hybridity testing and genetic confirmation in tomato will be shared. Application of genetic markers in DNA fingerprinting of crop varieties and genetic confirmation of mungbean (*Vigna radiata*) and mashbean (*Vigna mungo*) interspecific recombinants will be discussed. Moreover, effective use of biochemical markers for Early Generation Marker Assisted Selection (EG-MAS) for abiotic (heat, salinity, drought, cold, herbicide & water deficit) and biotic stress tolerance will be explained in prospect of breeding crops for changing climate. Molecular diversity analysis through multiple marker systems (SSR, SNPs, CAPS, RAPD, ISSR, URPs, ASP, InDel, SCAR protein profiling) in wheat, rice, cotton, mungbean, lentil, chickpea, tomato, sesame and olive for climate smart allele mining will be shared. With a futuristic approach, establishment of GBS based (SNPs) platforms for GWAS and genomic assisted breeding (GEB) for nutritional quality and climate resilience in pulses will be elucidated.

**RAPS-25-115: Ethnobotanical Exploration of Medicinal and Wild Plants of Tehsil Kot Chutta, District Dera Ghazi Khan, Southern Punjab, Pakistan**

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This is the first ethnobotanical research on the wild and medicinal plants of the Tehsil Kot Chutta, District Dera Ghazi Khan, Southern Punjab, Pakistan. The questionnaire method was used in the current study based on field visit. There were 120 respondents, out of which 97 were males and 23 were females. The data were collected by local community about medicinal and wild plants species from 26 localities of Tehsil Kot Chutta, District Dera Ghazi Khan, Southern Punjab, Pakistan. This study contains ninety plants from 39 families and 43 genera that were used to treat fifteen distinct illnesses brought on by microbes. The family Asteraceae was dominant with ten species as compared to other families. Route of administration was divided into oral, and topical. The Relative Frequency of Citation (RFCs) of collected plant species were ranged from 0.17 to 0.005. The highest relative frequency citation values were recorded for *Azadirachta indica* (0.17), *Eucalyptus camaldulensis* (0.16) and *Phoenix dactylifera* (0.14). The fidelity level of collected plants ranged from 33.33 % to 75 %. The species used values varied from 0.090 to 1.5. Based on the ICF data, 15 major categories of disease were reported in this study. Informant Consensus Factor (ICF) for the species ranged from 0.00813 to 0.0476.

**Keywords:** Wild edible plants; cardiac nervous system; relative frequency of citation

**RAPS-25-116: Mushroom science and non green revolution**

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Mushroom science represents an innovative fusion of microbiology, fermentation technology, and environmental engineering that transforms agricultural waste into valuable food and nutritional products. From thousands of mushroom species worldwide, approximately 3,000 are edible, with commercially cultivated varieties including button, shiitake, oyster, and specialty fungi grown on diverse lignocellulosic substrates requiring precise environmental controls such as optimal CO<sub>2</sub>, oxygen, humidity, and light conditions. The non-green revolution, a transformative approach in global agriculture, describes how edible and medicinal mushrooms significantly enhance human welfare through the bioconversion of agricultural residues into nutritious food, thereby addressing three critical challenges; increasing food supplies, improving healthcare outcomes, and reducing environmental pollution. Mushroom cultivation demonstrates exceptional sustainability benefits; spent mushroom substrates effectively absorb toxic heavy metals and pollutants, while mycelia facilitate soil remediation processes. These fungi provide superior nutritional value, containing essential amino acids, B vitamins, minerals, and bioactive compounds with proven health benefits including immune support and potential anticancer properties. The global mushroom market, valued at approximately USD 73 billion in 2025, continues expanding at a compound annual growth rate of 9.6%, with projections reaching USD 147 billion by 2034. Asia dominates global production, accounting for 82.8% of output, while the industry responds to rising consumer demand driven by growing vegan populations, health consciousness, and recognition of mushrooms as sustainable meat substitutes. For developing nations like Pakistan, establishing robust mushroom cultivation infrastructure presents significant opportunities to address nutritional deficiencies, generate employment in rural communities, reduce environmental waste, and create substantial economic value through both domestic consumption and export markets.

## **RAPS-25-117: Genetic characterization of Cotton germplasm using SSR based markers**

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Cotton is one of the most significant fibre and oil seed crop all over the world. *Gossypium hirsutum* is a tetraploid crop with genome size of about 2.5 Gb. A high degree of genetic similarity in landraces is a major hindrance in development of genotypes with desired traits. Estimation of genetic divergence and phylogenetic relations of landraces are basic need of breeding programs. Simple sequence repeats (SSRs) are 2-5 bases of DNA stretches distributed throughout the genome. Genomic SSRs are developed from the genomic regions. These are highly polymorphic and useful for genetic diversity studies. EST-SSRs are derived from the coding regions of the genome and are less polymorphic but highly transferable. SSR markers being codominant, multi allelic, locus specific and highly polymorphic are most suitable to study genetic diversity and phylogeny of a crop. This study was planned to estimate the extent of genetic diversity and phylogenetic relationships between local genotypes and Chinese varieties of cotton using gSSRs and EST-SSRs. In this study 100 genotypes of cotton (*G. hirsutum*) (including 24 mutants and 76 (Chinese) non mutant genotypes) obtained from PGMB (Plant Genetic & Molecular Breeding) were used. All mutants were derived from NIBGE-2467 (IR-NIBGE-5) using EMS mutagen. 20 SSRs (11 gSSRs, 9 EST-SSRs) were selected from Cotton Microsatellite Database (CMD) and synthesized commercially to survey on these genotypes. SSR assay-based profiling was used to study the genetic diversity of all the Upland cotton genotypes. 11 primers (5 gSSRs and 6 EST-SSR) (64.6%) yielded polymorphic bands while, 9 (35.4%) were monomorphic. Data analysis and interpretation for phylogenetic analysis based on (UPGMA) was performed using MEGA Software. The 100 genotypes were grouped into five major clusters, 'A', 'B', 'C', 'D' and E. All mutant lines were grouped into cluster 'A'. The similarity matrix was constructed on the basis of Nei and Li (1979) coefficient. The range of variations in genetic similarity matrix in all 100 genotypes was 0.21 to 1 with the average of 0.61. 296-1 is the mutant line which showed least genetic similarity 0.21 (21%) with 568 M3 SEL (mutant line) while 97% genetic similarity with mutant line 199. Polymorphism information content (PIC) value of each SSRs was estimated based on allele frequency of all genotypes to find informative markers. Out of 20 SSRs, 10 markers are informative markers. PIC value ranged from 0.4959 (MGHES-37) to 0.8238 (MGHES-60) with average of 0.64. Results of this study generates an information of genetic relatedness of local genotypes being cultivated in Pakistan and Chinese genotypes. Results of this study will be very helpful in future breeding programs of cotton and other genetic studies as well to get improved cultivars.

**Keywords:** *Gossypium hirsutum*, SSR markers, EST-SSRs, phylogenetic analysis, genetic diversity, PIC value

**RAPS-25-118: Species diversity, taxonomy, molecular systematics of wood-inhabiting fungal genus *Phlebia sensu lato* (Polyporales, Basidiomycota) in China**

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The genus *Phlebia* accommodates numerous species of wood-inhabiting fungi within the phylum Basidiomycota. This project employs the morphological and phylogenetic approaches to revise the generic and species classification of *Phlebia* s.l. and surveys the species diversity in China. The phylogenetic analyses were performed using multiple gene regions viz. the internal transcribed spacer (ITS), the large subunit nuclear ribosomal RNA gene (nLSU), the translation elongation factor 1- $\alpha$  (tef1), the small subunit of mitochondrial rRNA gene (mtSSU), the glyceraldehyde 3-phosphate dehydrogenase (GAPDH), RNA polymerase II largest subunit (rpb1), and RNA polymerase II second largest subunit (rpb2). We recognize twenty genera of *Phlebia* s.l., including three new genera, seven new species and seventeen new combinations. Descriptions, illustrations, phylogenetic trees to show the placements, and notes of new taxa are addressed.

## **RAPS-25-119: Synergistic Effect of Bacterial Biostimulant and Humic Acid on Nickel Stress Tolerance in Soybean**

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Nickel toxicity is among the rising challenges of abiotic stresses affecting plant growth and productivity. Sustainable, eco-friendly solutions, such as Humic acid (HA) and Plant Growth Promoting Rhizobacteria (PGPR), have shown potential in mitigating heavy metal toxicity. This study investigates the individual and combined effects of HA and PGPR on nickel stress tolerance in soybean (*Glycine max* L). A completely randomized design was employed with seven treatments. Nickel stress was applied at a concentration of 50 mg/kg, and HA at 100 mg/kg per plant. Remote sensing at the leaf scale was conducted using a PolyPen RP410 spectrometer to quantify spectral indices such as NDVI, MCARI1, SIPI, ARI1, and CRI1. Morphological parameters, including shoot biomass, root length, and stem thickness, were evaluated, along with biochemical parameters such as SOD, APX, and CAT activities. Nickel stress significantly reduced shoot length by 18% and NDVI by 48.15%, while enhancing CAT (3.6 %) and SOD (17%) activities. PGPR treatment improved shoot length (4.81%), NDVI (16%), and leaf length (8.7%). HA alone promoted root growth. The combined application of HA and PGPR synergistically alleviated nickel stress, improving antioxidant enzyme activity, shoot biomass, and stem thickness, suggesting their potential for enhancing stress resilience in soybean. These findings demonstrate that integrating HA and PGPR can restore photosynthetic efficiency, promote metabolic balance, and strengthen the plant's adaptive defense mechanisms, offering a sustainable approach for managing metal-contaminated soils and supporting environmentally friendly crop production systems.

**Keywords:** Nickel stress; Plant Growth-Promoting Rhizobacteria; synergistic effect; antioxidant enzymes; humic acid

**RAPS-25-120: Naphthalene acetic acid alleviates hydrocarbon stress in Chinese flowering cabbage through physiological and metabolomic modulations**

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Petroleum-derived pollutants pose serious risks to crop health and yield, especially in urban agricultural systems. This study examined the potential of Naphthalene acetic acid (NAA) for mitigating the hydrocarbon stress; an environmentally relevant and unexplored stress conditions in Chinese flowering cabbage (*Brassica rapa* var. *parachinensis*). The plants were exposed to the 5% kerosene oil as hydrocarbon stress and were exogenously sprayed with two concentrations of NAA (50, 100  $\mu$ M). Hydrocarbon stress was significantly ( $p < 0.05$ ) reduced shoot length by 24.3%, and dry biomass by 40%. The exogenous application of NAA (50  $\mu$ M) under hydrocarbon stress significantly increased the shoot length, root length, fresh biomass and dry biomass. Whereas, NAA application at 100  $\mu$ M showed more pronounced effects on shoot length (54.31%), root length (63.94%), fresh biomass (58.01%) and dry biomass (47.29%), compared with hydrocarbon stress alone. Photosynthetic pigments and antioxidant enzyme activities (SOD, CAT, POD & APX) were also enhanced under NAA treatment, contributing to improved redox homeostasis. Untargeted metabolomics revealed extensive metabolic reprogramming, with modulation of amino acids, phenolic compounds, flavonoids, glucosinolates, and TCA cycle intermediates. Most upregulated metabolites and enriched pathways were linked to amino acid metabolism, phenylpropanoid biosynthesis, and central carbon metabolism, highlighting their role in osmotic adjustment, ROS scavenging, and stress signalling. The DSPC interaction network further indicated strong positive relationships between primary and secondary metabolites, demonstrating an integrated defense response. Overall, this study provides novel mechanistic insights into NAA-mediated mitigation of hydrocarbon stress, showing that NAA enhances growth, antioxidant defenses, and metabolic adjustments. While these findings highlight NAA as a promising laboratory-based strategy for phytoprotection in hydrocarbon-contaminated soils, further field validation is required before practical applications can be realized.

**Keywords:** Abiotic stress; kerosene oil stress; *Brassica rapa* var. *Parachinensis*; antioxidant enzymes; metabolomic analysis.

**RAPS-25-121: In-Silico Genome Wide Identification, Characterization and Expression Analysis of SOS1 Gene Family in *Gossypium hirsutum* L. Under Drought and Salinity Stresses**

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The global production of upland cotton (*Gossypium hirsutum*) has declined in recent years due to increasing drought and salinity stresses. The SOS1 gene family plays a crucial role in maintaining ion homeostasis and enhancing stress resilience. In this study, a genome-wide analysis was conducted to identify and characterize SOS1 genes, including assessments of gene structure, conserved motifs, chromosomal distribution, phylogenetic relationships, Ka/Ks ratios, cis-regulatory elements, protein-protein interactions, 3D structures, and phosphorylation sites. Fifteen SOS1 paralogs were identified in *G. hirsutum* and functionally characterized. The presence of cis-regulatory elements such as ABRE, DRE/CRT, and MYB motifs further supported their role in stress responses. Ka/Ks analysis indicated strong conservation among gene paralogs, with most under purifying selection. Protein-protein interaction analysis revealed SOS1 association with antiporters, facilitating Na<sup>+</sup> efflux across the plasma membrane to mitigate drought and salinity effects. To validate the in-silico findings, the expression of 15 genes was analyzed under drought and salt stress using publicly available RNA-seq data, leading to the identification of five highly responsive genes. Subsequently, cotton seedlings were exposed to 400 mM NaCl and 20% PEG, and quantitative real-time PCR (qRT-PCR) was performed at 0 h, 3 h, 6 h, and 12 h. Significant transcriptional changes induced by stress were confirmed, with consistent upregulation of *GhSOS1-5* and *GhSOS1-11*. Collectively, this study provides the first comprehensive characterization of the SOS1 gene family in *G. hirsutum*, highlighting its role in conferring tolerance to abiotic stresses. These findings offer valuable insights for future molecular breeding programs aimed at improving cotton resilience.

**Keywords:** In silico characterization of *SOS1*; Cis-regulatory elements; phylogenetic analysis; expression profiling of *GhSOS1*.

## **RAPS-25-122: Foliar Application of Salicylic Acid Improved Morpho-Anatomical Features of Potato by Irrigating with Wastewater**

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The current study was carried out to determine the effect of salicylic acid with different concentrations of drain water by growing *Solanum tuberosum* L. in soil. Salicylic acid was used in three different treatments as 0, 0.5 and 1 mM SA while concentrations of drain water were 0, 2, 4 and 6 % respectively. The treatment was given to plants on weekly basis. Different physico-chemical tests including heavy metals were performed before and after harvesting of the plants. *Solanum tuberosum* L. was grown for the 60 days and different morphological, physiological and anatomical parameters were studied. The maximum metal (Cd) uptake was recorded in leaves of potato tuber as compared to other metals. The results clearly depicted that the plant growth was increased with highest SA treatment (1 mM SA) following maximum concentration of drain water (6% DW). The growth of potato plant was increased as the concentration of salicylic acid increased. It was also observed that the heavy metal uptake was maximum in highest concentration of drain water when 1 mM of salicylic acid treatment was applied. The aim of study was to check the ability of the potato tuber by giving various treatments of salicylic acid and to check the uptake of heavy metal from the soil to the upper parts of plant (leaves) grown under different concentrations of drain water. The crop can be further applied in the field to minimize the effect of dangerous and toxic pollutants found in the industrial wastes.

**Keywords:** Drain water; salicylic acid; metals; *Solanum Tuberosum*; pollution

**RAPS-25-123: Integrative Taxonomy Reveals a New Genus within Clitocybaceae from Changa Manga Forest, Pakistan**

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Fungal diversity remains vastly underexplored, particularly in tropical and subtropical forests. During a survey of macrofungi in the Changa Manga Forest, Pakistan, several specimens were collected that could not be assigned to any known genus within the *Clitocybaceae*. The updated classification of *Clitocybaceae* currently recognizes six genera: *Collybia*, *Lepista*, *Clitocybe*, *Dendrocollybia*, *Singerocybe*, and *Pseudolyophyllum*. Detailed morphological investigations and ITS-based phylogenetic analysis revealed that these specimens form a distinct and well-supported lineage, independent from all recognized genera of the family. The basidiomata of the newly proposed genus are medium-sized, featuring a convex to plane, white to cream, smooth, and non-hygrophanous pileus, unlike the often colored, hygrophanous, or pruinose pilei characteristic of *Lepista*. The lamellae are adnate to decurrent, whereas in *Lepista* they vary from adnate to sinuate or weakly decurrent. The stipe is centrally positioned, hollow, and lacks both annulus and volva, in contrast to the solid or stuffed stipe typical of *Lepista*. Cystidia are polymorphic and well-developed, a feature absent in *Lepista*. The basidiospores are ellipsoid to ovoid, smooth, thin-walled, and non-cyanophilic, differing from the verruculose, thick-walled, and distinctly cyanophilic spores of *Lepista*. The spore deposit is white to cream rather than pale pinkish buff as in *Lepista*. Basidia are clavate to broadly clavate and mostly 4-spored, but unlike *Lepista*, the basidial walls are non-cyanophilic. Based on combined morphological and molecular evidence, we propose a new genus within the family *Clitocybaceae* from Pakistan.

**Keywords:** Fungal diversity; ITS; new genus; morphology; phylogeny

## **RAPS-25-124: In Silico Exploration of *Syzygium aromaticum* L. Bioactive Compounds Targeting the Cancer-Associated Protein LKB1**

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Breast cancer is characterized by aberrant cell proliferation in the breast tissues and ranks among the main causes of death globally. Inadequate knowledge about the symptoms and early warning signs is one of the primary causes of delayed diagnosis. Among the drugs being developed for the treatment of breast cancer, compounds derived from plants and other natural products have shown potent anti-breast cancer properties. Breast cancer has been linked with a mutation in the tumor suppressor gene LKB1, whose highly conserved catalytic domain is particularly susceptible to mutations that can interfere with normal regulation and promote the proliferation of malignant cells. The capacity of the chemicals in *Syzygium aromaticum* L. for binding to protein active sites was examined using PyRx for molecular docking, with a focus on potential anti-cancer properties. The SwissADME was used for the Lipinski screening to evaluate the drug-like characteristics of *S. aromaticum*. and to conduct ADME analysis to evaluate the ligands' physicochemical characteristics, oral water solubility, and pharmacokinetics. Out of the 139 compounds, 29 exhibited the highest docking scores with the protein. From the top 29 ligands, 6-methyl-5-hepten-2-one and 2-heptanol (benzoate) showed positive outcomes from ADMET and drug likeness analysis, indicating their feasibility for oral administration. Phytochemicals from this plant that target the LKB1 protein have potential as bioactive compounds for breast cancer treatment. For clinical applicability, these substances must exhibit efficient systemic circulation, digestion, and absorption. Fourteen promising compounds showed potential, including 6-methyl-5-hepten-2-one and 2-heptanol (benzoate). Additionally, in vitro and in vivo studies are needed; however, these discoveries may lead to the discovery of innovative therapeutics for breast cancer.

**Keywords:** Breast cancer; Molecular docking; Physicochemical characteristics; ADMET analysis; Pharmacokinetics

## **RAPS-25-125: Hemp Agronomy and Variety Performance in the Midwest US**

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The Midwestern Hemp Research Collaborative (MHRC) received funding from USDA-NIFA under the Supplemental and Alternative Crops Program (award # 2022- 38624-38368) to conduct multi-location hemp grain and fiber variety and agronomy trials in Michigan, Indiana, Illinois and Wisconsin 2023-25. In 2024, six locations grew a total of 37 cultivars (25 grain, 26 fiber, some dual) solicited from private seed companies in the US, Canada, Europe and China. Trial design was an RCBD with four replications, and cultivars were assigned to either Michigan and Wisconsin (early maturing) or Illinois and Indiana locations (late maturing). Small plots 4-5 ft. wide by 15-20 ft. long with row spacing of 7-7.5 inches were seeded May 15 - June 11 at 19.5 pure live seed (PLS)/ft<sup>2</sup> for grain and 32.5 PLS/ft<sup>2</sup> for fiber, based on average seed size and germination, assuming 30% mortality. The trials received 100 lbs/ac of actual nitrogen, plus P and K based on soil test results. Fiber cultivars were harvested 10-14 days post flower initiation, while grain cultivars were harvested based on seed maturity. Observations of stand establishment, flowering date, height, sex ratio, floral THC concentration, stem diameter, grain or fiber yield, and grain proximate composition were collected. Stand establishment averaged 45% (1.67-100%). Grain yield at 9% moisture averaged 1,092 lbs/a (211 – 1,695) and fiber dry matter yield averaged 9,385 lbs/a (2,154 – 15,257). 2024 THC data is forthcoming, but in 2023, total THC concentration averaged 0.189% with the majority of cultivars being compliant. Linear mixed effects models were applied to analyze differences among cultivars in the lme4 package for R. Hemp cultivars differed significantly ( $p < 0.05$ ) on all parameters, highlighting adapted cultivars for grain and fiber production in the Midwest U.S.

**Keywords:** Hemp cultivars; grain and fiber yield; multi-location field trials; THC concentration

## **RAPS-25-126: Chlorophyll Fluorescence as a High-Throughput Phenotyping Tool to Accelerate Crop Improvement for Climate Resilience**

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Chlorophyll fluorescence has emerged as a powerful and non-destructive physiological tool to assess plant responses under diverse environmental stresses. It provides critical insights into the functional status of photosystem II (PSII) and associated energy partitioning mechanisms that directly influence plant growth and productivity. Because of its sensitivity to stress-induced changes, chlorophyll fluorescence has been increasingly used as a selection criterion in screening and breeding programs aimed at developing stress-tolerant cultivars. Recent advances in portable and high-throughput fluorescence measuring systems have broadened its application from controlled pot and greenhouse experiments to field-scale phenotyping platforms. Various protocols, including fast fluorescence kinetics (OJIP transients) and quenching analyses, allow detailed evaluation of photoinhibition, photoprotection, and recovery dynamics. These approaches not only help to dissect physiological mechanisms of tolerance but also provide rapid, reliable, and cost-effective tools for large-scale screening in breeding pipelines. By integrating high-throughput ChlF with genomics and other omics technologies, we can significantly accelerate the identification of superior genotypes. This integration will facilitate the development of crops that are better adapted to climate change, thereby contributing to sustainable agriculture and global food security.

**Keywords:** Crop breeding; High-throughput phenotyping; OJIP; JIP-test; NPQ; PAM; Stress tolerance; Photosystem II; Climate change

**RAPS-25-127: From Pest Resistance to Plant-Based Vaccines:  
CEMB's Frontier Innovations in Agricultural Biotechnology**

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CEMB being pioneer in development of insect and weedicide resistant cotton varieties has its vision in gene pyramiding through fusion ne and multiple herbicide resistance cotton development by application of transgenic and genome editing approaches. In a recent approach of editing of PQT3 gene in cotton has led to development of drought and salt tolerant cotton lines. The Antioxidant assays like APX, GPX, SOD along with visual staining with NBT has shown elevated level of antioxidant enzymes in response to 10 days stress developed through application of PEG, NaCl, H<sub>2</sub>O<sub>2</sub> individually as well as in combination. The problem of sucking insect and CLCuV has been dealt through editing of DNA and Beta satellite gene in cotton. The knockout efficiency reached 72% for DNA-A and 90% for the Beta satellite, leading to a marked reduction in viral titers and 90% mortality in whitefly vectors. Structural validation using AlphaFold2 confirmed these successful edits at the protein level. Additionally, CEMB has enhanced potato quality by extending shelf life, increasing vitamin A content. genetic analysis of edited potato lines revealed a significant reduction (90-99-fold) in VInv gene expression, alongside a fivefold decrease in reducing sugars in transgenic potato varieties. Further genome edited potato showed improved resistance to fungal diseases, Potato Virus X (PVX), and Potato Virus Y (PVY) developed through targeting their respective genes and transcription factors. CEMB successfully developed plant based vaccine against NDV and FMDV through expression of immunogenic proteins in Miazee and Alfalfa respectively. These results highlight the powerful potential of genome editing to combat plant viruses, enhance crop resilience, and address pressing agricultural challenges such as abiotic stress tolerance, paving the way for sustainable crop improvement in the future.

**Keywords:** Plant-Based Vaccines; CEMB; agricultural biotechnology

## **RAPS-25-128: Integrating Plant Science and Artificial Intelligence for Sustainable Food Systems**

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The integration of plant science with artificial intelligence (AI) is revolutionizing approaches to sustainable food systems. AI technologies such as molecular modeling, network pharmacology, and predictive analytics can enhance crop productivity, post-harvest quality, and nutritional value. Drawing on my research in plant molecular taxonomy, phytochemistry, and functional food development, Studies on *Capsicum frutescens*, *Nigella sativa*, and *Cymbopogon citratus*, where AI-assisted techniques have been applied to extend shelf life, identify bioactive compounds, and optimize cultivation strategies. Recent studies have demonstrated the utility of AI in analyzing genetic diversity, modeling plant environment interactions, and predicting responses to abiotic stress. Similarly, network pharmacology and molecular docking have been employed to evaluate the therapeutic potential of medicinal plants, contributing to the development of nutraceuticals. The talk will also highlight the role of AI in omics-based biofortification, particularly in legumes and leafy vegetables, where computational tools have guided micronutrient enhancement strategies. These innovations not only improve food quality but also support climate-resilient agriculture and resource-efficient farming. Finally, the discussion will be on pathways for translating academic research into commercial applications, including industry collaborations and intellectual property development. By bridging plant science and AI, we can build resilient, data-driven food systems that address global challenges in nutrition, sustainability, and food security.

**Keywords:** Artificial intelligence; integrating; agriculture; sustainable food systems

**RAPS-25-129: Morphological and Molecular Characterization  
Reveal a New *Cortinarius* (Cortinariaceae) Species from Pakistan**

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The genus *Cortinarius* (Cortinariaceae) represents one of the most species-rich lineages of ectomycorrhizal fungi worldwide, yet its diversity remains scarcely explored in South Asia. A new species, *Cortinarius shawarensis*, is described in this study from the Swat District, Khyber Pakhtunkhwa Province, Pakistan. Morpho-anatomical study and nrITS- based phylogenetic analyses confirmed the novelty and placement of this taxon in the genus *Cortinarius* subgen. *Telamonia* sect. *Safranopedes*. *Cortinarius shawarensis* is characterized by its convex and yellowish-gray to yellow-orange pileus with a dark yellowish-brown abrupt papillate center, narrowly adnate and moderate purple to dark yellowish-brown lamellae, cylindrical and pale yellowish-gray stipe developing dusky brown coloration and ellipsoid to elongate basidiospores (avg.  $6.62 \times 4.14 \mu\text{m}$ ). With the addition of this species, the total number of *Cortinarius* species reported from Pakistan has increased to twenty-four. This discovery contributes to the growing documentation of macrofungal diversity in Pakistan and highlights the importance of integrating morphological and molecular evidence in delimiting species within the complex and diverse genus *Cortinarius*.

**Keywords:** Ectomycorrhizal, macrofungi, mushroom, *Telamonia*, taxonomy

**RAPS-25-130: Effect of Nanoelicitors on Stevioside Content of *Stevia Rebaudiana* Bertoni**

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*Stevia rebaudiana* Bertoni is a natural non-caloric compound of high nutritionally and medicinally-valued component, widely applied as a safe substitute of sugar in diabetes and obesity and cardiovascular diseases. Although its production has the potential, but the commercial cultivation is minimal in Pakistan and hence research is needed to enhance its productivity and stevioside concentration. In the current work, copper oxide (CuONPs), zinc oxide (ZnONPs), and iron oxide (FeONPs) nanoparticles were synthesized by the green synthesis using *Nigella sativa* extract and respective metal salt. Foliar spray and soil drench were used for application of various concentrations of CuONPs (7.5 ppm, 10 ppm), ZnONPs (6 ppm, 8 ppm), and FeONPs (7.5 ppm, 10 ppm), as well as positive and negative controls. Growth parameters were measured after 106 days of 1st treatment. Results showed that Foliar application of ZnONPs-8 ppm exhibited the highest increase in growth characteristics, whereas drench application of CuONPs-7.5 ppm demonstrated the highest parameters, though, in general, foliar application was more effective. Findings indicated that foliar-treated plants exhibited a lower (0.3 nm/mL) MDA than the controls indicating that there was lower oxidative damage, whereas in drench treatments more MDA levels were found in positive controls (3.7 nm/mL). The major diterpenoid glycoside of *S. rebaudiana* i.e., stevioside, was extracted with the help of the Microwave-Assisted extraction and the amount of stevioside was quantified by UV-Visible spectroscopy. Results showed that a significant enhancement of stevioside accumulation under nanoparticle treatment was obtained. This strategy provides a viable alternative to increase the cultivation of this economically and medically valuable plant within Pakistan, lessening its reliance on imports and aid its commercial use.

**RAPS-25-131: Salt Stress Mitigation using *Ascophyllum nodosum* Extract on Tuberization in *Solanum tuberosum* L.**

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Potato (*Solanum tuberosum* L.) is the third major agricultural crop. It is one of the key staple food crops after wheat and rice. Osmotic stress and Ionic toxicity are the major abiotic stress factors that reduce the potato crop yield significantly. Sustainable methods are required to mitigate these stress. The experiment was designed to determine the effect of seaweed extract obtained from *Ascophyllum nodosum* on two commercially important potato cultivars *i.e.*, Kuroda and Lady Rosetta grown under NaCl stress. Healthy potato tubers of uniform sizes were planted in pots, filled with garden soil. Plants were treated with various concentrations (25, 50 and 75 mM) of NaCl after 30 days. Seaweed extract (0.5, 1.0 and 1.5%) was applied alone and in combinations at regular intervals of 10 days. The data of different morphological physiological and biochemical parameters were collected after harvesting. The results exhibit that NaCl reduced the growth (shoot length, root length, number of leaves, stem diameter) and yield parameters (number of tubers/plant, weight of tubers/plant, tubers diameter) under stress conditions as compared to the plants treated with seaweed extract and control unit. Seaweed extract improved the growth of plants by mitigating the adverse effects of stress induced by NaCl and enhanced the yield. During this investigation, antioxidant enzyme activities (POD & SOD), physiological (chlorophyll contents) and biochemical parameters (proline contents, total soluble sugar contents and protein contents) were also increased with the application of seaweed extract. *Ascophyllum nodosum* extract effectively reduced the salt stress in both potato cultivars by promoting growth and biochemical defense mechanisms. It offers a capable, eco-friendly approach to improve crop resilience under saline conditions.

**Keywords:** Antioxidant activity, *Ascophyllum nodosum* extract, Biostimulants, potato productivity, NaCl stress, Salinity stress, Seaweed extract

## **RAPS-25-132: Exploring Geographic Distribution and Diversity of Family Fabaceae through Digitization of Specimens Data Stored In Swat University Herbarium**

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Digitization of specimen's data is vital for biodiversity exploration and conservation of plant taxa. Data in the digitized form offers very easy management and provide information on different aspects of species, including locality, geographic distribution, associated species, relative abundance, threats and phenology etc. In the present study collection of family Fabaceae housed in Swat University herbarium, as well as our own fresh field collections were digitized in Open Herbarium digital database. The data were organized in Microsoft Excel sheet and georeferencing was done with the help of Google Earth software online. ArcGIS software was utilized for mapping the distribution pattern of specimen's collection. A total of 467 specimens of Fabaceae belonging to 30 genera and 82 species were present in the herbarium are now digitized. The data were published online in Openherbarium.org. The most represented genera were *Vicia* (113 specimens), *Lathyrus* (68), *Medicago* (64), *Astragalus* (63) and *Lens* (20), while rest of the genera were represented by less than 20 specimens per species. The specimens were collected from different localities, with Swat district being the most explored region with 358 specimens, Buner (27), Chitral (18) and Skardu (15) being the most represented localities. Within Swat a most of the specimens (162) were collected from Tehsil Matta, followed by Charbagh (51), Kabal (39), Kalam (39), Khwazakhela (35) and Barikot (24) specimens. Major collectors included Zahid Ullah (217 specimens), Wahid Ullah (142), Saddiqur Rehman (25), and Ajmal Khan (14) specimens. Most of the specimens collection were done in the year 2019, and among the months April and August was the dominant months of collection. The results showed that georeferenced record of SWAT is considerably different from the record of Quaid- I-Azam University Herbarium (ISL). The ISL has 2,122 specimens in 42 genera and 96 species, recorded from few administrative units i.e. Islamabad 1,603 specimens, Muzaffarabad (119), Attock (96), Skardu (85) and Mansehra (49). The herbarium collection enhances the pattern of plant diversity and distribution, identify new taxa, supports the conservation efforts by documenting rare and endangered species, and facilitate research in different field related to Botany. Therefore, it is essential to strengthen herbarium collection through ongoing exploration, documentation and preservation of plant specimens and to digitize the herbarium record for global research on any online platform.

**RAPS-25-133: One New Species of *Mycenoid fungi* from Khanspur, KPK, Pakistan**

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Decomposing fungi play a vital role in maintaining the health and balance of forest ecosystems worldwide. Khanspur is a famous hill station in Himalayan range and it has moist temperate forests. These forests host a treasure of basidiomycetous fungi. Among the macrofungi, the genus *Mycena* (Family *Mycenaceae*, Order Agaricales) is one of the largest, comprising more than 600 species globally. Members of this genus contribute significantly to forest nutrient cycling, organic matter decomposition, and ecosystem renewal. The present study focuses on the collection and identification of fungal specimens from Khanspur, District Abbottabad, Khyber Pakhtunkhwa, Pakistan, during July 2023. Collected samples were systematically dried, labeled, morpho-anatomically characterized, and subjected to phylogenetic analysis using the Internal Transcribed Spacer (ITS) region to confirm taxonomic placement. *Mycena parvisora* nom. prov. is characterized by crenate pileus margins, smaller size basidiospores ( $3.1 \times 1.8 \mu\text{m}$ ) and guttulated, ellipsoid to oblong shaped basidiospores, conical to obovoid shaped cheilocystidia, and smaller size caulocystidia ( $50.4 \times 7.2 \mu\text{m}$ ). In a phylogram based on ITS sequence data set, it gets separated from *Mycena flavoalba* (JF908436) and *Mycena rosea* (JF908473) with 95 bootstrap values. This study represents first molecular report of the genus as previously no new species of *Mycena* has been reported. Through extensive field surveys and comparative phylogenetic analysis, this study reports the discovery of a novel *Mycena* species from the Khanspur region. This finding enriches our understanding of fungal biodiversity in Pakistan and highlights the ecological significance of *Mycena* within Himalayan forest ecosystems.

**Keywords:** *Mycenaceae*, *Agaricales*, biodiversity, phylogram.

**RAPS-25-134: A Newly Isolated JAV4 Strain Enhances Drought Stress Tolerance in Soybean by Modulating Antioxidant Defense and Metabolite Accumulation**

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Global warming is a major environmental stressor that limits agricultural productivity, with drought stress being a harmful abiotic stress impacting world agriculture. This leads to imbalances in physiological, oxidative, and metabolic processes, directly impacting photosynthetic levels, nutrient utilization, and crop yield. In crops such as soybean (*Glycine max*), this can reduce their productivity by up to 30% which is aggravated by climate change events. This study aimed to isolate and characterize strains of plant PGPR with the ability to tolerate drought stress, evaluating their biostimulant effect under controlled conditions. Ten bacterial strains were isolated from collections of soil samples in drought environments at Kyungpook National University, of which JAV4 was selected for its tolerance to PEG and high production of exopolysaccharides, indoleacetic acid, siderophores and phosphate solubility, the strain was identified as *Bacillus paramobilis*, exogenous inoculation was evaluated in pots with eight treatments, this microbe inoculation significantly increased key parameters in stress-induced plants, including the 22.21% increase in relative water content, shoot length 27.80% and root weight 115.45%, in addition to improving spectral indices such as NDVI, CRI1 and MCARI by up to 30%, reflecting greater photosynthetic activity, on the other hand the application of microbe stimulated the activity of CAT and APX and reduced SOD, indicating less oxidative stress, which is why *B. Paramobilis* JAV4 is considered an alternative to conventional fertilizers for its application as a biofertilizer and stimulant, with the potential to enhance the resilience of soybean crops to drought stress conditions.

### **RAPS-25-135: Bioactive Potential of Secondary Metabolites of *Suaeda fruticosa* and its Endophytes**

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The growing number of drug-resistant infections has highlighted the pressing need for new bioactive substances. Supporting SDGs 3, 9 and 12; using *Suaeda fruticosa* an underutilized halophyte, the present study aims to address the worldwide need for natural antimicrobial agents and their sustainable utilization in the treatment of drug-resistant infections. Endophytes, (the microbes) which live inside healthy plant tissues, have emerged as a promising resource of antimicrobial compounds. These endophytes engage in mutualistic interactions with their host and produce a variety of bioactive secondary metabolites. The medicinal potential of the halophytic plant *Suaeda fruticosa*, indigenous to the saline regions of Pakistan, remains largely unexplored for its root-associated endophytes. In this study, the endophytic microbial diversity and phytochemical composition of *Suaeda fruticosa* roots were explored. Root samples were surface sterilized and inoculated onto BHI and PDA media to isolate bacteria and yeast respectively. Repeated streaking was performed to purify twelve different bacterial isolates, which were then identified through Gram Staining method. Results revealed the presence of *Bacillus* spp. (5 Gram-positive bacteria) and *Pseudomonas* spp. (7 Gram-negative bacteria). Similarly, one yeast (*Candida* spp.) was also identified. For chemical profiling, the crude methanolic root extract was subjected to solvent-solvent fractionation, yielding fractionated layers (FLs) hexane (5.50%), dichloromethane (9.27%), ethyl acetate (7.82%), butanol (16.81%), and aqueous (77.10%), respectively. Phytochemical screening revealed the presence of diverse secondary metabolites, including terpenoids, flavonoids, alkaloids, carbohydrates, diterpenes, and tannins, while saponins, anthocyanins, and coumarins were absent in all FLs. The antimicrobial potential of the FLs was assessed using agar well diffusion method. The findings of this study provide insights into the previously underexplored diversity of SMs found in the roots of *Suaeda fruticosa* and those produced *in vitro* by its endophytes.

**Keywords:** *Suaeda fruticosa*; Secondary Metabolites; Endophytes

**RAPS-25-136: Multi-Locus Phylogenetic, Morphological, and Scanning Electron Microscopic Data Revealed Two New Species of *Laccaria* (Agaricales; Hydnangiaceae) from Swat District, Khyber Pakhtunkhwa, Pakistan**

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This study presents the morphological and molecular characterization of two new species of *Laccaria* based on morphological, scanning electron microscopic and multi-locus phylogenetic analyses, from the temperate deciduous forests of Swat District, Khyber Pakhtunkhwa, Pakistan. *Laccaria* is a globally distributed ectomycorrhizal genus comprising about 100 species worldwide, of which only nine have been reported so far from Pakistan. Members of this genus are characterized by collybioid to omphaloid basidiomata with a convex, plane, or umbilicate hygrophanous pileus, adnate to decurrent, thick, and distant lamellae bearing a tough, fibrous, and often twisted stipe. Micro-morphologically, it has echinulate, acyanophilous and inamyloid basidiospores and the presence of clamp connections in all tissues. Detailed macro- and micromorphological examinations were combined with phylogenetic analyses of internal transcribed spacer (ITS), large subunit (28S), and translation elongation factor 1-alpha (*tefl-α*) sequence datasets revealed two distinct lineages within *Laccaria*, clearly separated from all previously reported taxa. Integrating morphological and molecular evidence, these taxa are herein identified and described as new. This study enriches the understanding of ectomycorrhizal fungal diversity in Pakistan and provides a valuable foundation for future taxonomic and ecological studies of the genus *Laccaria*.

**Keywords:** Broad leaf vegetation; fungal diversity; mycorrhizal; multi-locus; taxonomy

## **RAPS-25-137: Integrating Nanotechnology into Agriculture: The Role of Zinc Oxide Nanoparticles in Improving Drought Resistance in Mustard**

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Nanotechnology has gained considerable attention recently for its potential to improve plant growth and stress tolerance in agriculture. This study investigates the role of zinc oxide nanoparticles (ZnO NPs) synthesized using *Hibiscus rosa-sinensis* leaf extract in enhancing drought tolerance in *Brassica napus* (mustard) under controlled conditions. The experiment involved six treatments, including both stressed and non-stressed conditions, with the application of ZnO NPs and zinc sulfate as a comparison. Morphological parameters such as germination percentage, plant height, leaf area, and root length, as well as physiological parameters including chlorophyll content, membrane stability index (MSI), carotenoid content, and leaf relative water content (LRWC), were evaluated to assess the impact of ZnO NPs. The ZnO nanoparticles were synthesized using a green chemistry approach and characterized by UV- particle size analysis, visible spectroscopy, SEM, FTIR, and XRD to confirm their size and stability. The results showed that ZnO NP application improved drought tolerance by significantly enhancing the germination rate and mitigating drought-induced plant height and leaf area reductions. Physiologically, ZnO NPs increased chlorophyll-a and carotenoid contents and maintained LRWC under drought stress, suggesting their role in reducing oxidative damage and improving water retention. However, some parameters such as membrane stability and chlorophyll-b content showed complex responses, indicating the need to explore ZnO NP interactions under stress conditions further. The principal component analysis (PCA) confirmed that germination and LRWC were the most positively influenced by ZnO NPs under stress. These findings suggest that ZnO nanoparticles are promising to improve crop drought tolerance, but further research is required to optimize their application and understand their long-term impacts in agricultural settings. Future studies should focus on field trials to evaluate the practical viability of ZnO NPs in enhancing crop resilience to environmental stressors like drought.

**Keywords:** Mustard, Nano-fertilizer, Drought, crop yield

**RAPS -5-138: Genome Wide Identification and Functional Characterization of *LEA4-5* Genes in Response to Drought Stress in Brassica Species.**

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The production of edible oil is a major worldwide use of Brassica crops. The Brassica species have long been utilized for human nourishment, animal feed, and traditional medicine. Yield loss due to drought is a serious issue that requires attention. In rapeseed, drought stress negatively impacts seed development, yield, quality, shoot elongation, photosynthetic efficiency, germination, and the seedling establishment. The current study was planned to experimentally induced drought stress in brassica species, i.e. *B. carinata*, *B. juncea*, *B. oleracea*, *B. napus*, *B. nigra*, and *B. rapa*. Artificially induced drought stimulate the expression of genes that are sensitive to drought such as late embryogenesis abundant group 4-5 (*LEA4-5*). This work fully assessed the genome-wide identification of 21 *LEA4-5* genes in six Brassica species. These genes were then categorized into four unique groups for *LEA4-5* based on their evolutionary relationships. The examination of gene structures and motifs revealed that *LEA4-5* (two exons, one intron) gene in each group had somewhat similar exon-intron organization and conserved patterns of motifs. The predicted 21 *LEA 4-5* proteins ranged in length from 133 to 163 and the predicted molecular weights of the *LEA 4-5* candidates were dispersed along a spectrum ranging from 13372.67 kDa to 16779.43 kDa. The collinearity study revealed that the *LEA4-5* gene families experienced segmental duplications during their evolutionary history. Several presumed stress-related cis-acting elements were identified in the promoter region of the *LEA4-5* gene, indicating their role in conferring tolerance to drought and other abiotic stressors. The expression profile of *BnaLEA4-5* was dramatically modulated in different developmental tissues in response to drought stress. Furthermore, to examine drought tolerance-related indices in six Brassica species at the germination and seedling stages, 5%, 10%, 15% Polyethylene glycol 6000 (PEG 6000) treatment was used to provide artificially induced drought along with control in replicate manner. The morphological parameters (number and percentage of germinated seeds, as well as length, fresh and dry weight, water content, ratio, in both roots and shoots and vigor index) dropped as the concentration of PEG increased. The current study provided insight knowledge as both genes shield plants against the harm that comes from environmental stressors, particularly drought. This all facilitated the identification of Brassica species that exhibit greater resilience to drought

stress, hence assisting in the development of breeding and agricultural techniques focused on enhancing drought tolerance.

**Keywords:** Drought, Brassica species, Late Embryogenesis Abundant Group 4-5, genome-wide, yield and abiotic stresses.

### **RAPS-25-139: Wheat Photosynthetic, Molecular and Ascorbate Peroxidase Mediated Oxidative Stress Responses towards Soil Amendments under Drought Stress**

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Drought stress remains a major constraint to wheat productivity, particularly in arid and semi-arid regions where declining soil moisture disrupts photosynthetic efficiency, enzymatic regulation, and grain biochemical quality. In this study, the role of activated biochar as a soil amendment in enhancing drought resilience across selected wheat cultivars was evaluated. The study comprised of three cultivars (C1, C2, C3) grown under five drought stress (DS) levels with three levels of activated biochar as soil amendment (SA0, SA1, SA2). The Fourier transform infrared (FTIR) spectroscopy showed distinct peaks and prominent differences in functional groups were observed among the three cultivars with soil amendments. The higher level of activated biochar improved photosynthetic attributes across cultivars. The H<sub>2</sub>O<sub>2</sub> and O<sub>2</sub><sup>-</sup> production was reduced by 52% with SA2 when compared to SA0 under DS4. The Ascorbate peroxidase (APX) and DPPH activity increased by 48–65% under SA2, while ABTS showed slight suppression at DS4 in C2. Phenolic and flavonoid contents rose up to 2.4 and 2.2 folds, respectively under SA2 at DS4, as compared to SA0 at DS4, notably in C1. Molecular docking revealed binding affinities between FTIR predicted compound and APX protein interactions revealing their coordinative role in stress resilience. This integrated physiological and molecular approach provides novel insights into the mechanistic role of organically amended soil and APX enzyme in sustaining wheat performance under water-limited conditions.

**RAPS-25-140: Exogenous Application of Glutathione Enhanced Growth, Nutritional Orchestration and Physiochemical Characteristics of *Brassica oleracea* L. under Lead Stress**

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Heavy metal contamination, particularly lead (Pb), has emerged as a major environmental challenge limiting agricultural productivity and crop quality worldwide. Excessive Pb accumulation in soil disrupts plant metabolism, hampers nutrient uptake, and reduces yield quality. *Brassica oleracea* L. (broccoli), a nutritionally valuable vegetable crop of the Brassicaceae family, is highly susceptible to heavy metal stress, which compromises its growth and photosynthetic efficiency. The present study investigated the potential of glutathione (GSH) seed priming as a sustainable and cost-effective strategy to alleviate Pb-induced toxicity in broccoli seedlings. Seeds were primed with different concentrations of GSH (25, 50, and 75  $\mu\text{M L}^{-1}$ ) and evaluated for morphological, physiological, and biochemical responses under Pb stress. Lead exposure significantly reduced plant height, biomass, chlorophyll, protein, and phenolic contents, while markedly increasing proline accumulation. In contrast, GSH priming enhanced growth traits, total soluble proteins, chlorophyll concentration, mineral content, and gas exchange parameters, indicating improved photosynthetic and metabolic activity. A higher metal tolerance index and reduced Pb accumulation in plant tissues further confirmed the detoxification and protective role of GSH. The study highlights that GSH seed priming can effectively enhance lead tolerance in broccoli by strengthening its antioxidant defense and nutrient acquisition systems. This approach offers a practical, eco-friendly solution to mitigate heavy metal stress and improve the resilience and productivity of vegetable crops in contaminated soils.

## **RAPS-25-141: Application of Nano Selenium Alleviates Cd-induced Growth Inhibition and Enhances Biochemical Responses and the Yield of *Solanum melongena* L**

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Soil contamination with heavy metals, such as cadmium (Cd), reduces plant growth and yield. Therefore, an advanced agronomic technique is needed to alleviate Cd-induced stress in plants. Green Nanotechnology is a novel approach that offers effective and innovative solutions for various environmental problems. Selenium nanoparticles (Se- NPs) have not yet been studied concerning their potential use in seed priming (SP), foliar spraying (FS), and SP+FS in *Solanum melongena* L. (brinjal) under Cd stress. The present work was designed to synthesize Se-NPs from tomato fruit extracts following characterization via UV-visible spectrophotometry, FTIR, SEM and EDX and to investigate the effects of Se-NPs at 30 mg/L and 40 mg/L on the morphological and biochemical attributes, growth, and nutrient content of brinjal under Cd stress. Compared to control, the Chl a (9.8%), Chl b (21.6%), transpiration rate (52.5%), photosynthetic rate (31.4%) and stomatal conductance (55.5%) were significantly lower under Cd stress. Compared with Cd alone, FS with 30 mg/L alleviated Cd toxicity and improved the photosynthetic pigments (7.5%), plant height (36.1%), plant fresh weight (26.1%), ascorbic acid content (2.8%) and antioxidant activity (37.1%). Additionally, SP with 40 mg/L improved the proline (80.2%), protein (4.3%), phenol (9.7%), and metal tolerance indices (145%) and mineral contents (Mg<sup>2+</sup> (37.4%), K<sup>+</sup> (13.1%), Zn<sup>2+</sup> (63.3%) and Na<sup>+</sup> (13.8%) compared with Cd treated plants, which led to improvements in the growth and development by mitigating Cd stress. Conversely, SP+FS at 30 mg/L and 40 mg/L significantly increased the number of fruits (35 and 40%) as well as the fresh and dry weights compared to SP, FS and Cd only. Briefly, treatment with 40 mg/L mitigated the detrimental impact of Cd and improve *S. melongena* yield. Our results collectively suggest that Se-NPs application by SP+FS results in greater tolerance to stress and provides an eco-friendly technique to increase crop yield under heavy metal stress.

**Keywords:** Green synthesis; Nanoparticle characterization; Nutrient content; Photosynthesis; Antioxidant activity; Brinjal

## **RAPS-25-142: Taxonomic Notes on Megasporaceous Lichens from Leepa Valley, Azad Jammu & Kashmir**

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Leepa valley is located in western Himalayas, Azad Jammu & Kashmir. Valley is characterized by rugged topography. The climate of the area has diversified features including moist temperate, dry temperate forests, sub-alpine, high-alpine pastures, high elevated peaks covered with Pine forests and cold desert constitutes major portion of the area. These specific physiographic and climatic features present ecosystem diversity with variety of vegetation and wildlife. About one hundred and six (106) endemic wild plant species comprising 55 families have been reported from Leepa valley. Along with plants and animals, different fungi including lichens also exist in Leepa valley. Lichens are nature's most remarkable alliances comprising more than 20% of global fungal biodiversity. Lichenization represents a long living and self-sustaining system derived from mutualistic association between heterotrophic mycobiont and autotrophic photobiont. Globally, about 20,000 lichens taxa belonging to 1,008 genera are documented, with only 450 taxa from Pakistan. Lichen diversity in Pakistan contributes only 2% to worldwide lichen flora. About fifty (50) taxa of lichens have been reported from Azad Jammu & Kashmir however Leepa valley is a lichenologically blank spot in this region. During the lichenological surveys conducted in Leepa Valley Azad Jammu & Kashmir, many lichen specimens were collected and described using morpho-anatomical, chemical and multigene molecular markers. *Oxneriaria pakistanensis* is described as new to science while *O. sharanensis*, *Aspicillia nigroglomerata* are first time reported from Leepa valley Azad Jammu & Kashmir. This study will contribute to biodiversity assessment of the country, and is a step towards tenable molecular based infra-generic classification system that will ultimately narrow down the taxonomic choices which arise during morphology based identification system.

**Keywords:** Leepa valley, Megasporaceae, Multigene phylogeny

**RAPS-25-143: Morphological and Molecular Techniques Reveal Two Novel Species of *Entolomataceae*, (*Basidiomycota*, *Agaricales*) From Mianwali, Punjab, Pakistan**

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The family *Entolomataceae*, one of the most species-rich lineages within the *Agaricales*, comprises over 2,200 species worldwide, distributed across arctic to tropical habitats. The specimens collected during this study belong to two genera of the *Entolomataceae*, *Entoloma* and *Clitopilus*, both representing important lineages within the family. Members of *Entoloma* are characterized by their pink spore prints and angular basidiospores, exhibiting saprobic, lignicolous, ectomycorrhizal, or parasitic lifestyles, whereas *Clitopilus* is distinguished by its clitocyboid, omphaloid to pleurotoid basidiomata and incarnate spore prints bearing 5–12 longitudinal ridges. Despite their ecological and taxonomic importance, the *Entolomataceae* of Pakistan remains poorly documented, with only 13 *Entoloma* and eight *Clitopilus* species reported so far. This study integrates morphological and molecular approaches to describe two novel species of *Entolomataceae* from the Mianwali district, Punjab Province. Collections were examined by the macro- and micro-morphological characteristics. DNA sequences were used for phylogenetic inference using Maximum Likelihood and Bayesian analyses. Both taxa form distinct, well-supported lineages within *Entolomataceae* and display unique spore morphologies, pileipellis structures, and ecological traits that justify recognition as new species.

**Keywords:** integrative taxonomy, nrDNA, phylogeny, semi-arid

**RAPS-25-144: AI-Powered Nano-informatics for Plant Biotechnology: Integrating Neural Networks and Nanotechnology**

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The convergence of artificial intelligence (AI) and nanotechnology is redefining the landscape of plant biotechnology. This presentation explores the emerging discipline of AI-powered nanoinformatics, which leverages computational intelligence and nanoscale innovations to enhance plant research, crop improvement, and sustainable agriculture. By integrating artificial neural networks (ANNs) with nanomaterial-based sensing, delivery, and diagnostic systems, this approach enables the prediction, simulation, and optimization of complex plant–nanoparticle interactions. The talk highlights recent advances in data-driven nanomaterial design, predictive modeling of nanoparticle uptake and translocation, and smart nano-biosensors for real-time monitoring of plant health and stress responses. Furthermore, it discusses how AI-driven analytics accelerate the discovery of bio-nanointerfaces, improve precision in targeted delivery of agrochemicals, and contribute to environmentally resilient crop systems. This interdisciplinary framework bridges computational biology, nanoscience, and plant systems engineering laying the foundation for a new era of intelligent, sustainable, and data-centric plant biotechnology.

**Keywords:** Artificial Intelligence; Nanoinformatics; Neural Networks; Plant Biotechnology; Nanotechnology; Precision Agriculture; Biosensors; Sustainable Agriculture; Computational Modeling.

## **RAPS-25-145: Bacteria-Mediated Bio-Priming Improves Salt Stress Tolerance in *Zea mays* L.: Insights from Phenotypic and Metabolomic Analysis**

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In this study, soil samples were collected from two maize fields, and 15 bacterial strains were isolated. Based on key growth-promoting traits, four promising PGPR strains were selected and evaluated under 250 mM NaCl stress through bio-priming. Among them, two strains, that exhibited superior salt-stress tolerance in bio-priming experiment, were identified as *Bacillus aerius* and *B. cereus* species. Afterward, various treatments of bio-priming experiment (control, stress, stress + *Bacillus aerius*, stress + *B. cereus*) were subjected to LCMS analysis. Results indicated that biopriming under salt stress significantly improved plant biomass, antioxidant enzyme activity with statistical significance at  $P \leq 0.05$ . Bio- priming with *B. aerius* and *B. cereus* showed notable improvements in shoot length by 20% and 42%, root length by 31% and 28%, fresh biomass by 30% and 25%, and dry biomass by 25% and 15%, respectively. Additionally, bio- priming also enhanced antioxidant enzyme activities and reduced oxidative stress, as evidenced by increase in APX 25%, POX by 2-fold, and CAT by 52%. Metabolomic analysis using LC-MS revealed significant up-regulation of stress-related compounds, including L-citrulline by 4- fold, L-methionine by 15-fold, N-acetyl-alpha-D-glucosamine by 4.5-fold, p- benzoquinone by 1-fold, oxaloacetate by 4.5-fold, and 4-nitrobenzoyl-CoA by 3- fold, suggested the enhancing plant immunity and metabolic adaptation in bacterial- inoculated plants. These findings highlight the potential of bio-priming with *B. aerius* and *B. cereus* as an eco-friendly, cost-effective strategy to mitigate salt-stress in maize. However, further field trials are required to validate these results and explore the underlying mechanisms of bacterial-mediated stress resilience in natural environments.

**Keywords:** *Zea mays*, salt-stress, PGPR, bio-priming, metabolomics, LC-MS, antioxidant enzymes, stress resilience

**RAPS-25-146: Comparative Taxonomic and Molecular Study  
Reveal a New Species in *Candolleomyces* from Hot Dessert  
Climatic Zone Of Punjab, Pakistan**

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During a mycological survey conducted in 202 in Haroonabad, Punjab, Pakistan, several basidiomata of agaricoid fungi were collected from grassy areas within a moist agricultural habitat. Haroonabad, located in southern Punjab near the Cholistan Desert, lies within a subtropical semi-arid zone. Detailed Morphological and phylogenetic analyses revealed that these collections belong to the genus *Candolleomyces* (*Psathyrellaceae*). Globally, about 70 species of *Candolleomyces* are currently recognized, primarily distributed in tropical and subtropical regions. In Pakistan, approximately 23 species have been documented to date; however, many taxa remain undescribed and require further investigation. Species of this genus are saprobic agarics characterized by small to medium, delicate fruiting bodies with hygrophanous pilei that fade upon drying and brown to dark brown spore prints. Microscopically, they possess smooth, ellipsoid spores, lack pleurocystidia, and contain sphaerocysts within the veil tissue, which often give rise to floccose or granular remnants on the pileus surface. Comprehensive macro- and micromorphological analyses, supported by comparisons with known taxa, confirm that the collected specimens represent a new species of *Candolleomyces*. This discovery from the vicinity of the Hakra Canal, Haroonabad, Punjab, Pakistan, contributes to the growing understanding of fungal diversity and biogeography in the region.

**Keywords:** ITS sequencing, Taxonomy, Phylogeny, Hakra Canal

**RAPS-25-147: Chitosan Modulated Antioxidant Activity, Inorganic Ions Homeostasis and Endogenous Melatonin to Improve Yield of *Pisum Sativum* L. Accessions under Salt Stress**

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Effects of NaCl stress and foliar treatment of chitosan (CTS) on growth, antioxidant activity, inorganic ions and yield attributes of two pea (*Pisum sativum* L.) accessions were analyzed in this study. Experimentation was done in total 36 pots with 2 accessions and in three way completely randomized design (CRD) with 3 replicates. *P. sativum* plants were supplied with three salt concentrations (0, 60 and 120 mM) and two concentrations of CTS (0 and 120 mg/L). Both *P. sativum* accessions performed notably different from each other under salt stress. On the basis of remarkable reduction in biomass and yield parameters of ccession 200–03 under NaCl stress, it is assumed that this accession might be sensitive against salt stress. Whereas accession 200–06 under NaCl stress showed non-significant reduction in yield and biomass indicating that this accession might be resistant against salt stress. Foliar treatment of CTS boosted antioxidant enzyme activities, enhanced secondary metabolites (leaf proline and total phenolics), lowered the level of H<sub>2</sub>O<sub>2</sub> and improved the RMP and yield in both ccessions. Salt stress resulted in enhanced content of endogenous melatonin. Chitosan treatment further boosted melatonin synthesis. It is concluded that foliar treatment of CTS mitigated the deleterious effects of salt stress and modulated growth in *P. sativum* plants under salt stress. Therefore, it is recommended that chitosan induced growth modulation in plants may be exploited.

**Keywords:** Antioxidant; Lipid peroxidation; Reactive oxygen species; Pea; Salinity

**RAPS-25-148: A New Species of *Volvariella* from Kaha Hill  
Torrent of Koh-E- Suleiman, Pakistan**

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In this study, a new species of *Volvariella* was identified from the Kaha Hill Torrent of Koh-e-Suleiman, Pakistan, during macrofungal surveys conducted in 2024. The species was found growing gregarious on sand dunes under semi-arid climatic zone. The new species is characterized by having grey fibrillose pileus with white margins and pink lamellae bearing white stipe with a bilobed volva. Micro-morphologically it has sub- glubose basidiospores and fusiform cystidia. Detailed morphological and molecular examinations revealed it distinct, separating it from closely related taxa. Phylogenetic analysis based on ITS sequence data further supported its placement as an independent lineage within *Volvariella*. The discovery of this new taxon contributes to the growing understanding of the genus *Volvariella* in South Asia and highlights the fungal diversity of Kaha Hill Torrent of Koh-e-Suleiman, a relatively unexplored area of Pakistan.

**Keywords:** Fungal diversity, ITS, Koh-e-Suleiman Range, new species, phylogeny

## **RAPS-25-149: Resupinate Ectomycorrhizal Fungi of Himalayan Blue Pine Forests Revealed Through ITS-Based Molecular Analyses**

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Resupinate ectomycorrhizal (ECM) fungi are among the most inconspicuous yet ecologically vital members of forest ecosystems, forming essential symbiotic associations with tree roots that facilitate nutrient exchange and soil stability. Despite their importance, the diversity and taxonomy of these flattened, crust-like ECM forms remain poorly documented in Pakistan's Himalayan Moist Temperate Forests. We aimed to identify, characterize and conduct a phylogenetic analysis of the identified resupinate operational taxonomic units (OTUs) to determine their phylogenetic relationships with closely related species. In this study, ECM root tips of *Pinus wallichiana* (Himalayan blue pine) were collected from conifer-dominated stands in Patriata, New Muree and subjected to detailed morpho-anatomical and molecular analyses. ITS-based sequencing and phylogenetic inference on maximum likelihood tree identified several resupinate Basidiomycota, including *Sebacina*, *Tomentella*, and *Thelephora*, representing distinct evolutionary lineages. Morphological and anatomical observations revealed that *Sebacina* species formed rough to granular or bulbous mantles with clampless, plectenchymatous hyphae and oil-rich emanating structures, reflecting adaptive variation among regional lineages. *Tomentella* species displayed black, coralloid root tips with rough surfaces, a pseudoparenchymatous mantle, abundant cystidia, and septate Y-branched hyphae, confirming its placement within Thelephorales. In contrast, *Thelephora* species exhibited irregular monopodial to dichotomous branching, yellow-tipped dark brown roots, and a distinct outer parenchymatous and inner plectenchymatous mantle with bottle-shaped cystidia and a visible Hartig net, characteristic of Thelephoraceae ectomycorrhizae. The integration of morphological traits with ITS barcoding demonstrates how innovative molecular tools can reveal hidden fungal taxa that are often overlooked in traditional surveys. These findings contribute valuable DNA barcodes to global databases, establish a molecular baseline for future ECM studies in Pakistan, and underscore the role of resupinate ECM fungi as indicators of forest ecosystem health in a changing climate.

*E.mail: Keywords: Mycorrhizal symbiosis, forest ecology, molecular phylogram*

**RAPS-25-150: *Circinaria griseocellula* sp. nov. (Megasporaceae) and *Heteropladidium margallensis* sp. Nov. (Verrucariaceae), two novel species from Margalla Hills, Pakistan**

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Using an integrative approach combining morphology, anatomy, chemical characterization and phylogenetic analyses, we describe *Circinaria griseocellula* sp. nov. and *Heteropladidium margallensis* sp. nov. two new species from Pakistan. *Circinaria griseocellula* sp. nov. is closely related to *C. terrenoides* and characterized by white to silver-grey upper surface, plane to convex areoles, uneven, discontinuous algal layer, 120–140 µm thicker medulla and absence of apothecia and pycnidia. Diagnostic charactes of *Heteropladidium margallensis* sp. nov. are densely imbricate thin thalli, larger and wider asci (60-80 x 16-20 µm) and bigger ascospores (12-16 x 4.5- 6 µm), thinner algal and medullary layers. The new species found in scrub forest with temperate climate growing on limestone rocks of Margalla Hills.

**Keywords:** Megasporaceae, Verrucariaceae, molecular systematics

**RAPS-25-151: NAT1850-miR1850 Module: Deciphering the Molecular Network and Regulatory Mechanism Underlying the Balance Between Rice Growth and Cold Tolerance**

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Low-temperature damage is a major constraint to rice production in the cold regions of Northeast China, which leads to a yield reduction of up to 30%-40%. Currently, researchers have identified multiple genes and signaling pathways associated with low-temperature stress in rice. However, the role of microRNAs (miRNAs) in rice response to low-temperature stress remains poorly understood. In our previous study, we identified a rice-specific miR1850 whose expression is downregulated under cold stress. The primary transcript of miR1850 (pri-miR1850) generates two mature products: 21-nt miR1850.1 and 24-nt miR1850.2. Genetic analysis revealed that pri-miR1850 and miR1850.1 negatively regulate cold tolerance in rice at both the seedling and booting stages. Specifically, miR1850.1 inhibits the expression of the immunity-related gene NPR3 by mediating transcript cleavage and translation repression. Cold stress not only weakens the inhibitory effect of miR1850.1 on NPR3 but also enhances the transcription of the NPR3 gene. Genetic analysis demonstrated that NPR3 positively regulates rice cold tolerance, and the function of miR1850.1 in the low-temperature stress response is dependent on NPR3. Notably, high expression of NPR3 impairs rice yield, while reduced expression or knockout of NPR3 has no impact on yield-related traits. In rice, nearly 60% of annotated gene loci have Natural Antisense Transcripts (NATs). We identified a cis-NAT (designated NAT1850) that exhibits complete complementary overlap with the sequence of pri-miR1850, revealing a mutual regulatory relationship between pri-miR1850 and NAT1850. Further studies showed that pri-miR1850 and NAT1850 form double-stranded RNA (dsRNA), which generates a 21-nt small interfering RNA (siRNA) named siR1850. The sequence of siR1850 overlaps with those of miR1850.1 and miR1850.2 by 17 nt and 4 nt, respectively. Similar to miR1850.1, siR1850 can also target and inhibit NPR3 expression. The NAT1850-siR1850 pathway negatively regulates cold tolerance in rice at the seedling and booting stages through an NPR3-dependent manner. Interestingly, the regulation of rice nitrogen assimilation and yield by the NAT1850-siR1850 pathway is independent of the miR1850.1-NPR3 pathway and instead occurs via a separate pathway.

**RAPS-25-152: Survey of Fungal Diseases, their Identification and In-Vitro Biological Management from Local Fruits of District Rawalakot Azad Kashmir Tanveer Hussain\***

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The current research work was focused on the identification of fungal diseases from four selected wild fruit plants grown in District Poonch Rawalakot, Azad Jammu and Kashmir (AJK) during year 2023. The culturing of fungi was managed on different media like Potato dextrose agar (PDA), Malt extract agar (MEA), Nutrient agar (NA) and Water agar (WA) for diverse exploration and identification. A total 25 fungal species were isolated from apples, 17 fungal species were isolated from pear plants, 15 fungal species were identified from peach fruit plants and 17 fungal species were detected from different collected parts of apricot fruit plants. It was observed that two apple fruit diseases apple scab (100 %) and frog-eye leaf spot (100 %) were showed maximum incidence. Pear ring rot (80 %) identified from pear fruit and brown rot (80%) diseases isolated from peach were also shown maximum disease incidence (DI). The biomangement of most dominant fruit fungal diseases via medicinal plants extracts (MP), beneficial microbes (BM) and biofungicides (BF) were also under consideration. It was indicated that the zone of inhibition (ZI) significantly increased after all treatments but maximum diseases inhibition (33.33 mm) was measured after treatment with *Silene conoidea* MP extracts against apple scab disease as compared with the control (Neomycin). The treatment with *Silene conoidea* leaf extracts also indicated highest inhibition with 29.60 mm ZI as comparison to the control treatment with antibiotic (Tetracycline) against pear ring rot disease. The *Silene conoidea* MP stem extracts treatment indicated highest zone of inhibition 29.00 mm against pear ring rot disease. The treatment with leaf extracts of *Silene conoidea* indicated maximum ZI (27.67 mm) against peach pink fruit rot. The second biomangement technique BM as antagonistic activity was applied against dominant fruit diseases and observed that all BM were effective against selected diseases. Although the BM *Trichoderma asperellum* indicated highest antifungal activity with maximum ZI (28.33 mm) against apple scab disease while lowest antagonistic response with ZI (18.67 mm) was measured against apricot fruit spot disease after treatment with BM *Clonostachys divergens*. The most effective third biological management technique was applied against most dominant fungal diseases was biofungicides (BF). Hence, the five selected biofungicides (BF) indicated very effective reduction of fruit diseases. It was estimated that the BF Trialones indicated maximum apple scab disease inhibition (38.33 mm). Overall, it was observed that the effective biomangement study during invitro experimental trails was conducted against four selected diseases named as; apple scab, pear ring rot, peach pink rot and apricot fruit spot. Hence, it was

recommended the very effective biomanagement potential of selected medicinal plants (MP). *Silene conoidea* extracts indicated best management against three diseases.

**Key Words:** Fungal diseases; Biomanagement; Biofungicides; *Silene conoidea*; Apple scab; Antifungal activity

## **RAPS-25-153: Diversity of Wild Food Plants in Malakand and Hazara Divisions: Implications for Food Security and Biodiversity Conservation**

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Centre for Plant Sciences and Biodiversity, University of Swat, 19120, Charbagh Swat The local inhabitants of Malakand and Hazara divisions (Shangla, Batagram, Swat, Dir, Chitral, Buner, Kohistan, and Manshera districts) residing in mountainous forested valleys consume a variety of wild food plants (WFPs) as part of their diet during growing seasons of the year. This tradition is centuries old and is attributed to the agro-pastoralist life style, poverty, lack of agricultural land and lack of diversity in agriculture-based food. Traditional knowledge of WFPs is of vital significance in the context of food security, erosion of genetic diversity, climate change, agricultural expansion, and change in socio-economic setup of the rural communities. In order to explore the possible role of WFPs in future food security and increasing magnitude of options choices broadening of food basket Therefore an ethnobotanical study was conducted during spring 2025 in selected districts to document the botanical diversity, habitat, seasonality, traditional methods of recipes, and threats to WFPs. In total 50 key informants were interviewed using semi structured interviews, walk in the wood and focus group discussions. In total 60 WFPs species belonging to forty-five genera and thirty families were documented. These included two ferns, two mushrooms and 56 angiosperm species. Rosaceae was the dominant family with twelve species, followed by Fabaceae (5 species), Moraceae and Lamiaceae (4 species, each), and Polygonaceae (3 species). *Rubus* (3 species), *Berberis*, *Lathyrus*, *Vicia*, *Rumex*, *Pyrus*, *Prunus*, *Malva*, and *Ziziphus* with 2 species each were dominant genera in the area. The WFPs on the basis of habit were categorized as 27 herbs, 15 trees, 11 herbs, 2 mushrooms and 2 ferns. Fruits were the most consumed part (47%), followed by leaves (19%) and whole plant (9%). The most highly cited wild food plants included *Dryopteris juxtaposita* (Kwanjay), *Nasturtium officinale* (Thalmerra), *Diplazium esculentum* (Ladora), *Medicago polymorpha* (shpeshtay), *Rubus ellipticus* (Goraj), *Berberis lycium* (kwaray). WFPs still play an important role in the food and culture of the study area and the folk knowledge attached to them is remarkable in the region, although declining among the younger generations. The recorded species needs to be re-evaluated in local projects aimed at fostering indigenous strategies of food

security, as well as re-evaluating cultural heritage and sustaining small-scale food market circuits. These WFS are further recommended for nutritional and elemental analysis for the safety and efficacy of utilization.

**Keywords:** Wild Food Plants, Wild Fruits, Vegetables, Traditional Ecological Knowledge, Mountainous communities, Food Security, Biodiversity Conservation.

### **RAPS-25-154: Assessment of the Antioxidant and Antisnake Venom Potential of Indigenous *Cassia fistula***

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With regards to the innovation and sustainable approaches in plant sciences, the present study aims to contribute to good health and wellbeing based on natural antioxidants and anti-snake venom agents of plant origin. The study further aims to advancing global health and decreasing the reliance on artificial compounds supporting United Nations SDG 3 and 15. *Cassia fistula* (CF), commonly known as Golden shower tree or Amaltas is significantly recognized for its pharmacological profile and ethnomedicinal purposes backed by Ayurveda. It harbors a wide array of secondary metabolites (SMs) contributing to its antioxidant activity, however there is nearly a drought in relation to the anti-snake venom activity of the SMs of CF. The study has undertaken a critical probe in identifying the potential of CF as potent antioxidant and anti-snake venom agent using the hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) scavenging assay and venom neutralization assays against *Naja naja* venom (*in vitro*). The assays and the qualitative analysis of secondary metabolite was conducted using alcoholic extracts and/or fractionated layers (FLs) of pod's pulp, shells and seeds. The highest concentration of secondary metabolites from pulp and shell was found to be in the butanol layer (0.51% and 1.07%) respectively. However, the seeds yielded the major amounts in the methanolic extract (6.24%). Results of the qualitative chemical testing and the TLC analysis of all FLs of the pulp, shells and the crude methanolic extract of seeds revealed the presence of secondary metabolites of varied polarities including flavonoids, tannins, terpenoids, anthocyanins, carbohydrates, saponins, alkaloids, and coumarins. The findings of the investigation provide insights into the antioxidant potential and the detail previously remained undiscovered regarding the diversity of SMs responsible for the anti-snake venom potential of CF.

**Keywords:** *Cassia fistula*, antioxidants, secondary metabolites, anti-ophidic, *Naja naja*

**RAPS-25-155: Effect of Nano-Encapsulated Salicylic Acid on the Growth of Bell Pepper (*Capsicum annuum* L.)**

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Nanotechnology is rapidly emerging field in sustainable agriculture as it offers innovative and economical ways to enhance crop yield and nutritional values. This study was aimed to enhance the growth of bell pepper (*Capsicum annuum* L.) by applying chitosan encapsulated salicylic acid nanoparticles (SA-CNPs) to meet its high demand in market through approachable and economical ways. To determine the effects, foliar treatments of free salicylic acid (SA), chitosan nanoparticles (CNPs), SA- CNPs (all of 0.1% concentrations) and a control were applied thrice at fortnightly intervals. Sampling was done 15 days after the final application to assess the physiological, biochemical and yield parameters. The obtained results have shown that SA-CNPs significantly enhanced plant growth and physiological traits as compared to free SA, increasing plant height (1.74 fold), fresh weight (1.59 fold), dry weight (1.76 fold), and leaf relative water content (1.12 fold). Biochemical properties including chlorophyll a (1.62 fold), chlorophyll b (1.7 fold), carotenoids (2.17 fold), phenolics (2.15 fold) and flavonoids (2.28 fold), were also noticeably improved. Furthermore, total yield was increased by 3.8 fold under SA-CNPs treatment compared to free SA. These findings illustrated that encapsulation of salicylic acid with chitosan nanoparticles provides an efficient and controlled-release approaches with improved bioavailability which leads to enhancing plant growth, metabolism and productivity. This research highlights the potential of nanotechnology-based formulations as eco-friendly and cost-effective tools for sustainable agricultural development, particularly for enhancing the productivity of other high-value horticulture crops.

**Keywords:** Nanotechnology, Salicylic acid encapsulation, Sustainable agriculture

**RAPS-25-156: Impact of Iron Oxide Nanoparticles on Growth and Biochemical Parameters of Wheat (*Triticum Aestivum* L.) Under Cadmium Stress**

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Wheat (*Triticum aestivum* L.) is one of the most important staple crops worldwide but its growth and productivity are often limited by heavy metal contamination, particularly cadmium (Cd). Cd toxicity interferes with key physiological and biochemical processes, leading to stunted growth, chlorosis, and reduced yield. The present study aimed to explore the role of iron oxide nanoparticles (Fe<sub>2</sub>O<sub>3</sub> NPs) in reducing the harmful effects of Cd stress in wheat. The experiment was conducted under concentrations of Fe<sub>2</sub>O<sub>3</sub> NPs (50mg/L, 100mg/L) applied to wheat plants exposed to Cd stress (0.5mM and 1.0mM). The findings indicated that Fe<sub>2</sub>O<sub>3</sub> NPs significantly enhanced plant growth and improved biochemical responses under Cd stress. Results showed that growth attributes such as seed germination, root and shoot length, and biomass, along with biochemical parameters including chlorophyll content, total soluble proteins, total soluble sugar, proline levels were significantly reduced by Cd stress. Plants treated with nanoparticles showed highly significant increase in chlorophyll retention, antioxidant activity, and improved stress tolerance compared to control. Overall, the findings suggests that Fe<sub>2</sub>O<sub>3</sub> NPs can effectively mitigate Cd induced toxicity.

**RAPS -25-157: New and Noteworthy Species of *Candolleomyces* from Haroonabad, District Bahawalnagar Punjab Pakistan**

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In this study, the diversity of the genus *Candolleomyces* was investigated in Haroonabad, Pakistan, an area characterized by a hot desert climate. During field surveys conducted between 2023 and 2025, several basidiomata resembling *Candolleomyces* were collected from Haroonabad. Integrative morphological and molecular phylogenetic analyses revealed one new species within the genus, along with 2 taxa previously reported from other regions of Pakistan. The genus comprises saprobic fungi that are typically lignicolous or soil-inhabiting, commonly found growing on decaying wood and soil. Members of this genus are characterized by a brown to dark brown pileus with a squamulose to fibrillose surface, brown to dark brown lamellae, and the presence of an annulus. Microscopically, the basidiospores are brown to dark brown, and the absence of pleurocystidia distinguishes *Candolleomyces* from the closely related genus *Psathyrella*. This study enhances understanding of fungal diversity in arid ecosystems and expands the taxonomic and ecological knowledge of *Candolleomyces* in Pakistan.

**Keywords:** Fungal diversity, Hot Desert, ITS, *Psathyrellaceae*, Taxonomy

**RAPS-25-158: Chitosan and PGPR-Mediated Salt Tolerance in Turnip (*Brassica rapa* L.) By Modulation of Physiological and Biochemical Responses**

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Biostimulants offer a sustainable alternative to chemical fertilizers by enhancing plant growth and stress tolerance. This study assessed the effects of chitosan and plant growth-promoting rhizobacteria (PGPR) on the growth, physiology, and yield of turnip (*Brassica rapa* L.) under salt stress. PGPR were applied before sowing, while salt (50 and 100 mM NaCl) and chitosan (50 mg/L) were supplied through irrigation to 30 day old plants. Salt stress reduced plant biomass, chlorophyll content, and yield but increased electrolyte leakage, Na<sup>+</sup> accumulation, and antioxidant enzyme activity (SOD, POD, CAT). Both chitosan and PGPR alleviated these effects by reducing Na<sup>+</sup> uptake and enhancing antioxidant defense. The combined treatment produced the highest growth, chlorophyll content, and yield compared to individual applications. PGPR alone performed better than chitosan, but their combination showed the strongest improvement. Thus, integrating chitosan and PGPR is recommended as an eco-friendly alternative to chemical fertilizers for sustainable turnip cultivation.

**Keywords:** Biostimulants; Chitosan; Plant Growth-Promoting Rhizobacteria; Salt stress; *Brassica rapa*

**RAPS- 25-159: Evaluation of *Catharanthus roseus* L. for Remediation of Industrial Contaminated Soil Using Nanoplastics**

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A controlled pot experiment was performed to evaluate the impact of nanoplastics on *Catharanthus roseus* L. cultivated in industrially contaminated soil, focusing on ion ( $\text{Na}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{K}^+$ ) and heavy metal (Cr, Pb, Cd) uptake in different plants parts like root and shoot tissues. Various concentrations of contaminated soil like 0, 2, 4, and 6% used and mixed with garden soil. Four nanoplastic treatments control, polystyrene (PS), polyethylene terephthalate (PET), and their combination, were applied. Experiment was conducted over 85 days with a total of 48 pots arranged under controlled conditions. Scanning Electron Microscopy (SEM) analysis revealed PS particles were triangular, cracked surfaces while PET particles with rounded, crystalline morphology. EDX confirmed high carbon content in both plastics, while FTIR identified characteristic aromatic C–H stretching bands at  $3025\text{ cm}^{-1}$  (PS) and  $3000\text{--}3100\text{ cm}^{-1}$  (PET). Morphological, physiological, and antioxidant responses of seedlings were assessed. Maximum biomass was recorded under 6% PS treatment; combined PS+PET exposure inhibited enzymatic activities. Metal accumulation studies showed higher chromium uptake in shoots than roots. These results demonstrate the tolerance of *Catharanthus roseus* L. and its efficiency in improving the remediation of contaminated soils.

**RAPS-25-160: Assessment of Heavy Metal Contamination in Water, Soil, and Potatoes Irrigated with Different Water Sources in Sargodha and Sillanwali, Pakistan: Implications for Human Health**

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The study investigates heavy metal contamination in water, soil, and potatoes from irrigation sources in Sargodha and Sillanwali, Pakistan, with a focus on human health risks. Heavy metals, including cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), manganese (Mn), nickel (Ni), lead (Pb), and zinc (Zn), were analyzed using atomic absorption spectrophotometry in water, soil, and potato samples across three irrigation sources: tubewell (TW), canal (CW), and sewage water (SW). The study found that levels of Cd, Cu, and Mn exceeded the permissible limits set by the WHO in water samples, while other metals were below these thresholds. In soil, only Fe concentrations exceeded safe limits, while metals in potatoes, particularly Pb, Mn, and Ni, surpassed the permissible limits. Contamination indices, including contamination factor (CF) and bioconcentration factor (BCF), showed significant accumulation of metals in crops, especially at sewage-irrigated sites. The human health risk was assessed using estimated daily intake (EDI) and hazard quotient (HQ), revealing higher health risks at sewage-irrigated sites, particularly for Cd, Cu, and Zn. The results highlight the need for effective wastewater treatment to mitigate health risks associated with heavy metal contamination in food crops.

**RAPS-25-161: Synergistic enhancement of *Cannabis sativa* L. In vitro growth, metabolites production and antioxidant activity using silver nanoparticles and plant growth regulators**

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This study demonstrates the synergistic potential of plant growth regulators (PGRs) and silver nanoparticles (AgNPs)- a novel approach to enhance *Cannabis sativa* L. micropropagation, metabolite production, and antioxidant activity. Aimed at overcoming limitations in conventional propagation, Systematic optimization revealed that AgNPs (50 mg/L) combined with PGRs (1 mg/L TDZ + 0.1 mg/L NAA) significantly improved shoot proliferation over PGRs treatment alone. Similarly, optimized medium (0.5 mg/L BAP + 0.1 mg/L NAA + 5% sucrose) supplemented with elicitor (50 mg/L AgNPs) yielded highest callus induction 80%. In vitro-grown plants accumulated significantly higher primary metabolites than field-grown plants, including 22% higher protein, 33% greater carbohydrates and 11% increased lipids. Notably, AgNPs-treated callus cultures exhibited superior antioxidant capacity (66% DPPH scavenging). This is the first report demonstrating that AgNPs simultaneously enhance shoot proliferation, callogenesis, and primary metabolite accumulation in *C. sativa*. These findings establish that AgNPs act synergistically with PGRs to simultaneously improve *C. sativa* growth parameters, metabolite biosynthesis, and antioxidant potential, providing an efficient platform for pharmaceutical-grade biomass production.

**Keywords:** *Cannabis sativa* L., In vitro propagation, Silver Nanoparticles, Biochemical metabolites

**RAPS-25-162: Exogenous Omeprazole Modulates Aquaporin Activity and Redox Homeostasis to Improve Drought Tolerance in Maize (*Zea mays* L.) Hybrids**

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Drought stress adversely affects plant physiological processes by disrupting water relations and inducing oxidative damage. These effects can be mitigated through aquaporin activation or the application of growth regulators such as omeprazole (OMP). The present study examined the role of OMP in modulating water relations and redox balance in two maize hybrids (D-3366 and D-6619) under drought conditions. Two-week-old plants were grown under well-watered and drought-stressed regimes, with or without 10  $\mu$ M OMP application. Drought stress significantly reduced growth, leaf water status, and photosystem II ( $\Phi$ PSII) efficiency, while enhancing reactive oxygen species (ROS) production and membrane damage, particularly in the drought-sensitive hybrid D-6619. OMP application improved plant water status, enhanced the activities of antioxidant enzymes (peroxidase and catalase), and alleviated ROS-induced oxidative stress. Both hybrids exhibited increased non-photochemical quenching ( $\Phi$ NPQ) to dissipate excess excitation energy; however, this adjustment was more effectively regulated in D-6619. Moreover, OMP treatment enhanced linear electron flow (LEF), ATP synthase activity, and photoprotective responses, leading to improved PSII performance and reduced oxidative damage. Overall, OMP application mitigated drought-induced impairments by improving water relations, antioxidant capacity, and photosynthetic efficiency, with more pronounced benefits observed in the drought-sensitive hybrid D-6619.

**Keywords:** Maize. Drought, Omeprazole, ATP synthase, Aquaporin.

**RAPS-25-163: Ascorbic Acid Seed Priming: Inducing Salt Tolerance in Canola (*Brassica napus* L.) Plants by Strengthen Antioxidant Potential and Photosynthetic Capacity**

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Ascorbic acid (AsA) is a multifaceted water-soluble antioxidant crucial not only for managing reactive oxygen species (ROS), but also act as recycler of other antioxidants as well as co-factor for many growth and photosynthesis related enzymes. This study was set up to observe the ameliorative role of 200 ppm AsA applied as seed priming on two canola varieties (Dunkled and Cyclone) grown under 200 mM salt stress. Salt stress markedly reduced the biomass accumulation in both canola varieties. It also disrupted the ionic balance of canola plants by overaccumulation of Na<sup>+</sup> and Cl<sup>-</sup> coupled with a decrease in essential nutrients including K<sup>+</sup> and Ca<sup>2+</sup>. The salt induced osmotic stress and K<sup>+</sup> deficiency leads to lower stomatal conductance, water use efficiency, net assimilation rate and decreased gas exchange parameters. In addition, the oxidative stress further intensified the situation by unbalancing ROS equilibrium reflected by elevated H<sub>2</sub>O<sub>2</sub> and MDA levels which negatively affected membrane stability and photosynthetic process. The adverse effect of salt stress on structural and functional aspect of photosynthesis was observed by fluorescence technique. Reduction in PIABS, Fv/Fo and changes in energy fluxes further confirmed the salt induced damage. The reduction in net CO<sub>2</sub> assimilation rate was associated with lower ETRII under saline conditions. However, canola varieties activated physiological and biochemical mechanisms to cope with salt stress. The increase in CEF-PSI and NPQ were observed as photoprotective mechanisms as well as antioxidant battery system was boosted under salt stress. AsA seed priming reversed the salt toxicity by maintaining ionic balance, improving gas exchange parameters, chlorophyll content, enhanced the linear electron transport, and reduced donor-end limitations of PSI activity by facilitating electron transfer from PSII to PSI. Moreover, it also augmented the enzymatic (SOD, POD, CAT, APX) and non-enzymatic (AsA, phenolics, tocopherol, proline) antioxidants to neutralize excessive ROS under salt stress. Together these seed priming induced physiological and biochemical regulations help canola plants to enhance vegetative growth and yield under 200 mM salt stress. Thus, AsA seed priming can be a potential approach to mitigate salt-induced damages in canola crop.

**Key words:** Salt stress, Canola, NPQ, PSII, antioxidants, Yield

## **RAPS-25-164: Genome Editing for Food and Nutritional Security**

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CRISPR-based genome editing offers a precise approach for improving crop traits critical to agriculture. In this study, CRISPR technology was employed to enhance grain quality in rice by targeting genes involved in starch biosynthesis and grain composition. Edited lines exhibited improved nutritional profiles and cooking characteristics. In canola, targeted modification of the *acetolactate synthase (ALS)* gene conferred resistance to *ALS*-inhibiting herbicides, enabling more effective weed control. Furthermore, rice lines tolerant to heavy metals were developed through editing of genes involved in metal uptake and detoxification pathways. These results demonstrate the potential of CRISPR to generate crop varieties with improved grain quality, herbicide resistance, and tolerance to environmental stressors, contributing to sustainable crop production.

**Keywords:** CRISPR genome editing; Rice grain quality; Herbicide resistance; *ALS* gene; Heavy metal tolerance

## **RAPS-25-165: Biogenic nanoparticles for chromium stress tolerance in soybean**

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Heavy metal pollution, particularly by chromium (Cr), poses a critical challenge to sustainable agriculture due to its persistence, bioaccumulation, and severe phytotoxic effects on crops. Chromium toxicity impairs soybean (*Glycine max*) germination, chlorophyll biosynthesis, root growth, and nitrogen fixation, leading to substantial yield losses. Conventional soil remediation approaches are costly, inefficient, and often environmentally unsustainable. Nanotechnology offers an emerging strategy to mitigate abiotic stresses, and biogenically synthesized nanoparticles (NPs) have demonstrated promising eco-compatible properties for enhancing plant resilience. This study evaluated the performance of biogenic NPs in alleviating Cr-induced stress in soybean under controlled greenhouse conditions. A completely randomized design (CRD) was applied using four treatments: control (T1), Cr stress (T2), biogenic NPs (T3), and combined Cr + biogenic NPs (T4). Physiological and biochemical parameters were analyzed, including antioxidant enzyme activities (catalase, ascorbate peroxidase, and superoxide dismutase), morpho-physiological indices, biomass allocation, and metabolite profiles (soluble sugars, amino acids, and organic acids). Results indicated that Cr stress markedly reduced biomass, chlorophyll content, and water retention while elevating oxidative damage. However, the combined treatment (T4) significantly enhanced antioxidant enzyme activity, maintained photosynthesis spectral stability, improved relative water content, and restored metabolic balance compared with Cr-stressed plants. These outcomes highlight the ability of biogenic NPs to stimulate endogenous defense mechanisms and mitigate Cr toxicity, thereby improving growth and physiological performance. Overall, biogenic nanoparticles represent an effective and sustainable bio-stimulant strategy to enhance soybean tolerance to heavy metal stress, offering an environmentally sound approach for soil rehabilitation and advancing sustainable agricultural productivity.

**Keywords:** Chromium toxicity, Biogenic nanoparticles, Antioxidant defense, Oxidative stress, Sustainable agriculture.

**RAPS-25-166: Process Optimization of Bacterial Malachite Green Dye Degradation and Phytotoxicity Assessment toward Sustainable Water Reuse in Agriculture**

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Synthetic textile dyes such as malachite green are persistent environmental pollutants with severe ecological and health impacts. Conventional physicochemical treatment methods are often costly and generate secondary pollutants, necessitating eco-friendly alternatives. In the present study, *Enterobacter cloacae* AM-6 isolated from textile dye effluent was employed for the biodegradation of malachite green dye, and various physicochemical parameters were optimized to achieve maximum decolorization efficiency. Factors including pH, temperature, inoculum size, and nitrogen source were systematically varied to determine optimal conditions for enhanced dye degradation. The treated and untreated dye effluents were further evaluated through phytotoxicity assays using mung bean (*Vigna radiata*) as model test plant. Germination rate along with radical and plumule elongation were assessed to determine the toxicity reduction. Enhanced decolorization was achieved at 35°C, pH 6.0, and an inoculum size of 15% after 5 days of incubation at an MG concentration of 200mg/L in the presence of 1.5% sucrose and 1.5% tryptone. The germination rate (%) was improved from 0% (untreated effluent) to 42% (treated effluent). Results demonstrated significant improvement in seed germination in treated effluents compared to untreated controls, confirming effective detoxification alongside decolorization. This integrated approach not only establishes microbial decolorization as a sustainable and efficient method for dye effluent treatment but also highlights its potential application in recycling industrial wastewater for agricultural irrigation. Such eco-innovative strategies contribute to environmental restoration and align with the vision of a sustainable future.

**Keywords:** Malachite green, optimization, decolorization, phytotoxicity

**RAPS-25-167: Green-synthesized silver nanoparticles confer drought tolerance in wheat (*Triticum aestivum* L.) by enhancing growth, antioxidant activity, and physiological performance**

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Silver nanoparticles (AgNPs) are emerging as promising nano-agrochemical tools capable of mitigating the detrimental effects of drought on wheat by enhancing growth performance, physiological efficiency, and antioxidant capacity. In this study, AgNPs were green-synthesized using rice husk extract, and their crystalline, spherical, and stable nature was confirmed through UV–Vis spectroscopy, FTIR, XRD, and SEM analyses. Two wheat genotypes—drought-sensitive Dilkash and drought-tolerant Zincol—were evaluated under 30% and 70% soil moisture regimes, with foliar applications of AgNPs ranging from 100 to 800 ppm. The experiment was designed to assess the interactive effects of AgNPs on growth, photosynthetic pigments, organic osmolytes, stress biomarkers, and antioxidant enzymes, using a completely randomized design with three replications. Drought stress significantly reduced biomass accumulation, leaf number, tillering, and chlorophyll content in both genotypes, with Dilkash exhibiting greater sensitivity. Foliar application of AgNPs at moderate concentrations (100–300 ppm) effectively alleviated these drought-induced impairments by promoting growth, sustaining photosynthetic pigments, elevating osmolyte contents (proline and glycine betaine), reducing lipid peroxidation, and enhancing antioxidant enzyme activities (SOD, POD, CAT). Among the treatments, Zincol demonstrated a stronger recovery response at 300 ppm, reflecting its inherent drought resilience and greater responsiveness to nanoparticle-mediated modulation. However, higher AgNPs doses (600–800 ppm) exerted phytotoxic effects, leading to growth inhibition and physiological decline in both genotypes. Overall, these findings suggest that low to moderate concentrations of green-synthesized AgNPs can effectively mitigate drought stress in wheat by sustaining growth, osmolyte balance, and antioxidant defenses, highlighting their potential role in nano-enabled strategies for crop improvement under water-limited conditions.

**Keywords:** Drought stress; Silver nanoparticles; Antioxidants; wheat, Stress, foliar application

# **POSTER PRESENTATIONS**



**RAPS-25-168: Microwave Assisted Extraction of Lawsone: A Natural Dye of Commercial Acceptance**

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The textile industry contributes significantly to environmental pollution especially through production of synthetic dyes that are toxic, non-biodegradable, and carcinogenic. Plant based natural dyes present a viable alternative that is environment friendly. *Lawsonia inermis* L. (henna) contain lawsone, a natural dye. The present study focused on the efficient extraction of lawsone from *L. inermis* leaves using Microwave- Assisted Extraction (MAE), a rapid and sustainable green technology. For optimization of MAE, RSM was used. The independent variables were selected time (60-360 seconds), power level (300 to 900 W), cycles of extraction (1-3), and solvent type (Water, ethanol, and their combination). Lawsone yield was measured by UV-visible spectroscopy. Results showed that maximum lawsone yield (ca. 19.5 mg/g) was observed at 550 W power, 210 s extraction time and 2 g of plant material in water as a solvent. The extracted lawsone dye was applied to cotton and silk fabrics, employing pre- and post-mordanting techniques with alum and tannic acid. The dyed fabric samples were analysed for absorbance, colour coordinates colour strength, and colour fastness properties. Better dye fixation was proved by the UV-Visible spectroscopy of wash water especially in the silk which was mordanted with tannic acid. Results showed by UV analysis of washing water that the run # 15 and 37 gave most stable dyeing on silk preferably with Tannic acid as a mordant. The study proves that MAE is environmentally friendly, time-consuming, and very effective, viable way of generating lawsone in *L. inermis*.

## **RAPS-25-169: The Role of Nano-Biochar Foliar Application in Enhancing Maize Drought Resilience**

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Water stress is the most important factor among abiotic factors, adversely affecting worldwide food production. Pakistan is also among the top 10 countries affected by water stress. This challenge can be overcome by using organic substances. Nano-biochar is an advanced top-down nanostructured substance that is obtained from bulk biochar. To assess the effects of foliar application of nano-biochar (0.1%) on maize varieties (Suraj, Cobra, and Winner) under different moisture levels (optimal 100% of ETC, partial deficit 70% of ETC, and severe deficit 50% of ETC), a field experiment using a split-split plot design was conducted at the Botanical Garden, University of the Punjab, Lahore, Pakistan. The foliar application of nano-biochar improved soil's physicochemical properties. It significantly reduced proline content (5%), hydrogen peroxide (11%), and superoxide anion (10%), while boosting DPPH (2.7%), ABTS (3.6%), total phenolic content (15%), total flavonoids content (5.5%), relative growth rates and grain yield in maize plants. Additionally, results showed that foliar nano-biochar application produced notable improvements in growth and yield compared to no application, especially in physiological status, growth parameters, and yield attributes. Under drought conditions, foliar nano-biochar is an effective strategy to enhance maize resilience and productivity.

**Keywords:** Nanobiochar, Foliar application, Photosynthetic Pigments, Antioxidant enzymes, Reactive Oxygen Species

## **RAPS-25-170: Bioactive Potential of Potential of *Hibiscus Rosa-Sinensis* Petals**

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Hibiscus, which belongs to family Malvaceae is a significant collection of annual plants with enormous therapeutic potential. By concentrating on the antioxidant, antiproliferative, and antimutagenic properties of petal extracts, the current study aimed to explore the anticancer potential of *Hibiscus rosa-sinensis* petals. Plant extraction was carried out by maceration process with different solvents. Chemical tests for phytochemical evaluation of the petal extracts revealed the presence of proteins, tannins, flavonoids, coumarins, cardiac glycosides, saponins, and triterpenes. The extracts were then subjected to a spectrophotometric DPPH radical scavenging experiment to determine their antioxidant activity. In DPPH radical scavenging assay, antioxidant activity of *Hibiscus rosa-sinensis* ranged between 178±0.00% to 32±0.06%. Ethanolic extract had highest antioxidant potential while, lowest antioxidant activity was observed in petroleum ether extract. Through microscopic analysis to identify both normal and aberrant mitotic phases, antimutagenic activity was ascertained using the *Allium cepa* assay. In this assay, petroleum ether extract had highest antimutagenic activity with minimum mitotic index at 2 mg/ml (51.97±0.33%). Under a compound microscope with a 40X and 100X magnification, the plant extracts displayed chromosomal and mitotic abnormalities that were apparent. By using yeast cell model, antiproliferative activity was performed and hemocytometer was used for cell counting. Live and dead cells were observed under light microscope. The petroleum ether extract of *Hibiscus rosa sinensis* showed maximum antiproliferative activity with lowest cell viability (27.83±0.17%) at a concentration of (1mg/ml) while ethanolic extract showed the highest antiproliferative activity with lower cell viability (42.96±0.04%) at highest extract concentration (2mg/ml). The findings of the study reflected that the petals extract of *Hibiscus rosa-sinensis* have strong potential for usage as an anti-cancer agent.

**Keywords;** *Allium cepa*, Hemocytometer, Bioactive, Anticancer, China Rose

**RAPS-25-171: Mitigating Salt Stress in Pea (*Pisum sativum* L.)  
through Ascorbic Acid Application: Enhancing Growth,  
Physiology, and Yield under Saline Conditions**

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Salinity is a major abiotic stress limiting agricultural productivity worldwide, especially in countries like Pakistan where poor irrigation and soil management exacerbate the problem. This study investigated the mitigating effects of ascorbic acid (AsA) on the growth and yield of pea (*Pisum sativum* L.) plants exposed to salt stress. A pot experiment was conducted using a Completely Randomized Design (CRD) with twelve treatments, including varying concentrations of NaCl (50 mM and 100 mM) and foliar applications of AsA (0.4, 0.8, and 1.2 mM), both individually and in combination. Morphological, physiological, biochemical, and yield parameters were recorded and statistically analyzed using ANOVA. Results revealed that salinity significantly reduced root and shoot length, biomass, chlorophyll content, and yield, while increasing electrolyte leakage and sodium ion accumulation. Conversely, AsA treatments, particularly at 0.8 mM concentration, substantially improved plant growth, relative water content, chlorophyll synthesis, and antioxidant enzyme activity (SOD, POD, CAT), and reduced membrane damage and Na<sup>+</sup> toxicity. The combination of 0.8 mM AsA with 50 mM NaCl exhibited the best performance, maintaining ionic balance by enhancing K<sup>+</sup> uptake and improving pod and seed yield. The findings demonstrate that exogenous application of AsA acts as an effective antioxidant regulator, promoting salt tolerance in pea plants through improved physiological stability and enzymatic defense. This study suggests that AsA can be a sustainable, low-cost, and eco-friendly approach to enhance crop resilience under saline conditions, supporting food security in salt-affected regions.

**Keywords:** Ascorbic acid (AsA); Salt stress; *Pisum sativum* L.; Antioxidant enzymes; Plant growth and yield.

**RAPS-25-172: A New Record of the Scarlet Cup Fungus,  
*Sarcoscypha javensis* from Pakistan**

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The present study aims to enhance the understanding of fungal diversity and distribution in Pakistan. During a recent mycological survey in the moist temperate forests of Donga Gali in Abbottabad District, Khyber Pakhtunkhwa, Pakistan, several collections of striking scarlet cup fungi were collected from decaying hardwood-logs. Macro and micro morphological examination identified the specimen as *Sarcoscypha javensis*, a species previously known from Southeast Asia and Oceania but not reported from Pakistan till now. It was identified by the bright orangish-red, cup-shaped apothecia up to 3 cm in diameter, having cylindrical asci, with smooth, ellipsoid, hyaline ascospores bearing characteristic guttules. Molecular phylogenetic analysis based on sequencing of the ITS region of ribosomal DNA also confirmed its position. Globally, 18 species were described within this genus with only two species reported from Pakistan to date. Despite their ecological significance, the diversity of *S. javensis* remains poorly studied and under reported in Pakistan. The present collection represents the first record of *S. javensis* in Pakistan, thereby extending its known geographical range westward. This discovery contributes to the limited knowledge of discomycete diversity in the country and underscores the importance of continued mycological exploration. It also highlights the need for comprehensive surveys of macrofungi in temperate forest ecosystems.

**Keywords:** diversity, discomycetes, ITS, new record, taxonomy.

**RAPS-25-173: Synergistic Effect of Biofertilizers and Vermicompost on Growth, Nutrient Composition and Yield of *Pisum Sativum* L.**

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The integration of organic inputs such as biofertilizers and vermicompost is a promising strategy to enhance soil health and crop productivity for sustainable agriculture. The present study explored the impact of *Klebsiella oxytoca* and vermicompost on the growth, nutrient composition, and yield of *Pisum sativum* L. var. Advanta under controlled conditions. The experiment was carried out in pots following a randomized design, incorporating six distinct treatments: T1 (control), T2 (*Klebsiella oxytoca*), T3 (5% vermicompost), T4 (10% vermicompost), T5 (5% vermicompost + *K. oxytoca*), and T6 (10% vermicompost + *K. oxytoca*). Among all treatments, T5 (5% vermicompost + *K. oxytoca*) recorded the highest germination rate (97.63%) and significantly enhanced vegetative growth parameters, including root length (51.5%), shoot length (62.7%), shoot fresh weight (94.9%), number of leaves (60%), and number of branches (99.4%) compared to the control. Yield attributes were also markedly enhanced under T5, with a 62% increase in the number of pods per plant, 97% increase in pod fresh weight, 43% increase in grain fresh weight, 98.6% grain dry weight and a 59.6% enhancement in dry pod weight compared to control. Vermicompost enriches the soil with essential nutrients, enhancing its structure, moisture retention, and microbial vitality. *Klebsiella oxytoca*, a helpful soil bacterium, makes nutrients easier for plants to absorb, fixes nitrogen, and supports growth through natural hormones. Together, they help plants grow better and handle stress. Using both vermicompost and biofertilizer boosts nutrient uptake, improves plant health, increases yield, and reduces the need for chemical fertilizers in a sustainable way.

**Keywords:** Biofertilizer, vermicompost, peas, agronomical parameters, antioxidant activities, yield components.

**RAPS-25-174: Comparative Pollen Morphology of the Selected Members of Family Asteraceae, Lahore, Pakistan**

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Palynology, the study of pollen and spores, is a specialized branch of Botany that provides essential insights into plant Taxonomy, Evolution, Ecology, and Reproductive Biology. The Asteraceae, also known as the daisy or sunflower family, is one of the most diverse family of flowering plants. Palynological analysis of six (06) species belonging to five (05) genera viz. *Calendula*, *Bellis*, *Gazania*, *Helianthus*, and *Tagetes* was carried out. Using standard palynological procedures, the pollen were isolated and carefully examined under the microscope. Various morphographic features of pollen including shape, size, ornamentation type, size of ornaments, exine sculpture and, exine thickness were recorded. Qualitative and quantitative data revealed significant morphological similarities among pollen with few exceptions. Based upon the aperture type, two forms of pollen viz. tricolporate and tetracolporate were identified. Size of the pollen considerably varied among studied species. The highest equatorial diameter (40- 45  $\mu\text{m}$ ) and the polar diameter (40  $\mu\text{m}$ ) were recorded in *Gazania rigens* and *Calendula stellata* respectively. The lowest value of both was found in *Bellis perennis* viz. 20-25  $\mu\text{m}$  and 20-22  $\mu\text{m}$ , respectively. The largest pore diameter viz. 9  $\mu\text{m}$  was observed in *Calendula stellata* (Orange color variant), whereas *Calendula stellata* (Red) and *Calendula stellata* (Yellow) had smallest pore diameters (4  $\mu\text{m}$ ). The maximum value of colpus length (20  $\mu\text{m}$ ) was found in *Calendula stellata* (Orange) and *Tagetes erecta* (Orange), while *Calendula stellata* (Yellow) had the shortest of the colpi i.e. 4  $\mu\text{m}$ . *Gazania rigens* exhibited the maximum degree of colpus width (12  $\mu\text{m}$ ), whereas *Tagetes erecta* (Orange) had the lowest value of colpus width (2  $\mu\text{m}$ ). Present study will not only contribute to the existing knowledge about the genera but will also significantly contribute for the correct taxonomic placement of various taxa.

**Keywords:** Palynology, Asteraceae, Tricolporate, Tetracolporate, Colpus

## **RAPS-25-175: Assessment of Ultrasonic Seed Treatment on the Performance of Rice (*Oryza sativa* L.) Under Salt Stress**

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Rice (*Oryza sativa* L.) is a fundamental staple food. Because salinity causes Na<sup>+</sup> ions to accumulate in plants, it poses a significant barrier to agriculture, leading to toxicity and reduced yield. The experiment included two rice cultivars (Pk1121 and Super Basmati). Regards pot experiment in U0 condition (No ultrasonic) S0, S1, S2 and salt levels (0mM NaCl, 100mM NaCl, 200Mm NaCl). In U1 condition (ultrasonic treatment, 15 minutes), S0, S1 and S2. Under salt stress conditions, there was a decrease in shoot dry weight (g), plant height, leaf area (cm<sup>2</sup>), root length, root dry weight (g), root fresh weight (g), shoot fresh weight (g), tillers numbers, number of panicles, and grain yield. Salt stress was found to negatively affect the activity of antioxidant enzymes, specifically superoxide dismutase (SOD), peroxidase (POD), and catalase (CAT) the amount of anthocyanin, soluble sugar, water relative content, and sodium ion (Na<sup>+</sup>) content. The electrolyte leakage, proline content, potassium (K<sup>+</sup>) content, and calcium ion content increased under salt stress. Regards Patri dishes experiment, in U0 condition (no ultrasonic) S0, S1, S2 and salt levels (0mM NaCl, 100mM NaCl, 200Mm NaCl). In U1 condition (ultrasonic treatment, 15 minutes), S0, S1 and S2. In Pk1121, the U0 condition germination rate (100%) and in the U1 condition germination rate (80%). In super basmati, the U0 condition germination rate (60%) and in the U1 condition germination rate (60%). Under salt stress conditions, there was a decrease in root and shoot dry weight (g), root length and shoot length (cm), root and shoot fresh weight (g). Evaluated the data by using Fisher's analysis of variance and checked differences across the means of the treatments using the least significant difference (LSD) test at a 5% level of probability.

**Keywords:** rice (*Oryza sativa* L.), NaCl, ultrasonic

## **RAPS-25-176: Vermicompost and Mixed Biochar Induced Phytoremediation of Heavy Metals Contaminated Soil by Using Sudan Grass**

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This research was carried out to determine the role of *Sorghum × drummondii* (also called Super Sudan grass or jowar) to clean the polluted soil from a paper industry by effectively removing heavy metals using a phytotechnology approach. Different treatments were used like a control group (C0), biochar (BC), and vermicompost (VC). The plant was grown in soil mixed with different levels of contamination (0, 5, 10 and 15%). After 80 days, the plants were studied to check how these treatments affected their growth and ability to remove harmful metals from the soil. Before planting, the soil was tested for pH, electrical conductivity (EC), total dissolved solids (TDS), bicarbonates, nutrients such as nitrogen, phosphorus, potassium and heavy metals such as Chromium (Cr), lead (Pb), and cadmium (Cd) and a post-harvest analysis was also performed to check the percentage reduction in all these parameters. At the time of harvest, the plants were further analyzed for various morphological features. The results showed that maximum heavy metals uptake was observed in the shoots than in the roots of the plants (Shoot > Root). Highest concentration of nutrients (Phosphorus) and metals (Cd) was recorded in 15% concentration of soil along with organic treatments like biochar and vermicompost (applied as a single treatment). This shows that Sudan grass, when treated with organic additives, can be a good option for cleaning heavily polluted soils. Plants responded more positively to vermicompost compared to biochar treatment showing better growth and stress resilience as well as more efficiently remove heavy metals in the contaminated industrial soil. The main goal of this study was to understand how Super Sudan grass works with biochar and vermicompost treatments to improve plant growth and metal absorption. This research suggests that using natural materials like vermicompost and biochar can make phytoremediation technology safer and more effective, helping to clean up polluted soil in an eco-friendly way.

## **RAPS-25-177: Cloning and Molecular Characterization of Human Encoded Folate Receptor Alpha Gene**

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Folate receptor alpha (FR $\alpha$ ) is a glycosylphosphatidylinositol (GPI)-anchored membrane protein that plays a crucial role in the cellular uptake of folate, a vitamin essential for DNA synthesis, repair, and methylation. The overexpression of FR $\alpha$  has been observed in various human epithelial cancers, including ovarian, breast, and lung carcinomas, making it a potential biomarker and target for therapeutic drug design. The aim of the present study is to isolate the FR $\alpha$  gene from human tissue and express it in *Escherichia coli* to obtain recombinant FR $\alpha$  protein for further characterization. In this study, total RNA was extracted from human tissue, and complementary DNA (cDNA) was synthesized using reverse transcription. Specific primers were designed for the FR $\alpha$  gene, which was then amplified through polymerase chain reaction (PCR). The amplified gene fragment was analyzed by agarose gel electrophoresis to confirm the expected band size. The purified PCR product was digested with restriction enzymes BamHI and EcoRI and ligated into the pET-28a(+) expression vector using T4 DNA ligase. The recombinant plasmid construct was transformed into competent *E. coli* cells for gene expression. Blue-white screening using X-gal and IPTG was performed to distinguish recombinant colonies, where white colonies indicated successful insertion of the FR $\alpha$  gene. The positive transformants were cultured in LB broth containing IPTG to induce protein expression. The expressed recombinant FR $\alpha$  protein was analyzed through SDS-PAGE, and further purification steps were optimized to obtain a functional protein. This recombinant expression system provides an efficient and cost-effective method to produce human FR $\alpha$  protein in *E. coli*. The expressed protein can serve as a valuable tool for studying the structure and function of folate receptors and for developing FR $\alpha$ -targeted drug delivery systems and diagnostic assays in cancer research. This recombinant expression system allows large-scale synthesis of FR $\alpha$  without dependence on limited or ethically sensitive human tissue sources. The cloning of the receptor gene into *E. coli* ensures a continuous and pure supply of the receptor protein suitable for biochemical, diagnostic, and therapeutic studies. This strategy not only simplifies receptor procurement but also enhances reproducibility and sustainability in folate receptor-related research.

**Keywords:** Folate receptor alpha, *E. coli*, DNA extraction, PCR

**RAPS-25-178: Exploring the Taxonomic and Ecological Diversity of Macrofungi from Punjab, Pakistan**

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Punjab, Pakistan, hosts a mosaic of terrestrial habitats ranging from irrigated agricultural plains, natural forests and urban green spaces, which support considerable diversity. This study presents a systematic survey of macrofungi across representative habitats of Punjab, conducted seasonally to capture phenological variation. Specimens were collected following standard field protocols, photographed, and described morphologically; representative collections were deposited in a regional herbarium. Molecular identification via ITS nrDNA barcode was used in association with macro- and micromorphological characters to resolve taxonomic ambiguities. Using diversity indices and multivariate analyses, we assessed species richness and abundance. Results reveal a rich regional diversity and several taxa poorly represented in the literature, underscoring both high local diversity and the potential for previously unreported records. Ecological patterns reflect strong influences of substrate availability, land-use, and seasonality. Findings provide a baseline for conservation prioritization, sustainable use, and future bioprospecting, and highlight the need for continued integrative taxonomic work and long-term monitoring to track responses to land-use change and climate variability in Punjab.

**Keywords:** conservation, ecology, fungal biodiversity, ITS barcoding, saprobics

**RAPS-25--179: A New Species of *Inocybe* (*Inocybaceae*) from the Moist Temperate Forests of Shimla Hills, Pakistan, Based on Morphological and Molecular Evidence**

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The genus *Inocybe* (Fr.) Fr. (*Inocybaceae*, *Agaricales*) is one of the important ectomycorrhizal genera in *Agaricales*. The genus *Inocybe* is characterized by amygdaliform, ellipsoid to subcylindrical, smooth, angular, nodulose, or spinose basidiospores with a distinct apiculus and presence of pleurocystidia (Matheny et al. 2020). From Pakistan 38 species of *Inocybe* have been reported till date. During a project for the exploration of member of family *Inocybaceae* from moist temperate forest of Shimla hill (Himalays), field expeditions were conducted for collection of *Inocybe*. During this study, one new species of *Inocybe* has been reported, i.e. *Inocybe shimlaensis* that is characterized by brown to golden pileus, low and broad umbo, radially fibrillose, rimose to granulose, with brown appressed-squamulose stipe with only apex pruinose and submarginate base. Anatomically, it has small ( $6.8 \times 4.4 \mu\text{m}$ ) basidiospores and smaller conical to fusiform cheilocystidia. Phylogenetic estimation based on DNA sequences from the internal transcribed spacer (ITS) region and large subunit (LSU) of the nuclear ribosomal DNA (rDNA) genes is congruent with the morphological characters that help to delimit these as new species of *Inocybe*. This project will also be attempt to explore the diversity of macrofungi of Shimla hill based on morphological anatomical and phylogenetic analysis. Nevertheless, there remains a need for more extensive and methodical surveys to uncover the vast and diverse mushroom flora that has yet to be fully documented. It is hypothesized to get many novel taxa and the generated data will be useful in nursery and forest management.

**Key words:** *Inocybe*, Shimla hill, *Inocybe shimlaensis*

## **RAPS-25-180: Plants-climate faceoff. Strategies for Survival in a Shifting World**

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In the relentless faceoff between plants and a rapidly changing climate, survival hinges on adaptability and resilience. Climate change marked by rising global temperatures, erratic precipitation, elevated CO<sub>2</sub> levels, and escalating extreme weather events poses profound challenges to plant life, reshaping growth patterns, productivity, and distribution across ecosystems. Yet, plants have evolved an extraordinary arsenal of survival strategies to withstand these environmental upheavals. Through morphological adjustments, physiological flexibility, biochemical modulation, and genetic adaptation, plants counteract drought, salinity, heat, and other abiotic stresses. Central to these defenses are enhanced antioxidant systems, osmolyte accumulation, and precise regulation of stress-responsive genes. Additionally, symbiotic alliances with mycorrhizal fungi and rhizobacteria bolster nutrient acquisition, water efficiency, and overall stress tolerance. Advances in genomics, molecular biology, and remote sensing now illuminate these adaptive pathways, offering insights for breeding and conserving climate-resilient species. As the planet continues to warm, integrating ecological understanding with biotechnological innovation will be essential to fortify plant resilience, sustain agriculture, and preserve biodiversity. The unfolding plants–climate faceoff underscores an urgent need to decode nature’s adaptive wisdom to secure ecosystems in an uncertain future.

**Keywords:** climate change, plant adaptation, abiotic stress, resilience, symbiosis, sustainable ecosystems

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