ICPEP-7

Abstract Book

7th International Conference on Plants and Environmental Pollution

30 November - 2 December 2025

Conference Theme:

Plants & Ecosystems for Advancing LiFE (Lifestyle for Environment), Green Growth, and Sustainable Future

Organized by

International Society of Environmental Botanists (ISEB)
&
CSIR-National Botanical Research Institute, Lucknow



राष्ट्रीय वनस्पति अनुसंधान संस्थान लखनऊ

(वैज्ञानिक एवं औद्योगिक अनुसंधान परिषद्, भारत सरकार)

परिचय एवं इतिहास





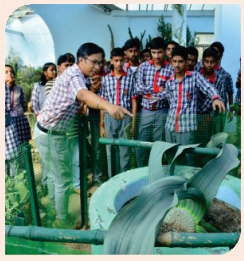
- राष्ट्रीय वनस्पति अनुसंधान संस्थान, लखनऊ (सीएसआईआर-एनबीआरआई), वैज्ञानिक एवं औद्योगिक अनुसंधान परिषद्, नई दिल्ली के अंतर्गत एक प्रमुख पादप विज्ञान अनुसंधान केंद्र है। संस्थान को पादप जैव-विविधता, जैव-प्रौद्योगिकी, जैव-सूचना विज्ञान, पर्यावरणीय आकलन, पर्यावरणीय विष-विज्ञान, जैव-उपचार एवं फार्मास्यूटिकल शोध कार्य में दक्षता हासिल है।
- 1800 ईसा पूर्व, सिकंदरबाग के रॉयल गार्डन के नाम से प्रसिद्ध इस वनस्पति उद्यान को मुग़ल सल्तनत के नवाबों द्वारा स्थापित किया गया था। नवाब वाजिद अली शाह ने अपनी बेगम के नाम पर इस उद्यान का नाम सिकंदरबाग रखा था। ब्रिटिश शासन काल में इस उद्यान का नाम गवर्नमेंट हॉर्टिकल्चर गार्डन कर दिया गया
- वर्ष 1932 में प्रसिद्ध वैज्ञानिक प्रो. बीरबल साहनी एवं डॉ. एस के चतुर्वेदी द्वारा इस सिकंदरबाग को वनस्पति उद्यान में तब्दील कर वर्ष 1948 में इसे नेशनल बोटेनिक गार्डन में परिवर्तित किया गया एवं 13 अप्रैल 1953 को वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्, नई दिल्ली (सीएसआईआर) द्वारा नेशनल बोटेनिक गार्डन को अंगीकृत कर 25 अक्टूबर 1978 में इसका नाम बदल कर राष्ट्रीय वनस्पति अनुसंधान संस्थान किया गया।





मुख्य शोध एवं विकास क्षेत्र







- पादप विविधता, वर्गिकी एवं निम्न तथा उच्च पादप समूहों के लिए डेटाबेस
- औषध विज्ञान, पादप रसायन एवं भेषज विज्ञान अध्ययन
- मानव स्वास्थ्य देखभाल हेतु हर्बल उत्पादों का विकास
- जलवायु परिवर्तन, सूक्ष्मजीवी एवं पर्यावरणीय प्रौद्योगिकियों पर अनुसंधान
- पारंपरिक एवं आणुविक प्रजनन द्वारा पादप सुधार एवं आनुवांशिक अभियांत्रिकी
- वनस्पति उद्यान, पादप संरक्षण एवं पुष्प कृषि हेतु पौधों की नवीन किस्मों का विकास
- ऊसर एवं अन्य बंजर भूमि के सतत् विकास हेतु कृषि-प्रौद्योगिकियाँ
- कौशल विकास कार्यक्रम एवं समाज कल्याण हेतु गतिविधियाँ

संस्थान की राष्ट्रीय सुविधाएँ एवं सेवाएं



वनस्पति उद्यान

उद्यान में देश की दुर्लभ, संकटग्रस्त, संजावटी एवं वाणिज्यिक रूप से महत्वपूर्ण गैर-फसली पौधों की 5,000 से अधिक प्रजातियां संरक्षित है। वनस्पति उद्यान लखनऊवासियों में सुबह की सैर के लिए पसंदीदा स्थानों में एक है। प्रतिदिन 1000 से अधिक लखनऊवासी उद्यान के हरे और ताज़ा वातावरण से लाभान्वित होते हैं।



पादपालय

सीएसआईआर-एनबीआरआई में देश का तीसरा सबसे बड़ा पादपालय स्थित है जिसमें शैवाल, ब्रायोफाइट्स, टेरिडोफाइट्स, शैक, जिम्नोस्पर्म और एंजियोस्पर्म के 2,50,000 से अधिक नमूने उपलब्ध हैं। यह राष्ट्रीय जैवविविधता प्राधिकरण द्वारा वर्गीकृत एक राष्ट्रीय कोष है।



प्राकृतिक जड़ी बूटी/औषधि संग्रहालय

संग्रहालय में प्रमाणित औषधीयों के करीब 2000 नमूने प्रदर्शित किये गए हैं । इन औषधीय नमूनों को देश के सुदूर भागों से एकत्रित कर इनके इस्तेमाल किये जाने वाले भागों जैसे रूट ड्रग्स, छाल ड्रग्स, लीफ ड्रग्स, स्टेम ड्रग्स, वॉज ड्रग्स, असंगठित ड्रग्स आदि के आधार एस आयुष प्रणाली के अनुसार वर्गीकृत किया गया है ।

पर्यावरण सूचना, जागरूकता, क्षमता निर्माण और आजीविका कार्यक्रम केंद्र

पर्यावरण सूचना, जागरूकता, क्षमता निर्माण और आजीविका कार्यक्रम केंद्र (ईएआईसीपी)पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय, भारत सरकार द्वारा पर्यावरण और वन क्षेत्रों के विषयों पर विशिष्ट कार्य करने हेतु स्थापित किया गया है। संस्थान में स्थित यह केंद्र हितधारकों के लिए 'पौधों एवं प्रदूषण' विषयक कार्यक्रमों एवं मिशन लाइफ के अंतर्गत विभिन्न कार्य रहा हैं।



कौशल विकास कार्यक्रम

संस्थान द्वारा विभिन्न कौशल विकास कार्यक्रम शुरू किए हैं जिनमें जैव-इनोकुलेंट प्रोडक्शन फॉर एग्रीकल्चरल एप्लीकेशन, कमर्शियल प्लांट टिश्यू कल्चर, क्वालिटी एनालिस्ट्स फॉर हर्बल इंडस्ट्री, जीनोमिक्स, इन-सिलिको एनालिसिस फॉर जीनोमिक्स एंड प्रोटियोमिक्स एवं ग्रीन स्किल डेवेलपमेंट मुख्य हैं।



केंद्रीय उपकरण सुविधा

संस्थान की यह सुविधा पादप आधारित विश्लेषणात्मक परीक्षण सेवाएँ प्रदान करती हैं जिसके अंतर्गत पौधों से प्राप्त होने वाले आवश्यक तेलों के परीक्षण के साथ साथ प्रमाणित संदर्भ सामग्री (सीआरएम) का विकास भी किया जाता हैं । इस सुविधा की परीक्षण और अंशांकन प्रयोगशालाओं के लिए राष्ट्रीय प्रत्यायन बोर्ड (एनएबीएल) से मान्यता प्राप्त हैं।



संस्थान द्वारा विकसित हर्बल उत्पाद

संस्थान ने वैज्ञानिक रूप से मान्य हर्बल उत्पादों का भी विकास किया है जिनमें एनबीआरएमएपी-डीबी: मधुमेह विरोधी हर्बल फार्मूलेशन(BGR34), एनबीआरआई यूरो-05, ट्रपिकल हर्बल कैंडिडा जेल, जोश: पारंपरिक काढ़ा, डेंटो जेल: दांतदर्द राहत जेल, क्रोमा -03: जैव उपलब्ध कर्क्युमिन, न्यूट्रीजैम शामिल हैं।



संस्थान द्वारा कृषि प्रौद्योगिकियाँ

संस्थान द्वारा किसानों को लाभान्वित करने हेतु विभिन्न प्रौद्योगिकियाँ विकसित की गयी हैं जिनमे नमो: 108 कमल की किस्म, एलोवेरा 'निहार', आर्सेनिक मुक्त धान 'मुक्ताश्री', उत्तर भारत हेतु हल्दी की किस्म-केसरी, सफेद मक्खी प्रतिरोधी तकनीकी, बीटी कॉटन तकनीकी, अवाकार्डिक एसिड आधारित ग्रोथ प्रमोटर, उच्च थीवेन युक्त ओपियम पॉपी लाइन, बायो-इनाकुलेंट्स, जैव-उर्वरक एवं जैव-कीटनाशी मुख्य है।

अधिक जानकारी के संपर्क करे:

निदेशक, वै.औ.अ.प.-राष्ट्रीय वनस्पति अनुसंधान संस्थान, लखनऊ

राणा प्रताप मार्ग, लखनऊ-226001; फ़ोन: 0522-2297804

हमारे सोशल मीडिया प्रोफाइल को फॉलो करे

@csirnbrilko | Csir Nbri | CSIR NBRI | csirnbriofficial

वेबसाइट: www.nbri.res.in

ICPEP-7

Abstract Book

7th International Conference on Plants and Environmental Pollution

30 November - 2 December 2025

Conference Theme:

Plants & Ecosystems for Advancing LiFE (Lifestyle for Environme
Green Growth, and Sustainable Future

Organized by

International Society of Environmental Botanists (ISEB)
&
CSIR-National Botanical Research Institute, Lucknow

PREFACE

The *Seventh International Conference on Plants and Environmental Pollution (ICPEP-7)*, jointly organised by CSIR-National Botanical Research Institute (CSIR-NBRI), Lucknow and the Indian Society of Environmental Biology (ISEB), brings together a diverse community of researchers, teachers, students, practitioners and policy thinkers who are united by a common concern: how to understand, conserve and wisely manage plant life and ecosystems under rapidly changing environmental conditions. This Abstract Book is a reflection of that collective effort. It showcases the breadth and depth of contemporary research at the interface of plant science and environmental sustainability, with a special emphasis on the challenges and opportunities in India and other parts of the world.

The thematic architecture of this volume has been designed to capture the major fronts on which the plant–environment discourse is advancing. *Theme 1: Biodiversity, Threatened plant conservation and Palaeosciences* highlights the urgency of documenting, conserving and restoring plant diversity, including rare, threatened and endemic taxa, while drawing lessons from palaeobotanical records and long-term environmental change. Contributions under this theme show how biodiversity underpins ecosystem resilience and cultural heritage alike, and how palaeoscientific insights can inform future-ready conservation strategies.

Theme 2: Climate change impacts on plants and ecosystems: Mitigation and adaptation strategies and *Theme 3: Plant Responses to Environmental Pollution* together capture the twin pressures of global warming and environmental contamination on plant productivity, physiology and community structure. The abstracts span controlled experiments, field-based studies, modelling approaches and case studies that examine heat and drought stress, altered phenology, extreme events, heavy metals, pesticides and other pollutants. They also explore mitigation and adaptation strategies ranging from climate-resilient crops and assisted migration to pollution-tolerant species and phytoremediation.

The transformative potential of microbes, molecules and modern tools is foregrounded in *Theme 4: Environmental Microbiology, Biotechnology and Nanotechnology*. The contributions here explore plant–microbe interactions, microbial consortia, biostimulants, genetic and molecular approaches, and the prospects and safeguards related to nanomaterials in agriculture and environmental management. These are complemented by *Theme 8: Nature-based solutions, biofuels and green technologies*, which gathers work on harnessing plant biomass, waste-to-wealth pathways, bioenergy crops, circular bioeconomy models and low-carbon technologies that align environmental stewardship with livelihood and energy security.

Recognising that environmental challenges are increasingly urban in character, *Theme 5: Urban ecosystem: Urban heat island effects and green belts* focuses on cities as living laboratories. The abstracts in this section address thermal stress, changing land use and the role of urban vegetation, green belts, wetlands and blue–green infrastructure in moderating microclimate, improving air quality and enhancing urban liveability. This urban lens is strengthened by *Theme 7: Geospatial technologies and modeling for environment and forest conservation*, which demonstrates how remote sensing, GIS, spatial modelling and ecological niche models are reshaping the way we map, monitor and manage landscapes—from forests and wetlands to farmlands and cityscapes.

Robust decisions require robust evidence, and *Theme 6: Environmental monitoring, assessment, and remediation* reflects this ethos. The contributions here present new indicators, monitoring frameworks, risk assessments and remediation protocols for soils, water bodies, air and biota. Together, they illustrate how careful measurement and interdisciplinary assessment can guide more effective interventions, regulations and community actions.

At a time when environmental discourse is increasingly shaped by development imperatives, *Theme 9: Bioeconomy and sustainable development goals* examines how plant resources and ecosystem services can be integrated into inclusive, low-carbon growth pathways. The abstracts in this theme highlight value chains, community-based enterprises, ecosystem service valuation, policy frameworks and nature-positive development models that seek to align environmental conservation with the Sustainable Development Goals.

The human–plant relationship is further explored in *Theme 10: Ethnobotany and plants for food and nutritional security*. This section foregrounds traditional ecological knowledge, underutilised crops, wild edibles and culturally important species that contribute to dietary diversity, nutrition, health and cultural identity. Complementing this, *Theme 11: Floriculture under changing climate* showcases research on ornamental plants, floriculture technologies and climate-resilient varieties, emphasising aesthetic, cultural and economic dimensions of plant-based livelihoods.

Finally, *Theme 12: Emerging environmental issues including microplastic pollution & mitigation strategies* reminds us that the environmental agenda is dynamic and evolving. The contributions here address newer contaminants, emerging risks and innovative mitigation approaches, with microplastics as a prominent example. Together, these studies reinforce the need for continuous vigilance, methodological innovation and proactive policy responses as new challenges emerge at the plant–environment interface. This Abstract Book is not merely a collection of summaries; it is a snapshot of a vibrant and rapidly evolving research landscape. The contributions span multiple scales—from genes, cells and organisms to ecosystems, landscapes and regions—and integrate field observations, experimental work, modelling, traditional knowledge and technological innovations. We hope that this volume will serve as a valuable reference for researchers, students, teachers, practitioners and decision-makers, stimulating new ideas, collaborations and applications.

The preparation of this Abstract Book has involved the dedicated efforts of many individuals and institutions. The organisers gratefully acknowledge the authors for submitting their work, the reviewers for their careful evaluation and constructive feedback, and the members of the editorial and organising committees for their meticulous compilation and coordination. We express our deep sense of gratitude to the Director, CSIR-NBRI, Lucknow, for providing constant encouragement, guidance and institutional support throughout the planning and organisation of ICPEP-7. We also thank the scientists, technical and administrative staff of CSIR-NBRI, the office-bearers of ISEB, collaborating institutions and sponsors for their continued support in making ICPEP-7 a reality. The financial assistance received from Research and Development Fund of National Bank for Agriculture and Rural Development (NABARD) towards publication of journal/ printing of proceedings is gratefully acknowledged. Every effort has been made to retain the originality of the abstracts while ensuring uniformity of style and format. The contents and views expressed in the abstracts are those of the respective authors, and do not necessarily reflect those of the organisers or publishers. Any inadvertent errors or omissions are sincerely regretted. Also, NABARD does not assume any responsibility for the contents published by "International Society of Environmental Botanists (ISEB)

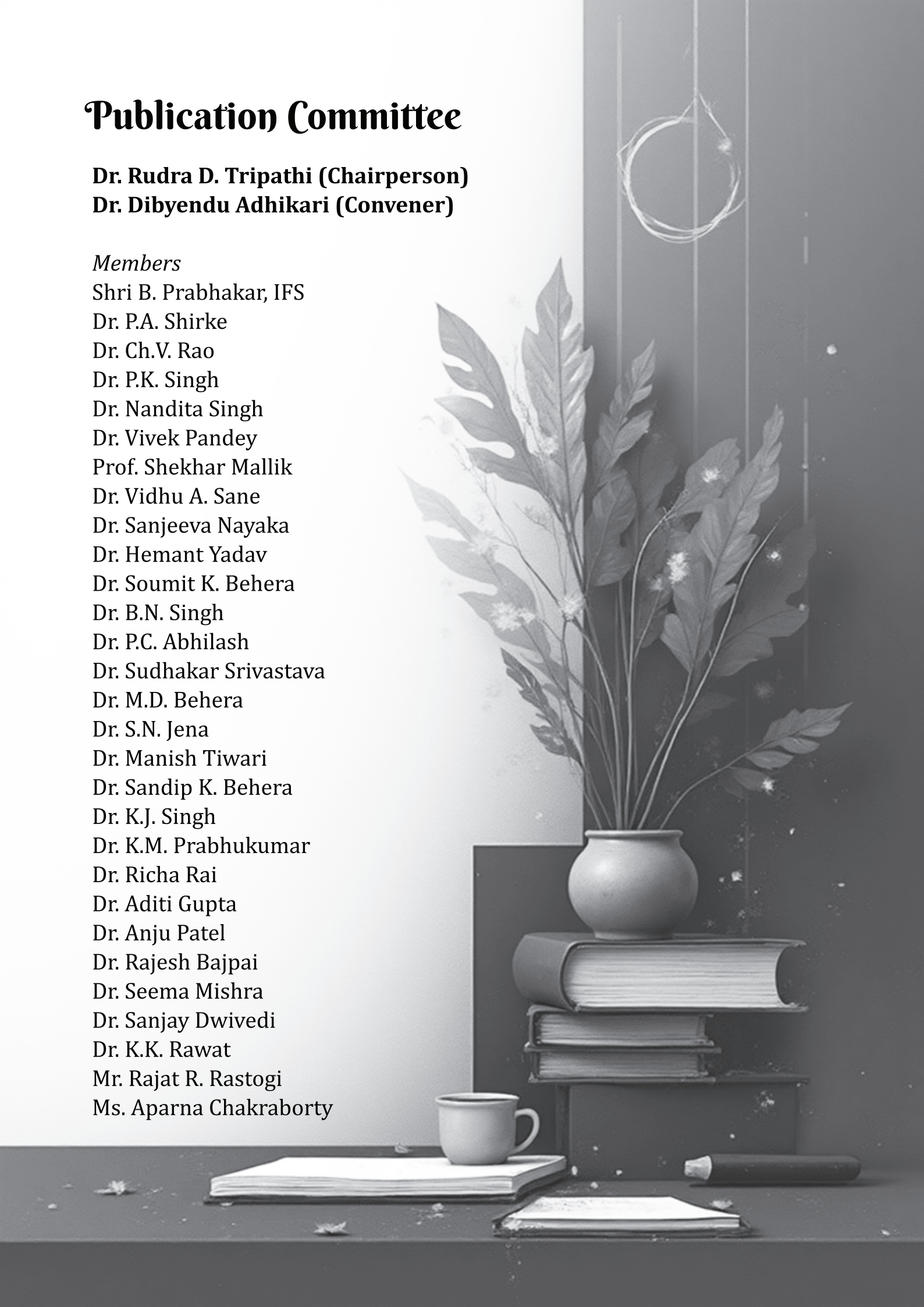
It is our earnest hope that this Abstract Book will inspire meaningful dialogue, foster new partnerships and contribute, in however modest a way, to the larger endeavour of building resilient ecosystems, sustainable societies and a more liveable planet for present and future generations.

Publication Committee
ICPEP-7

Publication Committee

Dr. Rudra D. Tripathi (Chairperson)
Dr. Dibyendu Adhikari (Convener)

Members
Shri B. Prabhakar, IFS
Dr. P.A. Shirke
Dr. Ch.V. Rao
Dr. P.K. Singh
Dr. Nandita Singh
Dr. Vivek Pandey
Prof. Shekhar Mallik
Dr. Vidhu A. Sane
Dr. Sanjeeva Nayaka
Dr. Hemant Yadav
Dr. Soumit K. Behera
Dr. B.N. Singh
Dr. P.C. Abhilash
Dr. Sudhakar Srivastava
Dr. M.D. Behera
Dr. S.N. Jena
Dr. Manish Tiwari
Dr. Sandip K. Behera
Dr. K.J. Singh
Dr. K.M. Prabhukumar
Dr. Richa Rai
Dr. Aditi Gupta
Dr. Anju Patel
Dr. Rajesh Bajpai
Dr. Seema Mishra
Dr. Sanjay Dwivedi
Dr. K.K. Rawat
Mr. Rajat R. Rastogi
Ms. Aparna Chakraborty



Contents

Themes No.	Thematic Area	Page No.
1	Biodiversity, Threatened plant conservation and Palaeosciences	1
2	Climate Change impacts on plants and ecosystems: Mitigation and adaptation strategies	19
3	Plant Responses to Environmental Pollution	35
4	Environmental Microbiology, Biotechnology and Nanotechnology	51
5	Urban Ecosystems: Urban Heat Island effects, Green belts	81
6	Environmental monitoring, assessment, and remediation	87
7	Geospatial technologies and modeling for environment and forest conservation	109
8	Nature based solutions, Biofuels and Green technologies	117
9	Bioeconomy and Sustainable Development Goals	133
10	Ethnobotany and Plants for food and nutritional security	151
11	Floriculture under changing climate	161
12	Emerging environmental issues including microplastic pollution & mitigation strategies	169

Scientific Programme

7th International Conference on Plants and Environmental Pollution (ICPEP-7)
30 November to 02 December, 2025
Venue: CSIR-National Botanical Research Institute, Lucknow-226001, India.
Tentative Programme Schedule

INAUGURAL SESSION **30 NOVEMBER 2025**	
TIME	**PROGRAMME**
09:00–10:00 AM	Registration
10:30–12:00 NOON	**Inaugural Session**
12:00–12:30 PM	HIGH TEA
PLENARY SESSION **VENUE: *LOTUS AUDITORIUM*** **DATE AND TIME: 30-11-2025, 12:30-14:00 PM**	
Chairperson **Co-Chairperson** **Rapporteur**	Prof. P. V. Vara Prasad, Kansas State University, USA Prof. Biswajeet Pradhan**,** University of Technology Sydney, Australia Dr. Dibyendu Adhikari, CSIR-NBRI, Lucknow
12:30–13:00 PM	**Plenary Talk-01** **Prof. Elina Oksanen** University of Eastern Finland, FINLAND **Email**: elina.oksanen@uef.fi ***Title****: Bending the curve for biodiversity loss–approaches from plant biology*
13:00- 13:30 PM	**Plenary Talk-02** **Prof. Swadhin K. Behera** Director (Application) Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Kanagawa, JAPAN. **Email**: behera@jamstec.go.jp ***Title****: From Oceans to Ecosystems: Harnessing AI Digital Twins to Understand and Predict ENSO, IOD, Monsoons, and Climate Extremes and their Environmental Impacts.*
13:30- 14:00 PM	**Plenary Talk-03** **Prof. Saroj K. Barik** Dean of Life Sciences, Department of Botany, North-Eastern Hill University, Shillong, Meghalaya, INDIA **Email**: Sarojkbarik@gmail.com ***Title***: *Threatened plants Conservation in Indian Himalayas*
14:00-15.00 PM	**LUNCH**

DAY 1

30TH NOVEMBER, 2025
Technical Session I

THEME 3: Plant Responses to Environmental Pollution

VENUE: *LOTUS AUDITORIUM*
DATE AND TIME:30-11-2025, 15:00-17:00 PM

Chairperson **Co-Chairperson** **Rapporteur**	Prof. Elina Oksanen, University of Eastern Finland, Finland Dr. R. D. Tripathi, CSIR-NBRI, Lucknow Dr. Richa Rai, CSIR-NBRI, Lucknow
15:00-15:30 PM	**Plenary Talk -01** **Prof. P. V. Vara Prasad** Distinguished Professor and Director, Crop Ecophysiology Kansas State University, USA **Email**: vara@ksu.edu **Title:** *Sustainable Agricultural Intensification for Advancing Food, Nutrition, and Ecosystem Health*
15:30- 16:00 PM	**Plenary Talk -02** **Prof. Viney P. Aneja** Department of Marine, Earth, and Atmospheric Sciences, Campus Box 8208, North Carolina State University, Raleigh, USA **Email**: vpaneja@ncsu.edu **Title:** *Nitrogen: The Emerging Global Cycle Crisis*
16:00- 16:30 PM	**Plenary Talk -03** **Prof. Om Parkash Dhankher** Crop Biotechnology, Stockbridge School of Agriculture, University of Massachusetts, Amherst, USA **Email**: parkash@umass.edu **Title:** *Strategies for Limiting Arsenic Accumulation in Food Crops.*
16:30-17:00 PM	**TEA BREAK**

POSTER SESSION I: 17:00-18:30 PM

Theme 2: Climate Change Impacts; Mitigation & Adaptation

Theme 3: Plant Responses to Environmental Pollution

Theme 6: Environmental Monitoring, Assessment & Remediation

Theme 12: Emerging Environmental Issues Including Microplastic Pollution & Mitigation Strategies

DAY 1 30th November, 2025 Technical Session II (PARALLEL SESSION) THEME 3: Plant Responses to Environmental Pollution	
VENUE: *LOTUS AUDITORIUM* DATE AND TIME: 30-11-2025, 18:30-20:10 PM	
Chairperson **Co-Chairperson** **Rapporteur**	Prof. Om Parkash Dhankher, University of Massachusetts, USA Dr. Debasis Chakrabarty, Chief Scientist, CSIR-NBRI, Lucknow Dr. Richa Rai, CSIR-NBRI, Lucknow
18:30-19:00 PM	**Invited Talk -01** **Prof. Sribash Roy** Department of Plant Sciences, University of Hyderabad, Telangana, INDIA **Email**: sribashroy@uohyd.ac.in ***Title***: *Elevated CO_2 Driven Population Specific Epigenome Modulation May be a strategy for Adaptation*
19:00 – 19:20 PM	**Oral Presentation -01** **Dr. Purabi Saikia** Department of Botany, Institute of Science, Banaras Hindu University, Varanasi, INDIA **Email**: purabisaikia@bhu.ac.in ***Title*:** Vegetation dynamics under anthropogenic disturbances along an urbanization gradient in Ranchi, Eastern India
19:20 – 19:30 PM	**Oral Presentation - 02** **Prof. Poornima Vajpayee** Professor, Department of Botany, University of Lucknow, Lucknow, INDIA ***Email***: devpoornima@rediffmail.com **Title**: *Plant-Nanoparticle interaction: Physiological, biochemical and metabolic alterations in medicinal plants under the influence of titanium oxide and copper oxide nanoparticle*
19:30 – 19:40 PM	**Oral Presentation - 03** **Dr. Jyoti Mathur** Associate Professor, Department of Bioscience & Biotechnology, Banasthali Vidyapith, Rajasthan, INDIA **Email**: jyotimathur@banasthali.in

	Title: *Phytoextraction efficacy of Helianthus annuus L. and Tagetes erecta L. for Sustainable Remediation of heavy metals from industrially polluted soil*
19:40 – 19:50 PM	**Oral Presentation - 04** **Dr. Aditya Abha Singh** Assistant Professor, Department of Botany, University of Lucknow, Lucknow, INDIA **Email**: abha2512.singh@gmail.com **Title**: *Evaluation of Air Quality in Relation to Particulate Matter and Air Pollution Tolerance Index of Plants Across Different Localities of Muzaffarpur City*
19:50-20:00 PM	**Oral Presentation - 05** **Dr. Amit Kumar Mishra** Scientist, Department of Botany, School of Life Sciences, Mizoram University, Aizawl, INDIA **Email**: amit.bhu.bot@gmail.com ***Title***: Scents of survival: Ultraviolet-B mediated stress adaptation in *Ocimum americanum* L.
20:00-20:10 PM	**Oral Presentation – 06 (Online)** **Dr. Pooja Sharma** Humboldt Postdoc Fellow, GERMANY Email: pooja.sharma@ufz.de Title: *Impact of climate and metal stress on plant physiology*
20:10 PM Onwards	**DINNER**

DAY 1 **30th November, 2025** **Technical Session III** **(PARALLEL SESSION)** **THEME 6: Environmental Monitoring, Assessment & Remediation**	
VENUE: *GLADIOLUS CONFERENCE ROOM* **DATE AND TIME: 30-11-2025, 18:30-20:10 PM**	
Chairperson: **Co-Chairperson:** **Rapporteur:**	Prof. Naveen Kumar Arora, BBA University, Lucknow Dr. Vivek Srivastava, Chief Scientist, CSIR-NBRI, Lucknow Dr. Poonam C. Singh, CSIR-NBRI, Lucknow
18:30-18:50 PM	**Invited Talk -01** **Prof. Naveen Kumar Arora** Professor, Department of Environmental Science, School of Earth and Environmental Sciences, BBA University, Lucknow, INDIA **Email**: nkarora.bbau@gmail.com ***Title***: *Restoration of productivity of salt affected agro-ecosystems using novel microbial technology: a lab to land approach for food security*
18:50- 19:10 PM	**Oral Presentation - 01** **Dr. Vivek Srivastava,** Chief Scientist, CSIR-NBRI, Lucknow, INDIA **Email**: vivek.nbri@csir.res.in ***Title****: Patent landscape for plant-based air purifier for improving indoor air quality.*
19:10 - 19:30 PM	**Oral Presentation -02** **Prof. Kamrun Nahar** Department of Agricultural Botany, Sher-e-Bangla Agricultural University (SAU), Dhaka, BANGLADESH **Email**: knahar84@yahoo.com ***Title:*** *Calcium and potassium reduce lead toxicity in Amaranthus tricolor by modulating antioxidant defense mechanisms*
19:30-19:40 PM	**Oral Presentation -03** **Dr. Shyam Narain Pandey** Professor, Department of Botany, Lucknow University, Lucknow, INDIA Email: snpandey511@gmail.com ***Title***: *Biochemical responses of wheat against zinc stress management*

19:40-19:50 PM	**Oral Presentation - 04** **Dr. Seema Mishra** Associate Professor, Department of Chemistry, University of Lucknow, Lucknow, INDIA **Email**: seema_mishra2003@yahoo.co.in ***Title***: *Arsenic Dynamics in Paddy Soils of Eastern Uttar Pradesh: Links to Rhizosphere Chemistry, and Rice Uptake and Transformation*
19:50-20:00 PM	**Oral Presentation - 05** **Dr Nivedita Chaudhary** Assistant Professor, Department of Environmental Science, School of Earth Sciences, Central University of Rajasthan, Rajasthan, INDIA **Email**: nivedita@curaj.ac.in ***Title****: A Comprehensive Biochemical, Physiological, and Metabolite Analysis of Wheat Cultivars to Combined Tropospheric Ozone and Water Stress*
20:00-20:10 PM	**Oral Presentation - 06** **Dr. Brajesh Kumar Dwivedi** Assistant Professor, Environmental Sciences, Botany Department, University of Allahabad, Prayagraj, INDIA **Email**: drbkdwivedi2@gmail.com , brajeshdwivedi@kmclu.ac.in ***Title:*** *Water footprint assessment and Aquifer profile towards developed hydrological approach in India*
20:10 PM Onwards	**DINNER**

DAY 2 **1ST DECEMBER, 2025**	
POSTER SESSION II **09:00- 10:00 AM** **Theme 1: Biodiversity, Threatened Plant Conservation & Palaeosciences** **Theme 9: Bioeconomy & Sustainable Development Goals** **Theme 10: Plants for Food & Nutritional Security, Ethnobotany** **Theme 11: Floriculture Under Changing Climate**	
PLENARY SESSION	
VENUE: *LOTUS AUDITORIUM* **DATE AND TIME: 01-12-2025; 10:00- 11:30 AM**	
Chairperson: **Co-Chairperson:** **Rapporteur:**	Dr. P. V. Sane, ISEB, Lucknow Dr. Samir V. Sawant, CSIR-NBRI, Lucknow Dr. Puneet Singh Chauhan, CSIR-NBRI, Lucknow
10:00- 10:30 AM	**Plenary Talk -01** **Dr. Jason C. White** Director, The Connecticut Agricultural Experiment Station 123 Huntington Street, New Haven, USA **Email**: Jason.White@ct.gov ***Title***: *Nanobiotechnology-based Strategies for Enhanced Crop Stress Resilience in a Changing Climate*
10:30- 11:00 AM	**Plenary Talk -02** **Dr. Ajit K. Shasany** Director, CSIR-National Botanical Research Institute, Lucknow, INDIA **Email**: director@nbri.res.in; director.nbri@csir.res.in ***Title***: *Harnessing Plant Innate Immunity to Enhance Climate Resilience*
11:00:11:30 AM	**Plenary Talk -03** **Prof. Rishikesh Bhalerao** Department of Forest Genetics & Plant Physiology, Swedish University of Agricultural Sciences (SLU), Umeå, SWEDEN **Email**: rishi.bhalerao@slu.se ***Title***: *The session Climate Change impacts on plants and ecosystems: Mitigation and adaptation strategies*
11:30 AM - 12:00 NOON	**TEA BREAK**

DAY 2 **01ST DECEMBER, 2025** **Technical Session IV** **THEME 1: Biodiversity, Threatened Plant Conservation & Palaeosciences** **&** **THEME 9: Bioeconomy & Sustainable Development Goals** **(*Special Session Sponsored by U.P. State Biodiversity Board, Uttar Pradesh*)**	
VENUE: *LOTUS AUDITORIUM* **DATE AND TIME: 01-12-2025, 12:00 – 14:00 PM**	
Chairperson **Co-Chairperson** **Rapporteur**	Dr. Ayyanadar Arunachalam, Director, ICAR-CAFRI, Jhansi Dr. Sanjeeva Nayaka, CSIR-NBRI, Lucknow Dr. Soumit K. Behera, CSIR-NBRI, Lucknow
12:00-12:30 PM	**Plenary Talk -01** **Prof. Puneet K. Dwivedi** Professor, Glenn '65 and Heather Hilliard Endowed Chair in Sustainable Forest Management, Clemson University, South Carolina, USA **Email**: dwivedi@clemson.edu ***Title***: *Using wood waste for sustainable aviation fuel production: Assessing climate benefits, unit price, and carbon abatement cost by taking a supply chain perspective in the United States*
12:30 -13:00 PM	**Plenary Talk -02** **Dr. B. Prabhakar, IFS** PCCF, Monitoring and Working Plan, Uttar Pradesh Secretary, Uttar Pradesh State Biodiversity Board, Lucknow, INDIA ***Email***: prabhakarburaifs93@gmail.com, upstatebiodiversityboard@gmail.com ***Title***: Role of Village Panchayats in Biodiversity Conservation
13:00 -13:30 PM	**Plenary Talk -03** **Dr. Ayyanadar Arunachalam** Director, ICAR-Central Agroforestry Research Institute, Jhansi, INDIA **Email**: arun70@gmail.com, a.arunachalam@icar.gov.in ***Title***: *Agroforestry enabled food security and environmental sustainability*
13:30 -14:00 PM	**Plenary Talk -04** **Prof. Mahesh G. Thakkar**

	Director, Birbal Sahni Institute of Palaeosciences (BSIP), Lucknow, INDIA **Email**: director@bsip.res.in ***Title*****:** From the Depths of Time to the Challenges of Tomorrow: Palaeosciences and the Future of our Planet
14:00- 15:00 PM	**LUNCH BREAK**
POSTER SESSION III: 14:30- 16:00 PM **Theme 4**: Environmental Microbiology, Biotechnology & Nanotechnology **Theme 5:** Urban Ecosystems, Urban Heat Island effects, Green Belts **Theme 7:** Geospatial Technologies & Modelling for Environment and Forest Conservation **Theme** 8: Nature-Based Solutions, Biofuels & Green Technologies	

DAY2

01ST DECEMBER, 2025
Technical Session V

THEME 1: Biodiversity, Threatened Plant Conservation & Palaeosciences
&
THEME 9: Bioeconomy & Sustainable Development Goals

(*Special Session Sponsored by U.P. State Biodiversity Board, Uttar Pradesh*)

VENUE: *LOTUS AUDITORIUM*
DATE AND TIME: 01-12-2025, 16:00 – 19:30 PM

Chairperson **Co-Chairperson** **Rapporteur**	Dr. U. C. Lavania, CSIR-NBRI, Lucknow Prof. Valliyodan Babu, Lincoln University, USA Dr. Sandip K. Behera, CSIR-NBRI, Lucknow
16:00- 16:30 PM	**Plenary Talk -01** **Dr. U. C. Lavania** INSA Senior Scientist, CSIR-NBRI, Lucknow, INDIA **Email**: lavaniauc@yahoo.co.in ***Title***: *Vetiver Grass Ecosystem Service Model: Prospecting through Development of Designer Genotypes*
16:30 - 17:00 PM	**Invited talk - 01** **Dr. Valliyodan Babu** Associate Professor, Department of Agriculture and Environmental Sciences, Lincoln University, USA **Email**: ValliyodanB@LincolnU.edu ***Title***: *Carbon Dynamics in Crops: An Integrated Flux-to-Traits Approach Towards Environmental Security*
17:00 - 17:20 PM	**Invited talk - 02** **Prof. Mohammed Latif Khan** Department of Botany, Dr. Harisingh Gour Central University, Sagar, MP, INDIA **Email**: khanml@yahoo.com, khanml61@gmail.com ***Title***: *Rethinking to Rebuilding- Stepping Towards Environment, Sustainability and Ecosystem Services*
17:20- 17:40 PM	**Invited talk - 03** **Prof. Tapati Das** Department of Ecology and Environmental Science, Assam University, Silchar, Assam, INDIA **Email**: das.tapati@gmail.com

	Title: *Living with Water: Ecological and Economic Pathways to Resilience in the Barak Valley, Assam*
17:40 - 18:00 PM	**Invited talk - 04** **Dr. Parminder Singh Ranhotra** Birbal Sahni Institute of Palaeosciences (BSIP), Lucknow, INDIA **Email:** parmindersingh_ranhotra@bsip.res.in ***Title:*** *Deciphering Vegetation and Treeline responses during Holocene in the Western Himalayas: On Pollen and Tree-ring investigations*
18:00 - 18:20 PM	**Invited talk - 05** **Prof. Daizy Rani Batish** Department of Botany, Panjab University Chandigarh, INDIA **Email**: daizybatish@yahoo.com, daizybatish@pu.ac.in **Title**: *Bio-resource Utilization of an Emerging Invasive Vine, Delairea odorata Lem., in the North-western Himalayas*
18:20- 18:30 PM	**Oral Presentation - 01** **Prof. Ksh. Lal Bihari Singha** Professor, Manipur University, Imphal, INDIA **Email**: lalbihari@manipuruniv.ac.in ***Title***: *Flowering-linked threats for the blooming bamboo species in the Indo-Burma biodiversity hotspot of Manipur with scientific interventions for their conservation*
18:30- 18:40 PM	**Oral Presentation - 02** **Dr. Jyoti Prasad Gajurel** Tribhuvan University, Central Department of Botany, Kathmandu, NEPAL **Email:** jpgajurel2010@gmail.com ***Title*****:** *Environmental Associations of Gene pools of the Himalayan Yew (Taxus wallichiana) in River Valleys of Central and Eastern Nepal*
18:40- 18:50 PM	**Oral Presentation - 03** **Dr. Somesh Gupta** Senior Technical Officer Uttar Pradesh State Biodiversity Board, Lucknow, INDIA **Email:** upstatebiodiversityboard@gmail.com ***Title*****:** *Significance of Heritage Sites in Biodiversity Conservation*
18:50- 19:00 PM	**Oral Presentation -04** **Dr. Sougata Sarkar** Assistant Project Manager, RCFC-NER, ARDD, CSIR-NEIST, Jorhat, Assam, INDIA **Email**: neistsougata@gmail.com

19:00-19:30 PM	***Title***: *Variation studies in rare Butea monosperma trees, its conservation strategies for socio-economic benefits* **Plenary talk – 02 (Online)** **Dr. Francisco Javier Corpas** Senior Scientist, Estación Experimental Del Zaidin, CSIC, Granada, SPAIN **Email**: javier.corpas@eez.csic.es ***Title*****:** *Crosstalk of nitric oxide and hydrogen sulfide during the ripening of pepper fruits*
19:30—21:00 PM	**CULTURAL PROGRAMME**
21:00 PM Onwards	**DINNER**

DAY 2 **01st DECEMBER, 2025** **Technical Session VI** **(PARALLEL SESSION)** **THEME 4: Environmental Microbiology, Biotechnology & Nanotechnology** **&** **THEME 8: Nature-Based Solutions, Biofuels & Green Technologies** **&** **THEME 12: Emerging Environmental Issues Including Microplastic Pollution and Mitigation Strategies**	
VENUE: *GLADIOLUS CONFERENCE ROOM* **DATE AND TIME: 01-12-2025; 16:00-18:30 PM**	
Chairperson **Co-Chairperson** **Rapporteur**	Prof. Mirza Hasanuzzaman, Sher-e-Bangla Agricultural University, Bangladesh Prof. Shekhar Mallick, JNU, New Delhi Dr. Suchi Srivastava, CSIR-NBRI, Lucknow
16:00- 16:30 PM	**Plenary Talk -01** **Prof. Mirza Hasanuzzaman** Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, BANGLADESH **Email**: mhzsauag@yahoo.com ***Title***: *Biostimulants for Enhancing Plant Tolerance to Environmental Stress*
16:30-17:00 PM	**Invited Talk -01** **Prof. Rana Pratap Singh** Department of Environmental Science Babasaheb Bhimrao Ambedkar University, Lucknow, INDIA **Email**: dr.ranapratap59@gmail.com ***Title***: *Designing novel below-ground and above-ground biodiversity for enhanced productivity and quality of products with Ecological Sustainability*
17:00-17:30 PM	**Invited Talk -02** **Prof. Shekhar Mallick** School of Environmental Sciences Jawaharlal Nehru University, New Delhi, INDIA **Email**: shekharm@mail.jnu.ac.in, shekharm@hotmail.com ***Title***: *Prospects, predictions and processes for recycling Rare Earth and Precious Elements from E-Waste for a Circular Economy*
17:30- 18:00 PM	**Invited Talk -03** **Dr. Pankaj K. Srivastava**

	Chief Scientist, CSIR-NBRI, Lucknow, INDIA **Email**: pankajk@nbri.res.in **Title**: *Microplastics: A Threat to Sustainability*
18:00- 18:10 PM	**TEA BREAK**
18:10- 18:20 PM	**Invited Talk -04** **Dr. Rashmi Mishra** Professor & Head, Department of Biotechnology, Noida Institute of Engineering & Technology (NIET), Greater Noida, INDIA **Email**: hodbiotech@niet.co.in ***Title***: *Phyto-management of Contaminated Sites: Integrating Ecology, Economy, and Technology*
18:20- 18:30 PM	**Invited talk -05** **Dr. Nirmal Renuka Rath Sharma** Assistant Professor, Department of Botany, Central University of Punjab, Bathinda, INDIA **Email**: renuka.bot@gmail.com, animal.renuka@cup.edu.in **Title**: *Phytohormone-induced Regulation of Antibiotic Bioremoval and Physiological Adaptations in Microalgae*
18:30- 18:40 PM	**Oral Presentation -01** **Prof. P.C. Abhilash** Associate Professor, Institute of Environment & Sustainable Development, Banaras Hindu University, Varanasi, U.P., INDIA **Email**: pca.iesd@bhu.ac.in; pca.iesd@gmail.com ***Title***: *Restoring Degraded Lands in India to Achieve the UN Sustainable Development Goals*
18:40- 18:50 PM	**Oral Presentation -02** **Dr. Sudhakar Srivastava** Assistant Professor, Institute of Environment & Sustainable Development, Banaras Hindu University, Varanasi, INDIA **Email**: sudhakar.srivastava@gmail.com **Title**: *Waste-derived Biochar mitigates arsenic toxicity and enhances rice (Oryza sativa L.) plant growth in contaminated soil*
18:50- 19:00 PM	**Oral Presentation -03** **Dr. Anita Singh** Assistant Professor Department of Botany, Institute of Science, Banaras Hindu University, Varanasi, INDIA **Email:** anita.1710@gmail.com ***Title***: *Waste-Water Irrigation of Agricultural Fields and Its Ameliorative Measures by Regulating Physiological and Metabolic Indices of Vegetable Crop*

DAY 3

2nd DECEMBER, 2025
Technical Session VII
(PARALLEL)

Theme 2: Climate Change Impacts; Mitigation & Adaptation
Theme 5: Urban Ecosystems, Urban Heat Island effects, Green Belts
Theme 7: Geospatial Technologies & Modelling for Environment and Forest Conservation

VENUE: *LOTUS AUDITORIUM*
DATE AND TIME: 02-12-2025, 09:30-11:30 AM

Chairperson **Co-Chairperson** **Rapporteur**	Prof. Viney P. Aneja, North Carolina State University, USA Prof. Puneet Dwivedi, Clemson University, USA Dr. Dibyendu Adhikari, CSIR-NBRI, Lucknow
09:30- 10:00 AM	**Plenary Talk -01** **Prof. Biswajeet Pradhan** Director, Centre for Advanced Modelling and Geospatial Information Systems (CAMGIS), School of Civil and Environmental Engineering, University of Technology Sydney, AUSTRALIA **Email**: Biswajeet.Pradhan@uts.edu.au, biswajeet24@gmail.com ***Title*****:** *Geospatial Intelligence for Assessing Plant Vulnerability and Ecosystem Resilience under Environmental Pollution*
10:00-10:30 AM	**Plenary Talk -02** **Prof. Mukunda Dev Behera** Centre for Ocean, River, Atmosphere and Land Sciences (CORAL) Indian Institute of Technology, Kharagpur, West Bengal, INDIA **Email**: mdbehera@coral.iitkgp.ac.in ***Title*****:** *Understanding Forest Ecosystem – Geospatial Modelling Perspective*
10:30-11:00 AM	**Invited Talk -01** **Prof. Ajay Sharma** College of Forestry, Wildlife and Environment, Auburn University, Alabama, USA **Email**: azs0365@auburn.edu ***Title***: Fire and forest management for forest sustainability: A southern U.S. perspective
11:00-11:30 AM	**Invited Talk - 02** **Dr. Debasis Chakrabarty** Chief Scientist, CSIR-NBRI, Lucknow, INDIA **Email**: debasis1972@rediffmail.com ***Title***: *Plants vs. Arsenic: Nature's Green Defence Against Toxins*

11:30-12:00 NOON	**TEA BREAK**
12:00-12:30 PM	**Invited Talk - 03** **Dr. Shalini Dhyani** Principal Scientist, Environmental Impact Assessment, Audit and Planning Division, CSIR-National Environmental Engineering Research Institute, Nagpur, INDIA **Email**: shalinidhyanineeri@gmail.com ***Title***: *Urban Blue-Green Infrastructure, Human-Nature Relationships, and Resilience in Indian Metropolises: Cities in Nature's Embrace*
12:30 - 12:40 PM	**Oral Presentation - 01** **Prof. Rajesh Raviya** Professor, Department of Life Sciences, Bhakta Kavi Narsinh Mehta University, Junagadh, INDIA **Email**:rdraviya@gmail.com ***Title***: *Assessing Ecological Niches: A Study on Bryophyte Habitat Suitability in the Semi-Arid Region, Gujarat*
12:40 -12:50 PM	**Oral Presentation - 02** **Prof. Faisal Ali Khan** DBS Global University, Dehradun-248011, INDIA **Email**: fakmoon@gmail.com ***Title***: *The Climate Change and Sustainable Development: Issues & Challenges with Special Reference to Environmental Protection Laws*
12:50- 13:00 PM	**Oral Presentation - 03** **Dr. Richa Rai** CSIR-NBRI, Lucknow, INDIA **Email**: richarai81@gmail.com ***Title***: *Tolerance Strategies of Three Ornamental Flowers to Ambient Air Pollutants*
13:00- 13:10 PM	**Oral Presentation - 04** **Dr. Ashutosh Kumar Singh** Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Menglun Town, Mengla Country, Yunnan Province, CHINA **Email**: ashutosh.evst11@gmail.com ***Title***: *Unveiling Glomalin's Legacy: Its role in soil remediation and feedback to climate change*
13:10- 13:20 PM	**Oral Presentation – 05** **Dr. Puneeta Pandey**

	Associate Professor, Centre of Environmental Studies, University of Allahabad, Prayagraj, INDIA **Email**: puneeta@allduniv.ac.in, puneetapandey@gmail.com ***Title**: Land Surface Temperature in Prayagraj using Geospatial Technology: Implications for Sustainable Development Goals (SDGs)*
13:20- 13:30 PM	**Oral Presentation -06** **Mr. Villa Guevara José Ange** Phytoremediation, Water pollution control, Facultad de Química, Universidad Nacional Autónoma de México, CDMX, MÉXICO **Email**: joseangelvilla@ciencias.unam.mx ***Title**: Totipotential cells of Pragmithes australis in the bioaccumulation of cadmium, in the improvement of treatment operations in artificial wetlands*
13:30- 13:40 PM	**Oral Presentation - 07** **Dr. Padma Sharma** Scientist B, Department of Ecology Environment and Remote Sensing, (JKDEERS), Jammu, INDIA **Email**: padmasharma17@gmail.com ***Title**: Climate change vulnerability and risk assessment of the forest sector in Jammu & Kashmir*
13:40- 13:50 PM	**Oral Presentation - 08** Ms. Sijagurumayum Geetanjali Devi Research Scholar, Department of Life Sciences (Botany), Manipur University, Manipur, INDIA Email: geetshija123@gmail.com *Title: Edaphic and phytosociological attributes of the microhabitats of Aconitum nagarum Stapf. in Dzuko Valley of Manipur*
13:50- 14:00 PM	**Oral Presentation - 09** Ms. Raashi Gupta Student, Department of Botany, Punjab University, Chandigarh-151401, INDIA Phone: 8699032750 Email: raashi1898@pu.ac.in ***Title**: Impact of Climate Change on Apple Cultivation in the Altitudinal Zones of Himachal Pradesh: Challenges and Adaptation Strategies*

DAY 3 **02nd DECEMBER, 2025** **Technical Session VIII** **(PARALLEL SESSION)** **THEME 10: Plants for Food & Nutritional Security, Ethnobotany** **&** **THEME 11: Floriculture Under Changing Climate**	
VENUE: *GLADIOLUS CONFERENCE ROOM* **DATE AND TIME: 02-12-2025; 12:00-14:00 PM**	
	Chairperson: Dr. Dalip Kumar Upreti, CSIR-NBRI, Lucknow **Co-Chairperson:** Dr, Sharad Srivastava, CSIR-NBRI, Lucknow **Rapporteur:** Dr. Vijay Vishnu Wagh, CSIR-NBRI, Lucknow
12:00- 12:30 PM	**Invited Talk - 01** **Dr. Dalip Kumar Upreti** Former Chief Scientist, CSIR-NBRI, Lucknow, INDIA **Email**: upretidknbri@gmail.com ***Title**: Evaluation of Ethno-Medicinal Lichens of India*
12:30- 12:50 PM	**Oral Presentation -01** **Dr. Chandra S. Mohanty** Chief Scientist, Plant Genetic Resources and Improvement Division CSIR-NBRI, Lucknow, INDIA **Email**: cs.mohanti@nbri.res.in ***Title**: Stress-Responsive Insights into Root-Tuberization of Winged Bean (Psophocarpus tetragonolobus (L.) DC.)*
12:50- 13:00 PM	**Oral Presentation -02** **Dr. Anushree Baruah** Assistant Professor, Department of Botany The Assam Royal Global University, Guwahati, Assam, INDIA **Email**: abaruah@rgu.ac, anushree611.official@gmail.com ***Title**: Evaluation of Neem (Azadirachta indica) and Tea (Camellia sinensis) leaf residues as Biological Nitrification Inhibitors (BNIs) in Rice Cultivation of Assam*
13:00- 13:10 PM	**Oral Presentation -03** **Dr. K. J. Singh** Principal Scientist, CSIR-NBRI, Lucknow, INDIA **Email**: khuraijam.js@nbri.res.in ***Title**: Role of Floriculture in Enhancing Environmental Sustainability Under Climate Variability*

13:10- 13:20 PM	**Oral Presentation -04** **Dr. Rakesh K Nainwal** Principal Scientist, CSIR-NBRI, Lucknow, INDIA **Email**: nainwal.rakesh@gmail.com ***Title***: *Global trend of Floriculture Productivity under changing Climate: Impact and Adaptive Strategies*
13:20- 13:30 PM	**Oral Presentation -05** **Dr. Vijay Vishnu Wagh** CSIR-NBRI, Lucknow, INDIA **Email**: vijay.wagh@nbri.res.in ***Title***: *Ethnobotanical wisdom in the face of Invasion: Traditional uses and adaptations in central India*
13:30- 13:40 PM	**Oral Presentation -06** **Dr. Bikarma Singh** Principal Scientist, CSIR-NBRI, Lucknow, INDIA **Email**: drbikarma.singh.nbri@csir.res.in ***Title***: *Invasive Weed Diversity and Phytochemical Dynamics in Turmeric Cultivation under Sodic Soils of Awadh Region, India*
13:40- 13:50 PM	**Oral Presentation -07** **Dr. Gaurav K. Mishra** Senior Scientist, CSIR- NBRI, Lucknow, INDIA **Email:** gmishrak@gmail.com ***Title***: *Ecological insights into the lichen communities of the Munsiyari region, Pithoragarh district, Uttarakhand*
13:50-14:00 PM	**Oral Presentation -08** **Ms. Leena Das** Department of Microbiology, Adarsha Science, J.B. Arts and Birla Commerce Mahavidyalaya, Amravati, Maharashtra, INDIA **Email**: leena18das@gmail.com ***Title*****:** *Synergistic antimicrobial evaluation between antibiotics and secondary metabolites isolated from B. pinnatum and M. elengi methanol extracts against pathogenic microorganisms*
14:10- 15:00 PM	**LUNCH**

	DAY 3 02 December, 2025 VALEDICTORY SESSION
TIME **15:00–16:00 PM** **16:00 Onwards**	**PROGRAMME** **VALEDICTORY SESSION** **HIGH TEA**

List of Abstracts and Authors

Theme 1: Biodiversity, Threatened plant conservation and Palaeosciences

Abstract code	Presentation title	Authors, affiliations &Email	Oral/ Poster
T1-A1	Deciphering vegetation and treeline responses during Holocene in the Western Himalayas: On pollen and tree-ring investigations	**Parminder Singh Ranhotra[1,2], Stuti Jain[1,3], Ipsita Roy[4], Bency David Chinthala[5], Nidhi Tomar[1,2], Rajesh Bajpai[3]** [1]Birbal Sahni Institute of Palaeosciences, 53 University Road, Lucknow, India | [2]Academy of Scientific and Innovative Research, AcSIR, Ghaziabad, India | [3]Department of Environmental Studies, North-Eastern Hill University, Shillong, India | [4]Indian Institute of Tropical Meteorology, Pashan, Pune, India | [5]Institute of Geography, University of Erlangen-Nürnberg, 91052 Erlangen, Germany Email: parmindersingh_ranhotra@bsip.res.in	Oral
T1-A2	Tree-rings unfold the Four-Century record of Forest-Stand and Treeline Dynamics of Fir and Birch in Kashmir, western Himalaya	**Stuti Jain[1,2], Parminder Singh Ranhotra[2]*, Bency David Chinthala[3], Rajesh Joshi[4], Mayank Shekhar[2], Rajesh Bajpai[1]** [1]Department of Environmental Studies, North-Eastern Hill University, Shillong, Meghalaya, India | [2]Birbal Sahni Institute of Palaeosciences, 53, University Road, Lucknow, UP, India | [3]Institute of Geography, Friedrich-Alexander-University Erlangen-Nürnberg, Wetterkreuz 15, 91058, Erlangen, Germany | [4]G.B. Pant National Institute of Himalayan Environment and Sustainable Development, Kosi-Katarmal, Almora 263 643, Uttarakhand, India Email: parmindersingh_ranhotra@bsip.res.in	Poster
T1-A3	People's perceptions and participation in mangrove conservation of Kachchh, Gujarat	**Asha Kumari Kumawat[1*], Supriya Vaish[1], Bhawana Pathak[1], and Sandeep Kumar[2]** [1]School of Environment and Sustainable Development, Central University of Gujarat, Kundhela, Vadodara, Gujarat, India | [2]Gujarat Forest Department, Gandhinagar, Gujarat, India Email: ashakumawat221098@gmail.com	Poster
T1-A4	Ecological insights into the lichen communities of the Munsiyari region, Pithoragarh district, Uttarakhand	**Akhilesh Kumar Maurya[1*], Gaurav K. Mishra[1], Dalip K. Upreti[1]** [1]CSIR- National Botanical Research Institute, Lucknow, India | AcSIR- Academy of Scientific and Innovative Research, Ghaziabad, Uttar Pradesh - 201002, India; Lichenology laboratory, Plant Diversity, Systematics and Herbarium Division, Email: gmishrak@gmail.com	Poster
T1-A5	Investigation on the variation of phytochemical constituents in *Pityrogramma astroamericana* Domin growing under the natural and controlled conditions	**Jyoti Jangid[1,2*], Rachna[1,3], Suman Patra[1], Sudhanshu Shahi[1], Sushree Sunandita Patel[1], BabitaKumari[1], Sandip Kumar Behera[1]** [1]Plant Diversity Systematic and Herbarium Division, CSIR-National Botanical Research Institute, Lucknow | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad | [3]Department of Botany, University of Lucknow, Lucknow, India Email: jyotijangid9997@gmail.com	Poster
T1-A6	Conservation of environment in Indian scriptures	**R. L. S. Sikarwar[1*]** [1]Centre for Indian Knowledge System, A.K.S. University, Sherganj, Panna Road, Satna (M.P.) 485001, India	Poster

		Email: sikarwarrls@gmail.com, rlssikarwar@rediffmail.com	
T1-A7	Environmental Associations of Genepools of the Himalayan Yew (*Taxus wallichiana*) in River Valleys of Central and Eastern Nepal	**Jyoti Prasad Gajurel[1, 2]** [1]Tribhuvan University, Central Department of Botany, Kathmandu, Nepal | [2]WSL Swiss Federal Research Institute, Switzerland Email: jpgajurel2010@gmail.com	Oral
T1-A8	Trilocular multi-seeded fossil fruit reported from Samruddhi Highway District Wardha Maharashtra India	**A.V. Kapgate[1*], D. S. Dhamdar[1], S.M. Meshram[2]** [1]Department of Botany Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur | [2]Department of Botany Manoharbhai Patel College, Sakoli Email: ashwinikapgate151@gmail.com	Poster
T1-A9	Report on unilocular angiospermic fruit from a new locality Wardha, Maharashtra, India	**J. R. Kawale[1*], M.N. Nagdevte[1], S.M. Andmeshram[2]** [1]Department of Botany, Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur | [2]Department of Botany Manoharbhai Patel College, Sakoli Email: janvikawale20@gmail.com	Poster
T1-A10	Flowering-linked threats for the blooming bamboo species in the Indo-Burma biodiversity hotspot of Manipur with scientific intervention for their conservation	**Lal Bihari Singha[1], Doly Maibam[1*], Elam Lisha[1], Sylvia Ningthoujam[1], Manoharmayum Geetmala[1]** [1]Department of Botany, Manipur University, Imphal, India Email: lalbihari@manipuruniv.ac.in dolymaibam@gmail.com	Oral
T1-A11	Change in nutritional contents and medicinal value of *Nephrolepis cordifolia* (L.) C. Presl collected from two different ecological zones in India	**Rachna[1*], Jyoti Jangid[1], Suman Patra[1], Sudhanshu Shahi[1], Sushree Sunandita Patel[1], Babita Kumari[1], Ratna Katiyar[2], Sandip Kumar Behera[3]** [1]Plant Diversity Systematic and Herbarium Division, CSIR-National Botanical Research Institute, Lucknow | [2]Department of Botany, University of Lucknow, Lucknow | [3]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad Email: mrachna61@gmail.com	Poster
T1-A12	Variation studies in rare *Butea monosperma* trees, its conservation strategies for socio-economic benefits	**Sougata Sarkar[1*], Ayan Kumar Naskar[2]** [1]RCFC, Agro-technology and Rural Development Division, CSIR-NEIST, Jorhat, Assam, india | [2]Wildlife Institution of India, Chandrabani, Uttarakhand, India Email: neistsougata@gmail.com	Oral
T1-A13	Edaphic and phytosociological attributes of the microhabitats of *Aconitum nagarum* Stapf. in Dzuko Valley of Manipur	**Sijagurumayum Geetanjali Devi[1*], Lal Bihari Singha[1]** [1]Department of Life Sciences (Botany), Manipur University, India Email: geetshija123@gmail.com	Oral
T1-A14	Chemical features of different aerial parts and in vitro culture of the endangered medicinal plant, *Stereospermum tetragonum*	**Vibha Pandey*, Debasis Chakrabarty** CSIR-National Botanical Research Institute, Lucknow-226001, India Email: vibhabiotech10@gmail.com	Poster
T1-A15	Ecological Studies of *Eulophia obtusa* (Lindl.) Hook. f. from Dudhwa National Park, Uttar Pradesh, India	**Neha Singh[1*], Ajit Kumar Das[1]** Laboratory of Plant Ecology, Phytotaxonomy, Ethnobotany and Conservation of Medicinal Plants, Department of Ecology and Environmental Science, Assam University, Silchar-788011, India	Poster

		Email: dasajitkumar15@gmail.com	
T1-A16	Taxonomy and Diversity Assessment of the Genus *Pogonatum* P. Beauv. (Polytrichaceae) in India	**Ankita Verma[1*] Vinay Sahu[1,2], Ashish Kumar Asthana[1] and Priyanka Agnihotri[1,2]** [1]Bryology Laboratory, CSIR-National Botanical Research Institute, Lucknow-226001 Email: ankitaverma1095@gmail.com	Poster
T1-A17	Hidden Green Gems of the Chambal Ravines: Discovering Nature's Botanical Treasures	**Tushar Anilrao Lohit[1,2*] and Vijay Vishnu Wagh[1,2]** [1]Plant Diversity, Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Lucknow, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad Email**:** tusharlohit2015@gmail.com	Poster
T1-A18	Assessing conservation status of *Dipteris wallichii* (R. Br ex Hook. et Grev.) T. Moore	**Ragini Kumari[1*] and Ajit Pratap Singh[1]** Pteridology Laboratory, CSIR-National Botanical Research Institute, Lucknow-U.P., India Email: ajitpsingh2000@gmail.com	Poster
T1-A19	Floristic study on pteridophytes with new records of the family Lycopdiaceae and Selaginellaceae from the Champawat District of Uttarakhand	**Nivedita Mall[1], Damini Yadav[1], Ajit Pratap Singh[1*]** Pteridology Laboratory, CSIR-National Botanical Research Institute, Lucknow-U.P., India Email: ajitpsingh2000@gmail.com	Poster
T1-A20	Phytogeographical assessment of family Poaceae Barnhart in Madhya Pradesh	**Smita Tiwari[1], Sukhendu Kumar Jana[1], Priyanka Agnihotri[1]** Plant Diversity, Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow, India	Poster
T1-A21	Assessment of the diversity and distribution of *Pteris* L. along elevational gradients in West Kameng district, Arunachal Pradesh	**Nivedita Mall[1], Ajit Pratap Singh[1*]** [1]Pteridology Laboratory, CSIR-National Botanical Research Institute, Lucknow-226001, India Email- ajit.p.singh@nbri.res.in	Poster
T1-A22	Some new records of liverworts and mosses from Western Himalaya, India	**Vinay Sahu[1,2]** Plant Diversity, Systematics, and Herbarium Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow, 226 001, Uttar Pradesh, India; [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, Uttar Pradesh, India. Email: vinay.sahu.nbri@csir.res.in	Poster
T1-A23	Climatic controls on mangrove species distributions in India: from wet Holocene to warmer futures	**Pujarini Samal[1*], Dibyendu Adhikari[1]** [1]CSIR-National Botanical Research Institute, Lucknow, India- 226001 Email: samalpujarini123@gmail.com	Poster
T1-A24	Role of Village Panchayats in Biodiversity Conservation	**B. Prabhakar[1*]** [1]PCCF, Monitoring and Working Plan, Uttar Pradesh/ Secretary, Uttar Pradesh State Biodiversity Board, Lucknow E-mail: prabhakarburaifs93@gmail.com	Oral
T1-A25	Significance of Heritage Sites in Biodiversity Conservation	**Dr Somesh Gupta[1*]** [1*]Senior Technical Officer Uttar Pradesh State Biodiversity Board, Lucknow E-mail: upstatebiodiversityboard@gmail.com	Oral

Theme 2: Climate change impacts on plants and ecosystems: Mitigation and adaptation strategies

Abstract code	Presentation title	Authors, affiliations & email	Oral/ Poster
T2-A1	Nanobiotechnology-based Strategies for Enhanced Crop Stress Resilience in a Changing Climate	**Jason C. White[1], Lijuan Zhao[2], Arturo Keller[3], Jorge Gardea-Torresdey[4]*** [1]Connecticut Agricultural Experiment Station, New Haven, CT, United States; [2]Nanjing University, Nanjing, China; [3]University of California, Santa Barbara, California, United States; [4]The University of Texas at El Paso, El Paso, Texas, United States Email: Jason.White@ct.gov	Oral
T2-A2	Nitrogen: The Emerging Global Cycle Crisis	**Viney P. Aneja[1*]** [1]Department of Marine, Earth, and Atmospheric Sciences, North Carolina State University Raleigh, NC 27695-8208, USA Email: vpaneja@ncsu.edu	Oral
T2-A3	UV-B induces cotyledon-specific MYBs to orchestrate photomorphogenesis and acclimation responses	**Aditi Pathak[1], Sarvjeet Singh[1], Deepika Sharma[2], Manish Tiwari[1]** [1]CSIR-National Botanical Research Institute (CSIR-NBRI), India; [2]BRIC-National Institute of Plant Genome Research (BRIC-NIPGR), India Email: pathakaditi231@gmail.com	Poster
T2-A4	Fire and forest management for forest sustainability: A southern U.S. perspective	**Ajay Sharma[1*]** [1]College of Forestry, Wildlife and Environment, Auburn University, Auburn, AL, United States of America Email: azs0365@auburn.edu	Oral
T2-A5	Scents of survival: Ultraviolet-B mediated stress adaptation in *Ocimum americanum* L.	**Amit Kumar Mishra[1*]** [1]Department of Botany, School of Life Sciences, Mizoram University, Aizawl, India Email: akmishra@mzu.edu.in	Oral
T2-A6	Impact of Climate Change on Apple Cultivation in the Altitudinal Zones of Himachal Pradesh: Challenges and Adaptation Strategies	**Raashi Gupta[1], Rajat Kumar[2], Harminder Pal Singh[2]** [1]Department of Botany, Panjab University | [2]Department of Environment Studies, Panjab University, Chandigarh E-mail: raashi1898@pu.ac.in, hpsingh_01@pu.ac.in	Oral
T2-A7	Fate of arsenic stress under climate warming and heat stress conditions in rice	**Pandey M[1], Pooja Negi[1], Radha Krishna P[1], Suraj Sampatrao Patil[3], Vinay Kumar[3], Srivastava A.K.[1,2]** [1]Nuclear Agriculture and Biotechnology Division, Bhabha Atomic Research Centre, Mumbai-400094, India; [2]Homi Bhabha National Institute, Mumbai-400094, India; [3]Department of Biotechnology, PES Modern College of Arts, Science and Commerce, Ganeshkhind, Pune 411016, India Email: manishp@barc.gov.in; biomanish@gmail.com	Poster

T2-A8	Decoding UV-B Stress: How Altered Source–Sink Relationships Influence Growth, Yield, and Grain Quality in Pearl Millet	**Pooja Singh[1], Krishna Kumar Choudhary[1]*** [1]Department of Botany, MMV, Banaras Hindu University, Varanasi-221005, India Email: poojasngh7579@gmail.com	Poster
T2-A9	Ocean Acidification driven shifts in Phytoplankton Size Class (PSC) distribution and changes in coastal dynamics of nearshore north-west Bay of Bengal – a polyphasic analysis	**Rohan Kr Biswas[1*], Avik Kumar Choudhury[1]** Phycology Ecology and Remote Sensing Lab (PEARL), Department of Botany, Ramakrishna Mission Vivekananda Centenary College, Rahara, Kolkata-700118 Email: rohan.biswas199798@gmail.com	Poster
T2-A10	Elevated CO_2-driven population-specific epigenome modulation may be a strategy for adaptation	**Sribash Roy[1]** [1]Department of Plant Sciences, University of Hyderabad, Telangana Email: sribashroy@uohyd.ac.in	Oral
T2-A11	Climate change vulnerability and risk assessment of the forestry sector in Jammu & Kashmir	**Padma Sharma[1*], Majid Farooq[1]** [1]Department of Ecology, Environment and Remote Sensing, Paryavaran Bhawan, Jammu and Kashmir, India Email: padmasharma17@gmail.com	Oral
T2-A12	Stress adaptation strategies in *Cenchrus biflorus* under ozone and heatwave conditions in arid Rajasthan	**Sanjay Anand[1], Nivedita Chaudhary[1]** [1]Department of Environmental Science, Central University of Rajasthan, Ajmer, India Email: 2022phdenv008@curaj.ac.in	Poster
T2-A13	Transcriptomic insights reveal cross-talk between biotic and abiotic stress pathways in rice under combined elevated CO_2, O_3, and temperature	**Rushna Jamal[1*], Vivek Pandey[1]** Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow, India Email: rushna.zarrin@gmail.com	Poster
T2-A14	Climate-smart wheat: Comparative evaluation of cultivar resilience under multiple stresses	**Sharfa Naaz[1,2], Mohammad Israil Ansari[2], Vivek Pandey[1]** [1]Plant Ecology and Climate Change Science Division, CSIR-NBRI, Lucknow, India; [2]Department of Botany, University of Lucknow, Lucknow, India Email: pandey64@gmail.com	Poster
T2-A15	Decoding the adaptive blueprint of *Gladiolus grandiflora* L. in soil and hydroponic systems	**Piyush Verma[1*], Chandra Sekhar Mohanty[1*]** [1]Department of Botany, University of Lucknow, Lucknow, Uttar Pradesh-226001, India | CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow, Uttar Pradesh-226001, India Email: cs.mohanty.nbri@csir.res.in	Poster
T2-A16	Temperature-controlled dormancy release in hybrid Aspen	**Rishikesh Bhalerao[1*]** [1]Professor, Department of Forest Genetics & Plant Physiology, Swedish University of Agricultural Sciences (SLU), Umeå, SWEDEN Email: rishi.bhalerao@slu.se	Oral

T2-A17	Variation in functional traits of *Odontoschisma* species across the elevational gradient in the alpine ecosystem of the Western Himalaya, India	**Ramya Ranjan Paul[1,2], Soumit K. Behera[1,2], Krishna Kumar Rawat[1,2]** [1]CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow, Uttar Pradesh-226001, India; [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, Uttar Pradesh, India Email: ranjanramya367@gmail.com; soumitkbehera@gmail.com	Poster
T2-A18	*In situ* light-response of photosynthesis of five tropical tree species across three forest types and contrasting canopy environments in the Similipal Biosphere Reserve, India	**Sonik Anto[1,2], Soumit K. Behera[1,2], Ramya R. Paul[1,2], Manas R. Mohanta[3], Sudam C. Sahu[3]** [1]Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, Uttar Pradesh, India; [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India; [3]Department of Botany, Maharaja Sriram Chandra Bhanjadeo University, Baripada-757003, Odisha, India Email: meetsonik@gmail.com	Poster
T2-A19	Response of elevated temperature and ozone stress on physiology and growth of selected tropical tree species	**Athira S. Nair[1,2], Soumit K. Behera[1,2]** [1]Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, India; [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India Email: athirasnair1599@gmail.com	Poster
T2-A20	Unravelling the interactive effects of elevated O_3 and temperature on crop physiology, growth, yield and adaptive strategies	**Hritika Goyal[1,2], Tarannum Khan[1,2], Richa Rai[1,2]** [1]CSIR-National Botanical Research Institute, Lucknow, India; [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India Email: hritikagoyal190@gmail.com	Poster

Theme 3: Plant Responses to Environmental Pollution

Abstract code	Presentation title	Authors, affiliations & email	Oral/ Poster
T3-A1	Impacts of ozone pollution on crops: insights from experimental work and global modelling	**Felicity Hayes[1*]** [1]UK Centre for Ecology and Hydrology, Bangor, Gwynedd, LL57 2UW, United Kingdom; United Nations Convention on Long-Range Transboundary Air Pollution - International Cooperative Programme on Natural Vegetation and Crops, United Kingdom Email: fhay@ceh.ac.uk	**Oral**
T3-A2	Impact of arsenic-contaminated soil and water on rice physiology, nutritional traits and food safety	**Aseem Trivedi[1*], Sejal Shukla[1], Jagriti Suryavanshi[1], Sanjay Dwivedi[1], Seema Mishra[1]** [1]Department of Chemistry, University of Lucknow, Lucknow-226007, India Email: aseemtrivedi18@gmail.com	Poster
T3-A3	Effect of Fluoride during early phase of plant development in *Vigna radiata* and *Vigna mungo*	**Gayatri Singh[1*], Geetgovind Sinam[1], Rekha Kannaujia[1]** [1]Environmental Science Division, CSIR-National Botanical Research Institute, U.P., India Email: gayatrisingh.15@gmail.com	Poster
T3-A4	Calcium and potassium reduce lead toxicity in *Amaranthus tricolor* by modulating antioxidant defense mechanisms	**Kamrun Nahar[1,*], Md. Sawrab Mia[1], and Mirza Hasanuzzman[2]** [1]Department of Agricultural Botany, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh | [2]Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh Email: knahar84@yahoo.com	Oral
T3-A5	Exogenous iron supplementation as a strategy to combat nickel-induced oxidative stress in *Solanum lycopersicum* L.	**Nilu Singh[1*], Divya Dubey[1], Rajiv Dwivedi[1], Grish Chandra Pathak[1]** [1]University of Lucknow, Lucknow-226021, U.P., India Email: nilu02072000@gmail.com	Poster
T3-A6	A comprehensive biochemical, physiological, and metabolite analysis of wheat cultivars under combined tropospheric ozone and water stress	**Nivedita Chaudhary[1*] and Naziya Tarannum[1]** [1]Department of Environmental Science, School of Earth Sciences, Central University of Rajasthan, India Email: nivedita@curaj.ac.in	Oral
T3-A7	Biochemical responses of wheat against zinc stress management	**S.N. Pandey[1*]** [1]Department of Botany, University of Lucknow, Lucknow, India Email: snpandey511@ gmail.com	Oral
T3-A8	Cadmium stress suppresses seedling growth by altering water homeostasis in rice	**Negi P[1*], Pandey M[1], Srivastava AK[1,2]** [1]Nuclear Agriculture and Biotechnology Division, Bhabha Atomic Research Centre, Mumbai-400084, India | [2]Homi Bhabha National Institute, Mumbai-400095, India Email: pjnegi0@gmail.com, poojan@barc.gov.in	Poster
T3-A9	Evaluation of air quality in relation to particulate matter and air pollution tolerance index of plants across different localities of Muzaffarpur city	**Aditya Abha Singh[1]*, Rana Eram[2]** [1]Department of Botany, University of Lucknow, Lucknow-226007, Uttar Pradesh, India | [2]University Department of Botany, Babasaheb Bhimrao Ambedkar Bihar University, Muzaffarpur, Bihar-842001, India	Oral

		Email: abha2512.singh@gmail.com	
T3-A10	Regulatory role of the miR858a–AtMYB12 module in arsenic tolerance and secondary metabolite biosynthesis under sulphur limitation in *Arabidopsis*	**Aruba Khan[1,2], Gurpreet Sandhu[2,3], Ria Khare[4], Prabodh Kumar Trivedi[1,2,3]** [1]Department of Biotechnology, CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), P.O. CIMAP, Near Kukrail Picnic Spot, Lucknow-226015, India; [2] Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India; [3] CSIR-National Botanical Research Institute (CSIR-NBRI), Rana Pratap Marg, Lucknow-226001, India; [4] University of North Carolina at Chapel Hill, Carrboro, North Carolina, United States Email: arubakhan61@gmail.com	Poster
T3-A11	Galactinol synthase 4 and marneral synthase 1 require sulfur assimilation pathway to provide tolerance towards arsenic stress under limiting sulphur condition in *Arabidopsis*	**Gurpreet Sandhu[1,2,3], Deeksha Kesarwani[2,3], Aruba Khan[3], Ria Khare[1,2], Pranshu Kumar Pathak[1,2,3], Prabodh Kumar Trivedi[1,2,3]** [1]CSIR-National Botanical Research Institute (CSIR-NBRI), Rana Pratap Marg, Lucknow-226001, India; [2] Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India; [3] CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), P.O. CIMAP, Near Kukrail Picnic Spot, Lucknow, India; University of North Carolina at Chapel Hill, UNC-Department of Biology, North Carolina, USA Email: gurpreetsandhulko@gmail.com	Poster
T3-A12	Quantification of pollution removal efficiency of an ornamental plant *Syngonium podophyllum* in closed chamber	**Mithilesh Kishori Bhardwaj[1] and Richa Rai[1]*** Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, India Email: mithilesh.nbri23j@acsir.res.in	Poster
T3-A13	Understanding the mechanisms of arsenic tolerance and resilience in the primitive bryophyte *Marchantia polymorpha* L.	**Prasanna Dutta[1,2], Kamya[1], Debasis Chakrabarty[1,2]** [1]Biotechnology and Molecular Biology Division, CSIR-National Botanical Research Institute, Lucknow-226001, India; [2] Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India Email: prasannadutta@icloud.com	Poster
T3-A14	Waste-derived biochar mitigates arsenic toxicity and enhances rice (*Oryza sativa* L.) plant growth in contaminated soil	**Sudhakar Srivastava[1*]** [1]Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi 221005, Uttar Pradesh, India Email: sudhakar.iesd@bhu.ac.in	Oral
T3-A15	Impact of climate and metal stress on plant physiology	**Pooja Sharma[1*]** [1]Department of Applied Microbial Ecology Helmholtz Centre for Environmental Research, Permoserstr. 15, 04318 Leipzig, Germany E-mail: pooja.sharma@ufz.de	Oral
T3-A16	Amelioration of arsenic induced toxicity in rice: Role of selenium and silicon in improving grain quality by reducing arsenic accumulation in rice (*Oryza sativa* L.)	**Vishnu Kumar1,2*, Sarvesh Kumar1, Sanjay Dwivedi1,3#, Seema Mishra4, Geetgovind Sinam1, Soumit Kumar Behera1 and Rajveer Singh Chauhan2, Vivek Pandey1** 1Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, India	Poster

		2Department of Botany, Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur- 273009, India | 3Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India 4Department of Chemistry, University of Lucknow, Lucknow-226007, India Email:vishnukumar772@gmail.com	
T3-A17	Dietary cancer risk from arsenic exposure through wheat and rice in the Middle Ganga Plain, India: hotspot mapping and mitigation approaches	**Pragya Sharma[1,2*], Sanjay Dwivedi[1,2#], Sarvesh Kumar[1], Seema Mishra[3], Vishnu Kumar[1], Ruchi Agnihotri[1], Ravi Kumar Tiwari[1], Abhishek Niranjan[1], Pramod Arvind Shirke[1,2]** [1]Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute Lucknow-226001, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India | [3]Department of Chemistry, University of Lucknow, Lucknow-226007, India Email: sharmapragya766@gmail.com	Poster
T3-A18	Dual impact of climate change and soil arsenic on growth, yield, and quality of rice (*Oryza sativa* L.)	**Sarvesh Kumar1,2*, Vishnu Kumar1, Pragya Sharma1, Ruchi Agnihotri1, Seema Mishra3, Rajesh Kumar Tewari2, Sanjay Dwivedi1,4# and Vivek Pandey1,4** 1Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, India | [2]Department of Botany, University of Lucknow, Lucknow-226007, India |[3]Department of Chemistry, University of Lucknow, Lucknow-226007, India | [4]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India Email: sarveshkumar891994@gmail.com	Poster
T3-A19	A Metal-Binding Expansin-Like Protein (OsELP) Confers Arsenic Tolerance in Rice	**Khushboo Chawda[1,2*] and Debasis Chakrabarty[1,2]** [1]Molecular Biology and Biotechnology Division, CSIR-National Botanical Research Institute, Lucknow 226001, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, India Email: khushboochawda8@gmail.com	Poster
T3-A20	Targeting OsNIP3;1 via CRISPR/Cas9: A strategy for minimizing arsenic accumulation and boosting rice resilience	**Puja Singh[1] and Debasis Chakrabarty[1]** [1]Molecular Biology and Biotechnology Division, CSIR-National Botanical Research Institute Email: chakrabartyd@nbri.res.in	Poster
T3-A21	Comprehensive genome-wide study of Glutaredoxin (GRX) gene family in the liverwort *Marchantia polymorpha* and exploring their roles in abiotic stress tolerance	**Shivani Singh[1,2], Debasis Chakrabarty[1,2]** [1]Academy of Scientific and Innovative Research (AcSIR), New Delhi, 110 001 | [2] Molecular Biology and Biotechnology Department, National Botanical Research Institute, Lucknow, 226001 Email: chakrabartyd@nbri.res.in, singhshivanii101997@gmail.com	Poster
T3-A22	Comparative Analysis of Tau class Glutathione-S-transferase gene of *Marchantia polymorpha* and Oryza *sativa* in response to Arsenic stress	**Monica kumari[1,2], Debasis Chakrabarty[1,2]** [1]Academy of Scientific and Innovative Research (AcSIR), New Delhi, 110 001 [2] Molecular Biology and Biotechnology Department, National Botanical Research Institute, Lucknow, 226001 Email: chakrabartyd@nbri.res.in, monica.kumari2014@gmail.com	Poster
T3-A23	Identification of Arsenic Tolerant and Sensitive Rice Varieties Through Systematic Evaluation	**Prerna Kumari[1,2], Shraddha Singh[1,2*], Sudhir Singh[1,2] and Anand D. Ballal[1,2]** [1]Nuclear Agriculture & Biotechnology Division, Bhabha Atomic Research Centre, Mumbai 400085, India; [2]Homi Bhabha National Institute, Mumbai 400094, India Email: prernak160@gmail.com	Poster

Theme 4: Environmental Microbiology, Biotechnology and Nanotechnology

Abstract code	Presentation title	Authors, Affiliation(s) & Address, Email	Oral/ Poster
T4-A1	Role of epiphytic growth-promoting bacteria (Acinetobactersp.) in improving arsenic tolerance in rice by modulating reactive oxygen species metabolism	**Mirza Hasanuzzaman[1*]** [1]Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh Email: mhzsauag@yahoo.com	Oral
T4-A2	Silencing of the Meloidogyne incognita Effector Gene Mi-EP1 via dsRNA feeding and host-delivered RNAi suppresses parasitism in tomato and Arabidopsis	**Alisha Guglani[1], Vishal Singh Somvanshi[2], Uma Rao[2], Arun Jagannath[1], Amar Kumar[1], Surekha Katiyar-Agarwal[3] and Manu Agarwal*** [1]Department of Botany, University of Delhi, Delhi-110007, India | [2]Division of Nematology, ICAR-Indian Agricultural Research Institute, New Delhi-110012, India | [3]Department of Plant Molecular Biology, University of Delhi, New Delhi-110021, India Email: alishaguglani30@gmail.com	Poster
T4-A3	Unveiling the potential of Si solubilizing microbe for abatement of abiotic and biotic stress in rice	**Anamika[1*], Ananya Dwivedi[1], Jasvinder Kaur[1], Vidisha Bisht[1], Suchi Srivastava[1*2]** [1]Department of Microbial Technology, CSIR-NBRI, Lucknow-226001 | [2]Academy of Scientific and Innovative Research, AcSIR, Ghaziabad-201002, India Email: anamikanbri1799@gmail.com	Poster
T4-A4	Detoxification of chromium (VI) from mining-contaminated soil using *Klebsiella* sp. (BH-A1)	**Anjali Srivastava[1*], Asha Lata Singh[1]** [1]Bioremediation Research Lab, Centre of Advanced Study in Botany, Institute of Science, Banaras Hindu University, Varanasi E-mail: anji.srivas@bhu.ac.in	Poster
T4-A5	Trace element-based silicon and selenium nanoparticles regulate antioxidant defense and confer salt stress tolerance in proso millet (*Panicum miliaceum*)	**Dipanwita Datta[1*], Sharmina Tasnim Labonnoya[1], Mirza Hasanuzzaman[1]** Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh Email: dipanwitadatta83@gmail.com; mhzsauag@yahoo.com	Poster
T4-A6	Role of phosphate solubilizing bacteria (*Acinetobacter* sp.) and nano phosphate fertilizer to improve vegetative and reproductive development and antioxidant defence in rice under salinity	**Faomida Sinthi[1*]and Mirza Hasanuzzaman[1]** Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh Email: sinthi72@gmail.com	Poster
T4-A7	Synergistic antimicrobial evaluation between antibiotics and secondary metabolites isolated from *B. pinnatum* and *M. elengi* methanol extracts against pathogenic microorganisms	**Leena Das[1*], Vilas. A. Kamble[1]** Department of Microbiology, Adarsha Science, J.B. Arts and Birla Commerce Mahavidyalaya, Amravati, Maharashtra, India Email: leena18das@gmail.com	Oral

T4-A8	Enhancing rice arsenic resistance by focusing on specific microRNA that targets γ-glutamyl cysteine synthetase	**Poonam Tiwari[1], Mohammad Israil Ansari[1] and Debasis Chakrabarty[2]** [1]Botany Department, University of Lucknow [2] Molecular Biology and Biotechnology, CSIR-NBRI Email: tpoonam.rs@gmail.com	Poster
T4-A9	Selenium and silicon nanoparticles mediated salt stress mitigation in soybean (*Glycine max* L.)	**Md. Sharif Ahmed[1], Omnia Ashraf Ria[2], Sharmin Akter Mim[3], Md. Sarwar Hosen[4], Mirza Hasanuzzaman[3]** [1]Department of Biochemistry and Molecular Biology | [2]Department of Agricultural Botany | [3]Department of Agronomy, Institute of Seed Technology | [4]Faculty of Agriculture, Sher-e-Bangla Agricultural University (SAU), Dhaka-1207, Bangladesh Email: sahmed.ru.bd@gmail.com	Poster
T4-A10	Enhancing rice growth and arsenic detoxification through zinc-solubilizing bacteria and nanochar application	**Md. Sarwar Hosen[1], Meher Nigar Miti[2], Samiul Alam[2], Mirza Hasanuzzaman[2]** [1]Institute of Seed Technology | [2]Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh Email: mehernigarmiti457@gmail.com	Poster
T4-A11	Effect of seed nano-priming on seven cultivars of wheat (*Triticum aestivum* L.): Phytostimulatory or toxic responses	**Rekha Kannaujia[1], Gayatri Singh[1], Vivek Pandey[2]** [1]Central Instrumentation Facility, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, U.P., India | [2]Plant Ecology and Climate Change Science, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow, India Email: rekha.kannaujia.nbri@csir.res.in	Poster
T4-A12	In vitro enrichment of targeted indole alkaloids from *Neolamarckia cadamba* (Roxb.) Bosser	**Rosani Kumari Shaw[1*], Arvind Kumar Maurya[1], Sanjeev Kanojiya[1], D. K. Mishra[1]** Botany Unit (SAIF & R), CSIR-Central Drug Research Institute, Sitapur Road, Jankipuram Extension, Lucknow-226031, India Email: rosanikumari789@gmail.com	Poster
T4-A13	Exploring the biostimulating roles of plant growth promoting rhizobacteria (*Mangrovibacter* sp.) in rice under salt stress	**Samiul Alam[1*] and Mirza Hasanuzzaman[1]** Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh Email: kbdsamiulalam@gmail.com; mhzsauag@yahoo.com	Poster
T4-A14	Evaluation of the interaction between pesticide-tolerant strains and biochar for their growth, pesticide degradation and cell release kinetics potential	**Santosh Kumar Yadav[1,2], Puja Khare[1,2]*** [1]Crop Production and Protection Division, CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India Email: santoshyadav5795@gmail.com	Poster
T4-A15	Application of nanofertilizer in conferring drought tolerance in soybean	**Sharmin Akter Mim[1*] and Mirza Hasanuzzaman[1]** [1]Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh Email: mimsharminakter11@gmail.com	Poster

T4-A16	Engineering synthetic microbial communities to mitigate human pathogens in agricultural soils	**Sonal Srivastava[1,2*], Kanika Chawla[1], Soumya Saxena[1], Vaibhav C. Agre[1], Shilpi Sharma[1], Pascal Piveteau[2]** [1]Department of Biochemical Engineering and Biotechnology, Indian Institute of Technology Delhi, Hauz Khas, New Delhi, India | [2]INRAE, OPAALE Research Unit (UR OPAALE), Rennes, France Email: evs.sonal@gmail.com	Poster
T4-A17	Evaluation of the antibacterial property of ZnO nanoparticles synthesised by using an edible and medicinal fern	**Suman Patra[1,2*], Babita Kumari[1], Jyoti Jangid[1,3], Rachna[1], Sushree Sunandita Patel[1], Madhu Sehgal[2], Sandip Kumar Behera[1]** [1]Plant Diversity, Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Lucknow, India | [2]Chhatrapati Shahu Ji Maharaj University, Kanpur, India | [3]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India Email: patrasumankumar2021@gmail.com	Poster
T4-A18	Enhanced scytonemin production in cyanobacterium *Symploca cartilaginea* under salinity stress: a sustainable approach for natural UV-protectant development	**Soujanya Shekhar Rana[1], Nirmal Renuka[2], Sachitra Kumar Ratha[1*]** [1]Algology Laboratory, CSIR-National Botanical Research Institute, Lucknow, 226001, India; [2]Algal Biotechnology Laboratory, Department of Botany, Central University of Punjab, Bathinda, 151401, India Email: sachitra.ratha.nbri@csir.res.in; soujanyasekhar.b2@gmail.com	Poster
T4-A19	Metagenomic insights into cyanide-degrading microbial communities from steel industry wastewater	**Anita Gupta[1]*, Saroj Kanta Barik[2], Pankaj Kumar Srivastava[1]** [1]CSIR- National Botanical Research Institute, Rana Pratap Marg, Lucknow, India | [2]Department of Botany, North-Eastern Hill University, Shillong, Meghalaya Email: ganita811@gmail.com	Poster
T4-A20	HY5 and COP1 antagonistically influence light-mediated nicotine biosynthesis in tobacco	**Deeksha Singh[1], Shambhavi Dwivedi[1,2], Nivedita Singh[1], Arpita Tiwari[1], Prabodh Kumar Trivedi[1,2]** [1]CSIR-Central Institute of Medicinal and Aromatic Plants, Picnic Spot Road, near Kukrail, Lucknow, U.P. | [2]Jawaharlal Nehru University, New Mehrauli Road, JNU Ring Road, New Delhi, India Email: deekshait@gmail.com	Poster
T4-A21	Molecular cross-talk between flavonoid and nicotine biosynthetic pathways in *Nicotiana tabacum*	**Basant Kumar Dubey[1,2*], Ratna Katiyar[2], Prabodh Kumar Trivedi[1]** [1]CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP) P.O. CIMAP, Near Kukrail Picnic Spot, Lucknow, India | [2]Department of Botany, University of Lucknow, Lucknow, India Email: basantdubey.cimap@csir.res.in	Poster
T4-A22	Crosstalk of nitric oxide and hydrogen sulfide during the ripening of pepper fruits	**Francisco J Corpas** Group of Antioxidants, Free Radicals and Nitric Oxide in Biotechnology, Food and Agriculture, Department of Biochemistry, Cell and Molecular Biology of Plants, Estación Experimental del Zaidín, Spanish National Research Council (CSIC), Granada, Spain Email: javier.corpas@eez.csic.es	Oral

T4-A23	Assessing the effect of phytohormone treatment on microalgae under Nitrogen stress	**Harsh Vardhan**[1*] [1]CSIR National Botanical Research Institute, Rana Pratap Marg, Lucknow, India Email: harshvardhancharan200@gmail.com	Poster
T4-A24	Identification, *In-silico* analysis, and characterization of methyltransferase involved in wedelolactone biosynthesis from *Eclipta prostrata* (L.) L.	**Krishan Chandra Shukla**[1], **Enakshi Sarkar**[1], **Pratibha Mishra**[1], **Vineeta Tripathi**[1*] [1]Botany Unit, SAIF & R Division, CSIR-CDRI, Lucknow, India*Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India Email: vineeta.tripathi.cdri@csir.res.in	Poster
T4-A25	AI-driven classification of Plant P450 Enzymes	**Nikita Tiwari**[1*], **Meher H. Asif**[1] Molecular Biology and Biotechnology, CSIR-National Botanical Research Institute, Lucknow-226001, U.P., India. Email**:** nikitatiwari.1992@gmail.com	Poster
T4-A26	Green-synthesis and Characterization of Carbon Quantum Dots from *Murraya koenigii*	**Pallavi Chattopadhyay**[1*], **Devyani Shukla**[2], **and Avanish Singh Parmar**[2] [1]Amity Institute of Biotechnology, Amity University Uttar Pradesh, Lucknow Campus, Lucknow, India | [2]Department of Physics, Indian Institute of Technology (BHU), Varanasi Email: pallavi96chatto@gmail.com	Poster
T4-A27	Genetic Enhancement of Pearl Millet (*Pennisetum glaucum* L.) against *Helicoverpa armigera*	**Anshu Sahu*[12], Indraneel Sanyal[12]** [1]CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India Email: kir.sahu28@gmail.com; anshu2541@gmail.com	Poster
T4-A28	De novo transcriptome analysis and the role of glycosyltransferases in the biosynthesis of flavonoid glycosides	**Pratibha Mishra**[1*], **Anshu Mohanta**[1], **Krishan Chandra Shukla**[1], **Enakshi Sarkar**[1], **Vineeta Tripathi**[1*] [1]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad | Botany Unit, SAIF & R Division, CSIR-CDRI, Jankipuram Extension, Lucknow, India Email: vineeta.tripathi.cdri@csir.res.in	Poster
T4-A29	Elucidation of heat stress-induced signal transduction for wedelolactone biosynthesis in *Eclipta prostrata* (L.) L.	**Enakshi Sarkar**[1*], **Archana Kumari**[1], **Krishan Chandra Shukla**[1], **Pratibha Mishra**[1], **Vineeta Tripathi**[1*] [1]Botany Unit, SAIF & R Division, CSIR-CDRI, Lucknow, Uttar Pradesh [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, Uttar Pradesh E-mail id: vineeta.tripathi.cdri@csir.res.in	Poster
T4-A30	Regulation of flavonoid biosynthesis by AtMYB12 confers enhanced biotic stress resistance in plants	**Tushita Rai Vineeta**[1*], **Hiteshwari Sinha**[1], **Ravi Shankar Kumar**[1], **Tapasya Datta**[1], **Aastha Shromona**[1], **Prabodh Kumar Trivedi**[1] [1]CSIR-Central Institute of Medicinal and Aromatic Plants P.O. CIMAP, Near Kukrail Picnic Spot, Lucknow Email: dtushitarai04@gmail.com	Poster
T4-A31	Overexpression of F-box protein KIB1 increases abiotic stress tolerance in	**Uma Gupta,**[1,2] **Indraneel Sanyal**[1*], **Pradeep Kumar**[2]	Poster

	Brassica juncea (L.) by brassinosteroid signalling	[1]CSIR-National Botanical Research Institute, Lucknow, India | [2]Department of Botany, University of Lucknow, India Email: i.sanyal.nbri@csir.res.in	
T4-A32	Regulation of pigmentation and fibre development by miRNAs in white and brown cotton (*Gossypium hirsutum*)	**Debashree Pattanaik, Sagar Prasad Nayak, Shafquat Fakhrah, Chandra Sekhar Mohanty*** Academy of Scientific and Innovative Research (AcSIR) | CSIR-National Botanical Research Institute (CSIR-NBRI), Rana Pratap Marg, Lucknow, Uttar Pradesh-226001, India Email: cs.mohanty.nbri@csir.res.in	Poster
T4-A33	*Bacillus amyloliquefaciens* modulates autophagy pathways to control *Rhizoctonia solani* infection in rice	**Mohd Mogees Ansari[1,2], Nikita Bisht[1], Tanya Singh[1,2], Puneet Singh Chauhan[1,2]*** [1]Microbial Technology Division, CSIR-National Botanical Research Institute, Lucknow, 226001 | [2]Academy of Scientific and Innovative Research(AcSIR), Ghaziabad, India Email: puneet@nbri.res.in, puneetnbri@gmail.com	Poster
T4-A34	Evaluation of antibacterial property of ZnO nanoparticle synthesised by using an edible and medicinal fern	**Suman Patra[1,2], Babita Kumari[1], Jyoti Jangid[1,3], Rachna[1], Sushree Sunandita Patel[1], Madhu Sehgal[2], Sandip Kumar Behera[1]** [1]Plant Diversity, Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Lucknow, 226001, Uttar Pradesh, India [2]Chhatrapati Shahu Ji Maharaj University, Kanpur, 208024, Uttar Pradesh, India [3]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, 201002, India Email**:** patrasuman.botany@gmail.com	Poster
T4-A35	Plant-Nanoparticle interaction: Physiological, biochemical and metabolic alterations in medicinal plants under influence of titanium oxide and copper oxide nanoparticles	**Poornima Vajpayee[1*], Subodh Kumar[1], Archana Dwivedi[1], Vippan Kaur[1], Akanksha Dubey[1]** [1]Ecotoxicology, Bioremediation and Nanotoxicology Laboratory, Department of Botany, University of Lucknow, Lucknow-226007 Email: devpoornima@rediffmail.com	Oral
T4-A36	When enemies inspire allies: Trichoderma makes Jasmonate metabolites when challenged by *Fusarium*	**Sakshi Priya[1,2], Isha Verma[1,2], Poonam C. Singh[* 1,2]** [1]Microbial Technology Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow, 226001, India | [2]Academy of Scientific and Innovative Research (AcSIR), CSIR-HRDG, Kamla Nehru Nagar, Ghaziabad, Uttar Pradesh, 201002 Email: Sakshi Priya sinhasp2000@gmail.com	Poster
T4-A37	Nanocomposite, nanobiochar and nanomaterials for soil health and crop management	**Vishnu D. Rajput[1*]** [1]Academy of Biology and Biotechnology, Southern Federal University, Rostov-on-Don, Russia Email: rvishnu@sfedu.ru; rajput.vishnu@gmail.com	Poster
T4-A38	Functional relevance of CAMTA5 governing Ca2+ dynamics and root development in Arabidopsis thaliana	**Sanjeev Yadav[1,2*], Zahra Iqbal[1], Samir V. Sawant[1,2]** [1]Molecular Biology and Biotechnology Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India Email: sy656000@gmail.com	Poster
T4-A39	Deciphering the mechanisms of arsenic tolerance in *Trichoderma*	**Prerana*, Poonam C Singh** Microbial Technology Division, CSIR-NBRI Lucknow, India	Poster

		Email: preranasingh0095@gmail.com	
T4-A40	*Paenibacillus lentimorbus* shapes maize root architecture and metabolic responses under nutrient	**Tanya Singh[1,2], Puneet Singh Chauhan[1,2*]** [1]CSIR-National Botanical Research Institute (CSIR-NBRI), Rana Pratap Marg, Lucknow 226001, India [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India Email: puneetnbri@gmail.com; puneet@nbri.res.in	Poster
T4-A41	Synergistic eco-physiological response of biochar and *Paenibacillus lentimorbus* application on chickpea growth and soil under drought stress	**Ankit Ojha[1,2], Nikita bisht[1,2], Tanya Singh[1,2], Mohd Mogees Ansari[1,2], Shiuly Bhowmik[1], Gauri Rai[1], Puneet Singh Chauhan[1,2*]** [1] CSIR-National Botanical Research Institute (CSIR-NBRI), Rana Pratap Marg, Lucknow, India [2]Academy of Scientifc and Innovative Research (AcSIR), Ghaziabad, India Email: Puneet@nbri.res.in	Poster
T4-A42	Unraveling the mechanisms of endophyte-mediated enhancement of growth and colchicine biosynthesis in *Gloriosa superba*	**Pradeep Semwal[1,2], Shashank Kumar Mishra[1], Puneet Singh Chauhan[1]*** [1]Microbial Technologies Division, Council of Scientific and Industrial Research-National Botanical Research Institute (CSIR-NBRI), Rana Pratap Marg, Lucknow-226001, India [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad- 201002, India Email: Puneet@nbri.res.in	Poster
T4-A43	Comprehensive Virome Profiling of Cotton Mealybug (*Phenacoccus solenopsis*) Reveals Diverse Viral Communities in the Salivary Gland and Midgut	**Ritika Dwivedi[1], Manisha Singh[1], Susheel Kumar[1] and Praveen C. Verma[1]** [1]Department of Molecular Biology and Biotechnology, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001 (UP) India Email: dwivediritika6@gmail.com.	Poster
T4-A44	Plant growth-promoting rhizobacteria Bacillus amyloliquefaciens reconfigures JAZ repressors, carbohydrate metabolism, and root architecture to alleviate stress induced by suboptimal nutrient conditions in Oryza sativa L.	**Nikita Bisht[1], Puneet Singh Chauhan[1*]** [1]CSIR-National Botanical Research Institute (CSIR-NBRI), Rana Pratap Marg, Lucknow, India-226001 Email: puneetnbri@gmail.com; puneet@nbri.res.in	Poster
T4-A45	Isolation and characterization of endophytes from contrasting chemotypes of *Commiphora wightii* for growth promotion and guggulsterones enhancement	**Deen Dayal Pandey[1], Shashank Kumar Mishra[1], Puneet Singh Chauhan[1,*]** [1]Microbial Technologies Division, Council of Scientific and Industrial Research-National Botanical Research Institute (CSIR-NBRI), Rana Pratap Marg, Lucknow-226001, India Email: deendayalpandey100@gmail.com	Poster

Theme 5: Urban ecosystem: Urban heat island effects and green belts

Abstract Code	Presentation Title	Authors, Affiliation(s) & Address, Email	Oral/ Poster
T5-A1	Urban blue-green infrastructure, human-nature relationships, and resilience in Indian metropolises: Cities in nature's embrace	**Shalini Dhyani[1*]** [1]CSIR-National Environmental Engineering Research Institute (NEERI), Nagpur, Maharashtra Email: shalini.dhyani@csir.res.in	Oral
T5-A2	Assessing the effect of green space spatial patterns on land surface temperature for sustainable urban planning	**Satyabhan Singh[1,2*], Priya Verma[1,2], Dibyendu Adhikari[1], Alka Kumari[2]** [1]Plant Ecology and Climate Change Science, CSIR-National Botanical Research Institute, Lucknow, India; [2]Department of Botany, University of Lucknow, Lucknow, India Email: satyabhansinghrathore25@gmail.com	Poster
T5-A3	Physiological evaluation of trees for mitigation of urban heat island (UHI) effects	**Mohd. Saad[1,2*], Soumit K. Behera[1,2], Sonik Anto[1,2], Irfan A. Ansari[1], Ramya R. Paul[1,2], Kamal Pal[1], Dibyendu Adhikari[1,2]** [1]Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India Email: myidmsss@gmail.com	Poster
T5-A4	Perception-driven plant preferences for vertical greenery systems in Lucknow, India	**Jasbeer Kaur[1*], Shipra[1], Priya Verma[1], Prem Prakash Singh[1], Dibyendu Adhikari[1]** [1]Plant Ecology and Climate Change Science Division, CSIR-NBRI, Lucknow, India Email: jasbeerkaurmgs@gmail.com	Poster
T5-A5	Monitoring of air-borne particulate matter in the urban environment and its remediation through plants	**Ankesh Tiwari[1], Sudhir Kumar Pandey[1]*** [1]Department of Botany, Guru Ghasidas Vishwavidyalaya, (A Central University) Koni, Bilaspur (C.G.)- 495009 Email: skpbhu@gmail.com	Poster
T5-A6	From Grey to Green: Enhancing Air Quality with Urban Vegetation/Urban Green Spaces: Key players in combating Air Pollution.	**Tarannum Khan[1,2] , Hritika Goel[1,2] , Richa Rai[1,2]*** [1] CSIR-National Botanical Research Institute Lucknow U.P [2] Academy of Scientific and Innovative Research (AcSIR) Ghaziabad U.P Email: khantarannum8765@gmail.com	Poster
T5-A7	Ornamental fruit culture for aestheticity and nutritional security in urban ecosystem	**Spoorti Tirki[1*], Sateesh R Patil[1], Bal Krishna[1], Pavankumar[1], Mahantesha BN[1], Praveen Joglikar[1] and Shankar Meti[1]** University of Horticultural Sciences, Bagalkot, Jain Irrigation System Ltd., Jalgaon, Maharashtra, India Email: tirkispoorti@gmail.com	Poster

Theme 6: Environmental monitoring, assessment, and remediation

Theme code	Presentation title	Authors, Affiliation(s) & Address, Email	Oral/ Poster
T6-A1	Plant invasion decreased the understory carbon sequestration in sub-tropical forest ecosystem: An Evidence from Sikkim Himalaya, India	**Anil Kumar Verma[1], Soumit Kumar BeheraRashmiNayak[2], N. Manika[1], Kiran Bargali[3], Lal Babu Chaudhary[2]** [1]Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, Uttar Pradesh, India | [2]Plant Diversity, Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, Uttar Pradesh, India | [3]Department of Botany, Kumaun University, Nainital-263001, Uttarakhand, India Email: anilkverma.lmp@gmail.com	Poster
T6-A2	Chromite mining and its adverse impact on environment and human health in Sukinda valley of India	**A. K. Gupta[1]** [1]Regional Office, Ministry of Environment, Forest and Climate Change, Lucknow, India Email: amitenv@yahoo.com; amitkr.gupta@nic.in	Poster
T6-A3	Waste-water irrigation of agricultural fields and its ameliorative measures by regulating physiological and metabolic indices of vegetable crop	**Anita Singh[1]** [1]Department of Botany, Institute of Science, Banaras Hindu University, Varanasi, 221005, Uttar Pradesh Email: anita.1710@gmail.com	Oral
T6-A4	Water footprint assessment and aquifer profile towards developed hydrological approach in India	**Brajesh K. Dwivedi[1*]** [1]Department of Applied Science–Environmental Science, Faculty of Engineering and Technology, KMCL University, Lucknow-226001, India Email: drbkdwivedi2@gmail.com; bkdwivedi@allduniv.ac.in	Oral
T6-A5	Assessment of metal leaching efficiency and phytotoxic response of bioleachates derived from mine waste	**Disha Mishra[1*], Puja Khare[1]** [1]Crop Production and Protection Division, CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow-226015, India Email: mishra.disha1@gmail.com	Poster
T6-A6	Seasonal Dynamics of Plant Communities and Soil Attributes in Grassland Ecosystem of Pilibhit Tiger Reserve: An Ecological Assessment through Multivariate and Indicator Species Analyses	**Rahul Kumar[1*], Soumit Kumar Behera[1]** [1]Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, India; [2]Academy of Scientific and Innovative Research (AcSIR), CSIR-HRDC, Kamla Nehru Nagar, Ghaziabad, India Email: rahul.in.india.1@gmail.com	Poster
T6-A7	Innovative cultivation strategies for reducing grain Arsenic in rice (*Oryza sativa* L.): Toward sustainable agriculture and environmental protection	**Rudra D. Tripathi[1]*, P.K. Singh[1], Poonam Tiwari[1], Reshu Chauhan[1], Surabhi Awasthi[1], Debasis Chakrabarty[1] and Pankaj K. Srivastava[1]** CSIR-National Botanical Research Institute, Lucknow, India Email: tripathird@gmail.com	Poster

T6-A8	Evaluating the phytoremediation potential of the medicinal plant *Ocimum basilicum* for mitigating indoor air pollution	**Sabuj Mondal [1,2] *, Vibhuti Singh[2]** [1]Department of Bioscience and Biotechnology, Indian Institute of Technology Kharagpur, West Bengal, India | [2]Department of Botany, University of Delhi, New Delhi, India Email: Sabujmondal1736@botany.du.ac.in	Poster
T6-A9	Physicochemical analysis of Parvati Arga wetland: a lesser-known Ramsar site from eastern U.P.	**Sakshi Srivastava[1]*, Rekha Sharma[1]** [1]Dept. of Botany, S.L.B.S. Degree College, Gonda, India Email: sakshisrivastava2708@gmail.com	Poster
T6-A10	Arsenic dynamics in paddy soils of eastern Uttar Pradesh: Links to rhizosphere chemistry, and rice uptake and transformation	**Seema Mishra[1]*, Sanjay Dwivedi[2]** [1]University of Lucknow, Lucknow | [2]CSIR-National Botanical Research Institute, Lucknow, India Email: seema_mishra2003@yahoo.co.in	Oral
T6-A11	Current Assessment Of Lichen Diversity And Implications Of Future Climate Change In Satna District, Central India	**Shweta Tiwari[1,2*], Kanchan Awasthi[1], Gaurav K. Mishra[2] and D.K. Upreti[2]** [1]Department of Botany, Maharshi University, Sitapur Road, P.O-Maharishi Vidya Mandir, Lucknow-226013, Uttar Pradesh, India [2]Lichenology Laboratory, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow - 226 001, Uttar Pradesh, India Email: shweta151tiwari@gmail.com	Poster
T6-A12	Sediment accumulation of Polyaromatic hydrocarbon in estuarine and coastal regions of Chandipur, east coast of India	**Subhashree Nayak[1]*, Smruti Prajna Pradhan[1], Pratyusha Nayak[1], Sthitaprajna Nath Sharma[1], Nishigandha Muduli[1], Lipika Patnaik[1]** [1]Environmental Science Lab, Department of Zoology, Center of Excellence in Environment and Public Health, Ravenshaw University, Cuttack, India *Email: lipikapatnaik@ravenshawuniversity.ac.in	Poster
T6-A13	Morphological characterization, elemental composition and distribution of *Chaetoceros* sp. of Dhamra Coastal water, Odisha, India	**Smruti Prajna Pradhan[1], Nishigandha Muduli[1], Pratyusha Nayak[1], Sthitaprajna Nath Sharma[1], Subhashree Nayak[1], Lipika Patnaik[1]*** [1]Ecotoxicology Laboratory, Department of Zoology, Center of Excellence in Environment and Public Health, Ravenshaw University, Cuttack, India Email: lipikapatnaik@ravenshawuniversity.ac.in	Poster
T6-A14	Ecotoxicological effects of Tributyltin Chloride (TBTCl) on freshwater bivalve *Lamellidens marginalis*: A quantitative study of histopathological alterations	**Sthitaprajna Nath Sharma[1], Nishigandha Muduli[1], Pratyusha Nayak[1], Shubhajit Saha[2], Smruti Prajna Pradhan[1], Subhashree Nayak[1], Lipika Patnaik[1]*** [1]Environmental Science Lab, Department of Zoology, Center of Excellence in Environment an Public Health, Ravenshaw University, Cuttack, India | [2]Department of Zoology, The University o Burdwan, Purba Barddhaman, West Bengal, India Email: lipikapatnaik@ravenshawuniversity.ac.in	Poster
T6-A15	Invasive weed diversity and phytochemical dynamics in turmeric cultivation under sodic soils of Awadh Region, India	**Bikarma Singh[1]*, R.C. Nainwal[1], Devendra Singh[1], Lal Bahadur[1], B.N. Singh[1]** [1]Botanical Garden, Plant Conservation and Agrotechnology Division, CSIR-National Botanical Research Institute, Lucknow, India | Academy of Scientific & Innovative Research (AcSIR), Ghaziabad 201002, Uttar Pradesh, India.	Oral

		Email: drbikarma.singh.nbri@csir.res.in	
T6-A16	Characterizing Arsenic-Responsive mRNAs and miRNAs in *Spinacia oleracea* for Establishing Molecular Control of Arsenic Stress	**Disha Maitra[1], Twinkle Singh[2], Debasis Chakrabarty*** National Botanical Research Institute, Lucknow-226001. Academy of Scientific and Innovative Research (AcSIR), New Delhi, 110001, India Email: dishamaitra2107@gmail.com, chakrabartyd@nbri.res.in	Poster
T6-A17	Assessing the bioremediation potential and Physiological Responses of *Chlorella* sp. and *Desmodesmus* sp. exposed to Arsenic (V)	**Prabhkirat Kapahi[a], Neeraj Meena[a], Tufail Fayaz[a], Esha Goyal[a], Sachitra Kumar Ratha[b], Nirmal Renuka[a]*** [a]Algal Biotechnology Laboratory, Department of Botany, Central University of Punjab, Bathinda 151401,India [b]Algology Laboratory, CSIR–National Botanical Research Institute, Lucknow – 226001, IndiaEmail: nirmal.renuka@cup.edu.in, renuka.bot@gmail.com	Poster
T6-A18	Assessing the influence of land use and soil biochemical properties on tropical ecosystem carbon dynamics in the Terai Region of Uttar Pradesh	**Ragib Husain[1,2], Soumit K. Behera[1, 2*]** [1]CSIR- National Botanical Research Institute, Rana Pratap Marg, Lucknow India | [2]Academy of Scientific and Innovative Research (AcSIR), AcSIR Headquarters CSIR-HRDC Campus, Postal Staff College Area, Sector 19, Kamla Nehru Nagar, Ghaziabad, India Email: soumitkbehera@gmail.com	Poster
T6-A19	MicroRNA-Mediated Regulation of Gene Expression in Response to Arsenic Stress in Rice	**Twinkle Singh[1], Disha Maitra[2], Debasis Chakrabarty[1]*** National Botanical Research Institute, Lucknow-226001. Academy of Scientific and Innovative Research (AcSIR), New Delhi, 110001, India Email: twinklesingh2107@gmail.com, chakrabartyd@nbri.res.in	Poster
T6-A20	Phytohormone-induced regulation of antibiotic bioremoval and physiological adaptations in microalgae	**Nirmal Renuka[1], Tufail Fayaz[1]** Algal Biotechnology Laboratory, Department of Botany, Central University of Punjab, Bathinda, 151401, India Email: renuka.bot@gmail.com, nirmal.renuka@cup.edu.in	Oral
T6-A21	Lake Sediments as records of regional changes	**Aryan Verma[1], Shiva Mishra[1], Anis[1], Vertika Shukla[1]*, Narendra Kumar[1]** [1]Department of Geology, Babasaheb Bhimrao Ambedkar (Central) University, Raebareli Road, Lucknow 226025 Email: vertika_shukla@rediffmail.com	Poster
T6-A22	Heterogeneous microclimates govern the bryophyte diversity patterns in the alpine ecosystem of the Indian Himalaya	**Ramya Ranjan Paul[1,2*], Soumit K. Behera[1,2*], Krishna Kumar Rawat[1,2], C. P. Singh[3]** [1]CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow226001, Uttar Pradesh, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, Uttar Pradesh, India | [3]Space Applications Centre, Indian Space Research Organization, Ahmedabad380015, Gujrat Email:ranjanramya367@gmail.com; soumitkbehera@gmail.com	Poster
T6-A23	Characterizing forest carbon dynamics in the Similipal Biosphere Reserve, India: An Eddy Covariance Study	**Soumit K. Behera[1,2]*, Ramya R. Paul[1,2], Sonik Anto[1,2], Prem P. Singh[1]**	Poster

		[1]Plant Ecology and Climate Change Science Division, CSIR - National Botanical Research Institute, Lucknow-226001, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad- 201002, India Email: soumitkbehera@gmail.com	
T6-A24	Exploring altitude-driven microclimate dynamics and invasive species distribution in heterogeneous landscape of Sikkim Himalayas	**Anil Kumar Verma[1], N Manika[1], Soumit Kumar Behera[1,*], RashmiNayak[2], Kiran Bargali[3], Lal Babu Chaudhary[2]** [1]Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, Uttar Pradesh, India | [2]Plant Diversity, Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, Uttar Pradesh, India | [4]Department of Botany, Kumaun University, Nainital-263001, Uttarakhand, India Email: soumitkbehera@gmail.com	Poster
T6-A25	Vetiver grass ecosystem service model: Prospecting through the Development of designer genotypes	**Umesh C. Lavania[1]*** [1]INSA Senior Scientist, CSIR-National Botanical Research Institute, Lucknow, India Email: lavaniauc@yahoo.co.in	Oral
T6-A26	Vegetation dynamics under anthropogenic disturbances along an urbanization gradient in Ranchi, Eastern India	**Purabi Saikia[1]** [1]Department of Botany, Institute of Science, Banaras Hindu University, Varanasi, India Email: purabisaikia@bhu.ac.in	Oral
T6-A27	Assessing physicochemical characteristics and surface water quality along the course of the Gomti River for irrigation and drinking purposes	**Fauzia Khan[1], Bhanu Pratap Bhaskar[1], Vertika Shukla[1], Sanjeev Kumar[1*], Narendra Kumar[2]** [1]Department of Geology, Babasaheb Bhimrao Ambedkar University, Lucknow, India | [2]Department of Environmental Science, Babasaheb Bhimrao Ambedkar University, Lucknow, India Email id: sanjivk845@gmail.com	Poster
T6-A28	Combined effects of heat stress and fly ash on morphophysiological responses and phytoremediation potential of Ipomoea carnea Jacq.	**Ashutosh Pandey[1,2], Vivek Pandey[1,3*]** [1]Plant Ecology and Climate Change Science Division, CSIR- National Botanical Research Institute, Lucknow, Uttar Pradesh, India | [2]Department of Botany, K S Saket P G College, Ayodhya, Uttar Pradesh, India | [3]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, India Email: apandeymsb@gmail.com	Poster
T6-A29	Impact of Radioactive Isotopes on non-human & human biota, around the nuclear power Plant in India: A Radio-ecological study	**Devi Deen Pandey[1]*** [1]BRNS,Mumbai, Indian Nuclea Society, Project Square, Anushaktinagar, Mumbai-400094, Mumbai. Email: pandeydevideen43@gmail.com	Poster
T6-A30	Comparative analysis of carbon and nitrogen content across three major forest types in Similipal Biosphere Reserve	**Irfan Ali Ansari[1], Soumit Kumar Behera[1]** Plant Ecology and Climate Change Science Division: CSIR-National Botanical Research Institute Lucknow-226001 Email: irfanevn78@gmail.com	Poster

T6-A31	Distribution, Evaluation of Contamination, and Risk Analysis of Potentially Toxic Elements in The Pamba River	**Anisha Ganguly[1], Ruchika Sah[1], Pooja Choudhary[1], Sachin Kavattu[1], Pawan Patel[1], Gajendra Kumar[1], Aakash Maurya[1], Ruchi Badola[1], Syed Ainul Hussain[1]** [1]*Wildlife Institute of India, Chandrabani, Dehradun 248001, India* Email: anishaganguly5@gmail.com	Poster
T6-A32	Phyto-management of Contaminated Sites: Integrating Ecology, Economy, and Technology	**Dr. Rashmi Mishra[1]** [1]Professor; Head, Department of Biotechnology, Noida Institute of Engineering & Technology (NIET) Greater Noida, India Email: hodbiotech@niet.co.in	Poster

Theme 7: Geospatial technologies and modeling for environment and forest conservation

Theme code	Presentation title	Authors, Affiliation(s) & Email	Oral/ Poster
T7-A1	Geospatial intelligence for assessing plant vulnerability and ecosystem resilience under environmental pollution	**Biswajeet Pradhan[1*]** [1]Director - Centre for Advanced Modelling and Geospatial Information Systems (CAMGIS), School of Civil and Environmental Engineering, Faculty of Engineering and IT, University of Technology Sydney, NSW 2007, Australia Email: Biswajeet.Pradhan@uts.edu.au	Oral
T7-A2	From oceans to ecosystems: Harnessing AI and digital twins to understand and predict ENSO, IOD, monsoons, and climate extremes and their environmental impacts	**Swadhin Behera[1*]** [1]Director, Application Laboratory, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Yokohama, Japan Email: behera@jamstec.go.jp	Oral
T7-A3	Projected climate-change impacts on the distribution of Camellia sinensis in the Western Ghats, India	**Shipra[1*], Pujarini Samal[1], Prem Prakash Singh[1], Dibyendu Adhikari[2]** [1]Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India Email: shipra3838@gmail.com	Poster
T7-A4	Assessing regeneration potential and environmental suitability of *Garcinia pedunculata* for conservation planning in India	**Benerjit Wairokpam[1], V.V. Wagh[1], TS Rana [1,2]** [1]Plant Diversity, Systematics and Herbarium Division, CSIR National Botanical Research Institute, Lucknow-226001, Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India | [2]Central Government Enclave, CSIR-Human Resource Development Centre (Council of Scientific and Industrial Research, Uttar Pradesh, Ministry of S & T, Govt. of India, New Delhi) Sector 19, Kamla Nehru Nagar, Ghaziabad, India, Email: ranatikam@gmail.com, vijaywagh65@gmail.com	Poster
T7-A5	Projected shifts in the climatic suitability and distribution of *Tectona grandis* L.f. in India under future climate scenarios	**Prem Prakash Singh[1*], Athira S Nair[1], Pujarini Samal[1], Soumit Kumar Behera[1], Dibyendu Adhikari[1]** [1]Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow *Email: prem12flyhigh@gmail.com	Poster
T7-A6	Spatio-temporal assessment of land use change in sacred groves of Madhya Pradesh using spectral indices (NDVI)	**Pranjal Jain[1*], Laxmi Sharma[2], Dr. Charu Lata[3]** [1]CSIR-National Institute of Science Communication and Policy Research (NIScPR), Dr K S Krishnan Marg, New Delhi, India, Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India | [2]J.C. Bose University of Science and Technology, YMCA, Faridabad, Haryana-121006, India | [3]CSIR- National Institute of Science Communication and Policy Research, Dr K S Krishnan Marg, New Delhi, India Email: pranjaljain141@gmail.com	Poster

T7-A7	Assessing ecological niches: A study on bryophyte habitat suitability in the semi-arid region, Gujarat	**Bhagyashri Dangar[1,2], Rajesh Raviya[1*]** [1]Department of Life Sciences, Bhakta Kavi Narsinh Mehta University, Junagad, Gujarat, India | [2]Centre of Excellence for Wildlife and Conservation Studies, Bhakta Kavi Narsinh Mehta University, Junagadh, Gujarat Email**:** rdraviya@gmail.com	Oral
T7-A8	Decoding forest cover transformation in the Dakshina Kannada District: A multi-temporal Landsat analysis using random forest and Google Earth Engine	**Sowmya[1]*, Rekha S.[2], Raghudas J.[1], Athishri A. N.[1], Raju Krishna Chalannavar [1]** [1]Department of Applied Botany, Mangalore University, Mangalagangotri-574199, Karnataka, India | [2]Department of Studies and Research in Applied Geology, VSK University, PG Centre, Nandihalli, Sandur-583119, Karnataka, India Email: sowmyachouhan99@gmail.com	Poster
T7-A9	Land surface temperature in Prayagraj using geospatial technology: Implications for sustainable development goals (SDGs)	**Puneeta Pandey[1*]** Centre of Environmental Studies, Institute of Interdisciplinary Studies, University of Allahabad, Prayagraj Email: puneeta@allduniv.ac.in, puneetapandey@gmail.com	Oral
T7-A10	Assessing potential biomass production on Urban Marginal Lands in Indian megacities using Geospatial technologies	**Vivek Verma[1,2*], Sheik Adil Edrisi[2]** [1]Department of Energy and Environment, Thapar Institute of Engineering & Technology, Patiala-147004, Punjab, India [2]School of Liberal Arts and Sciences, Thapar Institute of Engineering & Technology, Patiala-147004, Punjab, India Email: vverma_phd22@thapar.edu; vivekverma.kmc@gmail.com	Poster

Theme 8: Nature-based solutions, biofuels and green technologies

Theme code	Presentation title	Authors, Affiliation(s) & Email	Oral/ Poster
T8-A1	Designing novel below-ground and above-ground biodiversity for enhanced productivity and quality of products with ecological sustainability	**Rana Pratap Singh**[1*] [1]Director (Hon), Centre for Sustainable Agriculture and Environment, R&D Centre, PHSS Foundation for Science and Society, Eldeco Xpress Plaza, Lucknow-226025, India Email: dr.ranapratap59@gmail.com	Oral
T8-A2	Plant–Nanoparticle interaction: Physiological, biochemical and metabolic alterations in medicinal plants under the influence of titanium oxide and copper oxide nanoparticles	**Poornima Vajpayee**[1*], **Subodh Kumar**[1], **Archana Dwivedi**[1], **Vippan Kaur**[1], **Akanksha Dubey**[1] [1]Ecotoxicology, Bioremediation and Nanotoxicology Laboratory, Department of Botany, University of Lucknow, Lucknow, India	Oral
T8-A3	Bacillus amyloliquefaciens modulates autophagy pathways to control *Rhizoctonia solani* infection in rice	**Mohd Mogees Ansari**[1,2], **Nikita Bisht** [1], **Tanya Singh**[1,2], **Puneet Singh Chauhan** [1,2]* [1]Microbial Technology Division, CSIR-National Botanical Research Institute, Lucknow, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India *Email: puneet@nbri.res.in, puneetnbri@gmail.com	Poster
T8-A4	Supercritical CO_2 and hydrodistilled extracts of *Valeriana jatamansi* Jones: A green approach to bioactive compound recovery	**Jyoti**[1], **Kirti Agrahari**[2], **Narayan Prasad Yadav**[2], **Ram Swaroop Verma**[1], **Sudeep Tandon**[1] [1]Phytochemistry Division, CSIR-Central Institute of Medicinal and Aromatic Plants, P.O. CIMAP, Kukrail Road, Lucknow, India | [2]Bio-prospection and Product Development Division, CSIR-Central Institute of Medicinal and Aromatic Plants, Kukrail Road, Lucknow, India Email: s.tandon@cimap.res.in	Poster
T8-A5	Endophytic *Bacillus australimaris* mediates biocontrol and bioactive enhancement in *Gloriosa superba* under *Alternaria alternata* infestation	**Neha Yadav**[1,2], **Pradeep Semwal**[1,2], **Shashank Kumar Mishra**[1], **Puneet Singh Chauhan**[1,2] [1]Microbial Technologies Division, Council of Scientific and Industrial Research–National Botanical Research Institute (CSIR-NBRI), Rana Pratap Marg, Lucknow, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India Email: puneet@nbri.res.in	Poster
T8-A6	Impact of plant growth-promoting rhizobacteria (*Ochrobactrum* sp.) on maize (*Zea mays*) tolerance towards water stress	**Shashank Kumar Mishra**[1,2], **Pradeep Semwal**[1,2], **Puneet Singh Chauhan**[1,2] [1]Microbial Technologies Division, Council of Scientific and Industrial Research–National Botanical Research Institute (CSIR-NBRI), Rana Pratap Marg, Lucknow, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India Email: puneetnbri@gmail.com	Poster
T8-A7	Synergistic role of biochar and *Trichoderma yunnanense* in mitigating chromium toxicity and enhancing growth and oil yield of *Ocimum basilicum* L.	**Anju Patel***, **Priya Dubey**, **Pankaj Kumar Srivastava** CSIR–National Botanical Research Institute, Lucknow-226001, India Email: patel7anju@gmail.com	Poster
T8-A8	Evaluation of neem (*Azadirachta indica*) and tea (*Camellia sinensis*) leaf residues as	**Jasmine Sultana**[1], **Anushree Baruah**[1] [1]Department of Botany, Royal School of Life Sciences, The Assam Royal Global University, Guwahati, Assam	Oral

	biological nitrification inhibitors (BNIs) in rice cultivation of Assam	Email: abaruah@rgu.ac, anushree611.official@gmail.com	
T8-A9	Unveiling glomalin's legacy: Its role in soil remediation and feedback to climate change	**Ashutosh Kumar Singh[1*]** [1]Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Menglun Town, Mengla County, Yunnan Province, China 666303 Email: ashutosh.evst11@gmail.com	Oral
T8-A10	Bacterial assisted heavy metals phytoextraction potential of native plants and their histological observation growing on distillery sludge: A novel green technology tool for in-situ phytoremediation of hazardous industrial waste management for eco-restoration	**Ram Chandra[1*]** [1]Department of Environmental Microbiology, School of Earth and Environmental Sciences, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow-226 025 Email: prof.chandrabbau@gmail.com	Poster
T8-A11	Bio-adsorbents by transforming plant waste for efficient arsenic removal from contaminated water	**Sampurna Nand[1]*, Anju Patel[1], Siddhartha Shukla[2], Pankaj Kumar Srivastava[1]** [1]Environmental Technologies Division, CSIR-National Botanical Research Institute, Lucknow, India | [2]Dr. Ram Manohar Lohia Avadh University, Ayodhya, India Email: nandsam1005@gmail.com	Poster
T8-A12	Role of fulvic acid in enhancing physiological and antioxidant responses of rice under salt stress	**Umme Kulsum Sabiha[1]*, Kamrun Nahar[1], Mirza Hasanuzzaman[2]** [1]Department of Agricultural Botany, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh | [2]Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh Email: ummekulsumsabiha18@gmail.com	Poster
T8-A13	Synergistic effect of *Adathoda vasica* plant-derived biostimulant and PGPR on *Zea mays* L. for drought stress management	**Abhilasha Mishra[1*]** [1]Microbial Technology Division, CSIR-National Botanical Research Institute, Lucknow-226001, U.P. E-mail: abhilasha120797@gmail.com	Poster
T8-A14	Phytoextraction efficacy of *Helianthus annuus* L. and *Tagetes erecta* L. for sustainable remediation of heavy metals from industrially polluted soil	**Jyoti Mathur[1*]** [1]Department of Bioscience and Biotechnology, Banasthali Vidyapith, Rajasthan, India Email: jyotimathur@banasthali.in	Oral
T8-A15	Genetic synergy: Tailoring fungal strains to alleviate arsenic toxicity by modulating arsenic speciation	**Mariya Naseem[1*], Pankaj Kumar Srivastava[1]** [1]CSIR- National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001 Email: mariyanaseem01@gmail.com	Poster
T8-A16	Green-synthesis and characterization of carbon quantum dots from *Murraya koenigii*	**Pallavi Chattopadhyay[1]*, Devyani Shukla[2], Avanish Singh Parmar[2]** [1]Amity Institute of Biotechnology, Amity University Uttar Pradesh, Lucknow Campus, Lucknow, India | [2]Department of Physics, Indian Institute of Technology (BHU), Varanasi, India Email: pallavi96chatto@gmail.com	Poster

T8-A17	Bioprospection of indigenous cyanobacteria for scytonemin production in conditions of high salinity	**Soujanya Shekhar Rana[2]*, Sachitra Rath[1]** [1]Phycology Laboratory, CSIR-National Botanical Research Institute, Lucknow, 226001, India | [2]Algal Biotechnology Laboratory, Department of Botany, Central University of Punjab, Bathinda, 151401, India Email:sachitraratha78@gmail.com; soujanyasekhar.b2@gmail.com	Poster
T8-A18	Calcium and magnesium ions influence diversity and density of bacteriophage and sustaining the self-purification of river Ganga	**Ruchi Agnihotri[1,2*], Seema Mishra[3], Vishnu Kumar[1], Pragya Sharma[1], Sarvesh Kumar[1], Ravi Kumar Tiwari[1], Sanjay Dwivedi[1,4#], Geetgovind Sinam[1], and Vivek Pandey[1]** [1]Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, India [2]Department of Microbiology, Dr. Ram Manohar Lohia Avadh University Ayodhya- 224001, India [3]Department of Chemistry, University of Lucknow, Lucknow-226007, India [4]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India Email: agnihotri.ruchi1994@gmail.com	Poster
T8-A19	Modulating microalgal growth under nitrogen limitation through phytohormone application	**Harsh Vardhan[1], Esha Goyal[2], Nirmal Renuka[2], Sachitra Kumar Ratha[1*]** [1]Phycology Laboratory, CSIR-National Botanical Research Institute, Lucknow, 226001, India; [2]Algal Biotechnology Laboratory, Department of Botany, Central University of Punjab, Bathinda, 151401, India Email: harshvardhancharan200@gmail.com	Poster
T8-A20	Unravelling Biochar's Function in Hexavalent Chromium (VI) Removal from Contaminated Water	**Priyanka Umar[1]*, Sudhakar Srivastava[1]** [1]Institute of Environment Science and Sustainable Development, Banaras Hindu University, Varanasi, India Email: priyankaumar@bhu.ac.in	Poster
T8-A21	Global Patent Landscape of Plant-Based Air Purification Systems for Indoor Air Quality Enhancement	**Vivek Srivastava[1], Preeti Umarao[1] and Richa Rai[1]** Affiliation: [1]CSIR-National Botanical Research Institute, Lucknow Email: vivek@nbri.res.in	Oral
T8-A22	Influence of leguminous trees on adjacent grass biomass and soil properties in arid and semi-arid regions of Rajasthan	**Binay Kumar Mahato[1,2*], Sanjay Anand[2], Richa Rai[1], Nivedita Chaudhary[2]** [1]CSIR-National Botanical Research Institute (NBRI), Rana Pratap Marg, Lucknow, India; [2]Central University of Rajasthan, Ajmer, Rajasthan, India Email: bivhaykumar620@gmail.com	Poster

Theme 9: Bioeconomy and sustainable development goals

Theme code	Presentation title	Authors, Affiliation(s) & Address, Email	Oral/ Poster
T9-A1	Agroforestry enabled food security and environmental sustainability	**Ayyanadar Arunachalam**[1*] [1]Director, ICAR-Central Agroforestry Research Institute, Jhansi 284003, Uttar Pradesh, India Email: arun70@gmail.com	Oral
T9-A2	Novel approaches of plant biology for sustainable development within the planetary boundaries	**Elina Oksanen**[1*] [1]Dept. Environmental and Biological Sciences, University of Eastern Finland, Finland E-mail: elina.oksanen@uef.fi	Oral
T9-A3	Rethinking to rebuilding- stepping towards environment, sustainability and ecosystem services	**Mohammed Latif Khan**[1*] [1]Dr. Harisingh Gour Vishwavidyalaya (A Central University), Sagar, India Email: khanml61@gmail.com	Oral
T9-A4	Sustainable agricultural intensification for advancing food, nutrition, and ecosystem health	**P.V. Vara Prasad**[1*] [1]University Distinguished Professor, R.O. Kruse Endowed Professor and Director, Center for Crops, Climate and Communities, Department of Agronomy, College of Agriculture, Kansas State University, Manhattan, Kansas 66506, USA E-mail: vara@ksu.edu	Oral
T9-A5	Living with water: Ecological and economic pathways to resilience in Barak Valley, Assam	**Tapati Das**[1*] [1]Professor, Department of Ecology and Environmental Science, Assam University, Silchar, India Email: das.tapati@gmail.com	Oral
T9-A6	Restoring Degraded Lands in India to Achieve the UN Sustainable Development Goals	**P.C. Abhilash**[1*] [1]Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi 221005, India Email: pca.iesd@bhu.ac.in	Oral
T9-A7	Prospects, predictions and processes for recycling rare earth and precious elements from E-waste for a circular economy	**Shekhar Mallick**[1*] [1]Professor, School of Environmental Science, JNU, New Delhi, India Email: shekharm@mail.jnu.ac.in	Oral
T9-A8	The climate change and sustainable development: Issues and challenges with special reference to environmental protection laws	**Faisal Ali Khan**[1]* [1]Professor, DBS Global University, Dehradun-248011 Email: fakmoon@gmail.com	Oral
T9-A9	Outreach Activities Impact Analysis Under EIACP at CSIR-NBRI and Mission Life	**Anamta Nafees Warsi**[1*], **Anju Patel**[1], **Pankaj Kumar Srivastava**[1] [1]NBRI EIACP – Programme Centre, CSIR- National Botanical Research Institute, Lucknow-226001, India Email: anamtanafees83@gmail.com	Poster

T9-A10	Influence of Zinc Sulfate and Boron on Growth, Yield and Quality of Broccoli	**Kamal Pal[1,2], Dinesh Singh[2*], Ranjan Kumar Jadon[1], KJ Singh[2], Soumit K. Behera[2]** [a]Department of Horticulture science, College of Agriculture, J.S. University, Shikohabad, U.P. 208002 India. [b]CSIR- National Botanical Research Institute, Lucknow, U.P. 226001 India. Email: palkamal441@gmail.com	Poster
T9-A11	Bioresource utilization of an emerging invasive vine *Delairea odorata* Lem., in the north-western Himalayas	**Raashi Gupta[1], Shalini Ojha[1], Bhupender Singh[1] and Daizy R. Batish[1*]** Department of Botany, Panjab University, Chandigarh 160014 E-mail: daizybatish@yahoo.com	Oral
T9-A12	Digital resource centre (DRC) of MoEF& CC for environmental science and society interface	**Manish Chaudhary[1*], Anju Patel[1], and Pankaj Kumar Srivastava[1]** [1]NBRI-EIACP-Programme Centre, CSIR- National Botanical Research Institute, Lucknow, India Email: manishchaudhary941286@gmail.com	Poster
T9-A13	Lifestyle for Environment (LiFE)'s Waste Reduction (Swachhata Action) theme urges individual actions to conserve the environment	**Sandhya Mishra[1*], Anju Patel[1], Pankaj Kumar Srivastava[1]** [1]NBRI-EIACP Programme Centre, CSIR-National Botanical Research Institute, Lucknow, India Email: sandhyamanshi@gmail.com	Poster
T9-A14	Mission LiFE and Sustainable Development Goals: Individual Actions to achieve Environmental Sustainability	**Vartika Singh[1*], Anju Patel[1], and Pankaj Kumar Srivastava[1]** [1]NBRI-EIACP-Programme Centre, CSIR- National Botanical Research, Institute, Lucknow, India Email: vartikasingh378@gmail.com	Poster
T9-A15	Harnessing biomass for carbon sequestration: Bioeconomy's role in achieving SDG 13 (Climate Action)	**Anand Kumar[1*]** [1]Allahabad State University, Prayagraj, India Email: anandkumar@gmail.com	Poster
T9-A16	Enhancing turmeric (Curcuma longa L.) cultivation through integrated farming approaches in Bihar under CSIR-Aroma Mission	**Himanshu Sharma[1]*, Bikarma Singh[2]** [1]CSIR-National Botanical Research Institute, Lucknow 226001, Uttar Pradesh | [2]Academy of Scientific and Innovative Research (AcSIR), New Delhi Email: drbikarma.singh.nbri@csir.res.in	Poster
T9-A17	Impact of frontline demonstration on french bean variety Arka Komal in West Kameng Arunachal Pradesh.	**T.S. Mishra[1], Nilesh Mishra[2] and Pem Thinley[3]** [1]KVK West Kameng, Dirang Arunachal Pradesh | [2]Indian Institute of Toxicology Research, Lucknow (CSIR-IITR) | [3]KVK West Kameng, Dirang Arunachal Pradesh Email: tarashankarmishra2015@gmail.com	Poster
T9-A18	Comparative Phytochemical Profiling and Bioactivity Evaluation of *Lantana camara* Leaf and Flower Essential Oils: In Vitro and In Silico Insights	**Shiwa Chaubey[1,2,3], Nisheeth Rastogi[2], Manjoosha Srivastava[1]*** [1]Phytochemistry Division, CSIR-National Botanical Research Institute, Lucknow 226001, Uttar Pradesh, India [2]Department of Chemistry, Dr. W. E. Bauer Research Laboratory, Lucknow Christian Degree College, Lucknow 226018, Uttar Pradesh, India [3]Department of Chemistry, University of Lucknow, 226007, Uttar Pradesh, India Email: m.srivastava.nbri@csir.res.in	Poster

T9-A19	Skill development and promotion of mushroom consumption in certain villages of Gujarat	**Anil Satpathy[1], S.N. Tyagi1, Arun Arya[2*]** [1]Rista Foundation, C8 Navyug Society, Vadodara, India | [2]Department of Botany, MS University Vadodara Email: aryaarunarya@rediffmail.com	Poster
T9-A20	Repurposing of industrial wastes for meeting the challenges of soil degradation and achieving sustainable development goals	**Ananya Singh[1], Shekhar Mallick[1*]** [1]School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, India Email: shekharm@mail.jnu.ac.in	Poster
T9-A21	Intelligent Agriculture for a Progressive Agricultural Future	**Ravin Singh[1*], Dr. Puneet Singh Chauhan[2*]** CSIR-National Botanical Research Institute, Lucknow Email: raghavrajpoot247@gmail.com	Poster
T9-A22	Heavy Metal Transfer from Maternal Sources to Infants via Breastmilk: Current Status and Preventative Strategies	**Meghna Jaiswal[1] Rajveer Singh Chauhan[1] and Sudhakar Srivastava[2]** [1]Department of Botany, Deen Dayal Upadhyaya Goralhpur University, Gorakhpur -273009, Uttar Pradesh India [2]Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi - 221005, Uttar Pradesh, India Email: sudhakar.iesd@bhu.ac.in, chauhanrajveersingh@gmail.com	Poster
T9-A23	Biomolecular function of micronutrients and crops production: Management strategies under climatic changes	**S.N. Pandey[1*]** [1]Department of Botany, University of Lucknow, Lucknow-226007 Email: snpandey511@gmail.com	Poster

Theme 10: Ethnobotany and plants for food and nutritional security

Theme code	Presentation title	Authors, Affiliation(s) & Address, Email	Oral/ Poster
T10-A1	Restoration of productivity of salt affected agro-ecosystems using novel microbial technology: a lab to land approach for food security	**Naveen Kumar Arora[1*]** [1]Department of Environmental Science, School of Earth and Environmental Sciences Babasaheb Bhimrao Ambedkar University, Lucknow, India Email: nkarora.bbau@gmail.com	Oral
T10-A2	Phytochemical profiling of *Cucumis callosus* fruit residues for sustainable valorization and potential nutraceutical applications	**Shelly Chauhan[1*], Jitendra Panwar[1], Pankaj Kumar Sharma[1]** [1]Department of Biological Sciences, Birla Institute of Technology and Science (BITS), Pilani Campus, Pilani, (Rajasthan) 333031, India Email: p20230003@pilani.bits-pilani.ac.in	Poster
T10-A3	From Wild to Plate: Exploring Wild and Lesser Utilized Plants for Nutritional Security and Dietary Diversification in Central India	**Amit Kumar Bundela[1], P.C. Abhilash[1]** [1]Institute of Environment & Sustainable Development, Banaras Hindu University, Varanasi 221005, India E-mail: amitbundela@bhu.ac.in	Poster
T10-A4	Enrichment and purification of ω fatty acids from *Ocimum* seed oil for use as a nutraceutical to ailment chronic disorders	**Naziya Syed[1]*, Abhishek Kumar Yadav[1], Prasant Kumar Rout[1], Sarita[2], Kavita Singh[2], Dnyaneshwar U. Bawankule[2], Debabrata Chanda[2]** [1]Phytochemistry Division, CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow, India | [2]Bio-prospection and Product Division, CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow, India Email: nazia1794syed@gmail.com	Poster
T10-A5	Dried Aloe flower tea: Traditional uses and modern phytochemical validation	**Sudesh Kumar Banyal[1], Shweta Singh[1], Suresh Kumar Sharma[1], Devendra Singh[1], Lal Bahadur[1*]** [1]Division of Plant Conservation and Agrotechnology, CSIR-National Botanical Research Institute, Lucknow, 226001, India Email: lb.yadav.nbri@csir.res.in	Poster
T10-A6	Plants for feeding the future: The role of neglected and underutilized plants in local food security in Eastern U.P.,	**Ajeet Singh[1], Amit Kumar Bundela[1], and P.C. Abhilash[1*]** [1]Institute of Environment & Sustainable Development, Banaras Hindu University, Varanasi 221005, India Email: pca.iesd@bhu.ac.in	Poster
T10-A7	Gamma irradiation–driven improvement in Kalanamak rice (*Oryza sativa* L.): Agronomic advances across M1–M3 and comprehensive grain quality profiling in M3 generation	**Tanmai Mishra[1*], Rajveer Singh Chauhan[1]** [1]Department of Botany, Deen Dayal Upadhayaya, Gorakhpur University, Gorakhpur-273009, (U.P), India Email: tanmay21mishra@gmail.com	Poster
T10-A8	Ethnobotanical potential of pteridophytes through the lens of tribal communities of eastern Madhya Pradesh.	**Sandhya Barfal[1], Ajit Pratap Singh[1]** [1]Pteridology Laboratory, CSIR-National Botanical Research Institute, Lucknow-U.P., India, Email: ajitpsingh2000@gmail.com	Poster

T10-A9	Differential physiological and nutritional responses of Proso-millet varieties to future climate change	**Richa Rai[1*], Binay Kumar Mahato[1]** [1]CSIR-National Botanical Research Institute, Lucknow Email: bivhaykumar620@gmail.com	Poster
T10-A10	Ethnobotanical and Nutritional Evaluation of *Madhuca longifolia* (Mahua) Seed Oil	**Swati Srivastava[1], Priyanka Agnihotri[2], Sanjeeva Nayaka[2] and Manjoosha Srivastava[1*]** [1]Phytochemistry Division, CSIR-National Botanical Research Institute, Lucknow 226001, Uttar Pradesh, India [2] Plant Diversity, Systematics and Herbarium (PDSH) CSIR-National Botanical Research Institute, Lucknow 226001, Uttar Pradesh, India Email: m.srivastava.nbri@csir.res.in	Poster
T10-A11	Stress-Responsive Insights into Root-Tuberization of Winged Bean (*Psophocarpus tetragonolobus* (L.) *DC.*)	**Chandra Sekhar Mohanty[1*]** [1]Plant Genetic Resources and Improvement division, CSIR-National Botanical Research Institute, Lucknow, India Email: cs.mohanty.nbri@csir.res.in	Oral
T10-A12	Assessment of Lesser Explored Plant Composition and Local Medicinal Practices of Bhallesa Hills and Valleys of Pir Panjal Mountain of the Himalaya Biodiversity Hotspot"	**Opender Surmal[1,2] and Bikarma Singh[1,3*]** [1]Academy of Scientific & Innovative Research (AcSIR), Ghaziabad 201002, Uttar Pradesh, India. CSIR-Indian Institute of Integrative Medicine, Canal Road, Jammu, Jammu & Kashmir, India [2]Botanical Garden, Plant Conservation and Agrotechnology Division, CSIR-National Botanical Research Institute, Lucknow 226001, Uttar Pradesh, India. Email: drbikarma.singh.nbri@csir.res.in	Poster

Theme 11: Floriculture under changing climate

Theme code	Presentation title	Authors, Affiliation(s) & Email	Oral/ Poster
T11-A1	Flori-apiculture model: A catalyst for rural empowerment and sustainable livelihoods	**Sushree Sunandita Patel[1], Sandip Kumar Behera[1], Khuraijam Jiban Kumar Singh[1], Chandra Sekhar Mohanty[1], Soumit Kumar Behera[1], Abhilash Padhan[2]** [1]CSIR- National Botanical Research Institute, Rana Pratap Marg, Lucknow, India | [2]ICAR- National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi, India Email: sunanditap2105@gmail.com	Poster
T11-A2	Micro-propagation for conservation and sustainable use of floriculture crops	**Waseem Siddique[1,2], Jibankumar Singh Khuraijam[2,3] and Debasis Chakrabarty[1,2]** [1]Molecular Biology and Biotechnology Division, CSIR-National Botanical Research Institute, Lucknow 226001, India | [2]Academy of Scientific and Innovative Research (AcSIR), Gaziabad 201002, India | [3]Botanic Garden Division, CSIR-National Botanical Research Institute, Lucknow 226001, India Email: waseemsiddique84@gmail.com	Poster
T11-A3	Environmental significance and quality gaps in commercial *Magnolia champaca* oils	**Sudhanshu Shahi[1], MM Pandey[1], Vivek Srivastava[2] and K.J. Singh[3]** [1]Parijaat-Fragrance Lab, CSIR-National Botanical Research Institute, Lucknow, India | [2]Planning Division, CSIR-National Botanical Research Institute, Lucknow, India | [3]Botanic garden, CSIR-National Botanical Research Institute, Lucknow, India Email: vivek@nbri.res.in	Poster
T11-A4	Phytochemical diversity and ecological adaptation: Secondary metabolites as drivers of sustainable agroecosystems	**Shashi Pandey-Rai[1*]** [1]Laboratory of Morphogenesis, Department of Botany, Banaras Hindu University, Varanasi Email: shashi.bhubotany@gmail.com	Poster
T11-A5	Genomic Landscape and Evolutionary Insights of the Indian Sacred Lotus	**Garima Saxena[1,2*], Yogeshwar V. Dhar[3], Khuraijam J. Singh[1,2], Ajit K. Shasany[1,2], Mehar H. Asif[1, 2]*** [1]CSIR-National Botanical Research Institute, CSIR-NBRI, Rana Pratap Marg, Lucknow, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India | [3]International Centre for Genetic Engineering and Biotechnology, Aruna Asaf Ali Marg, New Delhi, India Email: garimasaxena6@yahoo.co.in	Poster
T11-A6	Exploring the effect of Gamma radiation on morphological, cytological and biochemical parameters of *Clitoria ternatea* L.	**Netra Kesharwani[1] and Vaibhav Srivastava[1*]** [1]Naithani Plant Genetics and Ecotoxicology Laboratory Email: vaibhavsri921@gmail.com	Poster
T11-A7	Comparative Dye Yield and Dyeing Efficiency of Control and Phosphate solublising Pseudomonas putida Treated Marigold (*Tagetes erecta*) Flowers on Silk Fabric	**Vaishali Mishra[1], Ambuj Shukla[2], KJ Singh[3], Puneet Singh Chauhan[2] and Manjoosha Srivastava[1*]** [1]Phytochemistry Division, CSIR-National Botanical Research Institute, Lucknow 226001, Uttar Pradesh, India	Poster

		[2] Plant Ecology & Environmental Technologies, CSIR-National Botanical Research Institute, Lucknow 226001, Uttar Pradesh, India [3]Botanical Garden, Plants Conservation Agrotechnologies Email: m.srivastava.nbri@csir.res.in	
T11-A8	Soil Nutrient Status of Miyawaki Forest: A sustainable approach for environment conservation under sodic waste land	**Devendra Singh [1,2], R.C. Nainwal[1,2*]** [1]Botanical Garden, Plant Conservation and Agrotechnology Division, CSIR-National Botanical Research Institute, Lucknow 226001, Uttar Pradesh, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, Uttar Pradesh, India Email: dev.singh.nbri@csir.res.in	Poster
T11-A9	Global trend of floriculture productivity under changing climate: Impact and adaptive strategies	**Rakesh Chandra Nainwal1*** [1]Botanical Garden, Plant Conservation and Agrotechnologies, CSIR-National Botanical Research Institute, Lucknow, India, Email: nainwal.rakesh@gmail.com	Oral

Theme 12: Emerging environmental issues including microplastic pollution & mitigation strategies

Theme Code	Presentation Title	Authors, Affiliation(s) & Address, Email	Oral/ Poster
T12-A1	Microplastics: A Threat to Sustainability	**Pankaj Kumar Srivastava[1*]** [1]Plant Ecology & Environmental Technology, CSIR-National Botanical Research Institute, Lucknow–226001 Email: pankajk.nbri@csir.res.in, drpankajk@gmail.com	Oral
T12-A2	Hidden danger beneath the soil: Assessing the risks of microplastics in agricultural fields of Uttar Pradesh, India	**Ekta Gupta*[1,2], Virendra Kumar Mishra[2], Pankaj Kumar Srivastava[1]** [1]Environmental Technologies Division, CSIR-National Botanical Research Institute, Lucknow-226001, India | [2]Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi, India Email: ekta2215@gmail.com	Poster
T12-A3	Microplastic pollution in terrestrial ecosystems: impacts on soil health and environment	**Ruchi Chauhan[1*], Anju Patel[1], and Pankaj Kumar Srivastava[1]** Environmental Technologies Division, CSIR-National Botanical Research Institute, Lucknow, India Email: chauhan11ruchi@gmail.com	Poster
T12-A4	Emerging contaminants in natural water resources and their fate in the environment	**Sejal Shukla[1*], Ruchi Agnihotri[1], Sanjay Dwivedi[1], Seema Mishra[1]** [1]Department of Chemistry, University of Lucknow, Lucknow226007, India Email: sejalshukla506@gmail.com	Poster
T12-A5	Microplastics interaction with dissolved organic matter	**Swati Verma[1*], Anju Patel[1], Pankaj Kumar Srivastava[1]** [1]Environmental Technologies Division, CSIR-National Botanical Research Institute, Lucknow, India Email: swati94127@gmail.com	Poster
T12-A6	Microplastic Remediation through Nanobiochar	**Tanushree Nandy[1*], Anju Patel[1], Pankaj Kumar Srivastava[1]** [1]Environmental Technologies Division, CSIR-National Botanical Research Institute, Lucknow, India Email: nandytanu16@gmail.com	Poster
T12-A7	Macroalgae associated bacteriomes across environmental substrates: Functional insights and emerging pollution linkages	**Vitasta Jad[1], Cathrine S Manohar[1*]** [1]CSIR- National Institute of Oceanography, Dona Paula, Goa, India, Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India Email: cathrine@nio.res.in	Poster
T12-A8	Microplastic-Arsenic Co-contamination: Microplastics as vector for Arsenic	**Garima Yadav[1*], Pankaj Kumar Srivastava[1], Anju Patel[1]** [1]Environmental Technologies Division, CSIR-NBRI, Lucknow, India Email: garimay491@gmail.com	Poster
T12-A9	A dual approach to unravel microplastic-induced stress in soil–plant ecosystems	**Shweta Yadav[1*], Poonam C. Singh[1]** [1]Microbial Technology Division, CSIR-NBRI, Lucknow, India Email: syvns55555@gmail.com	Poster

T12-A10	Emerging Nano-Biochar Approaches for Mitigating Heavy Metal Stress in Rice, Wheat Agroecosystems: Mechanistic Perspectives and Future Challenges	**Garima Awasthi[1*], Kumud Kant Awasthi[1], Mahipal Singh Sankhla[1], Anjali Awasthi[2], RD Tripathi[3], Sudhakar Srivastava[4]** [1]School of Basic and Applied Sciences, K.R. Mangalam University, Gurugram, India | [2]Department of Zoology, University of Rajasthan, Jaipur, India | [3]CSIR- National Botanical Research Institute, Lucknow, India | [4]Institute of Environment & Sustainable Development, Banaras Hindu University, Varanasi, India Email: gariimaa21@gmail.com	Poster
T12-A11	Microplastics: Small particles, big problems	**Rohit Chandravanshi[1], Sudhir Kumar Pandey[1*]** [1]Department of Botany, Guru Ghasidas Vishwavidyalaya, (A Central University), Koni, Bilaspur, 495009, Chhattisgarh, India	Poster

Abstracts under various thematic areas

Theme 1:
Biodiversity, Threatened plant conservation and Palaeosciences

T1-A1

Deciphering vegetation and treeline responses during Holocene in the Western Himalayas: On pollen and tree-ring investigations

Parminder Singh Ranhotra[1,2], Stuti Jain[1,3], Ipsita Roy[4], Bency David Chinthala[5], Nidhi Tomar[1,2], Rajesh Bajpai[3]

[1]Birbal Sahni Institute of Palaeosciences, 53 University Road, Lucknow, India | [2]Academy of Scientific and Innovative Research, AcSIR, Ghaziabad, India | [3]Department of Environmental Studies, North-Eastern Hill University, Shillong, India | [4]Indian Institute of Tropical Meteorology, Pashan, Pune, India | [5]Institute of Geography, University of Erlangen-Nürnberg, 91052 Erlangen, Germany

Email: parmindersingh_ranhotra@bsip.res.in

The Himalaya exhibits region specific hydroclimate and biodiversity under the influence of winter westerlies and south Asian summer monsoon. The monitored extreme climatic events, reducing ice masses, changes in the vegetation-cover, treelines etc. across the Himalaya in last few decades are challenging the future ecological stability under the face of temperature rise. To properly understand the future ecological responses, we need to connect the long-term vegetation and climate change records with the short-span meteorological records. Pollen-spores from subalpine peat deposits and tree-rings from the trees of subalpine treeline ecotone in the western Himalaya provided centennial to annual scale information on vegetation change and treeline dynamics during Holocene. Pollen investigations showed that during early Holocene the subalpine altitudes of 3300 to 3500 masl were devoid of the forest structure that presently forms treeline at ~3600 masl. The continued warm and moist conditions during Holocene favored the treeline shifts to higher elevations with glacier retreats, followed by the forest densification. The treeline of *Betula utilis* (Birch) started occupying the subalpine altitudes around 7ka and reached to their present altitudes during late Holocene. Quantitative decadal to annual scale tree-ring analysis of Birch and *Abies* (Fir) trees from upper treeline ecotones revealed the recruitment of Fir and Birch during mid-16th century, indicating the older treeline structures. Our tree-ring findings further show static behaviour of treelines and decline in the growth trends of Himalayan Fir and Birch during the last few decades. The decline in the recruitment of treeline tree species to higher elevations possibly relates to temporary pre-summer monsoon drought conditions due to winter-spring warming trend. Lower summit heights, steep slopes and thin soil cover are also limiting the treeline advancements, posing a future threat to the survival of treeline tree species mainly in the non-glaciated Himalayan valleys.

T1-A2

Tree-rings unfold the Four-Century record of Forest-Stand and Treeline Dynamics of Fir and Birch in Kashmir, western Himalaya

Stuti Jain[1,2], Parminder Singh Ranhotra[2]*, Bency David Chinthala[3], Rajesh Joshi[4], Mayank Shekhar[2], Rajesh Bajpai[1]

[1]Department of Environmental Studies, North-Eastern Hill University, Shillong, Meghalaya, India | [2]Birbal Sahni Institute of Palaeosciences, 53, University Road, Lucknow, UP, India | [3]Institute of Geography, Friedrich-Alexander-University Erlangen-Nürnberg, Wetterkreuz 15, 91058, Erlangen, Germany | [4]G.B. Pant National Institute of Himalayan Environment and Sustainable Development, Kosi-Katarmal, Almora 263 643, Uttarakhand, India

Email: parmindersingh_ranhotra@bsip.res.in

The Himalaya, having rich biodiversity, freshwater source and forest resources for livelihood, is highly vulnerable to climate change. The long-term spatio-temporal climate-induced ecological changes are least studied from the Indian Himalayan region. Using the tree-ring data, we investigated the forest-stand (age, girth and height) and treeline shift dynamics of *Abies pindrow* (Fir) and *Betula utilis* (Birch) for the last 400 years at the winter westerly dominated Gulmarg and Sinthan area, Kashmir, J&K, western Himalayas. At both the sites, Fir reached its present upper ecotone limit of >3500 masl by the mid-20th century with average shift rates of ~1.8 m/yr and 6.4 m/yr in ~360 years. The average shift rate of Birch along the Gulmarg

transect of ~3173 to 3522 m was ~0.86 m/year. Both the study sites showed high recruitment rate of Fir during the 19th and 20th centuries relating to the warming of spring and pre-monsoon months (February to May), and the availability of required soil-moisture for the growth. The decline of treeline advancement rate since 19th century, and the insignificant treeline shift of Fir and Birch during last few decades underscore the combined role of topography, human pressure and snow instability at the sites. Also, the age stand structure of Fir and Birch at Gulmarg site records the trees of age less than 200 years, possibly relates to the large-scale exploitation of trees for firewood by the local population. The developed correlation models between tree-age and girth were found significantly positive for the sites, showing the growth uniformity. This study provides understanding on the much neglected ecological aspect of the forest-stand structures and long-term interactions between tree recruitment and environmental processes. The outcomes and empirical models elucidate the importance of forest management, species conservation and sustainable use of forest resources under the threats of temperature rise and increasing human activities.

T1-A3

People's perceptions and participation in mangrove conservation of Kachchh, Gujarat

Asha Kumari Kumawat[1*], Supriya Vaish[1], Bhawana Pathak[1], and Sandeep Kumar[2]
[1]School of Environment and Sustainable Development, Central University of Gujarat, Kundhela, Vadodara, Gujarat, India | [2]Gujarat Forest Department, Gandhinagar, Gujarat, India
Email: ashakumawat221098@gmail.com

Mangroves provide a range of goods and ecosystem services to local communities across different spatial and temporal scales, yet their conservation largely depends on local awareness and involvement. This study investigates local perceptions and participation in the conservation of the largest mangrove area of Gujarat, the Kachchh region, using structured questionnaire surveys. A total of 197 respondents completed questionnaires containing both close- and open-ended questions, capturing demographic information, knowledge of mangrove functions, attitudes toward conservation, and involvement in restoration activities. Results showed that most respondents acknowledged the ecological significance of mangroves, especially their contribution to cyclone protection and fisheries, yet participation in conservation initiatives was limited. Engagement was often constrained by socio-economic factors, access to resources, and the availability of community-based programs. Approximately 81.21% of respondents indicated willingness to engage in conservation initiatives if accompanied by livelihood alternatives or incentives. The correlation between perception and participation was weakly negative, indicating a slight trend where higher perception scores do not necessarily align with higher participation. These findings highlight the need for targeted awareness programs, community-based management, and livelihood support to enhance active participation in mangrove conservation in Kachchh.

T1-A4

Ecological insights into the lichen communities of the Munsiyari region, Pithoragarh district, Uttarakhand

Akhilesh Kumar Maurya[1*], Gaurav K. Mishra[1], Dalip K. Upreti[1]
[1]CSIR- National Botanical Research Institute, Lucknow, India | AcSIR- Academy of Scientific and Innovative Research, Ghaziabad, Uttar Pradesh - 201002, India; Lichenology laboratory, Plant Diversity, Systematics and Herbarium Division, Email: gmishrak@gmail.com

Munsiyari, a “Place with Snow,” is located along the banks of the Goriganga River, with elevations ranging from 1,230 to 3,310 meters. A recent lichen collection was undertaken in this region to assess its lichen diversity. The study documented 126 species, representing 27 families and 58 genera. The family Parmeliaceae showed the highest diversity with 37 species, followed by Physciaceae (16

species), Verrucaceae (12 species), and Lecanoraceae (11 species). In the foothills (around 1,230 meters) along the Goriganga River, saxicolous lichen communities were dominant, particularly *Endocarpon* spp. and *Verrucaria* spp., growing abundantly on boulders and rocks in the river's fell fields. The lower montane region (1500–2500 meters) hosts a rich diversity of smooth-barked trees such as *Alnus nepalensis*, along with cultivated species like *Celtis*, *Pyrus*, and *Prunus*. These trees support a wide range of lichens, including Pyrenocarpous lichens and foliose species of *Canoparmelia*, *Heterodermia*, *Hyperphyscia*, and *Hypotrachyna,* as well as crustose lichen species of *Lecanora* and *Pyrenula* are also commonly found on *Quercus* and *Pinus* trees. In the middle montane zone (2500–3000 meters), dominated by forest vegetation of trees such as *Rhododendron*, *Cedrus*, and *Abies*, showed a luxuriant growth of Parmelioid lichen communities together with *Heterodermia* and crustose forms like *Pertusaria* and Lecanora species. The subalpine zone (3000–3,320 meters), mostly devoid of large trees and dominated by shrubby vegetation, supports rich corticolous foliose lichens such as *Parmotrema*, *Sticta*, *Nephromopsis*, and *Leptogium*, along with fruticose species like *Usnea*. Lichens play a crucial role in forest ecosystems. They support habitat diversity, act as pioneers in ecological succession, aid in nutrient cycling, serve as a food source, and function as bioindicators of environmental health. Their presence often reflects the stability and health of forest ecosystems. The distinct distribution of lichen communities helped to categorise the study area into different ecological zones. The current data on lichen communities serve as baseline information for future biomonitoring studies in the region.

T1-A5

Investigation on the variation of phytochemical constituents in *Pityrogramma astroamericana* Domin growing under the natural and controlled conditions

Jyoti Jangid[1,2*], Rachna[1,3], Suman Patra[1], Sudhanshu Shahi[1], Sushree Sunandita Patel[1], BabitaKumari[1], Sandip Kumar Behera[1]

[1]Plant Diversity Systematic and Herbarium Division, CSIR-National Botanical Research Institute, Lucknow | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad | [3]Department of Botany, University of Lucknow, Lucknow, India

Email: jyotijangid9997@gmail.com

The Pteridophyte, an ecologically significant ancient plant group, serves as a valuable resource for traditional medicine, agriculture, and industry and is utilized as food, fodder, fibre, dyes, aromatic oils, and aesthetic. The application of this group for various purposes depends on its photochemical constituents, including the secondary metabolites like phenolics (flavonoids), alkaloids, steroids, tannins, etc. The presence of these bio-active molecules is mainly responsible for the therapeutic property of fern sps, that is why, are used in folk medicine. Simultaneously, these secondary metabolites provide the strength of plants against various biotic and abiotic stresses. *Pityrogramma astroamericana* Domin, also known as Golden fern, is reported for ornamental uses but less explored for its phytochemical constituents. In India, its distribution is limited to the Western Ghats. The study aims to determine the changes in phytochemical constituents of *P. astroamericana* growing in control conditions (GF-C) as compared to the plant growing in its natural habitat (GF-N). The present study collected the plant and spores from its native habitat, Cardamom Hills, Munnar, Kerala, and cultivated this plant in a controlled condition from its spore sowing on Parker's and Thompson's (P&T) agar to hardening the plant in a pot with soil mixed with vermicompost and coco-pit. The result showed that TPC and TFC content were decreased in *P. astroamericana* grown *in vitro* as compared to growing in natural habitat, as TPC and TFC in GF-N were recorded 6.08 and 4.17-fold, respectively, higher with respect to GF-C. This result also resembles that with IC_{50} based on DPPH free radical assay. IC_{50} (µg/ml) was 994.27 for GF-N, while 131.87 for GF-C, which showed higher antioxidant activity in

GF-K than GF-N. Subsequently, out of 12 phenolic compounds that were present in GF-K, 5 compounds were absent in GF-C. This study clearly demonstrated the significant changes in phytochemical constituents against environmental conditions and thus, recommended the *in-situ* conservation of bio-resources for better sustainable development.

T1-A6

Conservation of environment in Indian scriptures

R. L. S. Sikarwar[1*]
[1]Centre for Indian Knowledge System, A.K.S. University, Sherganj, Panna Road, Satna (M.P.) 485001, India
Email: sikarwarrls@gmail.com, rlssikarwar@rediffmail.com

Indian culture has traditionally put a lot of value on how well people and environment can live together. The Vedas, Upanishads, Puranas, and epics like the Ramayana and Mahabharata are some of the oldest texts from India that teach us about the environment and our moral duty to conserve it. The Rigveda calls the Earth (Prithvi) the mother of all living things and encourages respect for rivers, mountains, forests, and animals. The Atharvaveda identifies several natural components as holy and vital to human existence, advocating for conservation methods far in advance of contemporary environmental science. The Bhagavad Gita and Manusmriti stress that people have a moral duty to maintain the balance between progress in the material world and protection of the natural world. Tree worship, holy groves (Dev Van), and water conservation systems like stepwells and tanks are all examples of community-driven environmental ethics in India. These actions are in line with the ideas of contemporary sustainability and ecological balance. The Indian Knowledge System (IKS) acknowledges that environmental degradation results in spiritual and moral degeneration, hence emphasizing the link between nature and human well-being. This research seeks to examine the environmental philosophy inherent in Indian scriptures, evaluate their scientific and ethical aspects, and elucidate their significance in contemporary environmental management and policy formulation. By looking at these old works again, we may come up with culturally based plans for sustainable development that mix old knowledge with modern conservation efforts.

T1-A7

Environmental Associations of Genepools of the Himalayan Yew (*Taxus wallichiana*) in River Valleys of Central and Eastern Nepal

Jyoti Prasad Gajurel[1, 2]
[1]Tribhuvan University, Central Department of Botany, Kathmandu, Nepal | [2]WSL Swiss Federal Research Institute, Switzerland
Email: jpgajurel2010@gmail.com

Taxus wallichiana Zucc. (Eastern Himalayan Yew) is a common species found at high altitudes from Central to Eastern Nepal. This study aimed to examine whether the gene pools of this species are associated with specific climatic conditions across six valleys, each characterized by distinct precipitation regimes on the southern slopes of the Nepalese Himalayas. Additionally, we sought to identify the influence of land-use patterns and geographic factors on the genetic structure of this rare and endangered species. Bayesian population structure analysis was employed to determine the number of gene pools, and their relationships with altitude, environmental, and geographic variables were assessed. Climatic data included air temperature, soil temperature, soil humidity, and rainfall, supplemented by data from World Clim. Our findings identified five distinct gene pools, each characterized by specific levels of inbreeding coefficients, altitudinal distribution, allelic richness, and unique temperature, precipitation, and humidity requirements. These gene pools coexisted within each valley of the study area, generally occurring at comparable altitudes. The results indicate that the gene pools of *Taxus wallichiana* are likely influenced by both climate change and land-use practices. Gene pools in the MCA regions were associated with lower annual temperatures, reduced precipitation, and minimal humidity.

Moreover, allelic richness varied significantly among gene pools, with those in the MCA regions exhibiting higher genetic diversity compared to others. General linear modeling revealed that certain gene pools prefer higher altitudes and cooler temperatures. Overall, this study provides valuable insights for developing targeted conservation strategies to mitigate the impacts of climate and land-use changes on *Taxus wallichiana*, one of the most ecologically and medicinally significant plant species of the Himalayas.

T1-A8

Trilocular multi-seeded fossil fruit reported from Samruddhi Highway District Wardha Maharashtra India

A.V. Kapgate[1*], D. S. Dhamdar[1], S.M. Meshram[2]
[1]Department of Botany Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur | [2]Department of Botany Manoharbhai Patel College, Sakoli
Email: ashwinikapgate151@gmail.com

The paper deals with a new euphorbiaceous fruit, *Euphorbiocarpon* gen. et sp. nov, from the Deccan intertrappean beds of Wardha district near Samruddhi highway (Lat 20.834289° N, and Long 78.816122° E). The fossil fruit is usually trilocular, drupaceous, and multi-seeded, oval to elliptical in shape, measuring 1.2 cm in length and 0.7 cm in diameter. However, rarely, one or two carpels become abortive, and the mature fruit shows a bilocular or unilocular condition. Most of the specimens, where only the endocarp is preserved in the fruit wall, are somewhat smaller in size, about 0.8 to 1.2 cm in length and 8 mm to 1.5 mm in diameter. The pericarp or fruit wall is well preserved, measuring about 2.85 mm in thickness and can be differentiated into a well-preserved epicarp, a thick and fleshy mesocarp, and a stony, multilayered endocarp. Seed is elliptical in shape, one in each locule, 2 to 4 in number, 0.7 mm to 1.3mm in length and 5 mm in diameter. Each seed consists of a multi-layered seed coat and a homogeneous endosperm. In some of the seeds, an embryo is also seen, which is somewhat oval in shape and about 190-230µm in diameter in cross-section. Besides, in the longitudinal section of one of the seeds a rod-like space is seen where an embryo might have been present.

T1-A9

Report on unilocular angiospermic fruit from a new locality Wardha, Maharashtra, India

J.R. Kawale[1*], M.N. Nagdevte[1], S.M. Andmeshram[2]
[1]Department of Botany, Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur | [2]Department of Botany Manoharbhai Patel College, Sakoli
Email: janvikawale20@gmail.com

A well-preserved dicot fruit was collected from Wardha near Samruddhi Highway (Lat 20.834289° N, and Long 78.816122° E) in Maharashtra District, Wardha. The fruit is triangular, unstalked. The fossil fruit is unilocular and is characterized by the presence of a bitegmic seed. The fruit is capsular with circumsessile dehiscence. The fruit though, shows some characteristics of the present-day families like Amaranthaceae, Nyctaginaceae, Chenopodiaceae, Portulacaceae and Caryophyllaceae. It has close affinities with the members of the family Portulacaceae. It could not conclusively be traced to any particular genus but is broadly placed under Portulacaceae.

T1-A10

Flowering-linked threats for the blooming bamboo species in the Indo-Burma biodiversity hotspot of Manipur with scientific intervention for their conservation

Lal Bihari Singha[1], Doly Maibam[1*], Elam Lisha[1], Sylvia Ningthoujam[1], Manoharmayum Geetmala[1]
[1]Department of Botany, Manipur University, Imphal, India
Email: lalbihari@manipuruniv.ac.in
dolymaibam@gmail.com

Unlike other plants, flowering in bamboos is a peculiar phenomenon due to its flowering and seeding at the end of a very long vegetative growth phase and dying in mass after

flowering. Globally, it has been reported that most of the bamboo species under flowering do not produce viable seeds. This has resulted in genetic erosion and species loss. Currently, many important bamboo species of Indo-Burma and Eastern Himalaya Biodiversity hotspots are in full bloom without seed set and are threatened by genetic erosion, resulting in extinction loss. Further, there are very limited studies on pollination biology and developmental biology of bamboo seeds, as the material is available after a very long intermast period. Therefore, it has become a deep concern with immediate in-depth studies to understand the reproductive biology of the bamboo species with scientific interventions for their regeneration through suitable methods so that they may be saved from mass extinction in this region and on the planet Earth. Field surveys were conducted to identify the geographical locations of bamboo species that are under flowering in Manipur. Studies on reproductive biology for a few bamboo species, including floral morphology, pollen production, pollination efficiency, pollination success, pollen viability, pollen germination, pollen-pistil interaction, embryo development, seed development, etc., were worked out following Nadgauda et al. (1993) and Thangaraja and Ganesan (2008). Suitable micropropagation methods were adopted for a few bamboo species, which were unsuccessful in seed set. This study revealed bloom in more than ten bamboo species, including *Bambusa nutans, B. tulda, B. kingiana, Dendrocalamus hamiltonii, Dendrocalamus latiflorus, D. hookerii, D. sikkimensis, Melocanna baccifera, Schizostachyum pergracile, Sinarundina riarolloana*. Among them, *D. sikkimensis, D. hookerii, Melocanna baccifera,* and *Schizostachyum pergracile* were recorded with successful pollination and seed set, whereas the rest of the bamboo species show a lack of pollination success due to protandry or gynandry - the critical behavior of sex organs in plants. In addition, the most interesting phenomenon of vivipary mode of seed germination was recorded in *D. hookerii,* which may be significantly linked to the phenomenon of climate change & drastic variation in the schedule of rainfall pattern. Among them, a total of three bamboo species were successfully regenerated through axillary bud culture in modified MS media, providing a ray of hope for their conservation.

T1-A11

Change in nutritional contents and medicinal value of *Nephrolepis cordifolia* (L.) C. Presl collected from two different ecological zones in India

Rachna[1*], Jyoti Jangid[1], Suman Patra[1], Sudhanshu Shahi[1], Sushree Sunandita Patel[1], Babita Kumari[1], Ratna Katiyar[2], Sandip Kumar Behera[3]

[1]Plant Diversity Systematic and Herbarium Division, CSIR-National Botanical Research Institute, Lucknow | [2]Department of Botany, University of Lucknow, Lucknow | [3]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad

Email: mrachna61@gmail.com

From ancient times, ferns have been used in traditional diets and for medicinal uses not only in India but also worldwide, due to their presence for nutritional components and bioactive compounds. However, the phytochemical constituents of the plant depend on the plant species and the environment in which it grows. *Nephrolepis cordifolia*(L.) C. Preslis one among those ferns that have both nutritional and medicinal value and is also widely distributed in India. This study aims to investigate the changes in phytochemical constituents in the leaflet of *N. cordifolia*, collected from two distinct ecological zones: Lucknow, U.P., (NC-N), and Munnar, Kerala (NC-K). In this regards, macronutrient (carbohydrate, and protein), mineral content, i.e., essential minerals (B, Ca, Mn, Fe, Cu, Mo, Co, Ni and Zn) and non-essential minerals (Cd, Cr and Pb), total phenolic and flavonoid content (TPC and TFC), profiling of phenolic compounds and DPPH free radical scavenging activity was estimated using the standard protocols. The results showed that macro-nutrients in NC-N, i.e., carbohydrate and protein, were 6.4 and 405.1%, respectively, higher than in NC-K. In contrast, the content of most of the essential minerals (7 out of 9) in

NC-K was significantly higher than in NC-N, while *vice versa* for total non-essential minerals, especially Cd and Cr. This result also resembles the higher ash (10%) content in NC-K than in NC-N (8%). Concurrently, the photochemical constituents with medicinal properties like total phenolic content, total flavonoid content and L-ascorbic were also observed 1.41, 2.94 and 10.7 fold higher in NC-K as compared to NC-N. Although *N. cordifolia* is known as a rich source of phytonutrients and medicine, determination of phytochemical analysis of the plant is necessary for its optimum utilization, as the present study clearly demonstrated that the variation in phytochemical constituents is governed by its environment. *Nephrolepis cordifolia* collected from Lucknow has a higher nutritive value, whereas the plant collected from Kerala has higher medicinal properties.

T1-A12

Variation studies in rare *Butea monosperma* trees, its conservation strategies for socio-economic benefits

Sougata Sarkar[1*], Ayan Kumar Naskar[2]
[1]RCFC, Agro-technology and Rural Development Division, CSIR-NEIST, Jorhat, Assam, india | [2]Wildlife Institution of India, Chandrabani, Uttarakhand, India
Email: neistsougata@gmail.com

Purulia, a remote district of West Bengal, India, is the only part of the Chotanagpur plateau which is a cradle to four different coloured flowers – scarlet, orange, yellow and white of *Butea monosperma*, Fabaceae that are nurtured in the wild. No earlier report of such coexistence occurred before our present work. The trees bearing scarlet flowers are popularly referred as *flame of the forest* or 'palash' in the local language. During full bloom, its true identity is exhibited, which nowadays insanely attracts tourists from all walks of life, ecological enthusiasts, nature lovers to Purulia across state and country borders, thus disrupting ecological harmony in every sense. Apart from abundantly available scarlet flower trees, the remaining three (orange, yellow and white) are very rare thus demand immediate conservation. Considering the visible on-site variation exhibited by flower colours, a preliminary investigation was initiated to perceive the existence of variation in flower morphology and pollen structures. Along with it, an incidental remarkable finding on the effect of aqueous extraction from petals of scarlet, orange, yellow and white flowers of *B. monosperma* is being reported for the first time as per our literature survey. The present study was focused on assessing variability in four different colours of flowers of this tree by considering six macroscopic and microscopic traits that has immense socio-economic and cultural importance among the natives. Length of flowers(cm), breadth of flowers(cm), ratio of length and breadth of flowers, length of polar axis(µm) of pollen, length of equatorial axis(µm) of pollen and ratio of length of polar and equatorial axis of pollen from ten flowers each from all four treatments (scarlet, orange, yellow and white colour flowers) of *B. monosperma* were recorded through microscopic techniques including SEM. The data were subjected to statistical analysis using Windostat Version 9.3 for ANOVA and Pearson's correlation. Significant variation exists between four different colours of flowers, considering six traits in *B. monosperma*. First report of contiguous release of more than one petal pigment in *B. monosperma,* unlike any other dye-yielding plants known so far. Suitable hypotheses-driven explanations have been made that need in-depth validation through cumulative effort in research and analysis from taxonomists, geneticists, biochemists, molecular biologists, as well as pathway engineers, horticulturists, plant tissue culturists, palynologists and plant breeders. The present study reveals the outcome of scrutiny of all the parameters considered and leaves behind a hypothesis of such questions which were beyond the scope of our study. In such regions where crop cultivation was next to impossible, *B. monosperma* growing luxuriantly in forests was a significant non-timber product yielding tree for rural inhabitants of the Chotanagpur plateau, India, especially known for producing lac and natural dye which had extreme

importance in shaping the socio-agrarian economy of this region. Presently, a dwindling business, but once upon a time was a thriving one that was this region's economic backbone.

T1-A13

Edaphic and phytosociological attributes of the microhabitats of *Aconitum nagarum* Stapf. in Dzuko Valley of Manipur

Sijagurumayum Geetanjali Devi[1*], Lal Bihari Singha[1]
[1]Department of Life Sciences (Botany), Manipur University, India
Email: geetshija123@gmail.com

Dzuko valley and the surrounding hills extend geographically from Nagaland in the north to Manipur in the south and lie between 25°31' N and 94°5' E, covering an area of about 90 km^2. It is situated at an altitude of 2452m asl with an annual temperature variation of -3 to 32°C, with an average rainfall of 2000-2500 mm. During the monsoon season, the valley flourishes with a stunning bloom of composite plant species, including the pink lily (*Lilium mackliniae)*, *Euphorbia sikkimensis*, *Aconitum* spp., *Caltha palustris*, *Potentilla* spp., and *Ranunculus* spp. etc. and therefore Dzuko valley is also recognized as 'Valley of Flowers'. This study was carried out to realize the seasonal variations in soil variables of *A. nagarum*, during the pre-flowering, flowering, and post-flowering periods and the phytosociological attributes for its micro-habitat at Dzuko valley. *Aconitum*, commonly referred to as aconite or monkshood comprises over 400 species under Ranunculaceae with rich diterpenoid alkaloids. Most of the species are well recognized for effective use in ailments for fever, rheumatism, and paralysis etc. and also serve as a reliable antidote for snake bites. Soil variables of the microhabitats were analysed following Allen *et al* (1974), whereas phytosociological parameters viz. frequency, density, abundance, importance value index (IVI), Whiteford's index, Simpson's index of dominance, Pielou's evenness index, and Whittaker's alpha and beta diversity etc. were worked out following Mishra (1968). Soils of the microhabitats of *A. nagarum* were found to be moderately acidic, sandy loam, loosely packed with high moisture content. Soil oxidizable organic carbon, Soil available Nitrogen and available Phosphorous were significantly higher during the flowering season whereas, Soil available Potassium was significantly higher during the post-flowering season. There was significant difference in the soil physico-chemical parameters between the three seasons. Present study also revealed information on population ecology of *Aconitum nagarum* where the density, frequency and abundance were found to be 5.3 individuals/m^2, 85% and 6.24 at their natural habitat in Dzuko valley of Senapati district. *Sinarundinaria rolloana* and *Carex polycephala* exhibited the highest values for IVI, Whiteford's index, and Simpson's index of dominance.

T1-A14

Chemical features of different aerial parts and *in vitro* culture of the endangered medicinal plant, *Stereospermum tetragonum*

Vibha Pandey*, Debasis Chakrabarty
CSIR-National Botanical Research Institute, Lucknow-226001, India
Email: vibhabiotech10@gmail.com

S. suaveolens DC. (Syn. *S. chelonoides*) and *S. colais* (Syn. *S. tetragonum*; *S. personatum*) are medium-sized deciduous trees of the family Bignoniaceae, found throughout the moist parts of India. Roots of *S. suaveolens* or *S. colais* are one of the ingredients of Dashamularishta, an Ayurvedic formulation. Traditional healers, rural communities, and pharmaceutical companies use barks, flowers, roots, and leaves of *Stereospermum* due to its anticancerous, analgesic, anti-inflammatory, antidiabetic, antibacterial, and other therapeutic properties. Overexploitation of *S. suaveolen* and *S. tetragonum* from wild habitats red-listed the plant as 'Endangered'. *S. tetragonum* is a valued medicinal plant since the use of Ayurveda, due to the presence of valuable phytochemicals in the plant. However, the chemical characteristic of the

plant is uncovered to only a limited extent. Therefore, this study included six aerial parts of the plant to uncover the elemental and metabolic composition of these parts. Also, limited in vitro culture studies on *Stereospermum* highlight the need for improved regeneration techniques. These parts include the root, stem and leaves, along with three different stages of flower (undeveloped flower bud to mature flower). Fallen fruits of *S. tetragonum* were collected from the CSIR-National Botanical Research Institute, along with aerial tissues from the tree. After surface sterilization, various explants were inoculated onto different media containing specific growth regulators to achieve distinct outcomes. To address persistent endogenous infections in excised organ cultures (shoot tips and nodal segments), treatments with $AgNO_3$ or Bavistin were applied. Activated charcoal supplementation was also tested to mitigate the inhibitory effects of phenolic compounds that diffuse into the culture medium, hindering regeneration. The elemental composition differed among plant parts, possibly due to differences in their physiological needs. Most of the elements were maximum in the developing flower, except for manganese. Measured flavonoids, which are rutin, quercetin, and kaempferol, were highest in leaves of the plant. However, gallic acid, protocatechuic acid, chlorogenic acid, caffeic acid and salicylic acid were maximum in the flowers of the plant (mostly mature flowers). Specific metabolites, cycloolivil and lapachol, were maximised using methanol and acetone extracts, respectively. Dormancy remains a major barrier to seed germination. Despite the limited availability of seeds, the maximum germination rate achieved was only 5%. In organ culture experiments, shoot tips and nodal segments demonstrated higher regeneration potential than rachis explants when treated with BAP and kinetin. As expected, the accumulation patterns of these metabolites vary with different tissues. Therefore, based on the required outcome of the product or study, the plant organ can be selected to proceed further. Also, these established *in vitro* cultures of *S. tetragonum* offer a promising approach to obtaining raw and purified plant materials while contributing to the species' conservation efforts.

T1-A15

Ecological Studies of *Eulophia obtusa* (Lindl.) Hook. f. from Dudhwa National Park, Uttar Pradesh, India

Neha Singh[1*], Ajit Kumar Das[1]
Laboratory of Plant Ecology, Phytotaxonomy, Ethnobotany and Conservation of Medicinal Plants, Department of Ecology and Environmental Science, Assam University, Silchar-788011, India
Email: dasajitkumar15@gmail.com

Genus *Eulophia* comprises about 217 taxa distributed in tropical and subtropical regions. In India, around 25 species of this genus are present. The present investigation was carried out to study the Ecological factors of *Eulophia obtusa* (Lindl.) Hook. f. a critically endangered orchid species listed in the IUCN was reported after a 118-year lapse in Dudhwa National Park, Lakhimpur Kheri, Uttar Pradesh, India**.** The species is a terrestrial orchid only distributed in the grasslands of Dudhwa under the waterlogged conditions in the monsoon season from mid-June to mid-October. A comprehensive taxonomic description of the species has been given to aid in its easy identification and documentation of its presence, evaluate its distribution, and estimate the population of *Eulophia obtusa* in the study area through rapid mapping exercise (RME). Detailed habitat, phenology, threats faced by the natural environment and conservation methods are discussed.

T1-A16

Taxonomy and Diversity Assessment of the Genus *Pogonatum* P. Beauv. (Polytrichaceae) in India

Ankita Verma[1*] Vinay Sahu[1,2], Ashish Kumar Asthana[1] and Priyanka Agnihotri[1,2]
[1]Bryology Laboratory, CSIR-National Botanical Research Institute, Lucknow-226001
Email: ankitaverma1095@gmail.com

The genus *Pogonatum* P. Beauv., member of the family Polytrichaceae, is an ecologically important genus among acrocarpous mosses, with over 50 species found primarily in tropical and subtropical regions, especially in Asia. In India, *Pogonatum* is notably present in the medium to high-altitude Himalayan areas, thriving in exposed, moist soils across forests, shaded slopes, in diverse and sometimes in disturbed environmental conditions. These taxa contribute to soil stabilization, water retention, and facilitate ecosystem succession. Their morphological features include erect and robust gametophytes, lamellate leaves containing photosynthetic filaments, and a hairy calyptra that safeguards the developing capsules. In India, approximately 20 species of *Pogonatum* are recognized, with a rich diversity particularly in the Eastern Himalayas, Northeast India, Western Himalayas, and Western Ghats. *Pogonatum neesii*, *P. microstomum*, and *P. urnigerum* are the most frequently found species. Identification of some of the species of the genus *Pogonatum* seems difficult due to their close morphological features. The present study aims to conduct a comprehensive taxonomic review and diversity of species within various climatic conditions.

T1-A17

Hidden Green Gems of the Chambal Ravines: Discovering Nature's Botanical Treasures

Tushar Anilrao Lohit[1,2*] and Vijay Vishnu Wagh[1,2]
[1]Plant Diversity, Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Lucknow, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad
Email**:** tusharlohit2015@gmail.com

The Chambal Ravines of India represent a fascinating landscape renowned for its unique geological formations and ecological importance. This study seeks to provide a comprehensive assessment of the floristic diversity within the Chambal Ravines spanning Madhya Pradesh, Rajasthan, and Uttar Pradesh. The research employs systematic field surveys and the collection of plant specimens from various habitats across the ravine ecosystem.

The study documented a rich and diverse assemblage of flora encompassing a broad range of plant species. Through comprehensive taxonomic analysis, 350 taxa belonging to 226 genera and 72 families were identified. The findings also highlight the occurrence of rare, endangered, and economically significant plant species within the ravines, emphasising their ecological value and the need for conservation efforts.

This assessment of floristic diversity offers a comprehensive understanding of the plant life within the Chambal Ravines of India. The findings contribute significantly to botanical knowledge while providing valuable insights for conservation strategies to preserve this unique landscape's ecological integrity and biodiversity.

T1-A18

Assessing conservation status of *Dipteris wallichii* (R. Br *ex* Hook. *et* Grev.) T. Moore

Ragini Kumari[1*] and Ajit Pratap Singh[1]
Pteridology Laboratory, CSIR-National Botanical Research Institute, Lucknow-U.P., India
Email: ajitpsingh2000@gmail.com

Global climate change is adversely impacting on survival of living organisms, including the pteridophytes. About 12000 species of pteridophytes are present around the world. In India approximate 1160 species are known to occur of which about 337 species are considered to be threatened or endangered. The *Dipteris* Reinw., belonging to family Dipteridaceae, is known with single species *Dipteris wallichii* (R. Br *ex* Hook. *et* Grev.) T. Moore from India. This taxon was recorded from Myanmar, Bhutan, China, Bangladesh, and strictly in north-east Himalayan region of India, henceforth, it was considered under vulnerable category (IUCN, 2000). Due to changing climate in and around of its natural habitat this species is facing risk of extinction in wild, necessitating its further assessment of conservation status. Present study aims to

assess the conservation status of *D. wallichii*. We have analysed its conservation status using 2012 IUCN Red List Categories and Criteria (Version 3.1). We analysed conservation status based on online data resources of GBIF, our own field-based data (point of occurrence in Balemu, and Jamiri circle of West Kameng, Arunachal Pradesh), other surveyed geographical regions of the country, and herbarium specimens all over the India. We plotted 63 points of occurrences, estimated extent of occurrence (EOO), and area of occupancy (AOO) by using GeoCAT tool. Our findings suggest that the *Dipteris wallichii* is facing a high risk of extinction. Study also infer that further extensive, prolonged, and multifaceted assessment is needed to derive more perfect conservational status which will be presented and discussed in the paper.

T1-A19

Floristic study on pteridophytes with new records of the family Lycopdiaceae and Selaginellaceae from the Champawat District of Uttarakhand

Nivedita Mall[1], Damini Yadav[1], Ajit Pratap Singh[1*]
Pteridology Laboratory, CSIR-National Botanical Research Institute, Lucknow-U.P., India
Email: ajitpsingh2000@gmail.com

Floristic study of pteridophytes is obligatory to know species composition, understand fern's role in ecosystems, to support conservation efforts, and to assess their economic value. Such study, involving new record of taxa is crucial for cataloguing the fern diversity, which are important for ecosystem sustainability, and for identifying the threatened species. Champawat in western Himalaya is spread in about 1781 km^2 area, situated in the eastern part of the Uttarakhand, bordering Nepal to the north-east, with approximately 200-2200 m elevation variation, 32-90% humidity range, and provides conducive climatic conditions for fern vegetation. Present study aims to provide a floristic account to develop an understanding on the total species composition of the pteridophytes of the Champawat. We surveyed five different tahsils *viz.* Barakot, Lohaghat, Pati, Champawat, and Purnagiri to provide a preliminary floristic account with new records and taxonomic circumscription of taxa. So far, we have investigated 91 species, 40 genera under 19 families of the pteridophytes with their correct taxonomic status. The families *viz.,* Polypodiaceae (*Arthromeris, Drynaria, Lepisorus, Loxogramme, Polypodioides, Pyrrosia, Selliguea*), Thelypteridaceae (*Christella, Glaphyropteridopsis, Pronephrium, Pseudocyclosorus, Pseudophegopteris, Thelypteris, Ampelopteris*), Pteridaceae (*Adiantum, Aleuritopteris, Coniogramme, Onychium, Pteris*), and Dryopteridaceae (*Dryopteris, Hypodematium, Polystichum*) has richest generic and species composition. Unlike to above, the families *viz.,* Ophioglossaceae (*Helminthostachys, Ophiglossum*), Osmundaceae (*Osmunda*), Gleicheniaceae (*Dicranopteris*), Lygodiaceae (*Lygodium*), Dennstaedtiaceae (*Dennstaedtia*), Aspleniaceae (*Asplenium*), Woodsiaceae (*Athyrium, Diplazium*), Blechnaceae (*Woodwardia*), Lomariopsidaceae (*Nephrolepis*), Tectariaceae (*Tectaria*), Davalliaceae (*Davallia, Leucostegia*), Equisetaceae (*Equisetum*), and Selaginellaceae (*Selaginella*) represented less genera and species composition. Discovery of *Huperzia hamiltonii* (Spreng.) Trevis (Lycopodiaceae), *Selaginella ornata* (Hook *et* Grev.) Spring, and *Selaginella vaginata* Spring (Selaginellaceae) from the study area is new addition to the pteridophytic flora of the western Himalayas. The observation on the floristic account with new records and taxonomic circumscription of taxa of the family Lycopdiaceae and Selaginellaceae shall be presented and discussed in the paper.

T1-A20

Phytogeographical assessment of family Poaceae Barnhart in Madhya Pradesh

Smita Tiwari[1], Sukhendu Kumar Jana[1], Priyanka Agnihotri[1]
Plant Diversity, Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow, India

E-mail: priyagni_2006@yahoo.co.in

The family Poaceae Barnhart, commonly known as the grass family, is one of the most significant and diverse groups in terms of economic, ecological, and evolutionary importance. It is distributed across all the climatic zones— arid, semi-arid, tropical, temperate, alpine, and even wetland ecosystems, reflecting the family's exceptional ecological adaptability and global dominance. It ranks as the fifth largest plant family globally, while in India, it holds the top position with around 263 genera and 1,291 species. Madhya Pradesh, a state in central India, lies between 23°28'23.9664'' N and 77°56'52.7928'' E. It is the second largest state in the country with a total geographic area of 3,08,252 km^2. Forests are predominantly found in central, southern, and eastern parts of the state, whereas in northern and western parts of the state are deficient in vegetation. Madhya Pradesh has the largest forest cover (77,414 km2) in the country, occupies 25.11% of the total geographical area of the state, and harbors a total of 2,213 species under 927 genera belonging to 163 families. Of these, 1654 species in 711 genera and 130 families belong to dicotyledons, and 559 species in 216 genera and 33 families belong to monocotyledons. Family Poaceae with 241 species is the largest family in the state, followed by Fabaceae (228 spp.), Asteraceae (140 spp.), Cyperaceae (103 spp.), and Acanthaceae (81 spp.). Whereas among the Poaceae, genus *Eragrostis* (24 spp.) is the largest genera, followed by *Panicum* and *Digitaria* (each with 9 spp.), *Aristida*, *Arthraxon*, and *Sporobolus* (each with 8 spp.) and *Sorghum* (7 spp.). The two species endemic to the state are *Digitaria duthieana* and *Spodio pogonjainii*, while *Microchloa indica* and *Lolium multiflorum* are the two rare species found in the forests of Madhya Pradesh.

T1-A21

Assessment of the diversity and distribution of *Pteris* L. along elevational gradients in West Kameng district, Arunachal Pradesh

Nivedita Mall[1], Ajit Pratap Singh[1*]
[1]Pteridology Laboratory, CSIR-National Botanical Research Institute, Lucknow-226001, India
Email- ajit.p.singh@nbri.res.in

The present study analyses the diversity and distribution pattern of 12 *Pteris* species along an elevational gradient (100-3000 m) spanning across subtropical to alpine forest areas. The species richness of *Pteris* increased with increasing elevation, with five species in tropical forest (100-1000 m), nine species in sub-tropical forest (1001-2000 m) and eight species in temperate forest (2001-3000 m). The highest species richness was found in the mid elevational gradient 1501-2000 m with 10 species while the lowest species richness was observed at highest elevation *i.e.* 2501-3000 m with four species. Species such as *P. aspercaulis*, *P. biaurita, P. vittata*, and *P. cretica* occurred across multiple elevational gradient, reflecting broad ecological adaptability, while *P. subindivisa* restricted to lower elevation, *P. longipes* to mid elevation and *P. confusa* were restricted to high elevations. The increasing species richness with elevation highlights the ecological heterogeneity and habitat complexity of the upper zones. The altitudinal distribution pattern reflects distinct ecological preferences among *Pteris* species, emphasizing the role of altitude and climatic conditions in shaping species richness and abundance along the gradient.

T1-A22

Some new records of liverworts and mosses from Western Himalaya, India

Vinay Sahu[1,2]
Plant Diversity, Systematics, and Herbarium Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow, 226 001, Uttar Pradesh, India; [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, Uttar Pradesh, India.
Email: vinay.sahu.nbri@csir.res.in

During a survey of bryophyte collection from Champawat, Uttarakhand, four species of leafy liverworts and two species of mosses have been reported new to western Himalaya. After critical investigation they were identified as *Cephalozia*

darjeelingensis Udar & D. Kumar, *Cylindrocolea kiaeri* (Austin) Vana, *Heteroscyphus parvus* A. Srivastava & S. C. Srivastava and *Jackiella javanica* var. *cordifolia* Schiffn., *Schwetschkeopsis formosana* Nog. and *Neckeropsis darjeelingensis* Gangulee.

Cephalozia darjeelingensis was earlier reported from Meghalaya and West Bengal-Darjeeling while *Cylindrocolea kiaeri* from Meghalaya and South India. *Heteroscyphus parvus* was earlier reported from Assam, Madhya Pradesh and Manipur and *Jackiella javanica* var. *cordifolia* from Arunchal Pradesh and Tamil Nadu. *Neckeropsis darjeelingensis* were earlier reported from West Bengal-Darjeeling and endemic to India while Schwetschkeopsis *formosana* from Madhya Pradesh-Pachmarhi and *West* Bengal-Darjeeling. The present study describes the extended range of distribution of these species from western Himalaya.

T1-A23

Climatic controls on mangrove species distributions in India: from wet Holocene to warmer futures

Pujarini Samal[1*], Dibyendu Adhikari[1]
[1]CSIR-National Botanical Research Institute, Lucknow, India- 226001
Email: samalpujarini123@gmail.com

Climatic regimes have been primary drivers of mangrove range dynamics in India i.e., from awetter Mid-Holocene to projected warmer futures. We quantify these controls by modelling the potential distributions of two dominant species viz., *Rhizophora mucronata* and *Avicennia officinalis* for the Mid-Holocene (~6 ka), present, and the 2050s/2070s under RCP 2.6 and RCP 8.5 using an eight-algorithm ensemble species distribution modeling (SDM) framework. The ensemble showed strong performance (AUC: 0.99 for *R. mucronata*, 0.97 for *A. officinalis*; TSS: 0.90 and 0.89), with support vector machines performing best and CART/BIOCLIM the weakest for *R. mucronata* and *A. officinalis*, respectively. Climatic predictors had species-specific controls e.g., for *A. officinalis*, Precipitation of the Wettest Month (Bio13) and Mean Temperature of the Warmest Quarter (Bio10) were most influential (jointly ~54–67%). Whereas *R. mucronata* was primarily governed by Precipitation Seasonality (Bio15) and Precipitation of the Warmest Quarter (Bio18). The Middle-Holocene's higher precipitation and sea-level high stand supported the broadest suitable habitats, consistent with palaeo-pollen evidence. In contrast, all future scenarios project net contraction of suitability for both species, alongside systematic landward shifts, indicative of sea-level rise interactions and prolonged soil inundation under intensified rainfall. Together, these results show that monsoon precipitation regimes and thermal extremes are plausibly the decisive constraints on mangrove biogeography in India. The highlights the need for climate-ready, species-specific conservation that enables landward migration (corridors, setback zones) and targets refugia where favourable climatic envelopes persist.

T1-A24

Role of Village Panchayats in Biodiversity Conservation

B. Prabhakar[1*]
[1]PCCF, Monitoring and Working Plan, Uttar Pradesh/ Secretary, Uttar Pradesh State Biodiversity Board, Lucknow
E-mail: prabhakarburaifs93@gmail.com

Biological diversity - or biodiversity - is the term given to the variety of life on Earth and the natural patterns it forms. The biodiversity we see today is the fruit of billions of years of evolution, shaped by natural processes and, increasingly, by the influence of humans. It forms the web of life of which we are an integral part and upon which we so fully depend. This diversity is often understood in terms of the wide variety of plants, animals and microorganisms. So far, about 1.75 million species have been identified, mostly small creatures such as insects. Scientists reckon that there are actually about 13 million species, though estimates range from three to 100

million. Biodiversity provides a large number of goods and services that sustain our lives. At the 1992 Earth Summit in Rio de Janeiro, world leaders agreed on a comprehensive strategy for "Sustainable Development" meeting our needs while ensuring that we leave a healthy and viable world for future generations. The first step towards conservation is sustainable utilization of biodiversity and its documentation. Biodiversity and associated knowledge is found in different ecosystems, under different legal management regimes. Local communities play a vital role in biodiversity conservation and their involvement is crucial for the success of conservation efforts. Community-based conservation approaches can lead to improved conservation outcomes, increased community ownership and improved livelihoods for local communities. The role of Village Panchayat's is to support the Biodiversity Management Committee (BMC), which is the primary body for preparing the People's Biodiversity Register (PBR). The PBR is a participatory process requiring intensive and extensive consultation with the people ensuring that PBR accurately reflects local biological resources and associated traditional knowledge. By empowering local communities to take an active role in managing their natural resources, we can ensure the long-term conservation of biodiversity.

T1-A25

Significance of Heritage Sites in Biodiversity Conservation

Dr Somesh Gupta[1*]
[1*]Senior Technical Officer
Uttar Pradesh State Biodiversity Board, Lucknow
E-mail: upstatebiodiversityboard@gmail.com

Heritage sites play a pivotal role in the conservation of biodiversity by serving as crucial repositories of both cultural and natural values. Biodiversity is closely linked to ecological security and therefore, human welfare. To strengthen the biodiversity conservation in traditionally managed areas and to check the rapid loss of biodiversity in intensively managed areas needs special attention. “Biodiversity Heritage Sites” (BHS) are well defined areas that are unique, ecologically fragile ecosystems - terrestrial, coastal and inland waters and, marine having rich biodiversity comprising of any one or more of the following components: richness of wild as well as domesticated species or intra-specific categories, high endemism, presence of rare and threatened species, keystone species, species of evolutionary significance, wild ancestors of domestic/cultivated species or their varieties, past pre-eminence of biological components represented by fossil beds and having significant cultural, ethical or aesthetic values and are important for the maintenance of cultural diversity, with or without a long history of human association with them. To declare a Biodiversity Heritage Site (BHS) in India, the State Government, in consultation with local bodies, must notify the area in the Official Gazette under Section 37 of the Biological Diversity Act, 2002. This process involves identifying areas of biodiversity importance, consulting with local communities, and potentially implementing restrictions to manage and conserve the site. In Uttar Pradesh in exercise of the powers conferred by sub-section (1) of section 37 of the Biological Diversity Act, 2002 (Act No.18 of 2003), the Governor, in consultation with the Uttar Pradesh State Biodiversity Board has notified the Ghariyal Rehabilitation Centre, Kukrail, Lucknow Reserve Forest as the Biodiversity Heritage Sites of Uttar Pradesh. This site is rich in floral biodiversity *viz.* Bael, Shahtoot (Mulbery), Ber, Amrood (Guava), Aam (Mango), Jacaranda, Jarul, Silver Oak, Casuarina, Kala Siris, Arjun, Kadamb, Kanji, Lasora, Maulshri, Arru, Balam Kheera, Jharberry, various species of bamboos etc. This Centre is also full of faunal biodiversity which includes Rhesus Monkey, Jackal, Fox, Common mongoose, Small Indian mongoose, Blue bull, Five striped squirrel, Common house rat, Indian mole rat, House mouse, Porcupine, Hare, Brown shrew, various snakes like- cobra, python, common Krait, Rat snake, Water Snake. Many species of fishes, *viz.*,

Chilwa, Katla, Mirla, Mangur, Rohu & Girai are found in the nearby Kukrail nala. Besides the natural fauna, the Gharial Rehabilitation Centre, Kukrail is now well-known for conserving (*Gavialis gangeticus*) the sole surviving member of the *Gavialldae.* This Centre has also contributed in conserving many species of turtle. This paper emphasizes the importance of integrating conservation efforts within heritage management frameworks to create synergies that benefit both biodiversity and cultural heritage, ultimately promoting a holistic approach to environmental stewardship.

Theme 2:

Climate change impacts on plants and ecosystems: Mitigation and adaptation strategies

T2-A1

Nanobiotechnology-based Strategies for Enhanced Crop Stress Resilience in a Changing Climate

Jason C. White[1]*, Lijuan Zhao[2], Arturo Keller[3], Jorge Gardea-Torresdey[4]
[1]Connecticut Agricultural Experiment Station, New Haven CT United States | [2]Nanjing University, Nanjing, China | [3]University of California, Santa Barbara, California, United States | [4]The University of Texas at El Paso, El Paso, Texas, United States
Email: Jason.White@ct.gov

Low use and delivery efficiency of conventional agrichemicals is a significant impediment to maintaining global food security, particularly given that a 60-70% increase in food production is needed by 2050 to support the projected population. Further confounding these efforts is climate change, which is forcing the cultivation of crops under more marginal and stress-inducing conditions. Under stress, plant cellular redox homeostasis is disturbed, resulting in the over-accumulation of reactive oxygen species (ROS) that damage biomolecules (lipids, proteins, and DNA), dysregulate physiology, and inhibit crop growth and yield. Thus, novel and sustainable strategies for enhancing food production under climate-stressed conditions are needed.

Nanobiotechnology approaches to engineer crops with enhanced stress tolerance is a safe, sustainable, and effective strategy to increase crop yield. Specifically, delivering ROS-scavenging nanomaterials (NMs), many of which are micronutrients and biostimulants, at the appropriate time and place can alleviate abiotic and biotic stress. Importantly, ROS production in living cells carries both costs and benefits. When present below a threshold level, ROS can mediate redox signalling and defense pathways that foster plant acclimatization against stress.

Nanoscale CuO, CuS, SiO_2, Fe_2O_3, and Ag treatment regimens as seed priming agents, foliar amendments, or combinations thereof, can be applied to control and tune ROS homeostasis. ROS-scavenging NMs can be applied during or after stressor exposure, resulting in the direct stimulation of plant defense pathways that will quench oxidative stress and enable adaptive growth. Alternatively, ROS-triggering NMs can be judiciously applied to crop species to prior to stressor exposure, pre-stimulating defense systems, priming stress responses, and subsequently increasing the biotic and abiotic stress resistance of crops. Evaluated stressors, both alone and in combination, include drought, extreme temperature (low, high) and disease pressure from bacterial, fungal, and nematode pathogens. Investigated plants include rice (*Oryza sativa*), maize (*Zea mays*), tomato (*Solanum lycopersicum*), soybean (*Glycine max*), and wheat (*Triticum aestivum*).

Examples of key findings include rice grown from primed seeds having 82% reduction in lesion size upon blast infection (*Magnaporthe oryzae*) and being significantly more cold-tolerant than untrained seeds. Also, primed maize seeds exhibited accelerated seed germination and an increased germination rate, greater seedling vigor, and better seedling growth under drought, saline, and cold stress conditions, indicating enhanced resilience to diverse and simultaneous stresses. In all cases, transcriptomic, metabolomic, and proteomic analyses indicate significant metabolic reprogramming that mechanistically explains the overall enhanced stress resilience.

This knowledge can be used to engineer climate-resilient crops. The ability to effectively tune nanoscale material structure and composition will be critical to maximizing positive impacts, including significantly reduced amounts of agrichemical use while simultaneously enhancing yield in the face of unpredictable abiotic and biotic stressors.

T2-A2

Nitrogen: The Emerging Global Cycle Crisis

Viney P. Aneja[1*]
[1]Department of Marine, Earth, and Atmospheric Sciences, North Carolina State University Raleigh, NC 27695-8208, USA
Email: vpaneja@ncsu.edu

Just as carbon fueled the Industrial Revolution, nitrogen has driven an Agricultural Revolution that fundamentally transformed global food

production. The use of synthetic nitrogen fertilizers and cultivation of nitrogen-fixing crops expanded exponentially during the twentieth century, with the most dramatic increases occurring after 1960. This transformation has profound implications: current anthropogenic fluxes of reactive nitrogen to the biosphere now approximately equal the total flux from all natural sources combined, including both terrestrial and oceanic systems. While natural nitrogen fluxes remain subject to considerable uncertainty, anthropogenic production of reactive nitrogen has increased nearly five-fold over the past half-century. This rapid acceleration has unequivocally established human activities as a dominant force in the global nitrogen cycle, eliminating any ambiguity about the relative importance of anthropogenic versus natural fluxes. The intensification of nitrogen use has been essential for achieving the crop yields and protein production necessary to support a growing global population. However, paralleling concerns with carbon cycling, the release of fixed nitrogen into natural environments generates adverse consequences across local, regional, and global scales. As anthropogenic nitrogen contributions continue to grow relative to natural budgets, we face mounting uncertainties regarding the long-term environmental and ecological implications of this unprecedented biogeochemical perturbation.

T2-A3

UV-B induces cotyledon-specific *MYB*s to orchestrate photomorphogenesis and acclimation responses

Aditi Pathak[1*], Sarvjeet Singh[1], Deepika Sharma[2], Manish Tiwari[1]
[1]CSIR-National Botanical Research Institute (CSIR-NBRI), India | [2]BRIC-National Institute of Plant Genome Research (BRIC-NIPGR), India
Email: pathakaditi231@gmail.com

Light is a quintessential factor that governs every aspect of growth and development across all plant species. Plants have evolved a wide range of photoreceptors to perceive and respond to different wavelengths of light. UV-B forms a minor yet significant component of the sunlight that reaches Earth's surface, and in plants, it is perceived by the UVR8-photoreceptor. Upon perception, UVR8 undergoes a conformational change from a homodimer to a monomer and initiates the signalling cascade in plants. Among the downstream UV-B responsive genes are a set of MYBs, MYB11, MYB12, and MYB111, which are regulators of the general phenylpropanoid pathway leading to increased production of flavonoids (quercetin, kaempferol, rutin) to protect plants from the deleterious effects of UV-B. The role of MYB13 has been recently identified to be involved in UV-B-induced photomorphogenesis and acclimation in Arabidopsis. We observed that MYB13 and MYB111 have overlapping patterns of expression in cotyledon and they provide photoprotection against UV-B in an additive manner. Here, we have demonstrated that UV-B-induced photomorphogenesis is mediated by both MYB111 and MYB13, as they target auxin-related genes involved in expansion in a UV-B-specific manner. A series of phenotypic, transcriptional, molecular, and detailed biochemical analyses revealed that the miR858a-MYB13/MYB111 module contributes to another layer of regulation initiated by UV-B exposure, which is still unknown. Furthermore, this study also provides an insight into the role of bZIP transcription factor HY5 in regulating miR858a, which in turn regulates MYBs in a UV-B-specific manner.

T2-A4

Fire and forest management for forest sustainability: A southern U.S. perspective

Ajay Sharma[1*]
[1]College of Forestry, Wildlife and Environment, Auburn University, Auburn, AL, United States of America
Email: azs0365@auburn.edu

Southern U.S. forests, predominantly composed of intensive pine plantations, are significant contributors to regional, national, and global economies. Recognised as some of the most productive forests worldwide, they

represent only 2% of the global forest area yet produce approximately 18% of the world's pulpwood and 60% of the nation's total harvested timber volume. These forests support 5.5% of regional employment and account for 7.5% of industrial economic activity, generating a wide array of products from toilet paper to lumber. Additionally, this region encompasses the North American Coastal Plain (NACP), a notable global biodiversity hotspot. Despite these contributions, the long-term sustainability of southern U.S. forests, along with their economic and ecological functions, faces mounting challenges. Increasing occurrences of windstorms, wildfires, and land conversions, coupled with reduced structural diversity due to the predominance of pine plantations, present significant threats to forest health, productivity, and resilience. The adoption of alternative silvicultural practices and prescribed fire regimes offers promising management strategies to advance sustainable forestry with multiple benefits. This presentation will highlight recent developments in silviculture and fire ecology aimed at bolstering forest health, resilience, and multifunctionality. Research indicates that uneven-aged silvicultural systems and regular application of fire can enhance forest resistance and resilience to hurricanes, increase structural complexity, promote species diversity, improve water quality and yield, and sustain elevated stand-level carbon stocks. The integration of silviculture and fire is essential for restoring multifunctionality in southern U.S. forests, thereby expanding ecological and economic advantages for conservation interests, the forest industry, and the broader public.

T2-A5

Scents of survival: Ultraviolet-B mediated stress adaptation in *Ocimum americanum* L.

Amit Kumar Mishra[1*]
[1]Department of Botany, School of Life Sciences, Mizoram University, Aizawl, India
Email: akmishra@mzu.edu.in

Ocimum americanum L., commonly referred to as American basil or lime basil, is an aromatic annual herb belonging to the Lamiaceae family. Traditional remedies have long used this plant due to its medicinal properties. People use its decoctions to alleviate coughs, as well as the leaves and the entire plant to treat respiratory disorders, rheumatism, and renal complications. In the context of global climate change and stratospheric ozone depletion, the increase in ultraviolet-B (UV-B) radiation poses a significant threat to plant health and productivity. Understanding how medicinal plants respond to elevated UV-B (eUV-B) is therefore crucial. This study examines the physiological and biochemical responses of *O. americanum* to eUV-B (38.8 KJ/m²) across three developmental stages: 30-, 60-, and 90-days post-transplantation. The findings reveal a marked reduction in growth parameters, chlorophyll content, and overall physiological performance under UV-B stress. However, the total phenolic content notably increased, indicating that secondary metabolism was upregulated as a protective strategy. Elevated UV-B triggered the accumulation of reactive oxygen species (ROS), including superoxide radicals and hydrogen peroxide, resulting in membrane damage and increased electrolyte leakage. Histochemical staining confirmed the localization of ROS, with brown and blue formazan deposits visualized in UV-B-treated foliar tissues. In response, antioxidant enzymes such as superoxide dismutase (SOD), catalase (CAT), ascorbate peroxidase (APX), and glutathione reductase (GR) showed significantly enhanced activity, suggesting an active defense mechanism. Furthermore, GC-MS analysis of the essential oils revealed increased concentrations of bioactive compounds, such as caryophyllene and β-ocimene, key monoterpenes and sesquiterpenes known for their therapeutic and ecological properties. These findings suggest that *O. americanum* adapts to UV-B stress by modulating its antioxidant system and enhancing the synthesis of specialized metabolites with protective functions, despite

compromised growth and physiological efficiency.

T2-A6

Impact of Climate Change on Apple Cultivation in the Altitudinal Zones of Himachal Pradesh: Challenges and Adaptation Strategies

Raashi Gupta[1], Rajat Kumar[2], Harminder Pal Singh[2]
[1]Department of Botany, Panjab University | [2]Department of Environment Studies, Panjab University, Chandigarh
E-mail: raashi1898@pu.ac.in, hpsingh_01@pu.ac.in

Apple production is an important part, providing livelihood to thousands of farming families and contributing to revenues in the state of Himachal Pradesh, India. However, in the last few years, climate change has substantially disrupted apple-growing conditions. Climatic elements like increased temperature, irregular rainfall patterns and less snowfall, have affected the quality and productivity of apples and these have had variable effects on apple at different altitudes across the state. Emerging anecdotal evidence or reports are prevalent, but more systematic reviews and comparisons of different climatic effects and adaptive practices across altitudes are limited. To explore the findings discussed above, a mixed-method design was used, consisting of field surveys, semi-structured interviews with farmers and a review of secondary climatic data using government handbooks, websites and schemes. These findings show that farmers across the lower hills experience shorter chilling hours and pest outbreaks as limiting factors. Irregular, rain or lack of rain, contributes to the quality of fruit, while in the upper hills, reduced snow coverage and frost damage are limiting production. Farmers are controlling this by using low-chill cultivars, improving water conservation, implementing integrated pest management and precision agriculture technologies. The study finds altitude-based vulnerability and assesses the adaptive capacity of apple farmers to climate change. The study calls for research participatory-based interventions, climate-resilient cultivars and policy frameworks to sustain apple production and community livelihoods in the state of Himachal Pradesh.

T2-A7

Fate of arsenic stress under climate warming and heat stress conditions in rice

Pandey M[1], Pooja Negi[1], Radha Krishna P[1], Suraj Sampatrao Patil[3], Vinay Kumar[3], Srivastava AK[1,2]
[1]Nuclear Agriculture and Biotechnology Division, Bhabha Atomic Research Centre, Mumbai-400094, India | [2]Homi Bhabha National Institute, Mumbai-400094, India | [3]Department of Biotechnology, PES Modern College of Arts, Science and Commerce, Ganeshkhind, Pune 411016
Email: manishp@barc.gov.in; biomanish@gmail.com

The continuous rise in atmospheric temperature and groundwater arsenic (As) contamination poses a serious threat to global rice production. India is especially vulnerable, as average maximum temperature is already reaching the critical threshold of 33 °C, beyond which the rice productivity will be reduced drastically. While the individual effects of heat stress and As stress have been investigated, their combined impact remains poorly understood. To address this, a greenhouse-level experiment was conducted in Indian rice (IR-64 variety) under simulated temperature regimes, including ambient (AM; 30/28 °C), heat-wave (HW; 34/28 °C), and climate-warming (CW; 36/31 °C). Under each temperature regime, plant growth was compared with/without arsenic (As) contamination (100 mg/kg soil). Preliminary phenotypic assessment at the seedling stage revealed that heat+As stress was more detrimental than the individual stresses. This was also supported by the selective upregulation of stress markers, including *OsHsp90* (CW and HW: 1.7- and 2.1-fold, respectively) and *OsABI* (CW and HW: 2.3- and 2.5-fold, respectively) under combined stress, compared with As alone, suggesting that a synergistic interaction is at play. Further, pot-level experiments were conducted to study heat-As interaction at the mature plant stage.

Here, As stress was given at three developmental stages, including vegetative maturity (45 DAS), half-inflorescence (60 DAS) and active grain-filling (75 DAS). The seed yield/plant showed maximum reduction under As+CW (0.32-fold), followed by As+HW (0.48-fold), CW (0.50-fold), HW (0.66-fold) and As (0.86-fold) relative to AM-control. The activities of various enzymes and metabolite levels were quantified, and a cumulative score-based ranking was performed across all the tested treatments, independently for source-strength (Σ-source), sink strength (Σ-sink) and sulfur metabolism (Σ-sulphur). Based on correlation analysis of these scores with seed yield/plant, Σ-sink(r=0.69) was highlighted as the major contributor towards stress-induced yield loss, followed by sulphur metabolism (r=0.39) and source strength (r=-0.15). The activities of ADP-glucose phosphorylase and sucrose synthase, which act as the major determinants of sink strength, showed maximum reduction under As+CW (0.63-fold), compared with those of AM-control. Similarly, the activity of serine acetyl thiol lyase,a key enzyme of sulphur metabolism,was only increased by1.02-fold in As+CW, while it was increased by 6.67-, 2.50-, 1.08- and 1.67-fold under As+HW, HW, CW and As-stress, respectively, relative to control plants. Additionally, the accumulation of grain-As levels was also found to be significantly increased by 2.41-and 0.46-fold under As+CW and As+HW, respectively, compared with those of As alone. Taken together, the findings substantiated that As-stress severity will be enhanced when it coincides with climate warming. The ongoing mitigation strategies need to be adjusted accordingly to remain effective under As+heat-induced combined stress.

T2-A8

Decoding UV-B Stress: How Altered Source–Sink Relationships Influence Growth, Yield, And Grain Qualityin Pearl Millet

Pooja Singh[1*] **and Krishna Kumar Choudhary**[1]
[1]Department of Botany, MMV, Banaras Hindu University, Varanasi-221005, India
Email: poojasngh7579@gmail.com

Climate change-driven fluctuations in stratospheric ozone dynamics have intensified the Ultraviolet-B (UV-B) radiation reaching the Earth's surface, posing new challenges to crop productivity and metabolic stability in major cereals. With rising global population and dietary demand shifts towards nutritional and climate-resilient crops, millets have emerged as promising alternatives to mainstream cereal crops. Among these, pearl millet exhibits exceptional tolerance towards drought, salinity, and heat stress, however, its response against enhanced UV-B stress remains largely unexplored. Recognizing its importance in sustainable food security systems, the present study investigation explored the impact of elevated UV-B exposure (eUV-B; ambient+7.2 $kJm^{-2}d^{-1}$) on pearl millet cultivars (HHB-272, HHB-67, MPMH-21, and MPMH-17) under natural field conditions focusing on the critical panicle development stage (PDS), and grain-filling stages (GFS). The results indicated that UV-B stress significantly affected growth morphology (Plant height, number of leaves, leaf area, and panicle length) at both the stages, with less pronounced effects on cultivars HHB-272 and HHB-67. Photosynthetic efficiency (*F*v/*F*m) declined at PDS in cultivars MPMH-21, and MPMH-17 due to higher generation of ROS depicted through biochemical and histochemical localization assays. Ultrastructural surface modifications in stomatal aperture, trichomes, wax deposition was also observed through SEM. Increased grain yield in all the cultivars indicated efficient allocation of resources towards damage, repair, growth and development. Declined grain quality attributes (TSS, RS, TFAA, SC, SP), and metabolic pathway analysis of the metabolites indicated a shift in photo assimilates towards fatty acid biosynthesis. These results will provide an insight that how UV-B radiation alters the source to sink relationship in pearl millet plants.

T2-A9

Ocean Acidification driven shifts in Phytoplankton Size Class (PSC) distribution and changes in coastal dynamics of nearshore north-west Bay of Bengal - a polyphasic analysis

Rohan Kr Biswas[1*], Avik Kumar Choudhury[1]
Phycology Ecology and Remote Sensing Lab (PEARL), Department of Botany, Ramakrishna Mission Vivekananda Centenary College, Rahara, Kolkata-700118
Email: rohan.biswas199798@gmail.com

Phytoplankton build the foundation of the marine food web as the primary producers of aquatic ecosystem. These microscopic aquatic photosynthetic protists are the drivers of global primary productivity and the oceanic carbon cycle. Phytoplankton are divided into three groups based on their size - Picophytoplankton (<2µm), Nanophytoplankton (2-20µm), and Microphytoplankton (>20µm). Due to the size differences, these Phytoplankton Size Classes (PSCs) represent distinct components of the aquatic food chains based upon their interactions with the consumers. PSCs are very sensitive to environmental stress and changes and are often used for environmental monitoring too. Among the stressors, as carbon emissions increase globally, Ocean Acidification (OA) is a concerning phenomenon that can alter the whole dynamics of the phytoplankton community. Even though coastal India encompasses a long coastline, the possible effects of the OA scenario on PSC distribution largely remained undocumented. To fill this research gap, the present study was conducted, which aims to evaluate possible signals of OA along the nearshore coastal water of the north-west Bay of Bengal (BOB), by integrating *in situ* carbonate chemistry measurements (October 2024 - September, 2025) with long-term (2004-2024) satellite-based remote-sensed oceanographic data. This study was conducted from the coastal regions of the north-west Bay of Bengal (BoB) represented by different stations, namely Digha, Shankarpur, Tajpur and Mandarmani. A combination of both methods provides a holistic view of the complex ecological system. Key parameters to assess OA were pH, Total Alkalinity (TA) and its components (Hydroxide, Carbonate and Bicarbonate fractions), Dissolved Inorganic Carbon (DIC), partial pressure of CO_2 (pCO_2), carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-) concentration, aragonite saturation state (Ω), Particulate Inorganic Carbon (PIC), Particulate Organic Carbon (POC). To interpret more accurately, supporting physical, biochemical and hydrological parameters such as Sea Surface Salinity (SSS), Sea Surface Temperature (SST), Dissolved Inorganic Nitrogen (DIN, including Nitrate, Nitrite, Ammonia), Dissolved Inorganic Phosphate (DIP), Dissolved Inorganic Silicate (DSi), Chlorophyll a concentration (Chla), Absorption due to Phytoplankton at 443nm (Aph), Coloured Dissolved Organic Matter (CDOM), Suspended Particulate Matter (SPM), Diffusion Attenuation Coefficient (K_d), Photosynthetically Active Radiation (PAR) were analyzed by either *in situ* sampling, satellite imagery or both. The spatio-temporal analysis showed some distinct shifts in carbonate chemistry as in winter pH drops with a rapid decline in alkalinity. Results of other parameters also suggest a near-future threat of OA in this region. This environmental stressor influences the PSC abundance, as strong evidence from RS data suggests that smaller PSC (pico and nanophytoplankton) abundance declined and larger PSC (microphytoplankton) abundance increased over time from 2004 to 2024. As global warming and carbon emissions continue to rise, we believe that it will further shift the PSC distribution to larger forms, thereby affecting the food web dynamics due to biodiversity loss and resultant impact on the blue economy of the region.

T2-A10

Elevated CO2-driven population-specific epigenome modulation may be a strategy for Adaptation

Sribash Roy[1]
[1]Department of Plant Sciences, University of Hyderabad, Telangana
Email: sribashroy@uohyd.ac.in

Adaptation is a permanent process where genetic changes in an entire plant population have been fixed over many generations by selective environmental pressure. Genetical basis of adaptation has been studied in detail. However, recent reports have focused on the epigenome of organisms that contribute to the adaptation process, if fixed over generations. Rise in atmospheric [CO_2] is imposing a great threat to the environment. Unravelling the plants responses towards rising atmospheric [CO_2] have largely been explored in genetical and morpho-physiological contexts. However, epigenetic factors, including DNA methylation and small RNAs, which play critical roles in adaptation, are largely unexplored. Depending on the phyto-geographic origin of species, it may respond differentially towards elevated [CO_2]. Our previous data suggested that two populations of *Arabidopsis thaliana* originating at very high (3500 m amsl) and low (700 m amsl) undergoes differential remodeling of their methylation pattern under e[CO_2]. However, the global methyl cytosine content remained unchanged but local level variations occurred depending on the origin of the population. Further, there was a loss of methylation and more protein-coding genes were differentially methylated than in other genomic contexts in both populations but more so in the low elevation one. The differential methylation status was validated in a few genes. Besides, a few small RNAs, an epigenetic regulator class, were also differentially expressed in response to elevated CO2. One *TSB4* gene is differentially methylated as well as differentially expressed under elevated CO2. We show that *TSB4*is regulated by RdDM pathway via 24nt siRNA. We identified a small RNA that mapped to the differentially methylated genes. Our data suggested the 24nt siRNA mapping to the differently methylated region of the *TSB4* promoter (upstream 1kb), which is differentially expressed in the low elevation population but not in the high elevation population. Understanding the evolution of epigenetic response towards e[CO_2] may help in future crop improvement strategies.

T2-A11

Climate change vulnerability and risk assessment of the forestry sector in Jammu & Kashmir

Padma Sharma[1*], Majid Farooq[1]
[1]Department of Ecology, Environment and Remote Sensing, Paryavaran Bhawan, Jammu and Kashmir, India
Email: padmasharma17@gmail.com

The National Action Plan on Climate Change (NAPCC), launched by the Government of India in June 2008, provides a comprehensive framework for addressing climate change through adaptation and the promotion of sustainable development. In line with this national strategy, the Jammu and Kashmir State Action Plan on Climate Change (SAPCC) adopts the IPCC AR5 framework to evaluate climate vulnerability and risk across key sectors, including the forestry sector. The assessment combined modelling approaches and data analysis to evaluate hazard, exposure, and vulnerability indicators. For the forestry sector, district-level data on biophysical and socio-economic parameters were analysed to identify the top two most vulnerable and at-risk districts. Indicators considered included total fire incidences detected (No.), road density (disturbance index) (km/ sq km), area under slope >30° (%), rural population (No.), dry days (No. of days/ year), forest area to total geographical area (%), biological richness (%) and mean temperature (Tmean). In terms of vulnerability, Rajouri recorded the highest total fire incidences (823) and ranked 4th in road density (2.1 km/sq km), while Udhampur had the second-highest total fire incidences (557) and ranked 6th for area under slope >30° (56.7%). For risk ranking, Jammu had the highest rural population (836,046) and maximum dry days (278.9 days/year), whereas Udhampur ranked 2nd in forest area proportion (57.23%) and 4th in Tmean (18.85°C). Districts such as Shopian and Baramulla are highlighted as high-risk zones, primarily due to greater exposure to climate extremes, forest area loss, and human pressures. The analysis highlights district-specific drivers of vulnerability and risk in the forestry sector,

indicating the need for targeted adaptation measures. Rajouri and Udhampur require enhanced fire management and slope stabilization strategies, while Jammu and Udhampur need climate-resilient forestry practices to address socio-economic exposure and climatic stressors. Pulwama, Shopian, and Baramulla emerge as priority districts for forest risk reduction and adaptation planning. Integrating these findings into SAPCC implementation can strengthen resilience in the forestry sector under changing climate conditions.

T2-A12

Stress adaptation strategies in *Cenchrus biflorus* under Ozone and heatwave conditions in Arid Rajasthan.

Sanjay Anand[1*], Nivedita Chaudhary[1]
[1]Department of Environmental Science, Central University of Rajasthan, Ajmer, India
Email: 2022phdenv008@curaj.ac.in

Arid ecosystems face concurrent stresses from rising tropospheric ozone and heat waves. *Cenchrus biflorus*, a drought-tolerant grass, provides a relevant model to evaluate how multiple stressors influence physiological and biochemical processes in native arid grasses; yet integrated field-to-lab insights remain limited. We hypothesize that there will be independent and interactive effects of elevated ozone and heat waves on growth, pigment composition, and antioxidant metabolism. Our objectives are to quantify morphological and biochemical responses under individual and combined stresses and to elucidate the role of antioxidant defenses in mediating stress tolerance. Plants were collected and acclimatized in open-top chambers and exposed to four treatments: ambient control, elevated ozone (+20 ppb), heat wave, and combined ozone + heat wave, with measurements taken at flowering. Data included growth metrics, pigment content, oxidative stress markers, antioxidant enzyme activities, and stomatal conductance. All stresses reduced growth relative to the control; the combination of ozone and heat produced the largest declines in leaf area and leaf number, accompanied by a compensatory increase in root length. Pigments declined (chlorophyll, carotenoids) while flavonoids and anthocyanins increased, indicating activation of secondary metabolism and antioxidant defenses. Total phenolics and ascorbic acid rose under stress, especially under the combined treatment. Antioxidant profiling revealed distinct patterns: heat stress upregulated CAT, DHAR, and MDHAR; ozone and the combined treatment induced APX and POX, respectively, with GR rising across all stresses, underscoring redox regulation. Stomatal conductance declined under ozone and showed partial recovery under the combined treatment, suggesting adaptive regulation of gas exchange. *Cenchrus biflorus* exhibits compartmentalized biochemical adjustments enabling survival under concurrent ozone and heat stress; the shift from growth toward enhanced antioxidant metabolism reflects an adaptive trade-off prioritizing cellular protection over biomass accumulation. These findings advance understanding of resilience mechanisms to multiple climatic stressors and inform predictions and management strategies for arid-region grasslands under future climate and air-quality scenarios.

T2-A13

Transcriptomic insights reveal cross-talk between biotic and abiotic stress pathways in rice under combined elevated CO_2, O_3, and temperature

Rushna Jamal[1*], Vivek Pandey[1]
Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow, India
Email: rushna.zarrin@gmail.com

Global climate change imposes multiple interacting abiotic stresses that critically constrain rice productivity. To elucidate the molecular basis of stress tolerance, transcriptome profiling was performed on two tolerant (NDR-2064, NDR-2065) and two sensitive (CSR-43, Shambha Sub-1) rice genotypes exposed to combined elevated CO_2,

O_3, and temperature (eCO_2 + eO_3 + eTemp) conditions, for three consecutive seasons, using Free-Air Enrichment Facility (FACE). The average gaseous concentrations achieved in the FACE rings were 521 ± 10 ppm CO_2 and 73 ± 4 ppb O_3, compared to ambient levels of 411 ppm CO_2 and 52 ppb O_3. In temperature rings, the mean canopy temperature was maintained at ~30.1°C, about 1.4°C higher than the ambient (~28.7°C), ensuring consistent exposure across the seasons. Differential expression analysis revealed a marked contrast in transcriptional responses: tolerant genotypes exhibited 2,117 upregulated and 7 downregulated genes, whereas sensitive genotypes showed 1,589 upregulated and 663 downregulated genes, reflecting genotype-specific transcriptional reprogramming under combined stress. Gene Ontology and pathway enrichment analysis demonstrated that tolerant varieties preferentially activated processes related to photosynthesis, energy metabolism, ion transport (ATPases, ABC, and HAK transporters), and protein stabilization, thereby maintaining cellular homeostasis under stress. In contrast, sensitive genotypes displayed enrichment in carbohydrate metabolism, cell wall modification, and secondary metabolite synthesis, indicative of a defensive yet energy-intensive response. Interestingly, numerous genes associated with biotic stress resistance—such as kinases, pathogenesis-related proteins, and transcription factors—were also upregulated in tolerant varieties under abiotic stress. This suggests a potential cross-tolerance mechanism, wherein varieties bred for biotic resistance exhibit enhanced abiotic stress resistance through convergent defense signalling and transcriptional regulation. Consistent with this, NDR-2065 showed the highest increase in grain yield (+89%), while NDR-2064 also exhibited a moderately significant rise (+35%) under combined stress, in comparison to their respective controls. In contrast, the sensitive varieties CSR-43 (–25%) and Shambha Sub-1 (–37%) showed substantial grain yield reductions, reflecting their poor assimilate partitioning and limited adaptive capacity under multifactorial stress. Overall, these findings underscore the molecular coordination that enables tolerant rice genotypes to maintain photosynthetic efficiency and energy balance under multifactorial stress, offering valuable insights and candidate genes for developing climate-resilient rice cultivars.

T2-A14

Climate-smart wheat: Comparative evaluation of cultivar resilience under multiple stresses

Sharfa Naaz[1,2], Mohammad Israil Ansari[2], and Vivek Pandey[1*]
[1]Plant Ecology and Climate Change Science Division, CSIR-NBRI, Lucknow, India[2] | Department of Botany, University of Lucknow, India
Email: pandey64@gmail.com

Climate change poses a significant threat to global wheat productivity, as rising atmospheric concentrations of carbon dioxide (CO_2), ozone (O_3), and temperature have a marked influence on plant growth and physiological processes. Despite substantial research efforts, limited information is available on how these climatic stressors interactively affect the resilience of wheat cultivars, particularly under combined elevated CO_2, O_3, and temperature (ECO_2 + EO_3 + ETemp) conditions. The present study hypothesized that elevated CO_2 may alleviate the adverse impacts of O_3 and temperature stress, and that cultivar-specific variations would determine the extent of resilience. To test this, eight wheat cultivars were evaluated for their growth, biomass accumulation, and physiological performance under individual and combined climate change variables. Plants were exposed to elevated CO_2 (550 ppm), elevated O_3 (ambient + 20 ppb), elevated temperature (ambient + 2 °C), and their combinations (ECO_2 + EO_3 and ECO_2 + EO_3 + ETemp), while ambient conditions served as the control. Key growth parameters (root length, shoot height, leaf area, and biomass) and physiological traits (photosynthetic rate and stomatal conductance) were quantified and compared across treatments. Among the tested cultivars, DBW 187 and WB 02 exhibited superior growth and biomass maintenance,

particularly under ECO_2 and combined ECO_2 + EO_3 + ETemp conditions. Similarly, DBW 187 and HD 2967 demonstrated strong physiological adaptability by sustaining photosynthetic activity and stomatal conductance under multi-stress environments. In contrast, PBW 154 showed marked reductions in all measured parameters, indicating poor resilience to combined climatic stresses. Overall, the findings reveal substantial cultivar-specific variability in wheat responses to concurrent climate change factors. The superior performance of DBW 187 and HD 2967 highlights their potential as promising candidates for future breeding programs aimed at developing climate-resilient wheat cultivars, thereby ensuring stable productivity under projected environmental scenarios.

T2-A15

Decoding the adaptive blueprint of *Gladiolus grandiflora* L. in soil and hydroponic systems

Piyush Verma[1*], Chandra Sekhar Mohanty[1*]
[1]Department of Botany, University of Lucknow, Lucknow, Uttar Pradesh-226001, India | CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow, Uttar Pradesh-226001, India
Email: cs.mohanty.nbri@csir.res.in

This study examined how two *Gladiolus grandiflora* L. cultivars "Yellow Nova Lux" and "White Prosperity" adapt to two different growing conditions: in traditional soil grown and a hydroponic setup. We compared their growth, physiology, biochemistry, anatomy, and gene expression to understand how growing conditions influence plant performance. Plants grown in the hydroponic system flowered earlier, produced more and larger florets, and developed bigger corms and a greater number of cormels than those grown in soil. They also showed higher photosynthetic rates, better water-use efficiency, and increased chlorophyll and carotenoid contents, indicating improved overall physiological health. Antioxidant testing using the DPPH assay revealed stronger radical scavenging activity in both cultivars under hydroponic conditions, with "Yellow Nova Lux" showing the highest antioxidant capacity suggesting greater stress tolerance and better postharvest quality. Microscopic observations supported these results, showing that hydroponically grown plants had wider vascular bundles, more organized parenchyma tissues, and broader stomata, which likely enhanced nutrient transport and gas exchange. Overall, hydroponic cultivation significantly improved floral quality, growth efficiency, and stress resilience in *G. grandiflora*. These findings highlight hydroponics as a sustainable and resource-efficient alternative to soil-based cultivation, offering a reliable way to produce high-quality gladiolus flowers year-round while reducing environmental impact and supporting commercial floriculture.

T2-A16

Temperature-controlled dormancy release in hybrid Aspen

Rishikesh Bhalerao[1*]
[1]Professor, Department of Forest Genetics & Plant Physiology, Swedish University of Agricultural Sciences (SLU), Umeå, SWEDEN
Email: rishi.bhalerao@slu.se

Trees in boreal and temperate regions undergo annual cycle of growth and dormancy. To survive winter, growth in shoot apex terminates and shoot apical meristem and growth arrested leaf primordia are enclosed within an apical bud. Growth arrest in buds is maintained through the winter by establishment of bud dormancy. For reactivating growth in spring during bud break, dormancy must be released. Dormancy is released gradually by prolonged exposure to low temperature so that bud break can be timed to coincide with the onset of spring. Dormancy release must be tightly regulated because premature dormancy release cause frost damage to buds. Robust temporal regulation of dormancy release requires buds to integrate a highly noisy temperature signal, the mechanism of which has remained elusive. I will describe our recent findings that reveal

how dynamic regulation of cell-cell communication acts as a variable temperature processing system for robust regulation of dormancy release in model tree hybrid aspen.

T2-A17

Variation in Functional traits of *Odontoschisma* species across the elevational gradient in the alpine ecosystem of the Western Himalaya, India

Ramya Ranjan Paul[1,2*], Soumit K. Behera[1,2*], Krishna Kumar Rawat[1,2]
[1]CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow, Uttar Pradesh, 226001, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, U.P.
Email: ranjanramya367@gmail.com, soumitkbehera@gmail.com

High-latitude and high-elevation ecosystems are projected to experience disproportionately severe impacts of climate change, accelerating biodiversity loss and altering ecosystem functioning. Functional trait-based approaches have therefore become essential tools for understanding how species respond to environmental gradients. Mountain systems, with sharp climatic transitions over short distances, provide an ideal setting for examining trait variation. The Himalaya, a global biodiversity hotspot, supports diverse habitats across one of the world's largest elevation gradients; however, functional traits of non-vascular plants, particularly bryophytes key components of alpine ecosystems remain poorly documented. In this study, we examined plant length and width, stem and leaf size, medullary and basal leaf cell dimensions, biomass, and water-relation parameters of *Odontoschisma* species across an elevational gradient (3000–4000 m) in the alpine ecosystem of the Western Himalaya. At each elevational band, ten healthy individuals of each species were collected, and detailed microscopic slides were prepared to measure morphological and anatomical traits. Biomass and water-relation parameters were quantified to evaluate their adaptive significance across the elevation. Although two *Odontoschisma* species (*Odontoschisma denudatum* (Mart.) Dumort. and *Odontoschisma sphagni* (Dicks.) Dumort.) have previously been reported from India, our assessment recorded only *O. denudatum* at the study sites and additionally identified *Odontoschisma pseudogrosseverrucosum* Gradst., S.C. Aranda & Vanderp., newly recorded for South Asia. Significant functional trait variation was observed across elevation ($p < 0.05$). Plant size, leaf dimensions, cuticle density, cell size, stem cross-sectional area, biomass, and water-storage capacity all varied markedly with elevation. Mid-elevations exhibited wider leaves, higher biomass, and the greatest water-storage capacity. Between the two species, *O. denudatum* displayed higher biomass than *O. pseudogrosseverrucosum*, indicating differential adaptive strategies along the gradient. Biomass was strongly influenced by plant and leaf size, whereas water-relation parameters showed no such dependence. Overall, this study provides the first detailed account of functional trait variation in *Odontoschisma* species across a Himalayan elevational gradient. The findings enhance understanding of trait–trait relationships in alpine ecosystem and offer a baseline for predicting their responses to future climate change in high-mountain ecosystems.

T2-A18

In situ light-response of photosynthesis of five tropical tree species across three forest types and contrasting canopy environments in the Similipal Biosphere Reserve, India

Sonik Anto[1,2]*, Soumit K. Behera[1,2], Ramya R. Paul[1,2], Manas R. Mohanta[3], Sudam C. Sahu[3]
[1]Plant Ecology and Climate Change Science Division, CSIR - National Botanical Research Institute, Lucknow-226001, Uttar Pradesh, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad- 201002, India | [3]Department of Botany, Maharaja Sriram Chandra Bhanjadeo University, Baripada 757003, Odisha, India
Email: meetsonik@gmail.com

Understanding species-level photosynthetic acclimation to light environments is critical for predicting forest response to increasing canopy fragmentation and climate variability. We quantified *in situ* light response of five dominant tropical tree species (*Shorea robusta*,

Croton persimilis, *Syzygium cumini*, *Schleichera oleosa*, and *Macaranga peltata*) across three forest types—Dry Deciduous (DDF), Moist Deciduous (MDF), and Semi-evergreen (SEF)—in Similipal Biosphere Reserve, India, during the pre-monsoon season. Using portable gas exchange and incident PAR measurements, we constructed photosynthetic light-response curves under contrasting light environments (open vs closed canopy) and fitted Gaussian response functions to derive maximum photosynthesis (Popt), saturating irradiance (PARopt), and response breadth (Ω). Across species, open-canopy leaves exhibited significantly higher Popt (+32%) and higher PARopt (+260–420 µmol m^{-2} s^{-1}) relative to closed-canopy leaves, indicating strong light acclimation. *Shorea robusta* and *Schleichera oleosa* showed the highest Popt (11.2-13.4 µmol CO_2 m^{-2} s^{-1}) and broadest Ω values, consistent with high-light adaptation in deciduous forests. *Croton persimilis* showed intermediate performance whereas *Syzygium cumini* and *Macaranga peltata* showed lower Popt, lower PARopt, and higher initial quantum efficiency under shaded conditions, reflecting shade tolerance. Forest-type effects were moderate; DDF species showed higher Popt under open canopy, whereas SEF individuals displayed broader Ω, consistent with heterogeneous light environments. No species showed sharp declines at peak irradiance, suggesting moderate resilience to high pre-monsoon PAR and vapor pressure deficit, though closed-canopy leaves approached saturation sooner. Our results demonstrate coordinated yet species-specific acclimation to light gradients in Similipal forests, with emergent trade-offs between shade tolerance and high-light productivity. These findings imply that increased canopy opening due to anthropogenic or climate-driven disturbances may favor light-acclimated species (*S. robusta*, *S. oleosa*) while potentially disadvantaging shade-adapted taxa (*S. cumini*, *M. peltata*). Incorporating species-level light physiological traits into forest management strategies can improve predictions of carbon dynamics and community shifts under future disturbance and warming scenarios.

T2-A19

Response of elevated temperature and ozone stress on physiology and growth of selected tropical tree species

Athira S Nair[1,2]*, Soumit K Behera[1,2]
[1]Plant Ecology and Climate Change Science Division, CSIR - National Botanical Research Institute, Lucknow-226001, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad- 201002, India
Email: athirasnair1599@gmail.com

Recent global climate change has become a threat to the growth and survival of life on the planet earth. Rising temperature because of increasing greenhouse gases in the atmosphere directly influence plant function, productivity, and ecosystem stability. Among these gases, increasing ozone concentration in the atmosphere is detrimental to plant growth and survival. Therefore, it is imperative to understand how tropical tree species respond to these changing environmental variables that could help in predicting future forest dynamics and carbon balance. Controlled experimental systems such as Open Top Chambers (OTC) and Free-Air Concentration Enrichment (FACE) facilities have been widely used to simulate future climate scenarios and assess plant responses under near-natural conditions. In the present research plan, we propose to investigate the individual and interactive effects of elevated temperature and elevated ozone on selected tropical tree species *Syzygium cumini, Ficus virens*, and *Tectona grandis* under FACE facilities. Despite substantial advances in understanding plant responses to climate change in temperate trees, studies involving tropical tree species under such open-field systems remain limited. The lack of experimental evidence from tropical regions poses a significant gap in predicting forest resilience, carbon sequestration potential, and physiological acclimation mechanisms under future climatic scenarios.

Addressing this gap is essential to enhance our understanding of how tropical forests will respond to the combined stressors of a temperature and ozone.

T2-A20

Unravelling the interactive effects of elevated O_3 and temperature on crop physiology, growth, yield and adaptive strategies

Hritika Goyal[1,2*], Tarannum Khan[1,2], Richa Rai[1,2]
[1]CSIR-National Botanical Research Institute, Lucknow, India | [2]Academy of Scientific and Innovative Research (AcSIR) Ghaziabad, India
Email: hritikagoyal190@gmail.com

Tropospheric ozone (O_3) and elevated temperatures are among the most critical abiotic stressors limiting global crop productivity under climate change. While their individual effects on crop physiology, photosynthesis, reproduction, and yield are relatively well established, their interactive impacts remain poorly understood. Elevated O_3 induces oxidative stress by generating reactive oxygen species (ROS), which disrupt stomatal regulation, reduce photosynthesis, and impair membrane stability. These effects alter biomass allocation and reproductive processes, including pollen viability, leading to yield losses ranging from 7–26% in major crops such as wheat, rice, maize, and soybean. High temperatures further destabilize cellular membranes, decrease Rubisco activity, impair photosystem function, and compromise reproductive success through reduced pollen viability, anthesis, and embryo formation. Together, these factors alter grain filling and allocation patterns, resulting in substantial yield reductions. Findings suggest that plant responses to O_3 and temperature exhibit similarities and may interact synergistically, additively, or antagonistically depending on species, developmental stage, and environmental conditions. Stomatal regulation and reproductive stages emerge as key determinants of plant vulnerability under combined stresses. Current crop models often treat O_3 and temperature separately, underestimating yield losses. Integrated physiological, molecular, and modeling approaches are therefore essential to improve predictions, guide breeding programs, and develop adaptive strategies to ensure global food security in a warming world.

Theme 3:

Plant responses to environmental pollution

T3-A1

Impacts of ozone pollution on crops: insights from experimental work and global modelling

Felicity Hayes[1*]
[1]UK Centre for Ecology and Hydrology, Bangor, Gwynedd, LL57 2UW, United Kingdom; United Nations Convention on Long-Range Transboundary Air Pollution - International Cooperative Programme on Natural Vegetation and Crops, United Kingdom
Email: fhay@ceh.ac.uk

Tropospheric ozone is an air pollutant that enters plants through the stomata and can cause damage to cells, affect metabolic processes, and sometimes lead to changes in phenology and biomass partitioning. In the short term, ozone pollution can cause a near-instantaneous effect on photosynthesis. Ozone-induced chlorosis can occur, with reductions in chlorophyll caused by ozone that further reduce the photosynthetic capacity, and this has been demonstrated for crops such as wheat, finger millet, pearl millet and bean. The quantity and quality of the crop can be affected, with many crops across the world showing negative impacts. Ozone-sensitive crops include the pulses soya, peanut, beans, cowpea and chickpea. Other ozone-sensitive staple crops include wheat, potato and sweet potato. Estimated global yield losses due to ozone are substantial, with calculated annual losses of 7% for wheat, and 12% for soybean. For some individual countries, the losses are much higher.

For wheat, ozone affects grain fill, including re-mobilisation of nitrogen to the grains, which reduces the total protein yield of wheat. The upper leaves contribute most to grain fill, and early onset of senescence is the primary cause of ozone-induced reductions in grain quantity and quality. Modelling of impacts is improved using ozone uptake rather than ozone concentration as the ozone metric, and further improved using photosynthesis-based models that take early senescence and the shortening of the grain fill time into account. Grain concentrations of some micronutrients were also affected by ozone, with interactive impacts of heat and drought stress.

Further knowledge of the combined impacts of ozone and climate conditions is important, including the physiological understanding of how the underlying metabolic processes are affected. These can further enhance country- and regional-scale modelling, as ozone pollution can be co-located with other stresses, giving variations in the extent of impact even within a country. In addition to meteorological stresses such as heat waves, there is also an impact of irrigation schemes through the changes to stomatal opening via soil moisture availability, and sometimes the benefit of irrigation can be lost due to increased consequent ozone uptake and ozone impacts. Large-scale regional and global modelling is increasingly important as this can be used to inform policy decisions that cover a range of potential scenarios involving reductions of emissions of ozone precursors, and also climate and environmental policies relating to climate change strategies.

This talk will cover insights from experimental work, combined with regional and global modelling examples that highlight how ozone affects crop yield and how this knowledge can be applied and interpreted at a broad scale.

T3-A2

Impact of arsenic-contaminated soil and water on rice physiology, nutritional traits and food safety

Aseem Trivedi[1*], **Sejal Shukla**[1], **Jagriti Suryavanshi**[1], **Sanjay Dwivedi**[1], **Seema Mishra**[1]
[1]Department of Chemistry, University of Lucknow, Lucknow-226007, India
Email: aseemtrivedi18@gmail.com

Arsenic contamination in rice is a growing global health concern, particularly in regions like South Asia due to the use of As contaminated groundwater for irrigation. This is especially more pronounced in developing countries such as Bangladesh and India where groundwater contamination levels of As far exceeds the WHO's safety threshold of 10 μgl^{-1}. In many parts of India the agricultural soil often exceeds the normal level of As i.e., $5mgkg^{-1}$, further in West Bengal and Eastern

districts of Uttar Pradesh, the level of As in soil is frequently exceeding the FAO threshold limit of 20 mg kg^{-1} for agricultural soils. It has been scientifically proven that irrigation with arsenic water significantly increases arsenic concentration in the rice plant tissues. The Codex Alimentarius Commission, a global authority on food standards, recommends limiting total arsenic in rice to 300 μgkg^{-1} and inorganic arsenic to 200 μgkg^{-1}. In recent years, it has been observed that As exposure restricted photosynthetic rates, water use efficiency, and stomatal conductance, impairing rice growth and yield. These physiological changes contributed to alterations in sugar and metabolite composition. As accumulation in rice not only compromise yield but it significantly hamper the nutritional and cooking quality of rice. Arsenic toxicity affects key components like amylose, lipids, proteins, vitamins, and amino acids. Farmers in eastern Uttar Pradesh widely cultivate short-grain aromatic varieties, such as Kanak Jeera, Shakkar Chini, Vishnu Bhog, Chini Kapoor, and Kalanamak. It has been noticed that the aroma quality of these rice varieties is reducing in recent years, however, the underlying reason is yet unknown. The climatic and environmental factors may be the potential cause. Since in these regions, paddy soil has been shown to have significant level of As contamination, thus, it is worthwhile to understand if As also hamper the aroma quality of rice similar to other quality traits. This understanding will add to improved agricultural practices in As contaminated areas.

T3-A3

Effect of Fluoride during early phase of plant development in *Vigna radiata* and *Vigna mungo*

Gayatri Singh[1*], Geetgovind Sinam[1], Rekha Kannaujia[1]
[1]Environmental Science Division, CSIR-National Botanical Research Institute, U.P., India
Email: gayatrisingh.15@gmail.com

India is one of the top producers of pulses in the world. Thus, the effect on quantity and quality of pulse production has a great significance on the economy, food security, and health. The areas where these pulses are grown are known for fluoride contamination in its soil. The aim of the study is to assess the effect of F^- on the growth parameters of *Vigna radiata* and *Vigna mungo*, during the early phase of their growth. The study also examined the role of antioxidant enzymes in stress tolerance from F-induced toxicity. The present study showed the accumulation of F^- in the *V. radiata* and *V. mungo*, in a dose-dependent manner. The level ranged from 3.51 – 4.96 $\mu g\ g^{-1}$ and 2.81 – 2.88 $\mu g\ g^{-1}$ in the root and leaves, respectively, at the contamination level of 30 $\mu g\ F^-\ g^{-1}$ (F30). The content of stress marker malondialdehyde and the antioxidant peroxidase enzyme increased in the plant tissue with increasing fluoride stress. Furthermore, photo-assimilates and carbon carrier molecules, i.e., sucrose content, increased by 26.3 and 11.4-fold in the root, while 25.3 and 19.1-fold in the leaf part of *V. radiata* and *V. mungo*, respectively. However, the enzyme involved in the first step of the nitrate assimilation pathway, i.e., nitrate reductase reduced by 5.5 and 5.0 fold in the root part of *V. radiata* and *V. mungo*, respectively. This is the first time reporting the cytotoxicity of fluoride on pulse crops*V. radiata* and *V. mungo*, where the mitotic index was reduced; an increase in relative abnormality rate and chromosomal aberration. The study would help the agriculturist in the cropping of pulse plants in F-contaminated areas of the country.

T3-A4

Calcium and potassium reduce lead toxicity in *Amaranthus tricolor* by modulating antioxidant defense mechanisms

Kamrun Nahar[1,*], Md. Sawrab Mia[1], and Mirza Hasanuzzman[2]
[1]Department of Agricultural Botany, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh | [2]Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh
Email: knahar84@yahoo.com

Plants exhibit morphological and physio-biochemical disarrays due to lead [Pb; 1000 µM Pb $(NO_3)_2$] exposure. The role of calcium [Ca, 5 mM Ca $(NO_3)_2$] and potassium (K, 5 mM K_2CO_3) in reducing Pb toxicity in amaranth (*Amaranthus tricolor* cv. BARI Data-2) was examined considering a Complete Randomized Design (CRD) with 3 replications. Relative water content (RWC %) decreased, but proline (Pro) content increased under Pb stress. Adding Ca or K, in combination with Pb further increased Pro and RWC. Lead stress increased H_2O_2 and destroyed membrane properties. The increase in lipid peroxidation/malondialdehyde (MDA) of Pb-affected lettuce indicates that the membrane property was adversely affected. In contrast, when plants were applied with Ca or/and K, plants showed improved membrane properties, reducing H_2O_2/MDA level. In amaranth, ascorbate (AsA) content decreased, but glutathione (GSH) content increased under Pb stress, but Ca or K addition increased both the AsA and GSH contents under Pb stress. The addition of Ca or K increased the activity of APX, DHAR, and GR under Pb stress. Chlorophyll *a and* Chlorophyll *b* contents decreased under Pb stress. Shoot fresh weight and root fresh weight decreased under Pb stress. When plants were applied with Ca or/and K increased the chlorophyll contents and growth parameters of Pb-affected plants.

T3-A5

Exogenous iron supplementation as a strategy to combat nickel-induced oxidative stress in *Solanum lycopersicum* L.

Nilu Singh[1*], Divya Dubey[1], Rajiv Dwivedi[1], Grish Chandra Pathak[1]
[1]University of Lucknow, Lucknow-226021, U.P., India
Email: nilu02072000@gmail.com

This study investigated the mitigation of nickel (Ni) induced oxidative stress in tomato *Solanum lycopersicum* L.) through exogenous foliar application of iron (Fe). Plants were exposed to varying Ni concentrations (Control, 10 ppm, 100 ppm, and 200 ppm), with a 1% Fe foliar spray applied to plants treated with 10 ppm and 100 ppm Ni to assess its protective effect. Exposure to 100 ppm and 200 ppm Ni significantly reduced root and shoot length, fresh and dry biomass, and caused interveinal chlorosis in young leaves, eventually progressing to necrosis under prolonged stress. Ni accumulation led to decreased chlorophyll content, leaf water potential, and relative water content, impairing photosynthetic efficiency and overall plant health. Antioxidant enzyme activities (SOD, POD, APX) increased with higher Ni concentrations, whereas CAT activity increased at 10 ppm Ni but declined at 100 ppm and 200 ppm. TBARS and H_2O_2 levels progressively increased with Ni concentration, reflecting heightened oxidative stress. Importantly, Fe application significantly alleviated Ni toxicity by improving plant phenotype, increasing chlorophyll content, restoring water status, enhancing antioxidant enzyme activities, and reducing TBARS and H_2O_2 accumulation. These results suggest that exogenous Fe application effectively mitigates Ni-induced oxidative damage, supporting its role in enhancing plant tolerance to heavy metal stress.

T3-A6

A comprehensive biochemical, physiological, and metabolite analysis of wheat cultivars under combined tropospheric ozone and water stress

Nivedita Chaudhary[1*] and Naziya Tarannum[1]
[1]Department of Environmental Science, School of Earth Sciences, Central University of Rajasthan, India
Email: nivedita@curaj.ac.in

Tropospheric ozone (O_3) and water stress (WS) are significant abiotic factors that adversely affect wheat growth, physiology, and yield. Elevated O_3 acts as a phytotoxic pollutant, causing oxidative stress through the production of reactive oxygen species (ROS) that damage cell membranes, decrease photosynthesis, and impede overall plant growth. Water stress restricts water availability, leading to stomatal closure that minimizes water loss and reduces CO_2 absorption and photosynthetic efficiency.

This study investigates the physiological and biochemical reactions of four wheat cultivars (RAJ-3077, RAJ-4079, RAJ-4120, and RAJ-4037) to increased ozone and water stress, both individually and in combination. These environmental stressors changed the amount of ROS that accumulated, the activities of antioxidant enzymes, and stomatal behaviour. This changed the integrity of the membrane and the stability of photosynthetic pigments. With consistent levels of carotenoid and phenolic compounds, strong ROS scavenging, and antioxidant defenses that maintained cellular homeostasis and postponed leaf senescence, cultivars RAJ-4037 and RAJ-4120 showed greater resilience. On the other hand, RAJ-3077 and RAJ-4079 were more vulnerable, showing more oxidative damage and less antioxidative ability. Although WS frequently triggered stomatal closure, which could restrict O_3 absorption, this protective response exhibited variations based on cultivar characteristics and stress severity. Apoplastic ascorbic acid emerged as an essential component in O_3 protection; yet, the diverse antioxidant defenses occasionally proved inadequate under combined stressors, leading to lipid peroxidation and cellular damage. The findings emphasize notable cultivar-specific variations in biochemical and physiological responses, underscoring the necessity of incorporating these qualities into breeding programs and crop management to improve wheat tolerance to environmental stressors, thereby providing sustainable solutions in the face of increasing pollution and climate variability.

T3-A7

Biochemical responses of wheat against zinc stress management

S.N. Pandey[1*]
[1]Department of Botany, University of Lucknow, Lucknow, India
Email: snpandey511@ gmail.com

Zinc is a micronutrient that plays an important role in cellular metabolism of plants as being activator of many enzymes, a constituent of biomolecules, a role in plant defense mechanisms, and osmoregulatory functions. Deficiency of zinc in soil is widespread in the world's arable land, including India. A bulk composite soil collected from the Janakipuram area of Lucknow district was characterized for some important fertility parameters (soil texture, density, pH, organic matter content, carbonates and bicarbonates, calcium, magnesium, and DTPA extractable available essential elements. Soil was slightly alkaline in pH (>7.4), low in organic matter (<0.3%), and moderately deficient in zinc (<0.6 ppm) and iron (ranged 4.6 ppm). Soil was applied with: I- nil (Control), II- $ZnSO_4$ @ 20 mg/kg soil III- $ZnSO_4$ @ 20 mg/kg soil + compost extract (40%) IV- $ZnSO_4$ @ 20 mg/kg soil + $FeSO_4$ @ 40 mg/kg soil and V- $ZnSO_4$ @ 20 mg/kg soil + citric acid (10 µMol.) to grow wheat (*Triticum aestivum* L.). Some important biochemical constituents (pigments, protein, activity of catalase and peroxidase, superoxide dismutase activity) were determined. Maximum growth (length and dry weight) and protein and pigment contents were observed in wheat leaves at the soil treated with zinc-enriched compost, followed by zinc and iron applications in the soil. Tissue contents of zinc and iron were also determined, 28 µg/g dry weight and 62 µg iron/g dry weight were determined at zinc-enriched compost application. Therefore, the study concluded that the zinc and iron management increased growth and biochemical constituents of wheat at all the above treatments, but the application of compost-enriched soil with zinc promoted maximum growth and biochemical constituents of wheat.

T3-A8

Plant-water homeostasis directly influences cadmium toxicity in rice

Negi P[1*], Pandey M[1], Srivastava AK[1,2]
[1]Nuclear Agriculture and Biotechnology Division, Bhabha Atomic Research Centre, Mumbai-400084, India | [2]Homi Bhabha National Institute, Mumbai-400095, India
Email: pjnegi0@gmail.com, poojan@barc.gov.in

Increasing industrialization is a continual source of heavy metal contamination for agricultural soils. Among these, cadmium (Cd) is a group I carcinogen with the highest global exceedance rate and contamination factor, which poses a serious risk to rice productivity and grain quality, with significant repercussions for rice-based agri-economies and food safety. This scenario is further complicated by changing climatic scenarios, as crops face heavy metal stress along with other dehydrating environmental stresses, including heat and drought. In view of this, the present study was performed to understand the relationship between Cd stress and plant-water homeostasis in rice. Post-germination phenotyping highlighted that Cd stress significantly reduced overall plant growth, in terms of fresh weight (0.63-fold), shoot length (0.63-fold), root length (0.35-fold) and number of crown roots (0.52-fold). Similar to rice, *Arabidopsis* plants showed a significant reduction in root growth under Cd stress, which was mediated by auxin efflux transporters (*PIN1* and *PIN4*). Although, Cd-induced growth-reduction in rice was associated with a time-course increment in Cd accumulation and ROS-injury, timing of stress imposition was found to influence the expression of Cd transporters. In plants subjected to 24-h stress regime under morning (9 PM), afternoon (2 PM) and evening (6 PM), *OsNRAMP5* was significantly upregulated (~4-fold) only under the morning stress regime, while *OsHMA2* and *OsHMA4* showed approx. 2.5-fold upregulation under the afternoon stress regime. By contrast, no significant change could be observed for evening stress imposition, suggesting a diurnal regulation of Cd transporter expression in rice. To better understand the compromised plant growth under Cd stress, time-kinetics of nutrient medium uptake (NM_{uptake}) was measured at every 24 h for a period of two weeks and data was analysed using linear fit equation. Interestingly, Cd-treated plants exhibited a dip in NM uptake within 24 h, which coincided with a reduction in medium pH, though osmolarity remained unchanged. Contrary to the positive slope (0.015) seen for control plants, Cd-treated plants exhibited a negative slope (-0.012) in NM uptake, suggesting a significant decrease in nutrient uptake over time. This was further corroborated via expression profiling of the PIP-aquaporin isoforms (major water-channel proteins), which revealed that most PIPs were either unchanged or downregulated at 24-h post-stress. Given the central role of ABA in regulating plant-water relations, we performed a post-germination phenotyping of *Arabidopsis* ABA signaling mutant lines under Cd stress, which suggested that Cd-induced growth inhibition was ABA-dependent. Taken together, our study highlights that Cd toxicity in rice is associated with disturbance in plant-water homeostasis, and this process is dependent on ABA-signaling. The inverse association between Cd stress and plant-water homeostasis can be used to devise a holistic approach for managing Cd-induced toxicity in crops.

T3-A9

Evaluation of air quality in relation to particulate matter and air pollution tolerance index of plants across different localities of Muzaffarpur city

Aditya Abha Singh[1]*, Rana Eram[2]
[1]Department of Botany, University of Lucknow, Lucknow-226007, Uttar Pradesh, India | [2]University Department of Botany, Babasaheb Bhimrao Ambedkar Bihar University, Muzaffarpur, Bihar-842001, India
Email: abha2512.singh@gmail.com

Air pollution represents a critical environmental challenge globally. In India, rapid industrialization and urban expansion have markedly intensified ambient air pollution levels. Muzaffarpur a rapidly urbanizing city in north Bihar is facing challenges due to air pollution. The study is focused on assessing air quality for a period of eight years and examining trends and temporal variations in gaseous pollutants and particulate matter in Muzaffarpur urban centre. It incorporates statistical analyses along with trajectory modelling to trace pollutant transport and dispersion, enabling identification of both regional and long-range pollution sources.

Seasonal and annual data of pollutants were analysed and pollution-rose and polar plots were designed using statistical softwares. Gaseous pollutants exhibited fluctuating patterns across the study years and remained within permissible limits. SO_2 recorded its highest concentration in 2018, NOx in 2017, while O_3 reached its peak in 2019. $PM_{2.5}$ levels were highest in 2017 and lowest in 2020. Seasonal variation showed minimum concentrations during monsoon and maximum during winter consistently exceeding the prescribed permissible limits. Moreover, metal characterization of PM showed associated heavy metals like Pb, Zn, Ni, Fe etc. Predominantly the PM source was from north-western direction of the city. Further, majority of PM pollution is due to industrial operations, transportation, and changes in land use dynamics of the city. Not surprisingly, in 2020 and 2021, air pollutants showed declining trend possibly due to COVID-19 lockdown phase, while escalated values were observed in 2023. This study examined pollution sources in Muzaffarpur and is intended to support policy refinement, guide mitigation strategies, and contribute to development of long-term plans for managing urban air quality. Incorporation of green belts along roads and highways can effectively reduce pollutant concentrations and mitigate environmental contaminants, thereby serving as a key strategy in promoting urban forestry and sustainable city planning. The study also analyzed Air pollution tolerance index (APTI) of selected plants species. Four different sites in Muzaffarpur city were selected to conduct the study, based on green areas, traffic congestion, land use, and sources of pollution. The sequence of locations based on air pollution was Akharaghat (AKG)> Bela Industrial Area (BIA)> Amgola Road (AMG)> Babasaheb Bhimrao Ambedkar Bihar University (BRABU). Because of the high traffic volume at the AKG site, a considerable accumulation of dust was observed. The highest dust deposition was observed in *Psidium guajava* (0.97 mg/cm^2) at AKG, and the lowest on *Nerium oleander* (0.32 mg/cm^2) at BRABU. The highest dust deposition was recorded on *Psidium guajava* at the AKG site, which exhibited highest pollution levels, while minimum deposition occurred on *Nerium oleander* at the BRABU site. Based on APTI, tolerant species were identified as *Azadirachta indica*, *Litchi chinensis*, *Hibiscus rosa-sinensis*, *Cassia fistula*, *Mangifera indica*, *Polyalthia longifolia*, *Psidium guajava*, *Syzygium cumini*, while *Terminalia arjuna, Dalbergia sissoo, Nerium oleander,* and *Morus alba* were comparatively sensitive. The sensitive species thus identified can be employed for pollution monitoring while the tolerant ones could be planted in urban areas to curb or minimize the air pollution.

T3-A10

Regulatory role of the miR858a–AtMYB12 module in arsenic tolerance and secondary metabolite biosynthesis under sulphur limitation in *Arabidopsis*

Aruba Khan[1,2], Gurpreet Sandhu[2,3], Ria Khare[4], Prabodh Kumar Trivedi[1,2,3]

[1]Department of Biotechnology, CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP) P.O. CIMAP, Near Kukrail Picnic Spot, Lucknow-226015, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India | [3]CSIR-National Botanical Research Institute, Council of Scientific and Industrial Research (CSIR-NBRI), Rana Pratap Marg, Lucknow-226001, India | [4]University of North Carolina at Chapel Hill, Carrboro, North Carolina, United States
Email: aruba khan61@gmail.com

Anthropogenic activities have led to widespread environmental contamination with heavy metals, among which arsenic (As) is a highly toxic metalloid posing severe risks to both plants and human health. In plants, As exposure triggers excessive generation of reactive oxygen species (ROS), causing oxidative stress and impairing cellular metabolism. To counteract these effects, plants activate detoxification mechanisms involving sulphur (S)-rich compounds such as glutathione (GSH) and phytochelatins (PCs). Sulphur, an essential macronutrient, is a structural component of several enzymes, coenzymes, and vitamins and plays a central

role in metal detoxification. Previous studies from our group identified Arabidopsis accessions Koz2-2 and Ri-0 as tolerant and sensitive, respectively, under arsenite [As(III)] and combined low-sulphur plus arsenite [LS+As(III)] stress. Sulphur deficiency has been associated with the activation of the phenylpropanoid pathway and upregulation of MYB transcription factors. Transcriptome analysis of the tolerant accession (Koz2-2) revealed higher expression of AtMYB12, a regulator of flavonoid biosynthesis. Flavonoids, derived from the phenylpropanoid pathway, play multiple roles in stress mitigation and growth regulation. The transcriptome findings were validated through RT-PCR analysis. Functional characterization showed that AtMYB12-overexpressing lines (AtMYB12OX) exhibited enhanced tolerance to LS+As(III) stress, while atmyb12 mutants were hypersensitive, confirming the positive role of AtMYB12 in stress tolerance. Interestingly, AtMYB12 expression is negatively regulated by microRNA858a (miR858a), which suppresses AtMYB12 accumulation, thereby influencing plant growth and secondary metabolism. Our findings suggest that modulation of the miR858a–AtMYB12 regulatory module enhances As tolerance while promoting the biosynthesis of secondary metabolites. This study provides new insights into the molecular interplay between nutrient deficiency and heavy metal stress and establishes AtMYB12 as a key regulatory node for improving arsenic tolerance and secondary metabolite production, with potential implications for developing resilient crop varieties.

T3-A11

Galactinol synthase 4 and marneral synthase 1 require sulfur assimilation pathway to provide tolerance towards arsenic stress under limiting sulphur condition in Arabidopsis

Gurpreet Sandhu[1,2,3], Deeksha Kesarwani[2,3], Aruba Khan[3], Ria Khare[1,2,*], Pranshu Kumar Pathak[1,2,3], Prabodh Kumar Trivedi[1,2,3,*]

[1]CSIR-National Botanical Research Institute, CSIR-NBRI, Rana Pratap Marg, Lucknow-226001, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India | [3]CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), P.O. CIMAP, Near Kukrail Picnic Spot, Lucknow, India, | University of North Carolina at Chapel Hill, UNC-Department of Biology, North Carolina, USA, Email: gurpreetsandhulko@gmail.com

Arsenic (As), a toxic metalloid and potent human carcinogen, severely limits plant growth and development. Sulphur (S), an essential macronutrient, plays a crucial role in detoxification through sulphur-rich compounds such as glutathione (GSH) and phytochelatins (PCs). Under combined As(III) stress and sulphur limitation [LS + As(III)], plants experience aggravated toxicity. Among natural Arabidopsis accessions, Koz2-2 was identified as tolerant, while Ri-0 exhibited high sensitivity under these conditions. Transcriptome analysis of these contrasting accessions revealed two key genes, Galactinol synthase 4 (AtGolS4) and Marneral synthase 1 (AtMRN1), which were highly upregulated in Koz2-2 under LS+As(III) stress. AtGolS4 encodes a galactosyltransferase, the rate-limiting enzyme in raffinose family oligosaccharide (RFO) biosynthesis, whereas AtMRN1 encodes an oxidosqualene cyclase involved in triterpene aldehyde (marneral) biosynthesis. Transgenic AtGolS4 overexpression lines (in Col-0, atgols4, and Ri-0 backgrounds) showed enhanced tolerance, while atmrn1 and AtMRN1CR:Koz2-2 mutants were sensitive to dual stress. Biochemical and expression analyses indicated higher GSH content, enhanced ROS scavenging, and reduced free sulphate in AtGolS4OX lines, contrasting with higher sulphate and lower GSH in atmrn1 mutants. Overexpression of AtGolS4 in the sulphate transporter mutant background (atsultr1;1CR) caused sensitivity, suggesting that sulphate availability limits S-based detoxification. Promoter analysis of AtGolS4 revealed MYC2-binding sites but no sulphur-responsive elements (SURE), and assays confirmed AtMYC2 as a potential

regulator. Together, these findings highlight AtGolS4 and AtMRN1 as important regulators of tolerance to combined sulphur limitation and As(III) stress, providing molecular targets for developing multi-stress-tolerant crops.

T3-A12

Quantification of pollution removal efficiency of an ornamental plant *Syngonium podophyllum* in closed chamber

Mithilesh Kishori Bhardwaj[1] and Richa Rai[1]*
[1]Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, India
Email ID: mithilesh.nbri23j@acsir.res.in

Indoor air pollution is having a great impact on human well-being as more that 90% of time humans spend their time on indoor premises. WHO has reported that 3.8 million people suffer from health issues due to polluted indoor environment. Poor IAQ has caused sick-building syndrome, nasal and ocular irritations, allergies, respiratory dysfunction and premature death. Identification of sustainable strategies to improve indoor air quality (IAQ), phytoremediation is the most novel strategy to absorb, adsorb, assimilate or transfer/reduce air pollutants. The objective of the present study is to quantify pollution removal efficiency of an ornamental plant *Syngonium podophyllum* exposed to mixture of BTEX and formaldehyde inside a closed chamber of known volume (2.264m^3). VOC concentrations were monitored using a VOC analyser over a 12-hour period per day under two scenarios: with plants (treatment) and without plants (control), each maintained for three consecutive days. The percent pollution removal efficiency (%PRE) varied influenced by factors such as leaf surface area, photosynthetic pathway, leaf surface structure, ability to sustain photosynthesis under low photosynthetically active radiation (PAR), stomatal conductance, and intrinsic detoxification mechanisms. The results suggest that *S. podophyllum* effectively reduced indoor VOC levels and holds potential as a suitable species for improving indoor air quality. Furthermore, it can serve as a model plant for mechanistic studies aimed at understanding plant-mediated VOC detoxification processes.

T3-A13

Understanding the mechanisms of arsenic tolerance and resilience in the primitive bryophyte *Marchantia polymorpha* L.

Prasanna Dutta[1,2], Kamya[1], Debasis Chakrabarty[1,2]
[1]Biotechnology and Molecular Biology Division, CSIR-National Botanical Research Institute, Lucknow 226001, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, India
Email: prasannadutta@icloud.com

This study addresses the pressing issue of high arsenic (As) contamination, which poses a severe threat to various life forms in our ecosystem. Despite this prevailing concern, all organisms have developed some techniques to mitigate the toxic effects of As. Certain plants, such as bryophytes, the earliest land plants, exhibit remarkable tolerance to a wide range of harsh environmental conditions, due to their inherent competence. In this study, bryophytes collected from West Bengal, India, across varying contamination levels were investigated for their As tolerance capabilities. Assessment of As accumulation potential and antioxidant defense efficiency, including SOD, CAT, APX, GPX, etc. revealed *Marchantia polymorpha* as the most tolerant species. It exhibited the highest As accumulation, antioxidative proficiency, and minimal damage. Transcriptomic analysis of *M. polymorpha* exposed to 40 µM As(III) for 24 and 48 hours identified several early responsive differentially expressing genes (DEGs) associated with As tolerance. These include *GSTs, GRXs, Hsp20s, SULTR1;2, ABCC2,* etc., indicating a mechanism involving vacuolar sequestration. Interestingly, one As(III) efflux-transporter, *ACR3*, an extrusion pump, known to combat As toxicity, was found to be differentially expressed compared to the control. The SEM-EDX analysis further elucidated the operation of As extrusion mechanism, which contributes to added As resilience in *M. polymorpha*. Yeast complementation assay using *acr3* yeast cells,

showed increased tolerance towards As(III), compared to the mutant cells, indicating As As-tolerant phenotype. Overall, these findings significantly enhance our understanding of As tolerance mechanisms in bryophytes. This can pave the way for the development of genetically engineered plants with heightened As tolerance and the creation of improved plant varieties.

T3-A14

Waste-derived Biochar mitigates arsenic toxicity and enhances rice (*Oryza sativa L.*) plant growth in contaminated soil

Sudhakar Srivastava[1*]
[1]Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi 221005, Uttar Pradesh, India
Email: sudhakar.iesd@bhu.ac.in

Arsenic (As) contamination in agricultural soils poses a serious threat to rice production and food safety. Therefore, this study aimed to investigate the potential impacts of different types of waste-derived biochar on As mobility in soil and the effect on As transfer and accumulation in the soil-rice system. Biochar was produced under limited oxygen conditions and applied at 1% (w/w) in soil to assess its impact on As uptake, plant physiological responses, and stress tolerance. The results showed that biochar amendments, specifically tea waste biochar (TWB), sweet lemon peel biochar (SLPB), and pomegranate peel biochar (PPB), had positive effects on plant morphology compared to plants grown in arsenic-contaminated soil alone. These effects included increased biomass, shoot and root length. The obtained result showed that the maximum increase in chl a, chl b and carotenoid was found to be 64-132%, 24-328%, and 64-108% in rice plants grown in As+SLPB amendment soil. Furthermore, biochar amendments induced an elevation in the activity of antioxidant enzymes (SOD, APX, GPX and CAT) in rice plants. SLPB amendments showed a reduction in As content in shoot and root by 37.21% and 27.26% respectively. Whereas PPB and TWB amendments also decreased As content in plants by 14-30% and 10-16%. However, banana peel-derived biochar (BPB) was found to be less effective in reducing As-induced toxicity in rice plants as compared to the other three biochar amendments. These, findings highlight the potential of waste-derived biochar as an eco-friendly strategy for sustainable rice cultivation in As-affected regions.

T3-A15

Impact of climate and metal stress on plant physiology

Pooja Sharma[1*]
[1]Department of Applied Microbial Ecology
Helmholtz Centre for Environmental Research,
Permoserstr. 15, 04318 Leipzig, Germany
E-mail: pooja.sharma@ufz.de

Metal contamination combined with climate stress strongly influences plant physiological performance, shaping growth, productivity, and resilience. In this study, we evaluated the interactive effects of cadmium (Cd) and zinc (Zn) toxicity under variable climate conditions on key physiological and morphological traits. Results showed significant reductions in plant height, chlorophyll content, total biomass, and number of leaves, indicating impaired photosynthetic efficiency and hindered carbon allocation. Metal stress accelerated leaf senescence, disrupted nutrient uptake, and altered stomatal regulation, while climate-induced heat and moisture fluctuations further intensified oxidative stress and root–shoot imbalances. Together, these stressors suppressed root development, reduced water-use efficiency, and modified cellular metabolism, ultimately limiting overall plant productivity. Understanding these combined impacts provides critical insights into plant adaptation strategies and helps develop resilient cropping systems for contaminated and climate-vulnerable environments.

T3-A16

Amelioration of arsenic induced toxicity in rice: Role of selenium and silicon in improving grain quality by reducing arsenic

accumulation in rice (*Oryza sativa* L.)

Vishnu Kumar[1,2]*, Sarvesh Kumar[1], Sanjay Dwivedi1[3#], Seema Mishra[4], Geetgovind Sinam[1], Soumit Kumar Behera[1] and Rajveer Singh Chauhan[2], Vivek Pandey[1]

[1]Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, India
[2]Department of Botany, Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur- 273009, India
[3]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India
[4]Department of Chemistry, University of Lucknow, Lucknow-226007, India
Email: vishnukumar772@gmail.com

Rice, a staple food more than half of the globe, is often exposed to arsenic (As), which disrupts photosynthesis, nutrient uptake, and antioxidant machinery, subsequently reducing growth, yield, and nutritive value. In this study, As exposure led to an 18% reduction in biological yield and a ~23% decrease in yield compared to control plants. Arsenic impaired photosynthesis by reducing essential macro-elements, caused membrane damage via reactive oxygen species (ROS) and depleted nutrients in rice tissues while increasing its own accumulation by ~11-fold. This increased level of As in grain was linked to increased health risks. This study evaluated the effects of selenite (Se^{IV}), selenate (Se^{VI}) and silicon (Si) supplementation to counteract these disruptions. The co-supplementation of Se^{IV} (1 mgl^{-1}) + Si (0.4%) was found to be a highly effective among different formulations. This treatment significantly improved rice growth, increasing yield by >100% compared to the As-only treatment. It enhanced membrane stability (~29%), restored photopigment levels and boosted photosynthesis by upto 56%. The treatment also improved grain quality markers, including carbohydrates, starch and protein, while retaining essential nutrients. Crucially, the Se^{IV} (1 mgl^{-1}) + Si (0.4%) supplementation reduced grain As levels by ~90%, bringing concentrations below WHO/FAOSTAT safety thresholds. This approach effectively mitigates As toxicity and is strongly supported as a sustainable agronomic solution.

T3-A17

Dietary cancer risk from arsenic exposure through wheat and rice in the Middle Ganga Plain, India: hotspot mapping and mitigation approaches

Pragya Sharma[1,2*], Sanjay Dwivedi[1,2#], Sarvesh Kumar[1], Seema Mishra[3], Vishnu Kumar[1], Ruchi Agnihotri[1], Ravi Kumar Tiwari[1], Abhishek Niranjan[1], Pramod Arvind Shirke[1,2]

[1]Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, India
[2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India
[3]Department of Chemistry, University of Lucknow, Lucknow-226007, India
Email: sharmapragya766@gmail.com

A field study was conducted in arsenic (As) affected regions of the Middle Ganga Plain (MGP), focusing on sixteen commonly cultivated wheat and rice cultivars across three agro-climatic zones with varying As concentrations in irrigation water and soil. The aim of the study was to assess the extent of As contamination in these major cereals and to explore their potential association with cancer risk in local populations. The study revealed that As concentrations in rice grains were up to three fold higher than in wheat, depending on total As (*t*As) levels in irrigation water, edaphic factors and crop genotypes. Its accumulation in grains was influenced by both the maturity time and plant height of the cultivar. Dwarf and semi-dwarf cultivars with shorter maturity periods accumulated approximately half As in comparison to tall and long duration cultivars. These effects were more pronounced in wheat than in rice. Phenolic accumulation was generally higher in rice than in wheat, however, cultivar specific variation dominated among the two cereals. Levels of these compounds were closely related to As accumulation in grains, where gallic acid showed a negative correlation with As accumulation, while other phenolic compounds, such as benzoic acid, coumaric acid, sinapic acid, kaempferol, and caffeic acid, exhibited strong positive correlations in wheat grains. Cumulative As intake from wheat or rice based diets, coupled with the use of As laden water for dough preparation and rice cooking, can lead to significantly increased cancer risk (*i.e.*>80 fold) in local populations. However, proper rinsing of rice (before cooking) and wheat (before flour preparation) grains in a 1:3 rice/wheat to water ratio could significantly reduce the cancer risk. Furthermore, the cultivation of short duration

cultivars and rinsing their grains may lead to an average reduction of 18% in cancer risk.

T3-A18

Dual impact of climate change and soil arsenic on growth, yield, and quality of rice (*Oryza sativa* L.)

Sarvesh Kumar[1,2]*, Vishnu Kumar[1], Pragya Sharma[1], Ruchi Agnihotri[1], Rajesh Kumar Tewari[2], Sanjay Dwivedi1[3#] and Vivek Pandey[1,3]
1Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, India
2Department of Botany, University of Lucknow, Lucknow-226007, India
3Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India
Email: sarveshkumar891994@gmail.com

Climate change and soil arsenic (As) contamination represent two converging environmental challenges that threaten rice productivity, quality, and food safety. Using Free-Air Concentration Enrichment (FACE) experiments, this study examined the individual and combined effects of elevated carbon dioxide (eCO_2), ozone (eO_3), and temperature (eTemp) under low and high As exposure on rice (*Oryza sativa* L.) growth, yield, and metabolic responses. Elevated CO_2 significantly enhanced shoot biomass, particularly under low As, while eTemp markedly reduced both shoot and root biomass, and eO_3 had minimal effects. Combined climatic stressors produced moderately positive effects on growth. Under low As, eCO_2 and eO_3 promoted root proliferation but restricted shoot elongation, whereas eTemp consistently suppressed both. High As exposure further aggravated yield losses, with the greatest reductions under eTemp (66%), followed by eCO_2 (48%), eO_3 (16%), and their combination (35%). Climatic stressors reduced sugar metabolite accumulation, whereas As exposure increased them. Most climatic variables decreased grain As concentration; however, eCO_2 under high As conditions raised grain As by ~9%, resulting in an estimated lifetime cancer risk of 65 individuals per 10,000 population, compared with 37 and 34 under eO_3 and eTemp, respectively. Despite this risk, higher amylose content under eCO_2 and As exposure may improve the dietary glycemic index. Overall, the interaction between climatic stressors and As contamination poses a dual threat to rice productivity and human health, emphasizing the need for As-resilient, climate-adaptive rice cultivars for sustainable food security.

T3-A19

A Metal-Binding Expansin-Like Protein (*OsELP*) Confers Arsenic Tolerance in Rice

Khushboo Chawda[1,2,*] and Debasis Chakrabarty[1,2]
[1]Molecular Biology and Biotechnology Division, CSIR-National Botanical Research Institute, Lucknow 226001, India
[2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, India
[*]Email: khushboochawda8@gmail.com

Arsenic (As) contamination in rice poses a significant health risk due to its toxic and carcinogenic properties. To mitigate As toxicity, plants utilize complex defense mechanisms, including the activation of stress-responsive genes. In this study, we identified OsELP, an expansin-like protein, as an As-responsive gene in rice through transcriptomic analysis. *OsELP* was localized to the cell wall and was found to be upregulated in response to arsenate [As(V)] and arsenite [As(III)] stress. When heterologously expressed in *Saccharomyces cerevisiae* (Δ*acr3* and Δ*ycf1*), *OsELP* enhanced As tolerance and accumulation. Site-directed mutagenesis revealed that cysteine (Cys) residues bind to As(III), while serine (Ser) residues bind to As(V). Rice lines overexpressing *OsELP* exhibited increased biomass, reduced levels of reactive oxygen species (ROS), and decreased membrane damage under As(III) stress. This overexpression significantly limited As translocation to aerial tissues, as confirmed by elemental analysis and SEM-EDX, resulting in considerably lower As accumulation in the grains. In contrast, the knockout (KO) line demonstrated increased As translocation to shoots and greater sensitivity to As. These

findings indicate that *OsELP* enhances As tolerance by sequestering As in the root cell walls through Cys- and Ser- residues, thereby restricting its movement within the plant. This study uncovers a novel role for an expansin-like protein in As detoxification, highlighting a potential genetic target for developing As-resistant crops to address agricultural and environmental challenges.

T3-A20

Targeting OsNIP3;1 via CRISPR/Cas9: A strategy for minimizing arsenic accumulation and boosting rice resilience

Puja Singh[1] and Debasis Chakrabarty[1]
1Molecular Biology and Biotechnology Division, CSIR-National Botanical Research Institute
Email: chakrabartyd@nbri.res.in

Arsenic (As) contamination in rice poses a significant global health threat. To reduce this risk, we utilized CRISPR/Cas9 genome editing to generate knock-out (KO) lines targeting key transporters: OsLsi1, OsNIP3;1 (NIP aquaporins) and OsLsi2 (anion transporter). This strategy exploited the functional redundancy of the large NIP family, aiming to reduce As accumulation without compromising plant growth. Compared to the wild-type (WT) under As-treated conditions, all KO lines exhibited significantly reduced As accumulation in the grain. Notably, the Osnip3;1 KO line displayed substantial reductions in As within both the xylem sap (71-74%) and the harvested grain (32-46%). Furthermore, this line demonstrated improved physiological performance and stress tolerance, evidenced by enhanced silicon uptake (23%) and significantly higher photosynthetic pigment concentrations (Total Chlorophyll: 79%). Critically, these benefits were achieved without compromising overall agronomic performance or grain yield under As stress. This study successfully utilizes genome editing for the first time to identify OsNIP3;1 as a prime, non yield limiting target for engineering safer, low arsenic rice varieties.

T3-21

Comprehensive genome-wide study of Glutaredoxin (GRX) gene family in the liverwort *Marchantia polymorpha* and exploring their roles in abiotic stress tolerance

Shivani Singh[1,2], Debasis Chakrabarty[1,2]
[1]Academy of Scientific and Innovative Research (AcSIR), New Delhi, 110 001
[2] Molecular Biology and Biotechnology Department, National Botanical Research Institute, Lucknow, 226001
Email:chakrabartyd@nbri.res.in, singhshivanii101997@gmail.com

Glutaredoxins (GRXs) are thiol-disulfide oxidoreductases that function as key regulators of redox homeostasis,development, and stress responses in plants. Despite their functional importance, little is known about the GRX gene family in early diverging land plants. In this study, we performed a comprehensive genome-wide identification of GRX genes in the liverwort Marchantia polymorpha and their role in abiotic stresses. A total of 17 MpGRX genes with 2 isoforms (19 MpGRX) containing the conserved Glutaredoxin domain (PF00462) were identified using BLAST, HMMER, and SMART approaches. Gene structure analysis revealed that six MpGRX genes contained a single intron, whereas the remaining genes exhibited more complex structures with three or more introns, suggesting gene expansion and functional diversification. Evolutionary analysis was conducted using non-synonymous (Ka) and synonymous (Ks) substitution rates between MpGRX genes and homologous genes from *Physcomitrella patens*, *Ceratopteris richardii, Pinus taeda, Arabidopsis thaliana,* and *Oryza sativa*. The results indicated generally low Ka values, except in one MpGRX–PtGRX pair with Ka = 1.59, suggesting potential functional divergence in gymnosperms. Ks-based divergence time estimates were consistent with known evolutionary separations. Selection pressure analysis based on Ka/Ks ratios revealed that most GRX gene pairs were under purifying selection, particularly those between M. polymorpha and mosses, ferns, and angiosperms. This study provides novel insights into the structural diversity, evolutionary history, and selective constraints acting on the GRX gene family in M. polymorpha, offering a foundation for future functional and comparative studies in early land plant lineages.

T3-A22

Comparative Analysis of Tau class Glutathione-S-transferase gene of Marchantia *polymorpha* and Oryza *sativa* in response to Arsenic stress

Monica kumari[1,2], Debasis Chakrabarty[1,2]
[1]Academy of Scientific and Innovative Research (AcSIR), New Delhi, 110 001
[2] Molecular Biology and Biotechnology Department, National Botanical Research Institute, Lucknow, 226001
Email: chakrabartyd@nbri.res.in, monica.kumari2014@gmail.com

Arsenic (As) is the 20th most ubiquitously present element in the environment and highly toxic to all forms of life. Arsenic enriched groundwater and soil are considered as major source of contamination in the food and water supplies. Soil As uptake by staple crops poses the risk of chronic human exposure through food. Bryophytes have efficient capabilities to cope up with various heavy metal stress. Among bryophytes, the thalloid liverwort *Marchantia polymorpha* is currently recognized as an excellent model organism in studies of As hyperaccumulation. In plants, GST function has been closely linked to stress responses. GSTs are thought to protect plants against this wide range of biotic and abiotic stresses by detoxifying reactive electrophilic compounds. Our lab is currently working on *Marchantia* and its transcriptome has been done in response to arsenic stress. We selected upregulated arsenic responsive *Marchantia* GST based on transcriptome data and validated it through qRT PCR and compared it with reported arsenic responsive GST of rice. This is done by purifing protein of both the GSTs, to see their activity and checking the tolerance of both genes in heterologous system. So, aim is to generate arsenic tolerant rice and study detailed As strategy in lower plants and genomics involve in the process.

T3-A23

Identification of Arsenic Tolerant and Sensitive Rice Varieties Through Systematic Evaluation

Prerna Kumari[1,2], Shraddha Singh[1,2*], Sudhir Singh[1,2] and Anand D. Ballal[1,2]
[1]Nuclear Agriculture & Biotechnology Division, Bhabha Atomic Research Centre, Mumbai 400085, India
[2]Homi Bhabha National Institute, Mumbai 400094, India

Arsenic (As), a widespread metalloid across many regions of India, adversely affects the productivity of various crops, including rice. Rice, the staple food for more than 700 million people worldwide, is also important food crop in India. High level of As in rice grains introduces As into human food chain, leading to several adverse health effects. To assess As toxicity and identify tolerant or sensitive rice varieties, detailed screening of 40 rice varieties was carried out with both arsenite- As (III) and arsenate- As(V). The evaluation of As-tolerance was performed at two stages: germination and seedling. Rice seeds were exposed to 25 µM As (III) or 100 µM As (V), physiological parameters i.e., germination percentage, root and shoot length, and biomass were recorded at different durations. Treatment with both arsenic species [As (III)] or [As(V)] reduced overall plant growth across all rice varieties studied; however, As (III) exhibited greater toxicity compared to As(V), with biomass and root length being the most affected parameters. Differential As-tolerance potential was recorded among rice varieties under both forms of arsenic stress. On the basis of this work, a few As-tolerant or As-sensitive rice varieties have been identified. The selected As-tolerant or sensitive varieties will be used to understand the molecular mechanisms of As-stress tolerance in rice.

Theme 4:

Environmental Microbiology, Biotechnology and Nanotechnology

T4-A1

Role of epiphytic growth-promoting bacteria (*Acinetobacter*sp.) in improving arsenic tolerance in rice by modulating reactive oxygen species metabolism

Mirza Hasanuzzaman[1*]
[1]Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh
Email: mhzsauag@yahoo.com

Arsenic (As) exposure is a severe global issue that drastically hampers the growth, metabolic system, and yield of crops. In recent years, the role of beneficial microorganisms in enhancing plant tolerance to abiotic stresses has gained significant attention. This study was devised to explore the role of As-tolerant plant growth-promoting bacteria (PGPB) in rice (*Oryza sativa* L. cv. BRRI dhan100). Rice seedlings were exposed to two doses of sodium arsenite (25 and 50 µM L^{-1} of $NaAsO_2$) at 7-days intervals with irrigation water. Three epiphytic As-tolerant PGPB strains, *Acinetobacter calcoaceticus*REP2, *A. bereziniae*GEP1 and *A. bereziniae*GEP3, were applied to the soil, maintaining an interval of 15 day. Arsenic-treated plants showed osmotic stress, which reduced plant height, tiller number, leaf area, and relative water content. Moreover, chlorophyll fluorescence and chlorophyll pigments were also reduced. Reactive oxygen species have been generated by suppressing the antioxidant defense system and leading to oxidative damage that is observed through increased malondialdehyde, hydrogen peroxide, proline and methylglyoxal content. Arsenic tolerant PGPB strains reduces As stress by improving photosynthetic properties, indole-3-acetic acid level, nutrient uptake ability, water balance, and aiding in methylglyoxal detoxification. The levels of ascorbate and glutathione, and their redox was improved due to the application of PGPB. The activities of antioxidant and glyoxalase enzymes, such as monodehydroascorbate reductase, dehydroascorbate reductase, glutathione S-transferases, glutathione reductase, catalase, ascorbate peroxidase, and the glyoxalase system, were improved through these PGPB applications. These findings show that these PGPB strains have the potential to protect rice from As-induced damage and improve its physiological and biochemical performance.

T4-A2

Silencing of the *Meloidogyne incognita* Effector Gene *Mi-EP1* via dsRNA feeding and host-delivered RNAi suppresses parasitism in tomato and *Arabidopsis*

Alisha Guglani[1], Vishal Singh Somvanshi[2], Uma Rao[2], Arun Jagannath[1], Amar Kumar[1], Surekha Katiyar-Agarwal[3] and Manu Agarwal*
[1]Department of Botany, University of Delhi, Delhi-110007, India | [2]Division of Nematology, ICAR-Indian Agricultural Research Institute, New Delhi-110012, India | [3]Department of Plant Molecular Biology, University of Delhi, New Delhi – 110021, India
Email: alishaguglani30@gmail.com

The southern root-knot nematode (*Meloidogyne incognita*) is one of the most destructive plant-parasitic nematodes (PPNs), causing global crop losses exceeding $80 billion annually. Its ability to parasitize over 2,000 plant species presents a significant challenge to global food security. In this study, we functionally characterized a candidate nematode effector gene, *Mi-EP1*, which is expressed 8.74-fold higher during the early J2 parasitic stage than in adult females. To evaluate its role in parasitism, J2-stage nematodes were transiently fed with double-stranded RNA (dsRNA) targeting *Mi-EP1* and used to infect the roots of Adzuki bean (*Vigna angularis*) and tomato (*Solanum lycopersicum*). These pretreated nematodes exhibited significantly reduced infectivity compared to controls. Moreover, host-delivered RNA interference (RNAi) achieved via virus-induced gene silencing (VIGS) in tomato, using constructs designed to target the nematode *Mi-EP1* gene, also led to suppressed parasitism. Additionally, transgenic lines of *Arabidopsis thaliana* expressing *Mi-EP1*-specific RNAi constructs showed marked reductions in nematode infection, including 26% fewer galls, 36% fewer females, 43%

fewer egg masses, and up to a 68% reduction in the reproductive index. These findings confirm *Mi-EP1* as a critical effector for nematode parasitism and validate it as a promising target for host-delivered RNAi-based resistance in crops. Further molecular analysis of *Mi-EP1* and its interaction with host plant pathways will enhance our understanding of plant-nematode interactions and help in the development of durable resistance strategies.

T4-A3

Unveiling the potential of Si solubilizing microbe for abatement of abiotic and biotic stress in rice.

Anamika[1*], Ananya Dwivedi[1], Jasvinder Kaur[1], Vidisha Bisht[1], Suchi Srivastava[1*2]
[1]Department of Microbial Technology, CSIR-NBRI, Lucknow-226001 | [2]Academy of Scientific and Innovative Research, AcSIR, Ghaziabad-201002, India
Email: anamikanbri1799@gmail.com

Silicon (Si) has gained attention in alleviating abiotic and biotic stress in plants and improving plant health, but its low solubility in soil limits its uptake by plants. Use of silicon-solubilizing bacteria (SSB) for increasing Si bioavailability, reducing pathogen attack and its interaction with arsenic (As) has been a compelling area of research amidst heavy metal toxicity. In this study, 265 bacterial isolates screened on NBRISSM media confirm *B. amyloliquefaciens* (NBRI-SN13) as the best silicon solubilizer (Si, 133.50–226.12 µg/mL) with an ability to antagonize *Rhizoctonia solani*. Further, its ability to impede arsenite (AsIII) translocation and reducing disease incidence under feldspar supplementation (Si+SN+As) was planned. Silicon supplementation was found to reduce As content by 52–72% in rice grain. Similarly, rice treated with SN13 and feldspar showcased fewer disease symptoms, higher shoot and root growth, and better overall health as compared to untreated controls. Upregulation of Si transporters (Lsi1, 2 and 3) genes in Si+SN+As-treated rice plants, linked to As translocation, offers new avenues for microbe-mediated reduction in As uptake by increasing Si transport. Biochemical analysis confirmed increased silicon uptake, higher chlorophyll and sugar levels, and improved stress tolerance in SN13-treated plants. The combined use of SN13 and silicon offers an eco-friendly and sustainable strategy for mitigation of abiotic and biotic stresses in rice.

T4-A4

Detoxification of chromium (VI) from mining-contaminated soil using *Klebsiella* sp. (BH-A1)

Anjali Srivastava[1*], Asha Lata Singh[1]
[1]Bioremediation Research Lab, Centre of Advanced Study in Botany, Institute of Science, Banaras Hindu University, Varanasi
E-mail: anji.srivas@bhu.ac.in

Chromium pollution is a serious environmental issue worldwide. Waste byproducts from industrial activities like tanning, electroplating, chemical manufacturing, mining, pigment production, and paper and textile dyeing release chromium into the agricultural environment. Chromium in soil mainly exists as Cr (III) and Cr (VI). However, Cr (VI) is highly toxic, water-soluble, mobile, and more reactive than Cr (III). The mobile form of Cr (VI) can easily be transported through plants and enters the food chain, ultimately impacting human health and causing diseases like epigastric pain, nausea, vomiting, severe diarrhoea, and haemorrhage. Therefore, reducing Cr (VI) levels in soil is crucial. Several physico-chemical methods are available to reduce Cr (VI), including chemical leaching, electrokinetic treatment, chemical reduction, ion exchange, and others. However, these methods are often expensive and generate secondary pollutants. Microbial methods are cost-effective, environmentally friendly, and efficient for converting Cr (VI) into Cr (III). The present investigation aimed to isolate and identify a novel bacterium from chromium (VI)- contaminated soil samples collected from the Gorbi mine area, Singrauli coalfield, evaluate its potential for Cr (VI) reduction to Cr (III), and enhance environmental and operational conditions to apply this in the bioremediation of Cr-

contaminated soils. A bacterium was newly isolated from contaminated soils of coal mines for chromium (VI) reduction and identified as *Klebsiella* sp. (BH-A1) through 16S rRNA gene sequencing. Calcium chloride and sodium alginate solutions were used to immobilize the bacterial cells of the isolated *Klebsiella* sp. Bacterial beads (*Klebsiella* sp. BH-A1) were employed to reduce 10 mg/kg Cr (VI)-contaminated soil under different environmental conditions, including bacterial bead biomass (200–1000 mg), pH (5–8), temperature (25–35 °C), and nutrient sources. Beads of *Klebsiella* sp. (BH-A1) (1000 mg/g) were effective in achieving 87% reduction of 10 $mgkg^{-1}$ Cr (VI) in the soil at pH 7 and 30 °C within a 6-hour contact period. Fourier transform infrared spectroscopy (FTIR) analyses confirmed the involvement of functional groups such as -OH, -NH, and -COOH in Cr-treated bacterial beads. These functional groups support their role in Cr (VI) and Cr (III) absorption on the bacterial cell surface. Field-emission scanning electron microscopy (FE-SEM) revealed that chromium-exposed *Klebsiella* sp. (BH-A1) exhibited increased cell size compared to untreated cells, indicating chromium absorption. Energy-dispersive X-ray spectroscopy (EDX) further confirmed chromium accumulation within the bacterial cells. Additionally, X-ray photoelectron spectroscopy (XPS) analysis of Cr-treated cells indicated the reduction of Cr (VI) to Cr (III). Furthermore, a phytotoxicity test demonstrated that the treated Cr (VI) had no adverse impact on *Vigna radiata* (Moong) seed germination. These findings suggest that *Klebsiella* sp. (BH-A1) could be a promising candidate for use in Cr detoxification from Cr-contaminated soils.

T4-A5

Trace element-based silicon and selenium nanoparticles regulate antioxidant defense and confer salt stress tolerance in proso-millet (*Panicum miliaceum*)

Dipanwita Datta[1*], Sharmina Tasnim Labonnoya[1], Mirza Hasanuzzaman[1]

[1]Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh
Email: dipanwitadatta83@gmail.com, mhzsauag@yahoo.com

Proso millet (*Panicum miliaceum*), a minor cereal with high nutrient value, presents potential for sustainable food production in arid regions due to its water and nutrient use efficiency. Salinity poses a substantial challenge to its growth and yield by disrupting photosynthesis, nutrient uptake, and redox balance. The beneficial trace elements, such as selenium and silicon supplementation, have been shown to mitigate abiotic stresses, yet the interactive effects of combined trace element-based nanoparticles in enhancing salt tolerance of proso millet remain inadequately explored. This study examined whether foliar supplementation of trace-element-based selenium nanoparticle (SeNP) and silicon nanoparticle (SiNp) would enhance growth and antioxidant defense of proso millet (*Panicum miliaceum* cv.BARI Cheena-1) under salt stress. The objective was to assess their individual and combined effects on physiology, biochemical, and enzymatic responses of the crop under salt stress. Experimental treatments included individual and combined foliar application of SeNP and SiNP (20 and 60 ppm) and salinity was induced by applying two concentrations of NaCl (150 and 200 mM) with irrigation. Results showed that salt stress markedly decreased biomass, chlorophyll, and relative water content while elevating malondialdehyde (MDA), hydrogen peroxide (H_2O_2), and proline levels of the stressed plant. The synergistic effect of combined SeNP and SiNP treatment reduced the oxidative damage by approximately 45-60%, expressed as decreased MDA, H_2O_2, and proline content, and nearly 30% regarding of the electrolyte leakage in the stressed plants. Membrane stability was confirmed by the relative water content, which increased further 25-40%. However, antioxidant enzyme activities (superoxide dismutase, peroxidase, ascorbate peroxidase, catalase, lipoxygenase, glyoxalase I, and glyoxalase II) were enhanced 60-90%, while

maintaining K^+/Na^+ homeostasis and stress resilience. The effectiveness of individual SiNP and combined SiNP and SeNP on the above traits was higher under 150 mM NaCl and 200 mM NaCl salt stress, respectively. Overall, supplementation with nanocarriers of trace elements, especially combined SeNP and SiNP, improved antioxidant defense and osmotic regulation in plants, suggesting a great potential to increase the resilience of proso millet to salt stress. Together, these results show a novel nanotechnology tools for increasing salt tolerance and stability of crop productivity under salt stress.

T4-A6

Role of phosphate solubilizing bacteria (*Acinetobacter* sp.) and nano phosphate fertilizer to improve vegetative and reproductive development and antioxidant defence in rice under salinity

Faomida Sinthi[1*] and Mirza Hasanuzzaman[1]
[1]Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh
Email: sinthi72@gmail.com

Agricultural productivity declined due to climate change and ultimately numerous natural and anthropogenic factors. Salinity problem aggravates the growth and development of all stages and reduces the yield, which apparently leads to hunger issues and imbalanced nutrition. The study aims at investigating the role of phosphate-solubilizing bacteria (PSB) and nano phosphate (NP) to mitigate the negative effects of salt on morphological, physiological, and biochemical changes in rice (*Oryza sativa* L. cv. BRRI dhan102). The study was done following a completely randomized design with three replications. Vigorous and uniform seedlings were exposed to 75 mM sodium chloride at a 7-day interval with irrigation water. Soil was inoculated with PSB and 5 ml L^{-1} NP was foliar applied. Salt stress induced a reduction in tiller number, plant height, biomass, leaf area, and relative water content. Moreover, chlorophyll fluorescence, chlorophyll content declined and ionic imbalance appeared. Whereas, oxidative stress indicating indices such as malondialdehyde, hydrogen peroxide, proline, methylglyoxal, and electrolyte leakage were elevated due to stress. In contrast, plants supplemented with protectants exhibited an enhancement of the ascorbate and glutathione redox pool. Supplementation of NP and PSB also enhanced the monodehydroascorbate reductase, ascorbate peroxidase, dehydroascorbate reductase, catalase, glutathione peroxidase, glutathione *S*-transferase, glutathione reductase, glyoxalase I and II compared to plants exposed to salt stress alone. These findings provide insights into the potential role of the NP and PSB to alleviate salt-induced damage and improve production.

T4-A7

Synergistic antimicrobial evaluation between antibiotics and secondary metabolites isolated from *B. pinnatum* and *M.elengi* methanol extracts against pathogenic microorganisms

Leena Das[1*], Vilas. A. Kamble[1]
[1]Research Scholar, Department of Microbiology, Adarsha Science, J.B. Artsand Birla Commerce Mahavidyalaya, Amravati, Maharashtra, India
Email: leena18das@gmail.com

The frequent incidence of bacterial and fungal infections and widespread antibiotic resistance are emergent concerns in public health. Hence, there is a need to harness the potential of natural bioactive compounds from plants towards the treatment of bacterial and fungal infections. Solitary antibiotics used lead to antibiotic resistance. The combination effect of antibiotics with natural products from plants is a prospective strategy to produce new antimicrobial agents, eliminating harmful side effects. To reveal the usefulness of synergistic activity shown by combining antibiotics and bioactive compounds isolated from plants should be well studied to increase the effectiveness. The objective of this study is to evaluate the interaction between the methanolic extract of two different plants, *B. pinnatum* and *M. elengi* and their individual

combination with standard antibiotics (Clindamycin, Vancomycin, and Fluconazole) against three pathogenic microorganisms *Staphylococcus aureus*, *Escherichia coli* and *Candida albicans,* using the agar well diffusion method. Phytochemicals and bioactive compounds in *B. pinnatum* and *M. elengi* methanolic extract were revealed using GC-MS. Bioactive compounds in plant extracts were compared to known compounds in the database library of National Institute of Standards and Technology. Antibiotics were procured from Himedia, India, to evaluate the combination effect of antibiotics and plant extracts. The synergistic activity of the standard antibiotics and the bioactive compounds isolated from plants against *S. aureus*, *E. coli* and *C. albicans* were determined using the agar well diffusion method. The interaction between antibiotics and bioactive compounds was estimated by statistical analysis using graph pad prism software. Phenol, flavonoids, saponins, alkaloids, steroids, terpenoids and cardiac glycosides were present in *B. pinnatum* and *M. elengi* methanolic extracts. GC-MS revealed thirteen (13) and eleven (11) bioactive compounds in *B. pinnatum* and *M. elengi* methanol extract, respectively. Three antibiotics, namely Clindamycin, Vancomycin and Fluconazole displayed inhibition ranging from 11 to 18 mm. *B. pinnatum* displayed inhibition zones of 18-19 mm and *M. elengi* exhibited inhibition zones of 18-21 mm against the tested organisms. Combinatory effects of antibiotics with *B. pinnatum* and *M. elengi* plant extracts revealed raised synergistic properties than compared individually. Development of novel products using bioactive ingredients from plants combined with commercially available antibiotics will serve as a potential alternative therapy to cure infections with no side effects because the combination effect of the standard drug and the plant bioactive compounds has exhibited more antimicrobial effects when compared individually against the pathogenic microorganisms, diminishing antibiotic resistance. Therefore, the use of current antibiotics could be maintained in combination with plant-derived antimicrobial agents as a therapeutic option in the treatment of various diseases.

T4-A8

Enhancing rice arsenic resistance by focusing on specific microRNA that targets γ-glutamyl cysteine synthetase

Poonam Tiwari[1], Mohammad Israil Ansari[1] and Debasis Chakrabarty[2]
[1]Botany Department, University of Lucknow
[2] Molecular Biology and Biotechnology, CSIR-NBRI
Email: tpoonam.rs@gmail.com

Arsenic (As) contamination poses a severe global threat to food safety, particularly in South and Southeast Asia, where rice cultivation using arsenic-laden groundwater results in elevated As accumulation in grains. This directly endangers human health and disrupts agroecosystem sustainability. In rice, arsenate [As(V)] is converted to arsenite [As(III)], which is detoxified via conjugation with glutathione (GSH) and compartmentalized into vacuoles. γ-Glutamyl cysteine synthetase (*OsECS*) catalyzes the rate-limiting step in GSH biosynthesis and thus plays a central role in regulating cellular redox balance and arsenic detoxification. However, post-transcriptional regulation of OsECS by microRNAs (miRNAs) remains largely unexplored. The present study focuses on enhancing arsenic tolerance in rice by targeting specific microRNAs that suppress OsECS expression. *In silico* analyses identified four potential OsECS-targeting miRNAs — osa-miR408-3p, osa-miR2092-5p, osa-miR390-5p, and osa-miR529a. Subsequent, *qRT-PCR* validation revealed osa-miR390-5p as the most prominent regulator of *OsECS* expression. Therefore, CRISPR/Cas9-based genome editing was employed to knockout osa-miR390-5p and develops transgene-free rice lines. These knockout lines will be characterized at molecular, physiological, and biochemical levels under As(III) and As(V) stress using qRT-PCR, ICP-MS, and antioxidant profiling. This approach is expected to yield transgene-free, arsenic-

resistant rice lines with significantly reduced arsenic accumulation in edible tissues. The findings will not only elucidate the miRNA-mediated regulation of GSH biosynthesis but also offer a sustainable, gene-editing-based strategy for mitigating arsenic toxicity in rice and improving food safety in arsenic-prone regions.

T4-A9

Selenium and silicon nanoparticles mediated salt stress mitigation in soybean (*Glycine max* L.)

Md. Sharif Ahmed[1,*], Omnia Ashraf Ria[2], Sharmin Akter Mim[3], Md. Sarwar Hosen[4], Mirza Hasanuzzaman[3]**

[1]Department of Biochemistry and Molecular Biology | [2]Department of Agricultural Botany | [3]Department of Agronomy, Institute of Seed Technology | [4]Faculty of Agriculture, Sher-e-Bangla Agricultural University (SAU), Dhaka-1207, Bangladesh

Email: sahmed.ru.bd@gmail.com

Soybean (*Glycine max*) is widely grown around the world for its contribution as a key source of vegetable oil, protein and animal feed; however, its growth and productivity is greatly impaired by salinity. To mitigate salt stress impacts on soybean, nanoparticles like Se and Si have been proven to enhance plant physiology and biochemistry under salinity. This study aimed to investigate the potential role of the application of SiO_2, Se and their nanoparticles to mitigate salt stress in soybean. The experiment was conducted in a net house through a completely randomized design (CRD) with three replications. The treatment included salt stress (150 mM NaCl) started at 16 days after sowing (DAS). Whereas foliar applications of SiO_2 (400 ppm), silicon nanoparticles (60 ppm Si(np)), sodium selenate (5 ppm Na_2SeO_4), and selenium nanoparticles (25 ppm Se(np)) began at 11 DAS and were repeated five times at six-day intervals until 40 DAS. Different morphological and biochemical parameters data were collected at 44 DAS. Salt-stressed soybean plants showed lowered physiological processes, including growth, photosynthetic activity, ion accumulation, and antioxidant defense, while increased electrolyte leakage and reactive oxygen species (ROS). Application of Si and Se regained these parameters to promote salinity-induced stress by enhancing antioxidant defense, scavenging of ROS, recovering ion balance and photosynthetic activity. Notable salinity tolerance was observed by both Si and Se treatment groups; however, Se(np) was the most effective in mitigating salinity-induced damage in soybean plants, demonstrating its importance in climate-resilient agricultural practices under saline conditions.

T4-A10

Enhancing rice growth and arsenic detoxification through zinc-solubilizing bacteria and nanochar application

Md. Sarwar Hosen[1], Meher Nigar Miti[2*], Samiul Alam[2], Mirza Hasanuzzaman[2]

[1]Institute of Seed Technology | [2]Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh

Email: mehernigarmiti457@gmail.com

Arsenic (As) is a naturally occurring metalloid that disrupts the physiological and biochemical functions of rice plants by inducing oxidative stress through the production of reactive oxygen species (ROS). However, zinc solubilizing bacteria (ZSB) and nano char (NC) have the potential role to enhance rice growth and mitigate arsenic stress through detoxification. The present investigation was executed to evaluate the role of ZSB and NC in improving growth and conferring As detoxification in rice (*Oryza sativa* L. cv. BRRI dhan101). The experiment was conducted in ashed house through a completely randomized design (CRD) with three replications. The treatment included ZSB and NC (0.2%) started at twenty-six DAT (day after transplanting) where seedlings were exposed to sodium arsenate (2 mM As) at the same time and repeated four times each. Arsenic-treated plants showed reduced growth attributes, low chlorophyll content and photosynthetic activity, whereas higher accumulation of malondialdehyde (MDA),

hydrogen peroxide (H_2O_2), increased lipid peroxidation, and electrolyte leakage. After application of ZSB and NC, the antioxidant enzyme activity was improved, especially superoxide dismutase (SOD), peroxidase (POD), and ascorbate peroxidase (APX) through application of As with ZSB+NC. Moreover, the Gly I and Gly II were also increased through the same combined treatment. Therefore, ZSB and NC would effectively mitigate As-induced physiology and oxidative damage and play a potential role as soil amendments in As-contaminated rice fields.

T4-A11

Effect of seed nano-priming on seven cultivars of wheat (*Triticumaestivum* L.): Phytostimulatory or toxic responses

Rekha Kannaujia[1]*, Gayatri Singh[1], Vivek Pandey[2]
[1]Central Instrumentation Facility, CSIR-National Botanical Research Institute, Rana Pratap Marg Lucknow-226001, U.P, India,[2]Plant Ecology and Climate Change Science, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow, India
Email: rekha.kannaujia.nbri@csir.res.in

To promote green nanotechnology, this study focused on the eco-friendly, cost-effective, and quick synthesis of silver nanoparticles using an aqueous solution of *Phyllanthus emblica* (Amla) fruit extract at room temperature and its priming effect on seed germination parameters of seven cultivars of wheat (*Triticum aestivum* L.).The synthesized B-AgNPs were characterized by different techniques, such as UV-visible spectrophotometer, high-resolution transmission electron microscope (HR-TEM), a scanning electron microscope (SEM), X-ray diffraction (XRD), dynamic light scattering (DLS) with zeta potential, and energy dispersive X-ray spectroscopy (EDX). The prepared AgNPs were found to have an average size of 20 nm. Fourier transform infrared spectroscopy (FTIR) confirmed the capping of natural antioxidants and polyphenols into biosynthesized AgNPs.The impact of seed priming with B-AgNPs was studied at four different concentrations (0, 50, 100, 250, 500 mg/L) on seed germination and seed germination parameters *Viz.* radical length (RL), plumule length (PL), relative root elongation (RRE), seedling vigor index (SVI), and germination index (GI) on seven wheat cultivars (HD-2967, WH-1105, KUNDAN, PBW-154, PBW-502, PBW-343, and DBW-17) at 3 days after treatment (DAT) and 5 days after treatment. Results showed a significant increment in seed germination percentage was observed in seeds treated with 100 mg/L B-AgNPs in PBW-343 Cv while DBW Cv showed no germination beyond 100 mg/L dose. Seed germination parameters were significantly enhanced in all the wheat cultivars treated with 100 mg/L B-AgNPs concentration compared to unprimed seed at 3 DAT and 5 DAT. At 3 DAT, significant increases in RL by 220.93%, 203.03%, 143.75%, 114.63%, 68.37%, and 66.66% were observed in KUNDAN, PBW-343, PBW-154, HD-2967, DBW-17, and WH-1105, respectively. However, SL was increased by 143.34%, 98.30%, 97.36%, 90.90%, and 69.79% inPBW-343, KUNDAN, PBW-502, PBW-154 andWH-1105, respectively. While 500 mg/L treatment had a toxic effect on seed germination and seed germination parameters in all the tested cultivars. The best dose of B-AgNPs was 100 mg/L, therefore, we supposed that the natural antioxidant-capped AgNPs were a promising nano-priming material to promote wheat seedling growth.

T4-A12

In vitro enrichment of targeted indole alkaloids from *Neolamarckia cadamba* (Roxb.) Bosser

Rosani Kumari Shaw[1*], Arvind Kumar Maurya[1], Sanjeev Kanojiya[1], D. K. Mishra[1]
[1]Botany unit (SAIF &R) CSIR-Central Drug Research Institute, Sitapur Road Jankipuram Extension, Lucknow-226031
E-mail: rosanikumari789@gmail.com

Neolamarckia cadamba (Roxb.) Bosser (Rubiaceae) is a fast-growing tropical tree valued for its diverse pharmacological

properties, including anticancer, antioxidant, anti-inflammatory, and antimicrobial. Its bioactive secondary metabolites, particularly indole alkaloids (IAs), have drawn interest for drug discovery and nutraceutical applications. However, natural yields of such metabolites are inconsistent and limited by environmental and developmental constraints, making *in vitro* elicitation a promising strategy for their enhanced production. Although *N. cadamba* has been well explored for its medicinal and silvicultural importance, studies addressing the *in vitro* enrichment of its secondary metabolites remain scarce. The present research aims to investigate the impact of different biotic and abiotic elicitors on the growth and targeted IAs accumulation in *in vitro* raised *N. cadamba* plantlets. This work is based on the hypothesis that the optimized elicitor treatments can significantly upregulate defense-associated metabolic pathways, thereby enhancing the phytochemical yield of related metabolites. Here, an efficient micropropagation system was initially established from the nodal segments of *in vitro* derived seedlings, cultured on MS medium supplemented with optimized plant growth regulators. These micropropagated plantlets were then subjected to varying concentrations of different elicitors for specific time period. Metabolite profiling was performed using UHPLC to quantify the targeted IAs. Results have indicated that elicitation with methyl jasmonate (MJ) and potassium chloride (KCl) markedly enhances biomass accumulation and IAs content compared to untreated controls. Upon application of MJ at 100µM concentration for 5 days and KCl treatment at 4g/l for 10 days enhanced accumulation of cadambine acid and strictosidine by 4 folds. However, with MJ of the same concentration, enhanced vallesiachotamine by 3 fold and KCl of same concentration enhanced vincosamide accumulation by 6-fold. This study establishes a foundation for further work on commercial-scale production of valuable phytoconstituents from *N. cadamba* through metabolic engineering. It also advances our understanding of *in vitro* stress biology by linking the elicitor signaling with secondary metabolism for plant defense.

T4-A13

Exploring the Biostimulating Roles of Plant Growth Promoting Rhizobacteria (*Mangrovibacter* sp.) in Rice Under Salt Stress

Samiul Alam[1*] and Mirza Hasanuzzaman[1]
[1]Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh
Email: kbdsamiulalam@gmail.com; mhzsauag@yahoo.com

Salinity is a severe global issue that drastically hampers the growth, metabolic system, and yield of crops. In recent years, the role of beneficial microorganisms in enhancing plant tolerance to abiotic stresses has gained significant attention. This study was devised to explore the role of salt-tolerant plant growth-promoting rhizobacteria (PGPR) in rice (*Oryza sativa* L. cv. BRRI dhan72). Rice seedlings were exposed to two doses of sodium chloride (75 and 150 mM NaCl) at 7-days intervals with irrigation water. Two epiphytic salt-tolerant PGPR strains, *Mangrovibacter sp.* WEP1 and WEP2, were applied to the soil, maintaining an interval of 15 days. Saline-treated plants showed osmotic stress and ion imbalance, which reduced plant height, tiller number, leaf area, and relative water content. Moreover, chlorophyll fluorescence and chlorophyll pigments were also reduced. Reactive oxygen species have been generated by suppressing the antioxidant defense system and leading to oxidative damage that is observed through increased malondialdehyde, hydrogen peroxide, proline, and methylglyoxal content. Salt-tolerant PGPR strains reduce salt stress by improving photosynthetic properties, indole-3-acetic acid level, nutrient uptake ability, water balance, and aiding in methylglyoxal detoxification. The levels of ascorbate and glutathione, and their redox were improved due to the application of PGPR. The activities of antioxidant and glyoxalase enzymes, such as monodehydroascorbate reductase, dehydroascorbate reductase, glutathione *S*-

transferases, glutathione reductase, catalase, ascorbate peroxidase, and glyoxalase system, were improved through these PGPR applications. These findings show that these PGPR strains, especially WEP2 have the potential to protect rice from salt-induced damage and improve its physiological and biochemical performance.

T4-A14

Evaluation of the interaction between pesticide-tolerant strains and biochar for their growth, pesticide degradation and cell release kinetics potential

Santosh Kumar Yadav[1,2], Puja Khare[1,2]*
[1]Crop Production and Protection Division, CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India
Email: santoshyadav5795@gmail.com

Soil pesticide contamination poses a significant ecological and health risk, adversely affecting soil microbial and faunal communities and entering the food chain through contaminated plants consumed by humans and animals. Microbial degradation of pesticides is a cost-effective technology. Immobilizing exogenous contaminant-degrading bacteria on a carrier can improve their survival and function under soil conditions, biotic and abiotic. The present study examined the interaction of Mentha-derived biochar with different pesticide-tolerant strains. The microbe-immobilizedbiochar was used to assess the degradation of a mixture of pesticides. The microbial cell release kinetics at different pH levels demonstrated that bacterial cells retained for longer periods at neutral pH compared to acidic and alkaline conditions. The results show that microbe-immobilized biocharaccelerated the degradation of a mixture of pesticides. The order of pesticide dissipation was dimethoate (85.94%) > malathion (79.76%) > alachlor (75.28%) > bromopropylate (60.45%). The degradation kinetics followed a first-order reaction. The biodegradation pathways of a mixture of pesticides were elucidated, as the intermediate products have also been identified.

T4-A15

Application of nanofertilizer in conferring drought tolerance in soybean

Sharmin Akter Mim[1*] and Mirza Hasanuzzaman[1]
[1]Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh
Email: mimsharminakter11@gmail.com

Climate change-induced drought poses significant threat to crop production. Adopting a climate-smart approach is crucial to enhance crop production in the drought-prone areas. Plants actuate different mechanisms through physiological and biochemical processes to mitigate the adverse conditions like drought. As silicon (Si) and its nanoparticle(NP) and selenium (Se) and its nanoparticle has shown its potential in mitigating various abiotic stress-induced damages in many plant species, our present study was done in order to focus on how the foliar application of Si (SiO_2= 400 ppm), SiNP (60 ppm) and Se (Na_2SeO_4= 5 ppm), SeNP (25 ppm) might help soybean (*Glycine max*) seedlings (10-day-old) to better withstand drought stress in order to investigate the mechanism of NPs in soybean under drought stress which is still undiscovered and there is less findings available. For this, the seedlings were exposed to drought in two conditions-25% Field capacity (FC) and 50% Field capacity (FC). Consequently, Drought stress led to significant reductions in key morphological, physiological and biochemical parameters. Due to stress, reduction in plant height, biomass, leaf area, and relative water content observed. Moreover, chlorophyll fluorescence, chlorophyll content declined and ionic imbalance appeared. Whereas, oxidative stress indicating indices such as malondialdehyde, hydrogen peroxide, proline, methylglyoxal, and electrolyte leakage elevated due to stress. In contrast, plants supplemented with protectants exhibited enhancement of ascorbate and glutathione redox pool. Supplementation of NP also

enhanced the monodehydroascorbate reductase, ascorbate peroxidase, dehydroascorbate reductase, catalase, glutathione peroxidase, glutathione *S*-transferase, glutathione reductase, glyoxalase I and II compared to plants exposed to drought stress alone. To summarize, foliar application of NPs significantly enhances the drought tolerance of soybean seedlings by strengthening both the antioxidant defense system and the glyoxalase pathway, thereby reducing oxidative damage, mitigating MG toxicity, and improving growth and biomass accumulation.

T4-A16

Engineering synthetic microbial communities to mitigate human pathogens in agricultural soils

Sonal Srivastava[1,2*], Kanika Chawla[1], Soumya Saxena[1], Vaibhav C. Agre[1], Shilpi Sharma[1], Pascal Piveteau[2]
[1]Department of Biochemical Engineering and Biotechnology, Indian Institute of Technology Delhi, Hauz Khas, New Delhi, India | [2]INRAE, OPAALE Research Unit (UR OPAALE), Rennes, France
Email: evs.sonal@gmail.com

The increasing prevalence of human pathogens in agricultural environments poses a significant concern for both food safety and crop productivity. Soil contamination by opportunistic organisms such as *Listeria monocytogenes* and *Klebsiella pneumoniae* has been increasingly documented, particularly in systems exposed to intensive cultivation, reclaimed water irrigation, and high agrochemical inputs. The ability of these pathogens to persist and proliferate in soil underscores the need for sustainable biological strategies that support plant growth while simultaneously reducing risks to human health. In this study, a culture collection of bacterial isolates exhibiting antagonistic activity and plant growth-promoting attributes was established. From this collection, synthetic microbial communities (SynComs) were rationally assembled to suppress *K. pneumoniae* and *L. monocytogenes* across multiple environmental contexts. Notably, the SynCom with the lowest complexity consistently inhibited pathogen growth in complex growth medium, compost, and tomato root systems. Furthermore, SynCom inoculation significantly enhanced plant biomass under controlled growth conditions relative to individual strain treatments. Interestingly, increased SynCom diversity did not correlate with improved efficacy. Instead, interspecies competition and functional overlap among strains frequently constrained community performance and stability. These results demonstrate that strategic SynCom design guided by functional complementarity and microbial compatibility is crucial for constructing a robust synthetic microbial community that can simultaneously suppress pathogens and promote plant growth in sustainable agriculture.

T4-A17

Evaluation of the antibacterial property of ZnO nanoparticles synthesised by using an edible and medicinal fern

Suman Patra[1,2*], Babita Kumari[1], Jyoti Jangid[1,3], Rachna[1], Sushree Sunandita Patel[1], Madhu Sehgal[2], Sandip Kumar Behera[1]
[1]Plant Diversity, Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Lucknow, India | [2]Chhatrapati Shahu Ji Maharaj University, Kanpur, India | [3]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India
Email: patrasumankumar2021@gmail.com

Ampelopteris prolifera (Retz.) Copel., a species of Pteridophyte belonging to the Thelypteridaceae family, is esteemed for its nutritional property, therapeutic efficacy and potential health advantages. Besides, this species has also been noted for its potential in ecological restoration due to its fast growth rate and high adaptation capability toward diverse edaphic environments, which signifies its role in local biodiversity and ecosystem dynamics. The presence of various bioactive molecules in *A. prolifera,* including the flavonoids, makes it a good candidate for medicine. Simultaneously, flavonoids present in the plant support the synthesis of nanoparticles due to their redox potential as

reducing and capping agents. Therefore, this plant might be used for the nanoparticle and also induce the medicinal property to the synthesized nanoparticle. The present study aimed to synthesize zinc oxide nanoparticles (ZnO-NP) through the aqueous frond extract of *A. prolifera*, underscoring the application of green biotechnology in the production of nanomaterials for biomedical purposes like antimicrobial activity. Synthesis of ZnO-NP was confirmed using spectroscopy through the presence of a distinct absorbance peak at 356 nm in its UV–Vis spectrum. Further, synthesized nanoparticles have been characterized for their size and shape via scanning electron microscopy (SEM), including the presence of bond or stretch of the active group of associated capping material using Fourier transform infrared spectroscopy (FTIR). The result showed that temperatures and time intervals of the calcination process used during the synthesis of the NP play a crucial role in determining the size and shape of the NP. The shape of NP was spherical, having a size in the range of 62-93 nm. Concurrently, an antimicrobial assay using the disc diffusion method on Mueller and Hinton agar demonstrated the inhibition zone (16 mm) against *Escherichia coli* by applying 500 µg of ZnO-NP suspended in DMSO. Therefore, this study recommended the use of the biological agents with medicinal value, like *Ampelopteris prolifera* for the synthesis of NP rather than the mechanical process because this process introduced the medicinal property to NP that boosts its application along with the other utility of NP.

T4-A18

Enhanced scytonemin production in cyanobacterium *Symploca cartilaginea* under salinity stress: a sustainable approach for natural uv-protectant development

Soujanya Shekhar Rana[1], Nirmal Renuka[2], Sachitra Kumar Ratha[1*]

[1]Algology Laboratory, CSIR-National Botanical Research Institute, Lucknow, 226001, India;

[2]Algal Biotechnology Laboratory, Department of Botany, Central University of Punjab, Bathinda, 151401, India

Email: sachitra.ratha.nbri@csir.res.in; soujanyasekhar.b2@gmail.com

Solar radiation is a major environmental factor contributing to skin ageing and carcinogenesis. Sunscreens containing inorganic and organic filters are widely used to mitigate ultraviolet (UV) radiation damage. However, concerns over the environmental and health impacts of inorganic ingredients have intensified the search for sustainable, bio-based alternatives. Scytonemin, a lipid-soluble indole-alkaloid pigment synthesized by cyanobacteria, has emerged as a promising natural UV-screening compound for cosmetic and pharmaceutical applications.

In the present study, the cyanobacterial strain *Symploca cartilaginea* was isolated from the soil crust of the semi-arid region of Punjab, India, and evaluated for scytonemin production under varying salinity conditions. The maximum scytonemin yield (2.66 mg g^{-1} dry weight) was recorded at 100 mM NaCl, representing a 6.5-fold increase compared to the control. Although salinity stress negatively affected growth, biomass, chlorophyll a, and carotenoid content, it significantly enhanced total phenolic content, suggesting activation of stress-induced secondary metabolite pathways. Confocal Laser Scanning Microscopy (CLSM) revealed thickening of the exopolysaccharide layer, indicative of increased scytonemin accumulation. Fourier Transform Infrared (FTIR) spectra of stressed biomass exhibited characteristic absorption bands at 1500–1600 cm^{-1} and 2927 cm^{-1}, corresponding to phenolic and indolic groups. Nuclear Magnetic Resonance (NMR) analysis further confirmed the presence of scytonemin by the para-substituted phenol signal at 7.4 ppm. Gas Chromatography–Mass Spectrometry (GC–MS) profiling identified additional bioactive compounds with antioxidant, antitumor, and emollient properties. Overall, the study demonstrates that salinity stress effectively enhances scytonemin biosynthesis in Symploca cartilaginea and highlights the potential of indigenous cyanobacteria as sustainable sources of eco-friendly UV-protectant molecules for cosmetic and pharmaceutical industries.

T4-A19

Metagenomic insights into cyanide-degrading microbial communities from steel industry wastewater

Anita Gupta[1]*, Saroj Kanta Barik[2], Pankaj Kumar Srivastava[1]
[1]CSIR- National Botanical Research Institute, Rana Pratap Marg, Lucknow, India | [2]Department of Botany, North-Eastern Hill University, Shillong, Meghalaya
Email: ganita811@gmail.com

Cyanide (CN) contamination is a serious environmental concern in steel industries where large volumes of wastewater are generated during various operations such as smelting, cooling, and rolling. The wastewater contains multiple toxic constituents, among which cyanide poses the greatest hazard due to its acute toxicity, persistence, and interference with cellular respiration. Despite the availability of several physical and chemical treatment methods but these approaches are costly, energy-intensive, and often produce harmful secondary pollutants. The study was based on the hypothesis that the microbial communities inhabiting cyanide-laden steel industry wastewater harbor diverse metabolic potentials, enzymes, and microorganisms that can be harnessed for efficient cyanide degradation. Samples collected from a steel industry wastewater treatment plant were assessed for physicochemical parameters such as pH, temperature, dissolved oxygen, and cyanide concentration were analysed following standard methods. Total community DNA was extracted from the samples using DNeasy® PowerSoil® Kit (QIAGEN) and the Illumina HiSeq 4000 platform was used for sequencing. The obtained sequences were processed for quality control and annotated using MG-RAST server and the SEED subsystem database within MG-RAST to determine taxonomic composition, functional gene abundance, and the presence of cyanide-degrading pathways. Alkaliphilic cyanotrophic microorganisms were isolated using cyanide-supplemented minimal media. Metagenomic profiling of cyanide-contaminated wastewater from a steel industry revealed high cyanide levels (21.6–27.59 mgL^{-1}) and alkaline conditions (pH ≥ 9), with elevated anions and metal ions. The microbial community was dominated by *Bordetella*, *Achromobacter*, *Pseudomonas*, and *Burkholderia*, known for cyanide degradation. Notably, phylum *Deinococcus* and genus *Mesorhizobium* were detected for the first time in cyanide-rich wastewater. Functional analysis showed enrichment of genes encoding rhodanese, nitrilase, nitrile hydratase, amidase, cyanide-insensitive oxidase, and malate: quinone oxidoreductase. Eight alkaliphilic isolates obtained from the samples degraded cyanide efficiently (10-50 mgL^{-1}) at pH 9.5, confirming their metabolic adaptation to alkaline, toxic environments. This study reveals diverse and functionally active cyanide-degrading microbial communities in steel industry wastewater. The detection of novel taxa and key degradative enzymes broadens current understanding of cyanide metabolism. The isolated alkaliphilic strains demonstrate strong potential for developing efficient, eco-friendly bioremediation systems for industrial cyanide waste treatment.

T4-A20

HY5 and COP1 antagonistically influence light-mediated nicotine biosynthesis in tobacco

Deeksha Singh[1], Shambhavi Dwivedi[1,2], Nivedita Singh[1], Arpita Tiwari[1], Prabodh Kumar Trivedi[1,2]
[1]CSIR-Central Institute of Medicinal and Aromatic Plants, Picnic Spot Road, near Kukrail, Lucknow, U.P. | [2]Jawaharlal Nehru University, New Mehrauli Road, JNU Ring Road, New Delhi, India
Email: deekshait@gmail.com

Nicotine constitutes approximately 90% of the total alkaloid content in leaves within the Nicotiana species, rendering it the most prevalent alkaloid. While the majority of genes responsible for nicotine biosynthesis expressed in root tissue, the influence of light on this process through shoot-to-root mobile ELONGATED HYPOCOTYL 5 (HY5) has been recognized. CONSTITUTIVE PHOTOMORPHOGENIC1 (COP1), a key regulator of light- associated responses, known for its role in modulating HY5 accumulation, remains largely unexplored in its relationship to light-dependent nicotine accumulation. The study identifies NtCOP1, a COP1 homolog in Nicotiana tabacum, demonstrates its ability to

complement the cop1-4 mutant in Arabidopsis thaliana at the molecular, morphological, and biochemical levels. Through the development of NtCOP1 overexpression (NtCOP1OX) plants, weobserved a significant reduction in nicotine and flavonol content, inversely correlated withthe down-regulation of the nicotine and phenylpropanoid pathway. Conversely, RISPR/Cas9-based on knockout mutant plants (NtCOP1 CR) exhibited an increase in nicotine levels. Further investigations, including yeast-two hybrid assays, grafting experiments, and western blotanalyses, revealed that NtCOP1 modulates nicotine biosynthesis by targeting NtHY5, thereby impeding its transport from the shoot to the root. We conclude that the interplay between HY5 and COP1 functions antagonistically in the light-dependent regulation of nicotine biosynthesis inTobacco.

T4-A21

Molecular cross-talk between flavonoid and nicotine biosynthetic pathways in *Nicotiana tabacum*

Basant Kumar Dubey[1,2*], Ratna Katiyar[2], Prabodh Kumar Trivedi[1]
[1]CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP) P.O. CIMAP, Near Kukrail Picnic Spot, Lucknow, India | [2]Department of Botany, University of Lucknow, Lucknow, India
Email: basantdubey.cimap@csir.res.in

The synthesis of secondary metabolites in plants represents an adaptive strategy that enhances stress tolerance and survival. Nicotiana tabacum L. (tobacco), an important member of the Solanaceae family, is an economically valuable crop known for its diverse alkaloids and specialized metabolites. Among these, nicotine is the most abundant alkaloid, synthesized primarily in the roots and transported to the leaves. Beyond its defensive role against herbivores, nicotine has shown potential therapeutic relevance in clinical trials targeting Parkinson's disease, dementia, ADHD, depression, and certain cancers. Secondary metabolism is intricately connected to primary metabolism, as it depends on shared precursors and biosynthetic enzymes. Flavonoids, another major class of secondary metabolites, contribute to plant development and defense through signaling and antioxidant mechanisms. Within this group, anthocyanins, water-soluble pigments responsible for red, blue, and purple hues, play critical roles in light protection, stress tolerance, and ecological interactions. Although nicotine and flavonoid biosynthetic pathways have been extensively characterized individually, their molecular and metabolic cross-talk remains poorly understood. This study aims to elucidate the interaction between flavonoid and nicotine biosynthesis in Nicotiana tabacum, focusing on carbon flux distribution and pathway interdependence. Understanding this regulatory interplay will not only advance knowledge of secondary metabolic networks but also enable strategic metabolic engineering to enhance crop productivity and stress resilience. Moreover, such insights hold translational potential for pharmaceutical and biotechnological applications, given the diverse therapeutic and protective roles of plant-derived secondary metabolites.

T4-A22

Crosstalk of nitric oxide and hydrogen sulfide during the ripening of pepper fruits

Francisco J Corpas[1*]
[1]Group of Antioxidants, Free Radicals and Nitric Oxide in Biotechnology, Food and Agriculture, Department of Biochemistry, Cell and Molecular Biology of Plants, Estación Experimental del Zaidín, Spanish National Research Council (CSIC), Granada, Spain
Email: javier.corpas@eez.csic.es

Nitric oxide (NO) and hydrogen sulfide (H_2S) have been identified as new gasotransmitters that serve as important signaling molecules in various physiological processes in higher plants, including fruit ripening [1]. Pepper (*Capsicum annuum* L.) fruits are among the most widely consumed horticultural products worldwide, whether fresh or processed. Nutritionally, they are particularly relevant due to their high vitamin C content, which is about 120 mg per 100 g of fresh fruit. Southwestern Spain is one of the leading production areas in Europe, holding significant economic

importance. Our research group has focused on the roles of reactive oxygen, nitrogen, and sulfur species (ROS, RNS, and RSS) during the ripening process of pepper fruits. Using biochemical, transcriptomic, proteomic, and metabolomic approaches, we have discovered that ripening is characterized by a physiological nitro-oxidative stress that significantly impacts various components, including catalase, ascorbate peroxidase, superoxide dismutase, and nitrosoglutathione reductase, among others [2-6]. Furthermore, our studies have shown that the exogenous application of nitric oxide (NO) can delay fruit ripening and increase vitamin C content by 40%. Many regulatory functions in this process are mediated by post-translational modifications promoted by NO and H_2S, such as nitration and *S*-nitrosation, as well as persulfidation. In summary, our findings suggest the presence of a complex network of reactive species that influence the ripening of pepper fruits and affect their overall quality.

T4-A23

Assessing the effect of phytohormone treatment on microalgae under Nitrogen stress

Harsh Vardhan[1*]
[1]CSIR National Botanical Research Institute, Rana Pratap Marg, Lucknow, India
Email: harshvardhancharan200@gmail.com

Limiting nitrogen is a well-documented method for increasing lipid production in microalgae, but it comes with a trade-off: it reduces overall biomass productivity, thus impacting lipid yield negatively. Recent studies show that phytohormones can alleviate oxidative stress in microalgae, leading to improved biomass and lipid production. The present study, to evaluate the lipid biosynthetic efficiency of microalgae *Desmodesmus* sp., investigated the effect of varying classes and concentrations of phytohormones (IBA, GA3, and Kinetin) with common nitrogen starvation factors, as N100 (100 mg L-1 NaNO3). Phytohormones, especially IBA (5mg L-1), gave the highest biomass of 1.3 g L-1 compared to 1.27 g L-1 in the standard BG11 control. The decolouration of cultures and quantitative data of N starved with phytohormone-supplemented treatments implied that the photosynthetic performance decreased from the late log phase to the stationary phase, compared to BG11, where HT9 (5 mg L-1 + N100) exhibited the highest accumulation of chl a and chl b during the early stationary phase, reaching 2.796 mg L-1 and 2.502 mg L-1, respectively, compared to controls. GA3 provided consistent performance up to day 14, resulting in the highest carotenoid accumulation (0.6 mg L-1) among the treatments. Optimised concentrations of PGRs were selected for protein, lipid, and carbohydrate estimation. The highest lipid productivity was reported in kinetin (5 mg L-1) at 46.39% DW compared to the control (24.12% DW), which is 1.9-fold higher. In contrast, a decrease in protein and carbohydrate content was reported in all the treatments. The FTIR spectra reveal strong signals for fatty acids, proteins, and carbohydrates in phytohormone-treated cultures and BG11 control. Notably, BG11 shows a protein-related peak at 1521.2 cm^{-1}, while the N100 treatment exhibits a unique peak at 557.32 cm^{-1}, indicating possible brominated derivatives. From the analytical data of GC-MS for biochemical compounds, a high proportion of SFA (saturated fatty acids), such as butanoic acid (C4:0), palmitic acid (C16:0), and steric acid (C18:0), was reported in all the treatments, especially in BG11 control. In contrast, the unsaturation levels of fatty acids were increased in all the nitrogen-starved with phytohormone-supplemented cultures, where the most abundant were high-value omega-3- (C18:3, C20:5), omega-6- (C18:2) and omega-9- (C18:1) fatty acids reported. In conclusion, this study demonstrated that phytohormones with nitrogen limitation could be a good candidate for increasing lipid production in the microalgae culture systems.

T4-A24

Identification, *In-silico* analysis, and characterization of methyltransferase

involved in wedelolactone biosynthesis from *Eclipta prostrata* (L.) L.

Krishan Chandra Shukla[1], Enakshi Sarkar[1], Pratibha Mishra[1], Vineeta Tripathi[1*]
[1]Botany Unit, SAIF & R Division, CSIR-CDRI, Lucknow, India*Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India
Email: vineeta.tripathi.cdri@csir.res.in

The sustainable bioprospecting of plant chemodiversity is paramount for addressing global unmet clinical needs and advancing therapeutic discovery. *Eclipta prostrata*(Bhringraj), a plant belonging to the Asteraceae family, is widely renowned for its medicinal properties attributed to a diverse profile of specialized metabolites. Foremost among these is Wedelolactone (WDL), a coumestan derivative and marker compound celebrated for its potent and diverse pharmacological activities. Despite its high therapeutic relevance, the core enzymatic machinery governing WDL biosynthesis remains obscure, creating a significant bottleneck for metabolic engineering and sustainable supply. Based on the putative pathway of WDL biosynthesis elucidated from transcriptomic and metabolic data, we hypothesized that key O-methyltransferases (OMTs) catalyze the final critical methylation step, converting the precursor molecule Demethylwedelolactone (DW) to WDL. We successfully cloned and sequenced the full-length cDNA of the putative OMT genes identified from *Eclipta prostrata* transcriptome data. *In silico* molecular docking was performed to predict enzyme-substrate specificity for various groups of flavonoids, with a specific focus on the DW-to-WDL conversion. The genes were subsequently subcloned, expressed, and the recombinant proteins purified for *in vitro* functional characterization. Enzymatic assays were initiated using model substrates (quercetin, luteolin, naringenin) and the native precursor, DW. Preliminary data confirm definitive methyltransferase activity towards the modal substrates, supporting their role in the coumestan pathway. The structural prediction from molecular docking strongly supports the binding specificity of the OMTs toward DW. This comprehensive study provides the crucial functional and structural evidence for the OMTs central to the WDL biosynthetic pathway. This foundational knowledge is paramount for advancing future metabolic engineering strategies, including the development of transgenic plants or microbial hosts aimed at achieving the sustainable and scalable green production of this valuable plant-derived therapeutic compound, thereby ensuring the preservation and efficient utilization of this critical environmental resource.

T4-A25

AI-driven classification of Plant P450 Enzymes

Nikita Tiwari[1*], Meher H. Asif[1]
Molecular Biology and Biotechnology, CSIR-National Botanical Research Institute, Lucknow-226001, U.P., India.
Email**:** nikitatiwari.1992@gmail.com

Cytochrome P450 enzymes play crucial roles in plant secondary metabolism, but accurate computational classification remains challenging due to sequence diversity and functional complexity. Current methods often struggle with imbalanced datasets and lack robust probabilistic calibration. We developed a transfer learning framework using ProtBert, fine-tuned on a carefully balanced dataset of 1,076 positive and 1,076 negative P450 sequences. Our approach incorporates strategic unfreezing of encoder layers, class-balanced sampling, focal loss optimization, and comprehensive probability calibration using Platt scaling with optimal threshold selection. The fine-tuned model achieved exceptional performance with an F1-score of 0.94, an AUROC of 0.97, and a precision-recall AUC of 0.96 on hold-out validation. Probability calibration significantly improved reliability, with an optimal classification threshold at 0.47 rather than the default 0.5. The model demonstrated robust performance across diverse P450 families and maintained high precision (0.93) while achieving a recall of

0.95. Our balanced deep learning framework provides highly accurate and well-calibrated predictions for P450 classification, outperforming traditional methods. The approach effectively handles class imbalance and provides reliable probability estimates, making it suitable for high-throughput annotation pipelines. This work enables more confident functional predictions to guide experimental characterization of plant P450 enzymes.

T4-A26

Green-synthesis and Characterization of Carbon Quantum Dots from *Murraya koenigii*

Pallavi Chattopadhyay[1*], Devyani Shukla[2], and Avanish Singh Parmar[2]
[1]Amity Institute of Biotechnology, Amity University Uttar Pradesh, Lucknow Campus, Lucknow, India | [2]Department of Physics, Indian Institute of Technology (BHU), Varanasi
Email: pallavi96chatto@gmail.com

Carbon Quantum Dots (CQDs) have emerged as promising nanomaterials due to their remarkable biocompatibility, photostability, low toxicity, and cost-effective synthesis. Their broad applicability in bioimaging, drug delivery, optoelectronics, and photocatalysis has stimulated growing interest in developing sustainable synthesis methods. However, there remains a need for eco-friendly and efficient fabrication approaches that yield highly fluorescent and stable CQDs from natural sources. In this study, CQDs were synthesized from a natural carbon precursor (*Murraya koenigii*) via a hydrothermal treatment, a bottom-up approach known for its simplicity and scalability. The optical, morphological, and surface characteristics of the synthesized CQDs were investigated using UV–VIS spectroscopy, Photoluminescence (PL), Transmission Electron Microscopy (TEM), Dynamic Light Scattering (DLS), Zeta Potential analysis, and Fourier Transform Infrared Spectroscopy (FTIR). Curry leaves are rich in antioxidants and alkaloids, which makes them a good candidate for CQD synthesis. In PL, maximum excitation at 320 nm wavelength and emission at 405 nm wavelength were obtained. The UV–VIS spectrum showed two distinct absorbance peaks corresponding to π–π and n–π transitions of carbon bonds. TEM analysis confirmed particle sizes in the range of 2–6 nm, supported by DLS results. The Zeta potential value (~20 mV) indicated good solubility and colloidal stability, while FTIR spectra peaks revealed multiple surface functional groups such as hydroxyl, carboxylic, amine, carbonyl, and cyanide, contributing to hydrophilicity and reactivity. The study presents a simple, sustainable route for synthesizing fluorescent CQDs from *Murraya koenigii*, which possesses desirable physicochemical stability and optical properties, making them suitable candidates for applications in bioimaging, drug delivery, and photonic devices.

T4-A27

Genetic Enhancement of Pearl Millet (*Pennisetum glaucum* L.) against *Helicoverpa armigera*

Anshu Sahu*[1, 2], Indraneel Sanyal[1, 2]
[1]CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, 201002, India
Email: kir.sahu28@gmail.com, anshu2541@gmail.com

Pearl millet (*Pennisetum glaucum* L.) is one of the important and major C4 cereal crops belonging to the family Poaceae. It is cultivated in the arid and semi-arid tropics where no other cereals can be successfully grown. In India, Pearl millet is the fourth most cultivated food crop after rice, wheat, and maize. Millets are climate resilient and can thrive in harsh conditions, commonly known as ‘Shree anna’ in India, making them very sustainable crops for the future. Millets play a crucial role in areas where other important crops struggle to thrive amidst shifting weather patterns**.** Pearl millet faces both abiotic stress (salinity, terminal drought and heat stress) and biotic stress (downy mildew, stem borers and ear head miner). *Cocculus hirsutus* trypsin inhibitor (ChTI), a serine proteinase inhibitor, is isolated from the medicinal plant Cocculus

hirsutus, belonging to the family Menispermaceae. It is an 18 KDa thermotolerant monomeric protein having insecticidal activity against *Helicoverpa armigera* and other insect pests. To enhance the tolerance of pearl millet to *Helicoverpa armigera* (Ear head worm), the ChTI gene encoding a protease inhibitor was introduced into pearl millet through genetic transformation. EHA105, a super virulent *Agrobacterium tumefaciens* strain carrying a binary vector driven by the CaMV 35S promoter and terminated by the *nos* terminator, was used for the development of transgenic plants. T_1 plants were screened through PCR, showing a 383 bp amplicon size with gene-specific primers. Insect bioassay of transgenic plants against *H. armigera* recorded 40-60% of weight loss and less feeding damage compared to the non-transgenic control leaf. The quantitative expression of the *ChTI* gene by qRT-PCR analysis showed up to 6-9 fold change in the T_1 progeny. The development of *Agrobacterium*-mediated transformation in pearl millet can serve as an effective approach to enhance crop productivity. Furthermore, the application of genomic tools and transcriptomic analyses can aid in identifying genes associated with biotic stress tolerance, contributing significantly to the genetic improvement of pearl millet.

T4-A28

De novo transcriptome analysis and the role of glycosyltransferases in the biosynthesis of flavonoid glycosides.

Pratibha Mishra[1*], Anshu Mohanta[1], Krishan Chandra Shukla[1], Enakshi Sarkar[1], Vineeta Tripathi[1*]

[1]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad | Botany Unit, SAIF & R Division, CSIR-CDRI, Jankipuram Extension, Lucknow, India
Email: vineeta.tripathi.cdri@csir.res.in

Ulmus wallichiana, a native of the Himalayas, is a traditional medicinal tree species belonging to the family Ulmaceae and is listed as endangered according to the IUCN Red List. *U. wallichiana* has anti-inflammatory and anti-osteoporosis properties, as it is used for the treatment of fractured bones. It also has antioxidant properties and the potential to treat hypertension. The medicinal properties of the plant are attributed to the unique secondary metabolites present in it. *U. wallichiana* is a rich source of diverse phenolic C-glycosides and many flavonoid C-glycosides. Quercetin-6-C-β-D-glucopyranoside, Naringenin-6-C-β-D-glucopyranoside, Ulmoside A, and Ulmoside B are the flavonoid C-glucosides that show osteoclastogenesis properties. We laid out a potential biosynthetic pathway for flavonoid C-glycosides based on transcriptome data from the plant. By knowing the route, it is easy to explore transcripts involved in the biosynthesis of flavonoid C-glycosides and their further cloning and characterization. The pathway leading to its biosynthesis can be modulated at the penultimate precursor by the action of glycosyltransferase. Plant secondary metabolite glycosyltransferases (UGTs) are a group of end-tailoring enzymes containing a signature PSPG motif responsible for glycosylating aglyconic secondary metabolites in plants. Transcriptome profiling of *U. wallichiana* can help elucidate the pathway and the role of UGTs for the synthesis of these flavonoid C-glycosides. De novo transcriptome of *U. wallichiana* generated 84208 transcripts using the Trinity assembler tool, and 73804 transcripts were annotated after clustering using CD-HIT-EST. Through transcriptome analysis, 217 glycosyltransferase genes were found to be involved in secondary metabolite biosynthesis. Full-length cloning of the UDP-glycosyltransferase gene into the pMD 20 T/A vector has been done, and the sequence has been confirmed by Sanger sequencing. In silico molecular docking of UDP-glycosyltransferase gene with different substrates like Dihydrochalcone, Eriodictyol, Kaempferol, luteolin, Naringenin, Quercetin, Dihydroquercetin, and dihydrokaempferol supports the role of UGT in biosynthesis of these flavonoid C-glycosides.

T4-A29

Elucidation of heat stress-induced signal transduction for wedelolactone biosynthesis in *Eclipta prostrata* (L.) L.

Enakshi Sarkar[1*], Archana Kumari[1], Krishan Chandra Shukla[1], Pratibha Mishra[1], Vineeta Tripathi[1*]
[1]Botany Unit, SAIF & R Division, CSIR-CDRI, Lucknow, Uttar Pradesh
[2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, Uttar Pradesh
E-mail id: vineeta.tripathi.cdri@csir.res.in

Eclipta prostrata, a member of the Asteraceae family, is a medicinal plant rich in diverse classes of secondary metabolites (SM). Wedelolactone (WDL), the marker compound of this plant, is pharmacologically active. Metabolite profiling of the plant upon heat treatment for 1h, 3h and 5h showed that there was an increase in the amount of WDL by 8-fold in whole plant under 1h treatment than that in the control plant. To further explore the heat-induced regulation of WDL biosynthesis we did comparative transcriptome analysis of *E. prostrata* under 1h heat stress (HS) with controlled condition. Differential gene expression (DGE) analysis identified 12207 genes to be significantly expressed in response to heat in *E. prostrata*. Among the total DEGs identified from the differential expression analysis 308 DEGs have been annotated to be involved in WDL biosynthesis pathway. Furthermore, heat responsive TFs such as HSF, AP2/ERF, WRKY, bZIP, MYB/MYC, NAC and B3 which were upregulated under HS have been identified from the heat transcriptome data of *E. prostrata*. Besides, other heat responsive genes (HRs) including *heat shock protein (HSP), superoxide dismutase (SOD), peroxidase (POX), glutathione reductase (GR)* and *glutathione s-transferase (GST)* were also upregulated in the heat-treated plants. The molecular basis of heat stress-induced signaling pathway that might be involved in increased WDL biosynthesis is yet to be known. Based on literature review and transcriptome data we hypothesized a probable heat-responsive molecular response in *E. prostrata* and inferred that under HS *E. prostrata* activates a calcium-dependent signaling pathway that promotes several kinases that induce downstream TFs which are responsible for expression and regulation of SM production.

T4-A30

Regulation of flavonoid biosynthesis by AtMYB12 confers enhanced biotic stress resistance in plants

Tushita Rai Vineeta[1*], Hiteshwari Sinha[1], Ravi Shankar Kumar[1], Tapasya Datta[1], Aastha Shromona[1], Prabodh Kumar Trivedi[1]
[1]CSIR-Central Institute of Medicinal and Aromatic Plants P.O. CIMAP, Near Kukrail Picnic Spot, Lucknow
Email: dtushitarai04@gmail.com

Plants produce a wide range of secondary metabolites, including flavonoids, which play essential roles in growth regulation, development, and responses to environmental stresses. Flavonoid biosynthesis is tightly controlled by specific transcription factors, among which MYB12, a member of the R2R3-MYB family, is a key regulator. While MYB12 is well-documented for its role in defense against pests and pathogens, its function in tolerance to other biotic stresses remains underexplored. In this study, we report that *Arabidopsis thaliana* MYB12 (AtMYB12) is significantly upregulated in response to infection by the necrotrophic fungus Rhizoctonia solani. Heterologous expression of AtMYB12 in tomato and its overexpression in *Arabidopsis* led to increased flavonoid accumulation and upregulation of defense-related genes, resulting in enhanced resistance to *R. solani*. In contrast, myb12 single mutants and myb11/12/111 triple mutants showed diminished flavonoid levels and compromised defense responses. These findings establish a novel role for AtMYB12 in mediating flavonoid-based defense and provide valuable insights into improving biotic stress tolerance in plants through transcriptional regulation.

T4-A31

Overexpression of F-box protein KIB1 increases abiotic stress tolerance in *Brassica juncea* (L.) by brassinosteroid signalling

Uma Gupta[1,2], Indraneel Sanyal[1*], Pradeep Kumar[2]

[1]CSIR-National Botanical Research Institute, Lucknow, India | [2]Department of Botany, University of Lucknow, India
Email: i.sanyal.nbri@csir.res.in

Indian mustard *Brassica juncea* (L.) is an economically important, oilseed crop of the Brassicaceae family belonging to the rapeseed-mustard (RM) group. *B. juncea* is cultivated in India, China, Bangladesh, Pakistan, Australia, Canada and Europe. It is predominantly cultivated as an oilseed crop in India over an estimated 6.2 million hectares, contributing to >85% of RM acreage. The yield potential of *B. juncea* can be realized up to 3500-4000 kg/ha. However, despite continuous breeding efforts over the last four decades, the national average productivity of Indian mustard still hovers around 1400 Kg/ha. Climate change has become a significant challenge in mustard production and productivity. This oilseed crop's overall output and productivity are hampered by abiotic factors like drought, salinity and frost, and high-temperature stress - both at the seedling and terminal stages. Severe yield losses due to abiotic stresses have been recorded, especially when the crop is exposed to adverse conditions during the reproductive phase, causing losses in mustard production. Brassinosteroids (BRs) are plant steroid hormones that play significant roles in plant growth and development and regulate abiotic stress responses. Thus, while the role of BR in plant growth and development is well known, the growth traits that BR can simultaneously stimulate and how these growth traits increase with abiotic and biotic stress tolerance are currently unknown. We chose to address these questions through the overexpression of F-Box protein KIB-1 in mustard. F-box/Kelch-repeat protein KIB1 (Protein KINK SUPPRESSED IN BZR1-1D 1) is a member of the F-box family protein and encodes a protein of 382 amino acids. KIB1 is an F-box E3 ubiquitin ligase that promotes the signalling of BRs by the degradation of BIN2 while blocking its substrate access. Genetic analysis demonstrates that KIB1 is essential for BR signalling, specifically for BR-induced BIN2 degradation. Biochemical studies revealed that KIB1 not only mediates BIN2 ubiquitination but also blocks its substrate access. BR signalling induces KIB1-BIN2 interaction, directly preventing BIN2 from interacting with its substrate and subsequently causes BIN2 ubiquitination and degradation. Previous studies show that transgenic *B. napus* plants with KIB-1 protein were characterized by increased seed yield, higher root biomass and length, and better dehydration and heat stress tolerance than the WT. Overall, a net positive impact on plant productivity and performance will be achieved by manipulating a single BR signalling protein. These findings will also provide a strong base for developing BR-based breeding programs for crop improvement.

T4-A32

Regulation of pigmentation and fibre development by miRNAs in white and brown cotton (*Gossypium hirsutum*)

Debashree Pattanaik[1], Sagar Prasad Nayak[1], Shafquat Fakhrah[1], Chandra Sekhar Mohanty[1*]
Academy of Scientific and Innovative Research (AcSIR) | CSIR-National Botanical Research Institute (CSIR-NBRI), Rana Pratap Marg, Lucknow, Uttar Pradesh-226001, India
Email: cs.mohanty.nbri@csir.res.in

Cotton (*Gossypium hirsutum*) is one of the important fibre crops of the world and forms the backbone of the textile industry. While white cotton is the most widely cultivated, naturally coloured varieties like brown cotton are gaining attention as eco-friendly alternatives since they reduce the need for chemical dyes. To understand how fibre colour develops and the role of microRNAs (miRNAs) in this process, we compared white and brown cotton varieties using small RNA sequencing. In our study we had identified 74 known miRNA families in white cotton and 61 in brown cotton, with 44 shared between both types. Interestingly, 11 miRNA families were more active in brown cotton. The genes targeted by these miRNAs were mainly linked to the production of secondary metabolites, particularly flavonoids compounds known to influence pigmentation. We also found that certain miRNAs, such as miR396e-5p, miR167l, and miR1446, were more abundant

in brown cotton, suggesting their involvement in pigment formation and fibre development. These results were further confirmed through real-time PCR analysis. In addition, we discovered 30 novel miRNAs in white cotton and 25 in brown cotton. Overall, our findings show that miRNAs play a key role in controlling fibre colour and development. Understanding these molecular mechanisms could help in breeding naturally coloured cotton varieties with improved colour, fibre quality, and environmental sustainability.

T4-A33

Bacillus amyloliquefaciens modulates autophagy pathways to control *Rhizoctonia solani* infection in rice

Mohd Mogees Ansari[1,2], Nikita Bisht[1], Tanya Singh[1,2], Puneet Singh Chauhan[1,2]*
[1]Microbial Technology Division, CSIR-National Botanical Research Institute, Lucknow, 226001 | [2]Academy of Scientific and Innovative Research(AcSIR), Ghaziabad, India
Email: puneet@nbri.res.in, puneetnbri@gmail.com

Rhizoctonia solani, a necrotrophic fungus, poses a significant threat to rice production by causing sheath blight disease, thereby impacting crop yield and agricultural sustainability. This study explores the potential of the plant growth-promoting rhizobacterium *Bacillus amyloliquefaciens* (SN13) as a biocontrol agent in the susceptible rice variety Swarna *against R. solani* infection. Disease incidence assessments show that untreated plants are severely affected by the pathogen, whereas SN13 treatment effectively suppresses fungal growth. Detached leaf assays further confirm that SN13 reduces tissue damage caused by *R. solani*, while physiological and biochemical analyses demonstrate improved growth in treated plants. Importantly, the application of chloroquine, an autophagy inhibitor, leads to increased disease incidence, whereas SN13 enhances autophagosome formation as revealed by Mono Dansyl Cadaverine (MDC) staining and confocal microscopy, suggesting a role for autophagy in plant defense. Gene expression studies highlight upregulation of autophagy-related (*ATG*) and defense genes (*BZ1, 5H5*, and *8A1*), supporting the activation of autophagy pathways by SN13. Additionally, metabolite profiling using GC-MS reveals the accumulation of defensesignaling molecules, including gluconic acid, arabitol, glucopyranoside, ribose, xylopyranose, and arabinofuranoside. Collectively, the findings demonstrate that *Bacillus amyloliquefaciens* SN13 triggers autophagy and modulates key defense mechanisms, offering an effective strategy to manage sheath blight disease in rice.

T4-A34

Evaluation of antibacterial property of ZnO nanoparticle synthesised by using an edible and medicinal fern

Suman Patra[1,2], Babita Kumari[1], Jyoti Jangid[1,3], Rachna[1], Sushree Sunandita Patel[1], Madhu Sehgal[2], Sandip Kumar Behera[1]
[1]Plant Diversity, Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Lucknow, 226001, Uttar Pradesh, India
[2]Chhatrapati Shahu Ji Maharaj University, Kanpur, 208024, Uttar Pradesh, India
[3]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, 201002, India
Email: patrasuman.botany@gmail.com

Ampelopteris prolifera (Retz.) Copel., a species of Pteridophyte belonging to the Thelypteridaceae family, is esteemed for its nutritional property, therapeutic efficacy and potential health advantages. Besides, this species has also been noted for its potential in ecological restoration due to its fast growth rate and high adaptation capability toward diverse edaphic environment which signifies its role in local biodiversity and ecosystem dynamics. The presence of various bioactive molecules in *A. prolifera* including the flavonoids make it good candidate for medicine. Simultaneously, flavonoids present in the plant supports the synthesis of nanoparticle due to redox potential as reducing and capping agents. Therefore, this plant might be used for the nanoparticle and also induce the medicinal property to the synthesized nanoparticle. The present study aimed to

synthesis of zinc oxide nanoparticles (ZnO-NP) through the aqueous frond extract of *A. prolifera*, underscoring the application of green biotechnology in the production of nanomaterials for biomedical purposes like antimicrobial activity. Synthesis of ZnO-NP was confirmed using spectroscopy through a presence of distinct absorbance peak at 356 nm in its UV–Vis spectrum. Further, synthesized nanoparticles have been characterized for its size and shape via scanning electron microscopy (SEM), including the presence of bond or stretch of active group of associated capping material using Fourier transform infrared spectroscopy (FTIR). The result showed that temperatures and time intervals of calcination process used during the synthesis of NP play a crucial role in determining the size and shape of the NP. The shape of NP was spherical having the size in the range of 62-93 nm. Concurrently, antimicrobial assay using disc diffusion method on Mueller and Hinton agar demonstrated the inhibition zone (16 mm) against *Escherichia coli* by applying 500 µg of ZnO-NP suspended in DMSO. Therefore, this study recommended the use of the biological agents with medicinal value like *Ampelopteris prolifera* for the synthesis of NP rather than mechanical process because, this process introduced the medicinal property to NP that boost its application along with the other utility of NP.

T4-A35

Plant - Nanoparticle interaction: Physiological, biochemical and metabolic alterations in medicinal plants under influence of titanium oxide and copper oxide nanoparticles

Poornima Vajpayee[1*], Subodh Kumar[1], Archana Dwivedi[1], Vippan Kaur[1], Akanksha Dubey[1]
[1]Ecotoxicology, Bioremediation and Nanotoxicology Laboratory, Department of Botany, University of Lucknow, Lucknow-226007
Email: devpoornima@rediffmail.com

Nanotechnology has become an alternative approach for its transformative potential in agriculture thus, the use of nanomaterials has also increased. The excessive use of nanomaterials resulting in elevated bioavailability in crop plants. Various plants respond differentially under different nanoparticles exposure. Nanoparticles may impose physiological, biochemical and metabolic alterations in medicinal plants of economic importance. We evaluated the responses of *Mentha arvensis* and *Ocimum basilicum* under different concentration of titanium oxide (TiO_2: 0, 0.5, 1.0, 2.5 and 5.0 µg ml^{-1}) and copper oxide (CuO: 0, 0.2 and 0.4 µg ml^{-1}) nanoparticles exposure in hydroponic growth chamber, respectively. The accumulation of TiO_2 and CuO nanoparticles were observed at all the concentrations in plant tissues (leaves, stems and roots) of *M. arvensis* and *O. basilicum*, respectively. The elevated oxidative stress markers (MDA and H_2O_2) and non-enzymatic antioxidants (cysteine and non-protein thiols) were observed at all the concentrations of TiO_2 nanoparticles in *M. arvensis* with respect to control. The alterations in enzymatic antioxidants (SOD, CAT, GPX, APX, AO and GST) were also observed. Further, the dose dependent decrease in relative peak area of α-pinene, β- pinene, Sabinene, Limonene, β-Myrcene was also recorded. Moreover, the level of MDA, H_2O_2 and antioxidant enzymes (SOD, CAT) was found increased in roots and leaves of *O. basilicum* on CuO exposure in concentration dependent manner. Major essential oil components of *O. basilicum* (caryophyllene, germacrene D, eugenol, ocimene, methyl-chavicol, geraniol and nerol) were also affected after CuO nanoparticles application. These findings highlighted the physiological, biochemical and metabolic alterations in medicinal plants under various levels of nanoparticle exposure. Hence, excessive use of TiO_2 and CuO nanoparticles in agri-technologies should be regulated for sustainable agriculture.

T4-A36

When enemies inspire allies: Trichoderma makes Jasmonate metabolites when challenged by Fusarium

Sakshi Priya[1,2], Isha Verma[1,2], Poonam C. Singh[* 1,2]
[1]Microbial Technology Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow, 226001, India | [2]Academy of Scientific and Innovative Research (AcSIR), CSIR-HRDG, Kamla Nehru Nagar, Ghaziabad, Uttar Pradesh, 201002
Email: Sakshi Priya sinhasp2000@gmail.com

The increasing demand for sustainable farming practices has encouraged the use of biological alternatives to chemical inputs for improving crop growth and resilience. Among these, species of *Trichoderma* are well known for their biocontrol and plant growth–promoting properties. However, little is known about the secondary metabolites produced by *Trichoderma* when it interacts with phytopathogens, and how these compounds might contribute to disease suppression and plant stimulation. This study was designed to explore whether the interaction of *Trichoderma harzianum* (IF63) with a pathogenic strain of *Fusarium chlamydosporum* f. sp. *lycopersici* (FOL7) could trigger the production of new metabolites with potential biostimulant and antifungal activities. The main objectives were to characterize the induced metabolites, test their bioactivity, and assess their role in enhancing tomato resistance against Fusarium wilt. For this purpose, *T. harzianum* was cultured alone and in the presence of live *Fusarium* in potato dextrose broth. The metabolites were extracted using ethyl acetate, and three types of extracts were prepared: from *Trichoderma* alone (T.ex), from *Fusarium* alone (F.ex), and from the co-culture (TF.ex). These extracts were analyzed through antifungal assays, seed germination and detached leaf tests, scanning electron microscopy (SEM), and gas chromatography–mass spectrometry (GC–MS). Their plant growth–promoting effects were evaluated under controlled pot experiments using tomato (*Solanum lycopersicum* cv. S-22). The co-culture extract (TF.ex) showed the strongest antifungal activity, inhibiting *Fusarium* growth by about 68% at 50 μg mL^{-1} and causing visible distortion of the fungal hyphae under SEM. GC–MS analysis revealed the presence of 64 metabolites, 22 of which were unique to TF.ex. The most prominent compound was methyl (3-oxo-2-pentylcyclopentyl) acetate, a methyl dihydrojasmonate structurally similar to jasmonic acid. Tomato seeds treated with TF.ex exhibited higher germination rates, increased vigour index, and better seedling development than untreated controls. In pot trials, TF.ex application led to significant reductions in disease severity (up to 81%) and improved physiological and biochemical traits such as chlorophyll content, relative water content, soluble sugar level, and antioxidant enzyme activities (SOD and CAT). The extract also maintained its antifungal properties under a range of abiotic stress conditions, including varying pH, temperature, and salinity levels. The results suggest that *Trichoderma* can alter its metabolic profile when challenged by *Fusarium*, leading to the production of methyl jasmonate–rich metabolites with both biostimulant and protective properties via signaling mechanism similar to the jasmonic acid pathway in plants, offering a novel insight into fungal defence responses. Overall, the study highlights the potential of pathogen-primed *Trichoderma* metabolites as stable, natural bioformulations that can enhance plant health and productivity, thereby contributing to environmentally sustainable crop management.

T4-A37

Nanocomposite, nanobiochar and nanomaterials for soil health and crop management

Vishnu D. Rajput[1*]
[1]Academy of Biology and Biotechnology, Southern Federal University, Rostov-on-Don, Russia
Email: rvishnu@sfedu.ru; rajput.vishnu@gmail.com

Past few decades, due to intensive agriculture cultivation, the soils are getting huge amount of chemical-based fertilizers/pesticides, which is directly/indirectly affecting soil microbiota; especially rhizospheric microbiome. These soil microbes are playing significant role in helping plants to uptake nutrients, make unavailable elements to available form, and responsible for decomposition to enhance soil fertility. However, due to chemical input by agricultural

practices are well as other anthropogenic activities. Soils are not only suffering with these agro-chemical inputs, but also facing other various abiotic-abiotic stresses, including heavy metal and emerging contaminate accumulation such as nanoparticles, microplastics, pharmaceuticals and personal care products. The organic matter in soil is continuously decreasing, globally, and soil are losing its fertility and productivity. Due to population explosion under this climate change era, to achieve the "Zero Hunger" goal in sustainable way is a challenging issue. The development and combination of various emerging technologies such as nanotechnology, carbon or biochar materials, genomic, synchrotron, neutron, microbiome and metabolome and genome editing tools opening new avenue to restore soil health via soil engineering; especially rhizospheric microbiome. Thus, our recent focus on research is to edit soil rhizospheric microbiome and study of the rhizosphere response, as determining the dynamics, nature and features of interactions in the soil-microbe-plants system. To analysis of the processes occurring in the rhizosphere in presence of nanoparticles, nanofertilizers and nanocarbon materials using synchrotron-neutron methods and NBIC (Nano-, Bio-, Information, and Cognitive) technologies are our main objective to improve the soil fertility, to restore degraded soils, we've also developing artificial soil system, it is necessary to solve the fundamental tasks that are of frontier importance for soil science today. Analysis the processes and mechanisms of interphase interactions between the surface of soil particles, plant roots and microbes with the participation of nanoparticles. Understanding the structure and functions of the rhizosphere and assessing the possibilities for optimizing its condition is critical for the design of artificial ecosystems. To study biological and ecological processes, and interactions in rhizosphere requires advanced technologies that is capable to decode this complex system. We are determining the functioning of the rhizosphere using frontier technologies, i.e., genomic, synchrotron, neutron tomography methods and computer modeling with microscopic methods. The neutron computed tomography helps to construct a 3D combined image of the rhizosphere structure at the micro-level. Whereas Omics technologies are using to characterize the microbiome and metabolome (complete set of small-molecule chemicals within a biological sample) of the rhizosphere. Application of these new technologies to study the nanoparticle – soil – microbiome – plant root system using advanced tools such as synchrotron- neutron radiation, genomic studies, bioinformatics, multi-omics studies – metagenomics and metabolomics helping to develop a breakthrough scientific result for the development of a strategy for sustainable agriculture development.

T4-A38

Functional relevance of CAMTA5 governing Ca^{2+} dynamics and root development in *Arabidopsis thaliana*

Sanjeev Yadav[1,2*], Zahra Iqbal[1], Samir V. Sawant[1,2]

[1]Molecular Biology and Biotechnology Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India

Email: sy656000@gmail.com

Calcium (Ca^{2+}) is a ubiquitous intracellular messenger molecule in many different signaling pathways. However, how Ca^{2+} signaling converges to root development is sparsely understood. Here, we illustrate that two independent T-DNA insertion mutants of CAMTA5 in *Arabidopsis thaliana viz.*, *camta5-1* and *camta5-2* displayed abrupt root development. Investigations suggest a disturbed calcium homeostasis in roots of these mutants. Further, experiments performed on different Ca^{2+} supplementation media shows a restored root phenotype at higher Ca^{2+} levels, contrary to root growth retardation at lower level, indicating its role in Ca^{2+} transport. The morphological comparison of wild-type and *camta5* mutants showed that functional loss of *CAMTA5* severely impairs the root length. This short root length phenotype of *camta5* mutant was restored by the complementation of

CAMTA5. These findings collectively indicate that *CAMTA5* is essential for primary root elongation. To characterize the *CAMTA5* native promoter, GUS transgenic lines of *Arabidopsis* were developed. In GUS histochemical assay, the expression of *CAMTA5* gene was found to be higher in 17 DAS roots as compared to other root developmental stages (3DAS,5DAS, 7DAS, 9DAS, 12DAS). The above results thus describe a novel role of *CAMTA5* in root development.

T4-A39

Deciphering the mechanisms of arsenic tolerance in Trichoderma

Prerana[1*], Poonam C Singh[1]
[1]Microbial Technology Division, CSIR-NBRI Lucknow, India
Email: preranasingh0095@gmail.com

Fungal-based remediation represents one of the most promising and environmentally sustainable strategies for arsenic mitigation. Fungi are known for their remarkable adaptability to extreme environmental conditions, including elevated temperatures and high concentrations of toxic metals. The present study aimed to evaluate the arsenic tolerance, bioaccumulation ability, and genetic basis of arsenic remediation in fungal isolates, along with assessing their plant growth–promoting potential under arsenic stress. A total of 67 fungal isolates were obtained from arsenic-contaminated vegetables collected from Lakhimpur and Lucknow (U.P.). All isolates were screened for arsenic tolerance at varying concentrations of As (III) (50-2000ppm) and As(V) (50-2000 ppm), out of which 11 isolates exhibited strong tolerance to high arsenic levels. These 11 isolates were further evaluated for bioaccumulation and biovolatilization using the silver nitrate assay, and all showed positive reactions, indicated by the formation of brown coloration due to silver arsenite/arsenate complexes. Molecular screening targeting key arsenic-remediation genes—methyl transferase, arsenate reductase, and arsenite oxidase—confirmed the presence of gene fragments involved in arsenic transformation pathways. Plant growth promotion under arsenic stress was also investigated using spinach as the host plant. Trichoderma-colonized plants (T1–T11) displayed clear improvements in morphology and biomass compared to non-colonized controls. While arsenic exposure caused severe shoot stunting and reduced growth in untreated plants, Trichoderma-inoculated plants showed enhanced growth even under arsenic stress. Among all isolates, T6–T11 demonstrated the most pronounced biomass enhancement under both stressed and non-stressed conditions, highlighting their strong plant growth–promoting ability. These results indicate that Trichoderma colonization effectively mitigates arsenic toxicity and supports plant growth in contaminated environments. Overall, this study demonstrates the potential of Trichoderma spp. in arsenic tolerance, transformation, and plant growth promotion, offering an integrated, eco-friendly strategy for arsenic remediation.

T4-A40

Paenibacillus lentimorbus shapes maize root architecture and metabolic responses under nutrient stress

Tanya Singh[1,2], Puneet Singh Chauhan[1,2*]
[1]*CSIR-National Botanical Research Institute (CSIR-NBRI), Rana Pratap Marg, Lucknow 226001, India*
[2]*Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India*
Email: puneetnbri@gmail.com; puneet@nbri.res.in

Global arable soils are increasingly limited in essential nutrients, leading to reduced crop yields. In this study, we evaluated the role of plant growth-promoting rhizobacteria (PGPR) *viz. Pseudomonas putida, Paenibacillus lentimorbus*, and their consortium in supporting maize (*Zea mays*) growth under nutrient-deficient conditions. PGPR inoculation improved plant health, as reflected by enhanced physiological and biochemical traits. Significant modifications in root system architecture were observed, including increases in root tips, branching points, total volume, and surface area, along with the formation of root cortical aerenchyma. Among the tested strains, *P. lentimorbus* showed the most pronounced

positive effects on growth and physiology compared with P. putida, the consortium, and uninoculated control plants. Moreover, *P. lentimorbus* influenced the expression of auxin-related and root development genes (e.g., *rum1*, *rul1*, *lrp1*, *rtcs*, *rtcl*, *rth*), thereby improving nutrient uptake and resilience to nutrient stress. Metabolite profiling using GC-MS further revealed strong root-microbe interactions, particularly involving carbohydrates and organic acids. Collectively, these findings demonstrate that *P. lentimorbus* enhances maize growth and nutrient stress tolerance by reprogramming root development, signaling pathways, and metabolic networks.

T4-A41

Synergistic eco-physiological response of biochar and *Paenibacillus lentimorbus* application on chickpea growth and soil under drought stress

Ankit Ojha[1,2], Nikita bisht[1,2], Tanya Singh[1,2], Mohd Mogees Ansari[1,2], Shiuly Bhowmik[1], Gauri Rai[1], Puneet Singh Chauhan[1,2*]
[1] CSIR-National Botanical Research Institute (CSIR-NBRI), Rana Pratap Marg, Lucknow, India
[2]Academy of Scientifc and Innovative Research (AcSIR), Ghaziabad, India
Email: Puneet@nbri.res.in

Drought stress, resulting from limited water availability, is a major constraint to global agriculture, particularly in rainfed systems where productivity depends on residual soil moisture. Chickpea (*Cicer arietinum* L.), a nutritionally and economically important legume cultivated on about 14.84 million hectares with an annual production of 15.08 million tonnes (FAOSTAT, 2020), is highly susceptible to drought, which adversely affects its growth and yield. While conventional breeding and genomic approaches have advanced drought tolerance research, their practical application remains limited due to technical complexity and ethical constraints. Hence, there is an urgent need for eco-friendly and readily applicable strategies to enhance chickpea resilience under water-limited conditions. This study developed an eco-compatible soil amendment integrating maize-stalk-derived biochar with the plant-beneficial rhizobacterium *Paenibacillus lentimorbus* (B-30488) to improve soil quality and chickpea growth under drought stress. The combined B-30488 + biochar treatment significantly enhanced soil physicochemical properties, enzyme activities, and microbial diversity. Scanning electron microscopy confirmed that the porous biochar matrix supported efficient bacterial colonization. Under drought, the synergistic treatment improved plant physiological and biochemical performance, root architecture, and anatomical features. Phytohormone (IAA, CK, JA, SA) and gene expression analyses (*GST*, *APX*, *CAT*, *ACO*) indicated their role in maintaining cellular homeostasis under stress. Overall, the integration of B-30488 and biochar strengthened soil health, enhanced drought tolerance, and promoted chickpea productivity, demonstrating a sustainable approach to improve agricultural resilience. Further research is warranted to elucidate underlying mechanisms and assess the long-term sustainability and ecological implications of this bioinoculant–biochar system.

T4-A42

Unraveling the mechanisms of endophyte-mediated enhancement of growth and colchicine biosynthesis in *Gloriosa superba*

Pradeep Semwal[1,2], Shashank Kumar Mishra[1], Puneet Singh Chauhan[1]*
[1]Microbial Technologies Division, Council of Scientific and Industrial Research-National Botanical Research Institute (CSIR-NBRI), Rana Pratap Marg, Lucknow-226001, India
[2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad- 201002, India
Email: Puneet@nbri.res.in

Gloriosa superba L. is an important medicinal plant known for its colchicine and gloriosine content. However, its cultivation and colchicine content are adversely affected by several biotic and abiotic stresses. The current study investigated the functional role of endophytic bacteria in enhancing growth, stress tolerance, and secondary metabolite biosynthesis in *G. superba*. A total of 82

rhizome samples of *G. superba* were collected across diverse agro-climatic zones of India and evaluated for colchicine content. Two contrasting chemotypes, NBG-06 (0.86%) and NBG-64 (0.02%), were selected for endophyte isolation. Seventy-six bacterial endophytes were screened for plant growth-promoting traits, enzymatic activity, and stress tolerance, of which 23 exhibited multiple PGP attributes. 16S rRNA sequencing identified *Bacillus* spp. as the dominant genus. Three strains, NBRI HYL5, HYL8, and LYN9, exhibited enhanced plant growth and colchicine content. GC-MS profiling of endophytes identified key colchicine precursors, phenylalanine, trans-cinnamic acid, and benzoic acid. Endophyte-treated plants showed improved nutrient uptake. Metagenomic analysis revealed increased *Bacillus* spp. and enriched colchicine-related biosynthetic pathways.

T4-A43

Comprehensive Virome Profiling of Cotton Mealybug (*Phenacoccus solenopsis*) Reveals Diverse Viral Communities in the Salivary Gland and Midgut

Ritika Dwivedi[1], Manisha Singh[1], Susheel Kumar[1] and Praveen C. Verma[1]
[1]Department of Molecular Biology and Biotechnology, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001 (UP) India
Email: dwivediritika6@gmail.com.

The cotton mealybug *Phenacoccus solenopsis* is a major pest of cotton, responsible for substantial yield losses. Despite its agricultural importance, the viral communities (virome) associated with this insect remain poorly characterized, and the scope of virus transmission through this pest has limited our understanding of its viral biodiversity. Using RNA-Seq, we performed de novo transcriptome assembly and differential gene expression profiling of the midgut and salivary glands. Approximately 140.45 million bases were assembled into 157,672 transcripts and 113,006 genes. This dataset was further compared with existing in-house transcriptomes from eggs plus first instar, second instar, third instar, and adult stages. Pairwise comparisons between developmental stages and the midgut and salivary gland datasets yielded 21,082 genes, providing deeper insights into viral abundance across tissues and life stages. To identify viral genomes present in the whole body, gut and saliva of the mealybug, both transcriptome assemblies were queried against a plant virus genome database using DIAMOND blastx with an 80% identity cutoff and an E-value threshold of 10^{-5}. We detected 56 distinct plant-associated viral genomes—12 from all developmental stages combined and 44 from the gut and saliva datasets—belonging to three known mealybug-transmitted viral families: Closteroviridae (ampeloviruses, closteroviruses), Caulimoviridae (badnaviruses), and Betaflexiviridae (trichoviruses), along with several unclassified viral groups. Some viral genomes exhibited substantial divergence, indicating potential new species, genera, families, or even orders. Several viral species were detected across multiple developmental stages and tissues. All identified viral genes corresponded to plant-associated virus genomes and were unique within the dataset. Additionally, a few viral groups currently known to infect non-plant hosts-such as the novel Fort Crockett Virus-were also detected. Overall, our findings reveal a highly complex and diverse viral community within the salivary glands and midgut of *P. solenopsis*, broadening current knowledge of mealybug-associated viromes and their potential host ranges. These results warrant further validation through PCR/RT-PCR.

T4-A44

Plant growth-promoting rhizobacteria *Bacillus amyloliquefaciens* reconfigures JAZ repressors, carbohydrate metabolism, and root architecture to alleviate stress induced by suboptimal nutrient conditions in *Oryza sativa* L.

Nikita Bisht[1], Puneet Singh Chauhan[1*]
[1]*CSIR-National Botanical Research Institute (CSIR-NBRI), Rana Pratap Marg, Lucknow, India-226001*
*Email: puneetnbri@gmail.com; puneet@nbri.res.in

Sustainable alternatives to chemical fertilizers are needed to enhance crop productivity and soil health while minimizing environmental impacts. In this study, we evaluated the efficacy of plant growth-promoting rhizobacteria (PGPR), namely *Bacillus amyloliquefaciens* (SN13), *Paenibacillus lentimorbus* (B-30488), and their consortium, in alleviating stress induced by nutrient-deficient conditions in rice. Physiological and biochemical assessments revealed a sharp decline in seedling growth under suboptimal nutrient regimes, whereas PGPR inoculation significantly enhanced performance. Nutrient profiling confirmed that PGPR treatments replenished mineral deficiencies evident in uninoculated seedlings. Untargeted metabolomics demonstrated distinct reprogramming of rice metabolism, with PGPR inoculation promoting the accumulation of sugars such as glucose, fructose, and mannose, in contrast to proline and glutamine enrichment under deficiency alone. Transcript analysis indicated that SN13 specifically modulated carbohydrate metabolism, underpinning its role in stress mitigation. In parallel, genome-wide analysis identified multiple OsJAZ repressors, whose differential expression patterns were closely linked to altered root system traits, xylem development, and lignification. Collectively, these findings highlight the mechanistic basis by which beneficial rhizobacteria SN13 integrate metabolic, transcriptional, and architectural responses to enhance adaptation in rice under sub-optimum nutrient regime, offering an eco-friendly avenue for sustainable crop improvement.

T4-A45

Isolation and characterization of endophytes from contrasting chemotypes of *Commiphora wightii* for growth promotion and guggulsterones enhancement

Deen Dayal Pandey[1], Shashank Kumar Mishra[1], Puneet Singh Chauhan[1,*]

[1]Microbial Technologies Division, CSIR-National Botanical Research Institute (CSIR-NBRI), Rana Pratap Marg, Lucknow-226001, India

Email: deendayalpandey100@gmail.com

Abstract: *Commiphora wightii* is an important medicinal plant known for its bioactive metabolites, including guggulsterones, having hypolipidemic and anti-inflammatory properties. However, several abiotic and biotic stresses influence the growth and bioactive content of *C. wightii*. In the present study we have isolated 78 endophytic bacteria from the leaf and stem of two contrasting (high and low guggulsterone-containing) chemotypes of *C. wightii* and characterized them for qualitative assessment of multiple plant growth–promoting traits, including auxin production, phosphate solubilization, siderophore production, ACC deaminase activity, and tolerance against different abiotic stresses, including salt, drought, and pH. Based on initial qualitative screening and abiotic stress tolerance, 33 endophytic bacterial isolates demonstrated multiple growth-promoting traits and tolerance against abiotic stresses. Further, these isolates were evaluated for quantitative estimation of PGP traits, which shows that 15 bacterial isolates show superior growth-promoting traits. These isolates were further assessed for their inoculation effect in maize under greenhouse conditions, which indicated that nine bacterial isolates demonstrated significant improved vegetative and biochemical parameters. These bacterial strains were identified through the 16S rRNA gene, which shows that most of the endophytes belong to the Bacillus genera. Further, these endophytes were assessed for quantitative abiotic stress tolerance activities till 10th day. Based on this, two endophytic bacterial strains, NBRI103-L13 (high guggulsterone-containing chemotype), and NBRI105-S7 (low guggulsterone containing chemotype), were selected based on the survivability and enhanced PGP traits were further assessed for their effect on growth promotion and secondary metabolites in *C. wightii* under greenhouse conditions. Greenhouse results showed plants treated with NBRI103 - L13 and NBRI105-S7 significantly increased vegetative (shoot and root length, plant fresh and dry weight) and biochemical (chlorophyll, carotenoid and sugar) parameters as compared to control plants. Further, HPLC results shows a significant enhancement in guggulsterone (E and Z isomers) content in endophyte inoculated plants.

Theme 5:

Urban ecosystem:
Urban heat island effects and green belts

T5-A1

Urban blue-green infrastructure, human-nature relationships, and resilience in Indian metropolises: Cities in nature's embrace

Shalini Dhyani[1*]
[1]CSIR-National Environmental Engineering Research Institute (NEERI), Nagpur, Maharashtra
Email: shalini.dhyani@csir.res.in

India's fast urbanization is profoundly altering ecosystems, landscapes, and human well-being. This talk presents a new narrative: urban resilience and liveability are inextricably linked to the ecological fabric of cities and the human connection to it. This has also emerged from our ongoing work in last more than a decade on urban green and blue-green infrastructure, ecosystem health assessment, and nature-based solutions in Indian cities. We have observed three main themes that show up. First, urban people' use patterns, physical and mental health, and pro-environmental behavior are significantly influenced by the availability and accessibility of urban green spaces (UGS) and blue-green infrastructure (BGI). Visible, close-by, and functional areas enhance nature-connectedness, which in turn promotes more sustainable lives, according to studies conducted in Indian cities. Second, institutional, biophysical, and sociocultural issues continue to impede the mainstreaming of BGI and nature-based solutions (NbS) in rapidly expanding Indian cities. These issues range from data deficiencies and governance gaps to unequal geographical distribution and upkeep of green assets. Third, ecosystem health and risk assessments, such as the use of the City Biodiversity Index (CBI), canopy-cover analysis, demand supply-gap and ward-wise ecological risk mapping, can offer the evidence base needed to incorporate ecological-social metrics into urban planning, allowing cities to move from grey-dominant infrastructure to nature-integrated systems. Our main takeaway indicates that ecological networks and human-nature linkages must be at the center of urban design and governance in order to create resilient, livable Indian cities. Indian cities should rethink growth as regeneration rather than just expansion by guaranteeing fair access to green/blue areas, fostering nature-connectedness among urban residents, and incorporating ecosystem health indicators into planning. In order to promote sustainability, equity, and well-being, through this talk my talk will endorse how urban growth in the Global South should embrace nature-driven approaches for socio-ecological resilience and localizing SDGs, GBF and Climate agenda.

T5-A2

Assessing the effect of green space spatial patterns on land surface temperature for sustainable urban planning

Satyabhan Singh[1,2]*, **Priya Verma**[1,2], **Dibyendu Adhikari**[1], **Alka Kumari**[2]
[1]Plant Ecology and Climate Change Science, CSIR-National Botanical Research Institute, Lucknow, [2]Department of Botany, University of Lucknow, Lucknow, India
Email: satyabhansinghrathore25@gmail.com

Despite increasing research on green spaces and their impact on land surface temperature (LST), findings continue to exhibit considerable variability and inconsistencies, evident in rapidly urbanizing cities, where land use change dynamics and population pressures exacerbate thermal challenges. The present study evaluates the impact of green patch size on the urban heat island (UHI) effect in urban and peri-urban areas of Lucknow, specifically examining its relation to LST by analyzing spatiotemporal changes in green space patterns and their cooling effects using remote sensing data. The methods involved processing Landsat satellite imagery for multiple years to derive LST maps, followed by the calculation of metrics viz., patch size and classes, using QGIS (Quantum Geographic Information System) software. This was done to assess the spatial configuration of green spaces and their influence on LST in the urban environment. The results revealed that larger green patches are negatively correlated with LST, leading to significant cooling effects in dense forested areas compared to the surroundings. While

smaller patches positively correlate with increased LST, exacerbating UHI by up to 1.38°C in urban zones due to reduced vegetation aggregation. The study concludes that larger, aggregated green patches are more effective in mitigating LST and UHI than smaller, fragmented ones, emphasizing the need for strategic urban greening to enhance thermal comfort. The significance of this research lies in its implications for urban planning in intense climates, where optimizing green patch size can guide the development of resilient green infrastructure, reduce heat stress, and promote sustainable adaptation to climate change and urbanization pressures.

T5-A3

Physiological evaluation of trees for mitigation of urban heat island (UHI) effects

Mohd. Saad[1,2]*, Soumit K. Behera[1,2], Sonik Anto[1,2], Irfan A. Ansari[1], Ramya R. Paul[1,2], Kamal Pal[1], Dibyendu Adhikari[1,2]
[1]Plant Ecology and Climate Change Science Division, CSIR - National Botanical Research Institute, Lucknow-226001, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad- 201002, India,
Email: myidmsss@gmail.com

Urban areas experience significantly higher temperatures than their surrounding rural areas which results in Urban Heat Island (UHI) effect. Rapid urbanisation, deforestation and climate change are the major reasons driving increase in temperature in urban areas leading to urban heat island (UHI) effects. Urban green spaces (UGS) are naturally effective in decreasing microclimate temperature, providing shade and increasing albedo effect. In Lucknow several sites were identified based on different land surface temperature (LST) using remote sensing technology. Various physiological and functional trait analysis of 25 trees were performed for screening the best performing plant in high LST zone. The physiological measurements were performed using Licor 6400-xt portable photosynthesis system and real time microclimate data were also recorded for each site using Licor850 CO_2/ H_2O Analyser. To establish the best performing trees in terms of evaporative cooling for enhancing the cooling effects in high LST zones, the physiological data were scored for each species from the six study sites. Among the different physiological parameters: net photosynthetic rate, transpiration rate and water-use efficiency was considered to rank trees based on their cooling efficiency. The result suggests *Pongamia pinnata, Cassia fistula, Azadirachta indica* and *Ficus virens* showed better physiological performance with increasing LST, suggesting its potential significance in mitigating UHI effect. These species offer the most effective combination of canopy structure and physiological performance required for meaningful urban heat island mitigation

T5-A4

Perception-driven plant preferences for vertical greenery systems in Lucknow, India

Jasbeer Kaur[1*], Shipra[1], Priya Verma[1], Prem Prakash Singh[1], Dibyendu Adhikari[1]
[1]Plant Ecology and Climate Change Science Division, CSIR-NBRI, Lucknow, India
Email: jasbeerkaurmgs@gmail.com

Rapid urbanization in Indian metros has reduced vegetation cover and intensified urban heat island (UHI) effects, necessitating nature-based cooling strategies such as Vertical Greenery Systems (VGS). However, deployment of VGS frequently overlooks residents' plant preferences, balcony constraints, and perceptions, which are factors that are critical for adoption, maintenance, and long-term performance. This study investigates locally preferred plant species for VGS integration through a citywide, semi-structured questionnaire administered to residents of Lucknow, India. The survey documented balcony plant assemblages, selection criteria, existing planting practices, and awareness and acceptance of vertical greening. Responses from diverse housing types and socio-economic groups indicate a preference for ornamental, flowering, and low-maintenance

species, most commonly money plant, tulsi, ferns, aloe vera, and hibiscus, which are valued for aesthetic appeal, adaptability to limited space, and ease of care. Synthesizing these perception-based insights, we propose a context-specific shortlist of candidate species compatible with local microclimate and cultural practices. The findings highlight the importance of community preferences in designing socially acceptable green infrastructure and provide a baseline for developing region-specific VGS models for urban residential buildings in Lucknow and comparable climatic regions. By aligning plant choice with user behavior and site constraints, the study supports scalable pathways to enhance urban biodiversity and improve microclimatic conditions.

T5-A5

Monitoring of air-borne particulate matter in the urban environment and its remediation through plants

Ankesh Tiwari[1], Sudhir Kumar Pandey[1]*
[1]Department of Botany, Guru Ghasidas Vishwavidyalaya, (A Central University) Koni, Bilaspur (C.G.)- 495009
Email: skpbhu@gmail.com

Particulate matter (PM) is a major problem in urban environments. According to the WHO and IARC, PM is classified as a Group 1 carcinogen. Rapid urbanization, industrialization, and unplanned development have significantly increased PM concentrations in the air. In Bilaspur city, PM_{10} and $PM_{2.5}$ levels often exceed the permissible limits set by the USEPA and CPCB. Therefore, source identification and effective remediation of PM are urgently needed to improve air quality and environmental health. The main objectives of this research are to quantify airborne PM deposited on plant leaves, identify its sources, and select suitable plant species for urban greening and PM remediation. Passive sampling of PM was carried out using plant leaves. PM concentrations among various selected plant species were compared to identify the most efficient plants for urban greening. A novel SEM image-based approach was used for PM source identification and particle counting. In addition, complete metal profiling was performed using the ICP-MS technique. Out of six plant species *Dalbergia sissoo* and *Senna siamea* were found to be the most efficient plant species for urban greening and PM removal. Elemental and morphological analyses revealed that most PM particles originated from anthropogenic and airborne sources. Plants are effective tools for the remediation of airborne PM, as they efficiently capture particles present in the air. The study also provided insights into PM sources, enhancing our understanding of urban air pollution. The proposed method offers an efficient approach for PM monitoring and source identification in urban environments. The identified plant species can be recommended for large-scale urban plantation programs aimed at improving air quality.

T5-A6

From Grey to Green: Enhancing Air Quality with Urban Vegetation/Urban Green Spaces: Key players in combating Air Pollution.

Tarannum Khan[1,2], Hritika Goel[1,2], Richa Rai[1,2]*
[1] CSIR-National Botanical Research Institute Lucknow U.P
[2] Academy of Scientific and Innovative Research (AcSIR) Ghaziabad U.P
Email: khantarannum8765@gmail.com

Rapid Urbanization and Industrial growth have significantly worsening air quality in cities worldwide, creating significant ecological and health related issues. Urban areas, characterized by dense populations and heavy vehicular and Industrial activities, contributes to high concentration of pollutants such as Particulate matter (PM), Nitrogen dioxide (NO_2), Sulphur dioxide (SO_2), Carbon monoxide (CO_2), and Ozone (O_3). Urban greening as a nature-based solution (NBs) has attracted worldwide recognition as a sustainable means to combat air pollution and improve ambient air quality. This study explores role of urban vegetation and green

spaces in improving air quality by acting as natural filters for pollutants and influencing microclimatic conditions. Identification of suitable plants at parks, green roofs, facades Innovation for horticulture from a larger perspective. These systemic recommendations shall be useful for growing potted ornamental fruit plants for hobbyists, landscape architects, researchers and commercial production of potted ornamental fruit plants.

T5-A7

Ornamental fruit culture for aestheticity and nutritional security in urban ecosystem

Spoorti Tirki[1*], Sateesh R Patil[1], Bal Krishna[1], Pavankumar[1], Mahantesha BN[1], Praveen Joglikar[1] and Shankar Meti[1]
University of Horticultural Sciences, Bagalkot, Jain Irrigation System Ltd., Jalgaon, Maharashtra, India
Email: tirkispoorti@gmail.com

In the present scenario, the world's 55% population lives in urban areas, and the ratio is expected to reach 68% by 2050. Rapid spatial development in urban ecosystems decreased terrestrial gardens within; indeed, urban residents spend 70-80% of their time living indoors. Though people are fascinated by growing ornamental plants, an intensified population in urban areas is limiting the space required for gardening, thereby decreasing green areas in cities, which in turn leads to the 'Urban heat island effect'. So, finding alternative solutions to address existing problems is the need of the hour in the modern lifestyle. Ornamental potted fruits such as lime, sweet orange, mandarins, mango, guava, fig, and pomegranate are used in many landscapes, like airports, and railways as a bonsai to improve the aesthetic value, but there are no standardized recommendations to grow these potted plants in semi-shaded places like balconies, verandas, etc. In this connection, an effort is being made to introduce potted ornamental fruit plants that consist of attractive foliage, and flowers with fruits enhance a psychological and nutritional need to lower stress levels and a healthy life. The research outcome provides systematic, productive potted fruit crops in an urban housing ecosystem that has the potential to improve food security, which is a transformational and roadside vegetation which contributes to pollutant removal through processes such as absorption, deposition and dispersion. Also to understand the environmental and social benefits of urban greenery.

Theme 6:

Environmental monitoring, assessment, and remediation

T6-A1

Plant invasion decreased the understory carbon sequestration in sub-tropical forest ecosystem: An Evidence from Sikkim Himalaya, India

Anil Kumar Verma[1], Soumit Kumar BeheraRashmiNayak[2], N. Manika[1], Kiran Bargali[3], Lal Babu Chaudhary[2]
[1]Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, Uttar Pradesh, India | [2]Plant Diversity, Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, Uttar Pradesh, India | [3]Department of Botany, Kumaun University, Nainital-263001, Uttarakhand, India
Email: anilkverma.lmp@gmail.com

This study underscores the altitude driven patterns of plant invasion along with changes in its species composition, biomass accumulation, and carbon sequestration potential in native vis-a-vis invaded plant communities in sub-tropical forest ecosystem in Sikkim Himalaya, India. We conducted systematic sampling across stratified gradients, covering an area of 7,600 m² in both invaded and non-invaded zones A total of 51 herbaceous species from 20 families, dominated by Asteraceae (42%) were found present in invaded communities. The highest species diversity was recorded at mid-elevation zone in the non-invaded sub-tropical forest ecosystem and the invaded zones exhibited greater homogeneity as compared to the uninvaded native understory communities in the same altitudinal zone. Biomass accumulation varied significantly with altitude. In invaded sites, biomass production was highest at mid-elevation zone (56.82 Mg ha^{-1}). Targeted invasive species *Ageratina adenophora*, *Mikania micrantha, Lantana camara, Chromolena odorata* contributed approximately 34% of the total invaded community's biomass. Among four targeted species, *A. adenophora* was the most dominant invasive species across all the elevation zones. The findings also revealed that non-invaded native understory communities had significantly higher total biomass, with 83% attributed to aboveground biomass, which was 51.74% higher than the invaded zones. These findings indicate that invasion of non-native species significantly reduces the biomass of the affected plant communities. Additionally, the significant reduction in biomass and carbon stock in invaded areas calls for effective management strategies to control invasive species and restore native vegetation. Such measures are essential for enhancing the resilience of these ecosystems in the face of climate change.

T6-A2

Chromite mining and its adverse impact on environment and human health in Sukinda valley of India

A. K. Gupta[1*]
[1]Regional Office, Ministry of Environment, Forest and Climate Change, Lucknow, India
Email: amitenv@yahoo.com, amitkr.gupta@nic.in

India is the world's third-largest supplier of Chromite, or iron chromium oxide ($FeCr_2O_4$) is the mineral source of chromium. In its purest form, chromite comprises chromium (Cr_2O_3) at 68% and iron oxide (FeO) at 32%, primarily used in metallurgy for producing stainless steel and high-temperature alloys, and as a refractory material due to its high heat stability. In India, 98% of the chromite ore reserves are found in the Sukinda Valley, located in the Jajpur district of Odisha, and it has been exploited mostly by the opencast mining process since 1950. Chromium exists in six different forms, among which Chromium (III) and Chromium (VI) are the two main valence states of the metal that take part in inducing environmental toxicity. The trivalent form of chromium exhibits relatively mild toxicity in comparison to the hexavalent form of chromium. The former also maintains glucose, lipid, and protein metabolism. Hexavalent chromium is water-soluble and severely toxic due to its soluble nature. Due to a high stripping ratio, a huge quantity of overburden

(OB)containing a significant quantity of Chromium and other heavy metals is annually generated in the valley. This not only affects the natural environment but also the health of villagers and mining workers residing in the territory of contamination-prone areas. Studies have also indicated that the ongoing mining activities and their untreated disposals into the natural environment are not just affecting crop production but also degrading the soil quality, thereby making it unsuitable for agricultural purposes. It is utmost important to create awareness among the people and the society to take essential steps in contradiction to the raging threats of chromium contamination in the environment, especially in the Sukinda Valley periphery of Odisha.

T6-A3

Waste-water irrigation of agricultural fields and its ameliorative measures by regulating physiological and metabolic indices of vegetable crop

Anita Singh[1*]
[1]Department of Botany, Institute of Science, Banaras Hindu University, Varanasi, 221005, U.P.
Email: anita.1710@gmail.com

The increasing rate of urbanization and industrialization has worsened the quality of water resources. Due to the scarcity of fresh water, wastewater is commonly used to irrigate agricultural lands. However, along with the beneficial impacts the wastewater irrigation also has some negative consequences like metal contamination in soil and particularly in food chains. It has been found that heavy metal concentrations were several-fold higher in all food samples collected from wastewater irrigated areas. The level of Cd, Pb and Ni concentrations were above the prescribed safe limits of Indian WHO/FAO and EU standards in food crops. So, to reduce the availability of toxic substances from the wastewater in the plant parts, some innovative approaches and technologies are imperative. These technologies should justify the overall concept of sustainability. In this regard, amendment of organic fertilizer, combination of organic and inorganic fertilizer and biochar (simple/modified) have been done in wastewater irrigated soil to regulate the metal toxicity and other physiological activities of soil and plants. Currently, more focus has been given on the application of biochar as an adsorption agent for reducing the availability of heavy metals in the plants. The experiment was conducted in untreated wastewater irrigated agricultural fields located at Lohta, Varanasi. The experimental plots of 1x1 m^2 for both simple and modified rich husk biochar, including control, were prepared and applied at doses of 5,10, 15 and 20 t/ha. For each treatment, three replicates were prepared. The seeds of spinach plants collected from IIVR, Varanasi, have been sown at 2cm depth and in 5 rows in each plot. For Biochemical and physiological analysis, plants were harvested after 20 Days after germination (DAG) and for morphological assessments, plants were harvested at 45 DAG. The application of rice husk biochar with different doses (15,20 and 30 t/ha) in wastewater-irrigated soil with and without modification by using $KMnO_4$ as a modifying agent led to reduction in the metal availability in the vegetable crops as well as improved the soil nutrient dynamics. The microbial community growth and carbon source utilization were significantly enhanced in biochar-treated soils compared to the control, which consequently increased the plant biomass. The application of both simple and modified biochar also increased spinach biomass, with the highest yield observed at 15 t/ha of modified biochar. Additionally, modified biochar treatments significantly reduced Cd, Ni, Cu, Zn, Cr, Co, and Pb concentrations in the roots and shoots of spinach plants. High-resolution mass spectrometry (HR-MS) analysis identified a significant number of compounds in the samples, with 255 detected in control plants, 289 in simple biochar-treated plants, and 313 in modified biochar-treated plants. The overall observation indicates the amendment of modified biochar would be able to improve soil health by enhancing microbial activity, increasing nutrient availability as well as increases the quality of food crops by reducing

heavy metal uptake and increasing the secondary metabolite production and growth indices.

T6-A4

Water footprint assessment and aquifer profile towards developed hydrological approach in India

Brajesh K. Dwivedi[1*]
[1]Department of Applied Science- Environmental Science, FoET, KMCL University, Lucknow-226001
Email:drbkdwivedi2@gmail.com, bkdwivedi@allduniv.ac.in

Water footprint (WF) is a tool to estimate water consumption by humans and the available fresh water. WF focused on how anthropogenic activity impacted the quantity and quality of sediment deposition and the patterns in the water channel and the geochemical environment. The physical and chemical characteristics of surface/spring and well water samples were examined for a 2-year fluctuation in 2022–2024 in the downstream riverway of the Ganga at south-eastern Prayagraj city. The ionic speciation and minerals dissolution/ precipitation were calculated. Water wells, characterizing ground water circulation at shallow depths, are moderate to high mineralized waters of Na-HCH_3. In contrast to the shallow environment, the CO_2-rich, deeper water of the Ca-HCO_3-SO_4 type undergoes significant changes in the baseline chemistry along flow lines with increasing residence time. The heavy metal concentration ranged between 18.61-29.14, 03.14 -09.91, 51.25-78.08, 34.29-23.49, 0.18-0.72, 21.26-22.60, and 10.72- 13.44 mg/kg for Co, Cu, Cr, Cd, Ni, Zn and Pb, respectively. Geo-accumulation index was noted between 0 and 2 (class 2), which showed that the sediment was contaminated to moderately contaminated and may have adverse effects on the freshwater ecology of the river, especially post-flow. There were analyzed green-to-blue water footprint ratio i.e., 0.7-010. Mathematical equations were also derived for the hydrogeological variables for a better understanding of the study area; hence, proper management strategies are required to control the direct discharging of wastewater in the river flow in a way of zero-discharge and ecological integration towards a developed hydrological approach in India.

T6-A5

Assessment of metal leaching efficiency and phytotoxic response of bioleachates derived from mine waste

Disha Mishra, Puja Khare*
Crop Production and Protection Division, CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow - 226 015, India
Email: mishra.disha1@gmail.com

Mining industries have made exceptional progress in recent decades for metal extraction; however, mine wastes still contain significant quantities of valuable metals that can be further recovered. The disposal of these tailings poses environmental risks due to the potential leaching of toxic metals. The present study aims to assess the phytotoxicity of bioleachates derived from mine waste to evaluate their suitability for metal recovery and phytostabilization. A novel microbial consortium was employed to facilitate the leaching of metals from mine waste, and the phytotoxicity of the resulting bioleachates was tested using a germination assay in *Cicer arietinum* seeds. The effects of bioleachates collected at different time intervals were examined on germination, protein content, chlorophyll levels, and antioxidant enzyme activities. The mine waste was acidic (pH 5.01) and enriched with metals (Fe > Al >Mn> Zn > Cr > Cu) with low organic carbon and available phosphorus content. Mineralogical analysis revealed the presence of quartz, kaolinite, sepiolite, pyrite, and limestone, while morphological studies indicated a non-homogeneous surface with aggregated particles. Leachates collected on the 3rd and 15th days showed significant variations in germination index, growth parameters, chlorophyll, and protein content as compared to the control. The mean germination time was 8.3 days, with a germination index of 40, increasing to 60 on the 3rd day. Metal concentrations in bioleachates increased over time, particularly for Fe, Al, Cr, and Cu. Thus, the use of microbial consortia demonstrated efficient metal recovery with minimal phytotoxicity, supporting cleaner and sustainable approaches for simultaneous metal recovery and phytostabilization.

T6-A6

Seasonal Dynamics of Plant Communities and Soil Attributes in Grassland Ecosystem of Pilibhit Tiger Reserve: An Ecological Assessment through Multivariate and Indicator Species Analyses

Rahul Kumar[1,2*], Soumit Kumar Behera[1,2]
[1]Plant Ecology and Climate Change Science Division, CSIR NBRI, Rana Pratap Marg, Lucknow 226001, India | [2]Academy of Scientific and Innovative Research (AcSIR), CSIR-HRDC, Kamla Nehru Nagar, Ghaziabad, India
*Email: rahul.in.india.1@gmail.com

Seasonal variations have a significant impact on grassland ecosystems, influencing both vegetation and soil resources. This study investigated the impact of seasonal changes on plant communities and soil properties within the Pilibhit Tiger Reserve, India, employing clustering, Indicator Species Analysis (ISA), and diversity indices. A total of 34 species (13 families) were found in the pre-monsoon season, 21 species (10 families) in the post-monsoon, and 20 species (7 families) during winter, with perennials dominating (57–80%). Grassland species showed variability in photosynthetic type across the seasonal shift, accounting for C3 species >57% in both pre- and post-monsoon seasons, while for C4 species, 60% in winter. Diversity indices also showed a significant trend of variability across seasons (Shannon: $H = 44.59$, $p < 0.0001$; Simpson: 1-D = 37.57, $p < 0.0001$), although evenness remained unchanged ($p = 0.443$). Soil parameters exhibited strong seasonal patterns: available nitrogen (AN) and potassium (AK) peaked during pre- and post-monsoon, while total nitrogen (TN), phosphorus (AP, TP), and Total organic carbon (TOC) were highest in winter ($p < 0.0001$). Season-specific indicator species were identified by Indicator Species Analysis (ISA), such as *Saccharum munja* (IndVal = 85.1, $p < 0.001$, pre-monsoon), *Apluda mutica* (IndVal = 76.53, $p < 0.001$, post-monsoon), and *Chrysopogon zizanioides* (IndVal = 79.31, $p < 0.001$, winter). Spearman's correlation test revealed that AN was positively associated with AK ($rs = 0.92$, $p < 0.0001$) and TK ($rs = 0.74$, $p = 0.006$), but negatively with TP ($rs = -0.59$, $p = 0.041$). TOC showed positive correlation with AP ($rs = 0.89$, $p < 0.001$) and TP ($rs = 0.70$, $p = 0.012$), while negatively correlating with species richness (SR; $rs = -0.87$, $p < 0.001$). Shannon diversity showed positive relationships with AK ($rs = 0.83$, $p < 0.001$) and TK ($rs = 0.66$, $p = 0.019$), whereas SR was negatively linked to AN ($rs = -0.86$, $p = 0.003$) and TOC. Overall, community diversity was enhanced by potassium and phosphorus, while excess availability of nitrogen and organic carbon limits the richness. These findings demonstrate that both soil properties and seasonal changes influence grassland biodiversity, and indicator species can serve as ecological markers for monitoring and conserving the Terai grasslands.

T6-A7

Innovative cultivation strategies for reducing grain Arsenic in rice (*Oryza sativa* L.): Toward sustainable agriculture and environmental protection

Rudra D. Tripathi[1]*, P.K. Singh[1], Poonam Tiwari[1], Reshu Chauhan[1], Surabhi Awasthi[1], Debasis Chakrabarty[1] and Pankaj K. Srivastava[1]
CSIR-National Botanical Research Institute, Lucknow, India
Email: tripathird@gmail.com

Arsenic is a pervasive environmental contaminant and carcinogen that enters the food chain primarily through arsenic-laden drinking water and irrigation of paddy fields under waterlogged conditions. To mitigate this risk, we developed the rice cultivar CN1794-2-CSIR-NBRI (Muktashri), which exhibits low arsenic accumulation in grains while retaining high levels of essential micronutrients, including Fe, Cu, Zn, Se, and Ni. Using a transgenic approach, we introduced the phytochelatin synthase (PCS) gene from *Ceratophyllum demersum*, which enhanced arsenic sequestration in roots and significantly reduced its translocation to grains. Additionally, we engineered Arabidopsis thaliana with the arsenic methyltransferase gene (WaarsM) from the fungal strain

Westerdykella aurantiaca. Transgenic *A. thaliana* and rice expressing WaarsM demonstrated improved arsenic tolerance and volatilized substantial quantities of arsenicals, thereby minimizing arsenic accumulation in aerial tissues and grains. These findings underscore the dual utility of WaarsM in reducing arsenic entry into the food chain and enhancing phytoremediation potential. The expression of PCS and WaarsM in rice offers a promising strategy for arsenic detoxification through methylation and volatilization. Furthermore, integrating biotechnological interventions with microbe-plant interactions and supplementation of selenium and sulfur compounds led to additional reductions in grain arsenic levels. Nitric oxide was also found to modulate arsenic detoxification pathways, contributing to enhanced tolerance in rice under arsenic stress.

T6-A8

Evaluating the phytoremediation potential of the medicinal plant *Ocimum basilicum* for mitigating indoor air pollution

Sabuj Mondal [1,2 *], Vibhuti Singh [2]
[1]Department of Bioscience and Biotechnology, Indian Institute of Technology Kharagpur, West Bengal, India | [2]Department of Botany, University of Delhi, New Delhi, India
Email: Sabujmondal1736@botany.du.ac.in

Indoor air pollution has emerged as a silent but significant environmental challenge, affecting both human health and plant physiology. Exploring natural and sustainable solutions, such as phytoremediation, offers an eco-friendly alternative for mitigating volatile and gaseous pollutants**.** The present work explores the adaptive and phytoremediative capacity of *Ocimum basilicum* (basil) when exposed to common indoor air pollutants, particularly volatile organic compounds (VOCs) such as naphthalene and gaseous sulfur dioxide (SO_2). Healthy plants were cultivated under controlled indoor conditions to examine variations in growth, physiology, anatomy, and biochemical performance under pollutant stress. Basil exhibited steady germination efficiency across different growth media, establishing its resilience and suitability for controlled experimental setups. Exposure to naphthalene induced mild physiological alterations, while SO_2 exposure triggered more pronounced effects such as leaf yellowing, reduced turgidity and visible tissue damage, including structural disorganization in the stem and vascular tissues. Additionally, gas-exchange measurements (using Infrared Gas Analyzer, IRGA) indicated fluctuations in photosynthetic rate, transpiration, and stomatal conductance, confirming pollutant-induced stress responses. Biochemical assays reflected enhanced antioxidant activity, increased phenolic content, and modulation of enzymatic defense pathways, as adaptive mechanisms. ICP–MS analysis validated the absorption and elemental redistribution of pollutants within plant tissues, showing significant isotopic shifts in hydrogen, carbon, nitrogen, and sulfur, suggesting active pollutant uptake and metabolic adjustment. Moreover, pollutant-exposed basil plants exhibited an increase in its bioactive constituents carvacrol, thymol, rosmarinic acid, and flavonoids, which are known to mitigate oxidative stress and are involved in inflammatory signaling. Overall, the findings demonstrate that *Ocimum basilicum* is a physiologically adaptable and biochemically potent species capable of mitigating airborne toxins while contributing valuable therapeutic metabolites.

T6-A9

Physicochemical analysis of Parvati Arga wetland: a lesser-known Ramsar site from eastern U.P.

Sakshi Srivastava[1]*, Rekha Sharma[1]
[1]Dept. of Botany, S.L.B.S. Degree College, Gonda, India
Email: sakshisrivastava2708@gmail.com

Parvati Arga wetland (Bird Sanctuary), situated in Gonda district of Uttar Pradesh, is one of the largest natural flood plain wetlands in the state. Rich and heterogeneous in flora and fauna, Parvati Arga wetland comprises two freshwater oxbow lakes *viz.* Parvati and Arga.

Since not much research work has been carried out on this biologically rich Ramsar site, we have started a thorough physicochemical study of the lake water. Various factors such as continuous fluctuation and decline in the average annual rainfall (from 1993-2023), decrease in water level of Parvati lake, water pollution, increase in siltation, conflict between farmers and water department, and community engagement in illegal activities, have resulted in wetland degradation and ultimately affected the water quality of the lakes. Hence, a preliminary analysis of various physicochemical parameters such as water turbidity, pH, Total Dissolved Solids, Total Hardness, Calcium, Magnesium, Total Alkalinity, Chloride, total iron, nitrate, sulphate, fluoride, Free Residual Chlorine, Chemical Oxygen Demand, Biological Oxygen Demand, Total Suspended Solids, Electrical Conductivity at 25°C, Total Coliform (MPN/100 ml), Faecal Coliform (MPN/100 ml) and *E.coli* has been carried out.

T6-A10

Arsenic dynamics in paddy soils of eastern Uttar Pradesh: Links to rhizosphere chemistry, and rice uptake and transformation

Seema Mishra[1]*, Sanjay Dwivedi[2]
[1]University of Lucknow, Lucknow | [2]CSIR-National Botanical Research Institute, Lucknow, India
Email: seema_mishra2003@yahoo.co.in

Arsenic (As) is a ubiquitous element that is nonessential for plants and toxic to all forms of life. The continuous loading of As in arable land by means of contaminated irrigation water is of serious concern. In recent years, high levels of As have been reported in groundwater (>1310 µg L^{-1}), soil (>35 mg kg-1) and in rice grain (0.179 to 0.932 mg kg^{-1}) in several districts of U.P., (India) situated in the Himalayan Terai region. Soil physico-chemistry is crucial in As accumulation in soil as well as its release in the soil solution. fractionation of As was performed in As-contaminated paddy field soils from U.P., i.e., Middle Ganga Plain (MGP). The concentration of As in soil and its release in different fractions were strongly correlated with the soil properties. The levels of available P, S, Fe, and Ca, and clay content are the main factors for As accumulation and availability in soil. Further, As translocation and speciation in rice were studied in laboratory conditions to understand As metabolism in plants. The rice plants were exposed to inorganic and methylated As species: arsenate, methylarsonate, and dimethylarsinate, the pentavalent forms commonly found in soil. The results showed that arsenate and methylarsonate were efficiently reduced to their trivalent forms in rice root and shoot, but dimethylarsinate was untransformed. Most of the As in arsenate and methylarsonate-exposed plants was localized in roots (48-83%) in the form of various thiol-complexes. Since chemical transformation of arsenic in soil and plant root are important factors affecting its uptake and translocation to grains, it is important to study the key soil properties leading to grain arsenic variation and to restrict arsenic translocation to the grain.

T6-A11

Current Assessment of Lichen Diversity and Implications of Future Climate Change in Satna District, Central India

Shweta Tiwari[1,2*], Kanchan Awasthi[1], Gaurav K. Mishra[2] and D.K. Upreti[2]
[1]Department of Botany, Maharshi University, Sitapur Road, P.O-Maharishi Vidya Mandir, Lucknow-226013, Uttar Pradesh, India
[2]Lichenology Laboratory, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow - 226 001, Uttar Pradesh, India
Email: shweta151tiwari@gmail.com

Lichens are complex organisms and their thalli are the result of cyclic symbiotic associations between at least two very different organisms: a heterotrophic fungus (mycobiont) and a phothosynthetic partner (photobiont). Lichens differ substantially from higher plants because of their poikilohydrous nature and combined with other physiological processes makes lichen growth particularly susceptible to

climatic variations, pollution and other environmental factors and liable to changes at genetic, individual, population and community levels. Lichens have been used as predictive tools for investigating land forming processes and rates of environmental change. Cryptogams especially lichens play a significant role in structure and function of ecosystem. Their relative effect on ecosystems in which they occur is far greater than their total plant biomass. Lichens are cosmopolitan in distribution and grow on any substratum that provides a convenient foothold to them. In the present study authors explore the Satna district situated in eastern part of Madhya Pradesh is well known for its coal deposits. The state has typical undulating, topography comprised of small hillocks and plains. The *Mangifera indica*, *Shorea robusta*, *Diospyrus melanoxylon*, *Azadirachta indica* and *Pongamia pinnata* trees forms the major forest vegetation of the district. Among the different trees, the *Mangifera indica* growing in orchards and as wild show good growth of lichens. The small mountainous areas having exposed sandstone and siliceous rocks show growth of saxicolous lichens. The district is represented by the occurrence of 57 species belonging to 27 genera and 13 families of lichens. The lichen family Teloschistaceae shows its dominance with 7 species followed by Lecanoraceae with 4 species. The district shows maximum diversity of corticolous lichens presented by 32 species followed by and 30 saxicolous species. Among the different growth forms, crustose lichens show their maximum with 35 species followed by 13 foliose, 3 squamulose and 2 leprose species. *M. indica, S. robusta* and *D. melanoxylon* bear luxuriant growth of lichens represented by 7, 6 and 5 species respectively while The *P. pinnata*, *A. indica* trees bear single species. The crustose lichen *Rinodina sophodes* and *Lecanora tropica* grows luxuriantly on most of the trees. The open exposed sand stone rocks also bear luxuriant growth of saxicolous lichen species such as *Baculifera remensa, Lichinella flexa, Pyrenopsis triptococca* and *Peltula steppa. Caloplaca* and squamulose genera *Peltula* exhibit their luxuriant growth on rocks. *Parmotrema praesorediosum* foliose lichen exhibit luxuriant growth both on trees and exposed siliceous rocks in hilly areas of the district. The present diversity and distribution record of lichens in the district will act as a baseline data for carrying out climate change and biomonitoring studies in area in future.

T6-A12

Sediment accumulation of Polyaromatic hydrocarbon in estuarine and coastal regions of Chandipur, east coast of India

Subhashree Nayak[1]*, Smruti Prajna Pradhan[1], Pratyusha Nayak[1], Sthitaprajna Nath Sharma[1], Nishigandha Muduli[1], Lipika Patnaik[1]
[1]Environmental Science Lab, Department of Zoology, Center of Excellence in Environment and Public Health, Ravenshaw University, Cuttack, India
*Email: lipikapatnaik@ravenshawuniversity.ac.in

Polycyclic aromatic hydrocarbons (PAHs) are the most persistent, hydrophobic group of contaminants in the aquatic environment. PAHs accumulate in sediments and are absorbed by marine organisms, posing a threat to different life forms. Various studies have confirmed the presence of PAHs in the coastal water, emphasizing the need for continuous monitoring. Chandipur is one of the major fish landing centers and a very high number of trawlers operate in coastal waters. Trawling activities contribute to increasing the PAHs load in the surrounding water. These eventually get deposited in the sediment and are a major threat to the marine fauna as well as increase health risk for humans. In the present study, pollution level, source and risk associated with sediment PAHs were carried out and the area of study has scanty information about PAHs pollution of Odisha coast. Sediment samples of the estuarine and coastal region were collected from 13 GPS fixed stations using a Van veen grab during the pre-monsoon and post-monsoon period. Extraction of PAHs from sediment samples was carried out by ultrasonication using n-Hexane and dichloromethane as solvents, followed by their detection and quantification using high-performance liquid chromatography (HPLC). The ecological risk assessment of PAHs was

evaluated based on the effective range low (ERL) and effective range median (ERM) values of sediment quality guidelines (SQG) and the toxicity equivalence quotient (TEQ_{BaP}) method. For the detection of pollution emission sources of PAHs (petrogenic or pyrolytic), the Molecular diagnostic ratio (MDR) was used. Moran's Index was calculated to observe the distribution pattern (regular or clustered) and sources (i.e., point or non-point source) of individual PAHs. In most of the sampling sites, low molecular weight PAHs consisting of 2 and 3-ring PAHs contributed the maximum to the total PAHs as compared to high molecular weight PAHs. PAHs source diagnostic ratio confirmed both petrogenic and pyrolytic origin of PAHs, with predominance of petrogenic ones in maximum stations. Moran's Index value revealed that PAHs present in the study area demonstrated both localized and dispersed distribution patterns that are released from point and non-point sources, respectively. The ERL and ERM values confirm low to moderate risk to the aquatic organisms and indicate a need for regular PAHs monitoring. Therefore, to manage these existing contaminants, various control measures should be introduced to reduce and regulate PAHs entry into the marine environment and minimize the impact of PAHs on sediment-dwelling organisms.

T6-A13

Morphological characterization, elemental composition and distribution of *Chaetoceros* sp. of Dhamra Coastal water, Odisha, India

Smruti Prajna Pradhan[1], Nishigandha Muduli[1], Pratyusha Nayak[1], Sthitaprajna Nath Sharma[1], Subhashree Nayak[1], Lipika Patnaik[1]*
[1]Ecotoxicology Laboratory, Department of Zoology, Center of Excellence in Environment and Public Health, Ravenshaw University, Cuttack, India
Email: lipikapatnaik@ravenshawuniversity.ac.in

The distribution, abundance and richness of diatoms directly influence the production and health status of the aquatic ecosystem. With a growing population, pollution load has increased, which also has its impact on the diversity and distribution of diatoms with physico-chemical parameters. The current study focuses on the analysis of physico-chemical parameters, distribution and elemental composition of *Chaetoceros* species of Dhamra coastal water sampled during 2021-22, covering three seasons (pre-monsoon, monsoon and post-monsoon). Surface water samples were collected from 12 transect points (6 from the estuary and 6 coast). Physico-chemical parameters like SST, pH, DO, salinity, transparency, silicate, nitrite, nitrate, phosphate and sulphate were analysed. Compound microscope and scanning electron microscope coupled with EDX were used for enumeration, ultrastructure and elemental composition of *Chaetoceros* sp. A total of 14 *Chaetoceros* sp. were identified from Dhamra. Seasonal abundance of *Chaetoceros* species was high in monsoon and distribution was maximum in the estuarine region compared to the coastal. *Chaetoceros* sp. mainly depend on silicate for their frustule formation like other diatoms. *C. decipiens, C. didynum, C. curvisetus, C. danicus* and *C. affinis* were the most dominant species throughout the year. Monsoon season was the most favourable for the growth and diversity of *Chaetoceros* sp. abundance was also found to be positively correlated with nitrite (r =871) and nitrate (r =0.878) whereas, strong negative correlation was observed between *Chaetoceros* sp. with pH (r =-0.622), transparency (r =-0.622), salinity (r =-0.785) and sulphate (r =-0.580) (significant at $p \leq 0.05$). *Chaetoceros* network visualisation map was made in VOSviewer software using the bibliographic data of PubMed database to know the overall work on *Chaetoceros* species along with plankton and diatoms as main keywords. Shannon's diversity index(H') and Simpson's evenness index(D) were observed to be higher in monsoon (2.223 and 0. 8729) as compared to pre-monsoon (2.002 and 0.8495) and post-monsoon (2.2 and 0.8689) whereas Margalef's species richness index was higher in post-monsoon (2.392) as compared to pre-monsoon (1.987) and monsoon (2.06). Principal component analysis (PCA) was studied to analyse the environmental variable affecting *Chaetoceros* sp. K dominance curve showed

maximum abundance of *C. decipiens, C. curvisetus* and *C. affinis* in pre-monsoon, *C. decipiens, C. danicus* and *C. didymus* in monsoon and *C. didymus* in post-monsoon. From SEM-EDX analysis 9 elements were found from the surface of *Chaetoceros* sp. The present study highlights the abundance and distribution of *Chaetoceros* sp. which are strongly affected by the environmental variables, mainly the presence of nutrients. Nitrite and nitrate are the most effective parameters that induce the growth of *Chaetoceros* sp. which may cause a bloom in near future.

T6-A14

Ecotoxicological effects of Tributyltin Chloride (TBTCl) on freshwater bivalve *Lamellidens marginalis*: A quantitative study of histopathological alterations

Sthitaprajna Nath Sharma[1], Nishigandha Muduli[1], Pratyusha Nayak[1], Shubhajit Saha[2], Smruti Prajna Pradhan[1], Subhashree Nayak[1], Lipika Patnaik[1]*

[1]Environmental Science Lab, Department of Zoology, Center of Excellence in Environment and Public Health, Ravenshaw University, Cuttack, India | [2]Department of Zoology, The University of Burdwan, Purba Barddhaman, West Bengal, India

Email: lipikapatnaik@ravenshawuniversity.ac.in

With the increasing pollutant burden in freshwater ecosystems, the need for an efficient biomarker for monitoring aquatic health. Histopathology serves as one of the most favorable markers in ecological risk assessment that provides an insight into the structural damages caused at a subcellular, cellular, organ as well as organismal level due to acute and chronic exposure to different environmental toxicants. Tributyltin chloride (TBTCl-a derivative of organotin Tributyltin), which is used as a fungicide, herbicide, and PVC stabilizer, has posed havoc on the health status of freshwater invertebrates, mostly the bivalve molluscs. Bivalves are sessile filter feeders with high pollutant bioaccumulation capacity, and can be impacted due to the presence of TBTCl, which alters the metabolism, development, endocrine functions and cause oxidative stress in these organisms. Histopathological studies are the most reliable biomarker that can bridge the gap between biochemical alterations and ecotoxicological outcomes. The present study focuses on (i) Analysis of histopathological alterations in gill and hepatopancreas tissue of freshwater bivalve *Lamellidensmarginalis* exposed to sublethal concentrations ofTBTCl, (ii) Quantitative interpretation of the alterations in terms of histopathological indices. The bivalves were exposed to five sublethal concentrations of TBTCl, such as 0.2 (T/5), 0.1 (T/10), 0.067 (T/15), 0.05 (T/20), and 0.04 (T/25) mg $L^{-1,}$ which are $1/5^{th}$, $1/10^{th}$, $1/15^{th}$, $1/20^{th,}$ and $1/25^{th}$ of the LC_{50} (1 mg L^{-1}), respectively. The tissues were processed through fixation, dehydration, Paraplast embedding followed by microtome sectioning (5-6µ) and slide preparation with Hematoxylin-eosin staining. Obtained light microscope images were quantitatively analyzed to determine Organ Index (I_{org}), Total Index (I_{tol}), Histopathological Condition Index(Ih), and the Bioeffect Assessment Index (BAI). Major alterations were observed in the gill and hepatopancreas in terms of architectural and structural changes, deposition of lipofuscin aggregates, vacuolation, necrosis, rupture of gill filament epithelial cells, epithelial detachment, gill lamellar fusion, lateral cilia damage and ciliary exfoliation, atrophy, hyperplasia of filament, Infiltration of hemocytes, irregularities in lumen structure of digestive tubule, tubule regression, etc. The histopathological indices confirm significant changes in both tissues, with higher alterations in hepatopancreas. BAI indicates a gradation in the intermediate dose concentrations for the gill tissue. This study concludes that TBTCl impacts the histopathology of freshwater bivalve *Lamellidens marginalis* in a dose-dependent manner.

T6-A15

Invasive weed diversity and phytochemical dynamics in turmeric cultivation under sodic soils of Awadh Region, India

Bikarma Singh[1]*, R.C. Nainwal[1], Devendra Singh[1], Lal Bahadur[1], B.N. Singh[1]

[1]Botanical Garden, Plant Conservation and Agrotechnology Division, CSIR-National Botanical Research Institute, Lucknow, India | Academy of Scientific & Innovative Research (AcSIR), Ghaziabad 201002, Uttar Pradesh, India.
Email: drbikarma.singh.nbri@csir.res.in

Turmeric (*Curcuma longa* L.), an essential life-giving spice and medicinal plant, encounters substantial agronomic difficulties in sodic soil conditions, especially in the Awadh region (UP) of India. This research explores the variety of invasive weed species and their ecological relationships within turmeric farming practices under the stress of sodicity. A thorough field assessment was carried out during 2020-2025 at various locations in the Awadh area to recognize the predominant weed species and evaluate their effects on the health and yield of the crop. At the same time, a phytochemical analysis of turmeric rhizomes and leaves was conducted to examine changes in curcuminoid levels and other bioactive substances in relation to weed pressure and soil sodicity. The result uncovered a diverse array of invasive weed species, with *Parthenium hysterophorus*, *Ageratum conyzoides, Euphorbia prostrata, Chenopodium album* and *Celosia argentea* being among the most common. These species demonstrated vigorous growth patterns, leading to competitive nutrient depletion and changes in microclimatic conditions. Phytochemical assessments indicated variations in the concentrations of curcumin, demethoxycurcumin, essential oil contents and other phytochemical constituents, implying that both abiotic stress and biotic interactions influence the production of secondary metabolites in turmeric. The study emphasizes the necessity for integrated weed management approaches tailored to sodic ecosystems and highlights the significance of maintaining phytochemical integrity for both agricultural and medicinal purposes. These findings can guide sustainable turmeric farming practices and assist soil reclamation initiatives in the marginal lands of the Indo-Gangetic plains.

T6-A16

Characterizing Arsenic-Responsive mRNAs and miRNAs in *Spinacia oleracea* for Establishing Molecular Control of Arsenic Stress

Disha Maitra[1], Twinkle Singh[2], Debasis Chakrabarty*
National Botanical Research Institute, Lucknow-226001.
Academy of Scientific and Innovative Research (AcSIR), New Delhi, 110001, India
Email: dishamaitra2107@gmail.com, chakrabartyd@nbri.res.in

Arsenic (As) contamination poses a major threat to spinach cultivation and food safety. Although previous studies examined either mRNA or miRNA responses to heavy-metal stress, the coordinated regulatory relationship between miRNAs and their target genes under As(III) stress in spinach had not been explored. In this study, we performed an integrated analysis of mRNA and miRNA expression in roots and shoots following As(III) exposure, identifying 33 and 18 differentially expressed miRNAs and 7272 and 5809 differentially expressed mRNAs in roots and shoots, respectively. Tissue-specific enrichment analyses revealed that secondary metabolite pathways, signaling components, ABC transporters, nitrate transporters, and major transcription factor families (MYB, bZIP, NAC, bHLH) were dominant in roots, whereas ribosomal proteins, carotenoid biosynthesis genes, and stress-responsive genes such as GST, SAUR, glutaredoxin, ascorbate peroxidase, and MATE efflux transporters were enriched in shoots. This work will focus functional validation and regulatory characterization of key components controlling arsenic tolerance. Three highly upregulated transporter genes were validated through RT-qPCR and subsequently cloned into pTZ and pYES vectors. Parallel to this, a refined transcriptome re-analysis enabled the identification of the most arsenic-responsive miRNAs, prediction of their target mRNAs, and construction of a high-confidence miRNA–mRNA regulatory network

highlighting key transporters, antioxidant enzymes, and transcription factors likely regulated by these miRNAs under As(III) stress. This work provides the first integrated miRNA–mRNA regulatory framework for arsenic stress in spinach and offers experimentally supported candidate genes and regulatory modules for future functional validation. The outcomes lay the foundation for developing molecular breeding and genome-editing strategies aimed at reducing arsenic accumulation and improving stress resilience in spinach.

T6-A17

Assessing the bioremediation potential and Physiological Responses of *Chlorella* sp. and *Desmodesmus* sp. exposed to Arsenic (V)

Prabhkirat Kapahi[a], Neeraj Meena[a], Tufail Fayaz[a], Esha Goyal[a], Sachitra Kumar Ratha[b], *Nirmal Renuka[a]

[a]Algal Biotechnology Laboratory, Department of Botany, Central University of Punjab, Bathinda 151401, India

[b]Algology Laboratory, CSIR–National Botanical Research Institute, Lucknow – 226001, India

Email: nirmal.renuka@cup.edu.in, renuka.bot@gmail.com

Heavy metal pollution, mainly arsenic (As), poses a significant ecological threat in aquatic environments. This study investigates the removal efficiency of As (III) and its impact on the growth, pigments, and metabolites of the microalgae *Chlorella* sp. and *Desmodesmus* sp. On the 14th day, *Desmodesmus* sp. showed a higher As (III) removal efficiency (71% ± 2.6%) compared to *Chlorella* sp. (47.6% ± 5%). Microalgal growth was not impacted at lower As (III) concentrations (1-10 mg L^{-1}) compared to the control, but chlorophyll levels decreased at 10 mg L^{-1} in both species. Higher concentrations (25-100 mg L^{-1}) significantly inhibited the growth of *Chlorella* sp. and *Desmodesmus* sp., showing 1.1 and 5.8-fold growth inhibition at 100 mg L^{-1}, respectively, compared to the control. Carbohydrate content increased in both species, with a maximum of 1.2 to 1.3-fold at 10 mg L^{-1} as compared to the control. The protein content declined with the increase in As (III) concentrations, while the lipid content was enhanced with the increase in As (III) concentration up to 10 mg L^{-1}. GC-MS analysis of ethanolic extracts showed distinct changes in the metabolite profile in As (III) exposed treatments in both the microalgae species compared to the control. Some distinct compounds in As (III) exposed treatments included dotriacontane, hexanedioic acid, tetracosane, benzene, propanoic acid, dodecanoic acid, and stearic acid. These findings suggest that *Chlorella* sp. and *Desmodesmus* sp. can tolerate high As (III) concentrations (up to 10 mg L^{-1}). Future studies can be directed to evaluate the heavy metal remediation potential of these microalgae from aquatic environments.

T6-A18

Assessing the influence of land use and soil biochemical properties on tropical ecosystem carbon dynamics in the Terai Region of Uttar Pradesh

Ragib Husain[1,2], Soumit K. Behera[1, 2*]

[1]CSIR- National Botanical Research Institute, Rana Pratap Marg, Lucknow India | [2]Academy of Scientific and Innovative Research (AcSIR), AcSIR Headquarters CSIR-HRDC Campus, Postal Staff College Area, Sector 19, Kamla Nehru Nagar, Ghaziabad, India

Email: soumitkbehera@gmail.com

Soil CO_2 efflux (SCE) is the most important component of terrestrial carbon dynamics, strongly influenced by land use and land cover change (LULC), soil biochemical properties, and microclimatic variations. Even though its importance is recognized, limited information is available on how these factors interact across different tropical land use and land cover systems in the Terai region of Uttar Pradesh, India. It was hypothesized that variations in LULCs and associated soil properties significantly influence SCE through the changes in soil organic carbon (SOC), microbial activity, and nutrient dynamics. The objective of this study was to quantify the seasonal variability of SCE and identify its major governing factors across the dominant LULC types of the region. The SCE was measured seasonally during 2023-2024 over nine representative classes of LULC, namely,

forest, plantation, and agricultural systems. In this process, soil biochemical parameters, specifically microbial biomass carbon (MBC), total organic carbon (TOC), total nitrogen (TN), total phosphorus (TP), pH, and electrical conductivity (EC), along with microclimatic variables, were analyzed to characterize their inter-relationships. Preliminary analyses showed large spatial and temporal variability in SCE within the studied LULC types. Forest ecosystems generally showed higher SOC and microbial activity, whereas agricultural systems exhibited greater management-driven variations. We found strong correlations between SCE and key soil biochemical parameters, which highlight the role of soil microbial and nutrient dynamics in regulating CO_2 emissions. The study underscores the critical influence of land use-specific soil characteristics on ecosystem carbon fluxes. Understanding these linkages between different LULCs provides a foundation for developing management strategies that enhance soil carbon sequestration and mitigate CO_2 emissions. Such insights are vital for predicting future carbon source sink shifts in response to climate change in tropical ecosystems.

T6-A19

MicroRNA-Mediated Regulation of Gene Expression in Response to Arsenic Stress in Rice

Twinkle Singh[1], Disha Maitra[2], Debasis Chakrabarty[1]*
National Botanical Research Institute, Lucknow-226001.
Academy of Scientific and Innovative Research (AcSIR), New Delhi, 110001, India
Email: twinklesingh2107@gmail.com, chakrabartyd@nbri.res.in

MicroRNAs (miRNAs) are key epigenetic regulators of gene expression and play crucial roles in plant growth, development, and stress responses. Arsenic (As) contamination in rice, a major global food crop, poses serious health risks such as cancer and neurological disorders. The involvement of miRNAs in As stress response has not been extensively characterized. In this study, we identified hundreds of miRNAs from As(III)-treated and untreated rice samples after 24 hours of exposure. Approximately fifteen miRNAs, including osa-miR7693-5p, osa-miR408-5p, osa-miR528-3p, osa-miR6245, osa-miR398b, osa-miR169f.2, osa-miR2870, osa-miR528-5p, and osa-miR408-3p, exhibited significant differential expression (greater than 2-fold change; $p < 0.05$) under As stress, indicating their potential roles in defense and detoxification pathways. Target prediction and functional annotation revealed that these miRNAs regulate genes involved in transporter activity, transcriptional regulation, heat shock response, auxin signaling, and metal ion homeostasis. Integrated transcriptome analysis further demonstrated a strong correlation between miRNA expression patterns and global transcriptional changes, highlighting the interconnected regulatory networks activated during As stress. Validation using real-time PCR confirmed the differential expression of selected miRNAs and their corresponding target genes, reinforcing the significance of miRNA-mediated signaling in the rice As stress response. Overall, these findings provide new insights into the molecular mechanisms underlying As tolerance and offer a foundation for the development of arsenic-resilient rice varieties, contributing to improved food safety and sustainable agriculture in contaminated regions.

T6-A20

Phytohormone-induced regulation of antibiotic bioremoval and physiological adaptations in microalgae

Nirmal Renuka[1], Tufail Fayaz[1]
Algal Biotechnology Laboratory, Department of Botany, Central University of Punjab, Bathinda, 151401, India
Email: renuka.bot@gmail.com, nirmal.renuka@cup.edu.in

The widespread discharge of antibiotics into aquatic environments has become a major ecological concern due to their persistence, bioaccumulation potential, and capability to enhance the proliferation of antibiotic-resistant genes. Algae-based

bioremediation offers an environmentally friendly approach for removing antibiotics, as microalgae possess the ability to effectively sequester, transform, and/or degrade these pollutants. Moreover, the resultant biomass can be valorized for the production of industrially relevant compounds, thereby integrating wastewater treatment with resource recovery. The present study elucidates the effects of different phytohormones, indole-3-acetic acid (IAA), gibberellic acid (GA), and kinetin (KIN), on ciprofloxacin (CIP) removal efficiency and physiological responses in *Chlorella sorokiniana*. The baseline CIP removal efficiencies of *C. sorokiniana* ranged from 43.63% to 76.6%, which significantly increased upon phytohormone supplementation with IAA (87.97-93.70%), GA (84.96-88.76%), and KIN (48.75-76.05%). Phytohormone treatments enhanced biomass productivity and photosynthetic efficiency, indicating a reduction in antibiotic-induced oxidative stress. Under combined CIP and phytohormone exposure, the activities of key antioxidant enzymes-superoxide dismutase, catalase, glutathione reductase, and ascorbate peroxidase were significantly upregulated. Metabolomic profiling revealed that phytohormones result in distinct modulations of lipid, alkanes, phenolic, and carbohydrate metabolic pathways, indicating biochemical adaptations that facilitate stress alleviation and pollutant degradation. The findings revealed the role of phytohormones in enhancing both the physiological resilience and bioremediation capabilities of microalgae, highlighting their potential utility in the effective treatment of antibiotics in aquatic environments.

T6-A21

Lake Sediments as records of regional changes

Aryan Verma[1], Shiva Mishra[1], Anis[1], Vertika Shukla[1]*, Narendra Kumar[1]
[1]Department of Geology, Babasaheb Bhimrao Ambedkar (Central) University, Raebareli Road, Lucknow 226025
Email: vertika_shukla@rediffmail.com

Lakes are vital freshwater ecosystems that act as sensitive recorders of environmental changes within their catchments. Sediment deposited at the lake bottom over time preserves a detailed history of these changes, making them valuable archives for paleoenvironmental studies. Understanding the mineralogy of lake sediments provides crucial insights into past weathering processes, climatic fluctuations, and anthropogenic activities within the drainage basin. In view of the geological importance of lakes, the present study aimed to characterize minerals present in lake sediments in and around Lucknow using SEM-EDS technique. Lucknow being in the region of Gomati River Basin is highly water fed and encompasses various lakes and ponds in the region as the geological memento of the past trails of the rivers. Sediment samples were collected from various lakes in and around Lucknow in the Gomati River Basin. The SEM-EDS analysis of the sediment samples collected from four different lakes in and around Lucknow revealed interesting results on morphology and mineral composition of sediments. Variations in surface morphological features were reported in SEM study of the studied sediment samples, which may be caused due to the mechanical and chemical actions, different catchment characteristics, and anthropogenic disturbances. Many grains were characterized by Irregular, angular to sub-angular outlines, rough and weathered surfaces, flakiness and micro-features, which indicate short distance of transportation from their source. The results obtained from EDS spectra revealed the heterogeneous composition. The identified minerals species included quartz, feldspars (*K-feldspar and plagioclase*), mica (*muscovite and biotite*) and various other minerals. SEM data provides clues about the origin and transport history of the mineral particles. Irregular and angular shapes often suggest minimal transport, indicating the minerals likely originated from nearby geological sources. Weathered surfaces suggest exposure to environmental elements, potentially due to erosion and weathering processes. EDS analysis successfully identified

a range of elements present in the lake sediments, corresponding to various mineral phases. The presence of these minerals in the lacustrine environment offers valuable clues about the geological history of the region suggesting that there was a transition of fluvial to lacustrine environment in the region back in the geological time. This study effectively demonstrated the utility of SEM-EDS in characterizing the mineralogical composition of lake sediments. The combined approach provided valuable morphological information from SEM analysis, along with elemental identification and data from EDS. This allowed for a comprehensive understanding of the mineral phases present in the sediments. Correlating the mineralogical data with factors like pollution levels, biological activity within the lakes could provide deeper insights into the health and functioning of the lake ecosystems.

T6-A22

Heterogeneous microclimates govern the bryophyte diversity patterns in the alpine ecosystem of the Indian Himalaya

Ramya Ranjan Paul[1,2*], Soumit K. Behera[1,2*], Krishna Kumar Rawat[1,2], C. P. Singh[3]
[1]CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow226001, Uttar Pradesh, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, Uttar Pradesh, India | [3]Space Applications Centre, Indian Space Research Organization, Ahmedabad380015, Gujrat
Email:ranjanramya367@gmail.com; soumitkbehera@gmail.com

Alpine ecosystems are highly vulnerable to climate change, yet the role of fine scale in situ microclimate on biodiversity patterns remains poorly understood. While vascular plants have been widely studied, bryophytes, despite being a major element of alpine vegetation remain comparatively understudied. In this study, we measured growing season in situ microclimate and its functional relationship with bryophyte diversity across three alpine sites in the Indian Himalaya (Tungnath, Chansal Pass, and Tawang). Microclimatic variables: photosynthetically active radiation, air and soil temperature, absolute humidity, and ambient CO_2 conc. were recorded alongside systematic bryophyte sampling in above and below the treeline vegetation zones at each alpine sites. A total of 173 species (94 mosses, 79 liverworts) were documented across the alpine sites. Diversity indices underscore the Eastern Himalaya site supported more diverse and heterogeneous associations than Western Himalayan sites. Regression analyses revealed absolute humidity as the strongest predictor of overall bryophyte diversity, while air and soil temperature primarily influenced terrestrial bryophytes. Tawang site was significantly warmer (15.97 ± 1.62 °C) and more humid (20.2 ± 0.88 mmol mol^{-1}), supporting the highest richness and heterogeneity, compared to the cooler, drier Chansal Pass and Tungnath sites. Eastern Himalayan conditions align with the tundra optimum (5–25 °C), suggesting that bryophyte distributions may lag ongoing regional warming. Our study provides the first microclimate–bryophyte baseline for the Indian Himalaya and highlights that even minor shifts in humidity and temperature can restructure alpine biodiversity, underscoring the need to integrate microclimatic data into biodiversity–climate models.

T6-A23

Characterizing forest carbon dynamics in the Similipal Biosphere Reserve, India: An Eddy Covariance Study

Soumit K. Behera[1,2]*, Ramya R. Paul[1,2], Sonik Anto[1,2], Prem P. Singh[1]
[1]Plant Ecology and Climate Change Science Division, CSIR - National Botanical Research Institute, Lucknow-226001, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad- 201002, India
Email: soumitkbehera@gmail.com

Tropical forests play disproportionately important role in carbon sequestration and storage, with complex regulation mechanism by microclimate and community structure. Similipal Biosphere Reserve, a complex hilly and undulating terrain with varying elevation situated in the northern part of Orissa's Mayurbhanj district plays a crucial role in the

water and carbon cycle at regional vis-à-vis global scale. Yet very few field-based data on related processes exist for Similipal Biosphere Reserve. The forest is predominantly moist mixed deciduous forest with tropical semievergreen forest in areas with suitable microclimatic conditions and sporadic patches of dry deciduous forests and grasslands. In the wake of global change, there is a need for a better understanding of the current and future response of the forest biome in this complex landscape. An Eddy Covariance (EC) flux tower was recently installed in the core area of the Similipal Biosphere Reserve in May 2024 to study forest carbon fluxes and sequestration. The project aims to measure the real-time exchange of exchange of CO_2, H_2O and energy between the semi-evergreen forest and the atmosphere to understand forest carbon dynamics and the net ecosystem exchange (NEE). The eddy covariance (EC) is one of the most effective methods to directly measure the surface mass and energy fluxes within atmospheric boundary layers at the regional scale. This study will be first of its type for Similipal Biosphere Reserve to measure forest carbon sequestration and predict climate change impact on forest carbon dynamics. The long-term data generated from this research intend to help formulate effective strategies for future forest management and contribute valuable information to national and global carbon balance models.

T6-A24

Exploring altitude-driven microclimate dynamics and invasive species distribution in heterogeneous landscape of Sikkim Himalayas

Anil Kumar Verma[1], N Manika[1], Soumit Kumar Behera[1,*], RashmiNayak[2], Kiran Bargali[3], Lal Babu Chaudhary[2]

[1]Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, Uttar Pradesh, India | [2]Plant Diversity, Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, Uttar Pradesh, India | [4]Department of Botany, Kumaun University, Nainital-263001, Uttarakhand, India
Email: soumitkbehera@gmail.com

The Himalayan region, marked by varied altitudes and experiencing continuous changing climatic conditions, offers a unique and complex landscape for examining the role of microclimate, the suitability of environmental conditions adjacent to plant canopy, in establishing and colonizing invasive species in the geologically fragile and heterogeneous Sikkim Himalayan landscape. Microclimatic attributes viz. photosynthetically active radiation (PAR), air temperature (AT), soil temperature (ST), ambient CO_2, and absolute humidity (AH) were measured across seven elevational gradients ranging from 600 m to 2700m in Sikkim Himalaya. Further, all seven gradients were grouped into three elevational zones, namely the lower elevations (600 m-1200 m), mid-elevations (1200 m-2100 m), and the higher elevations (2100 m-2700 m). A significant elevation-dependent trend was identified in the PAR across three altitudinal zones: the lower (609.52 mol m2s1), middle (769.40 mol m2s1), and highest (901.44 mol m2s1) elevations. Temperature fluctuations influenced the variation of AH, which ranged from 10.18 mol mol 1 to 29.40 mol mol^{-1} Elevation-dependent AT and ST shows declining trends with increasing elevation.43 species were found associated with *A. adenophora* along different elevation communities. The maximum species richness was observed in mid-elevation (1500 m–2100 m). Canonical correspondence analysis showed that PAR, ambient CO_2, and humidity along elevations influenced species richness. The study focuses on the local-scale climate effects on species composition and distribution in the ecologically sensitive Himalayan ecosystem. These insights contribute to a better understanding of how climatic factors influence species survival and proliferation, particularly in the context of invasive species. In addition, the findings highlight the importance of proactive conservation efforts in the delicate Himalayan ecosystem, which plays

an integral role in preserving intricate biodiversity and critical landscapes.

T6-A25

Vetiver grass ecosystem service model: Prospecting through the Development of designer genotypes

Umesh C. Lavania[1]*
[1]INSA Senior Scientist, CSIR-National Botanical Research Institute, Lucknow, India
Email: lavaniauc@yahoo.co.in

Vetiver grass, *Chrysopogon zizaniodes* (L.) Roberty, a perennial C4 grass, traditionally valued for its aromatic essential oil in the roots for its perfumery and medicinal value since ancient times, and hedge rows for contour protection over centuries, has lately attracted global attention as a natural means for multifarious environmental applications, including conservation and detoxification of degraded soil and water and long-term carbon sequestration deep into the soil likened to trees. Efforts are underway globally to make the vetiver plantations ecosystem sustainable. The successes in all these directions are realized through the identification and development of designer genotypes valued in the aroma industry, as well as addressing the concerns of environmentalists, policy makers, and providing resource generation to local communities as an ecosystem service approach. India is the native home of vetiver, sporting two geographically differentiated, distinct morphotypes. A repertoire of natural diversity occurring across India offers opportunities to develop designer genotypes for specific applications. Keeping in fitness with the biological potential of 'Vetiver Grass Model' for industrial vs. environmental applications, necessary emphasis has been laid on scoring root biodiversity to realize specific applications on these two counts, necessitating to identification of ideal root types suitable for high essential oil concentration for the former and high soil binding property and deep penetration property for the latter. Axiomatically, the R & D efforts made have facilitated: (i) Commercial cultivation through development of high yielding short duration varieties, (ii) Carbon sequestration sporting thick deep penetrating roots suitable for long term carbon sequestration deep into the soil through tufted fast growing roots, and (iii) Identification of dual purpose varieties forming higher root-mesh for efficient binding of the loose soil, high toxic metal absorption potential, as well as fast growing shoots suitable for fodder and also useful for cottage products. Lately, vetiver plantations are being attempted for mine rehabilitation as well as for fodder and carbon sequestration, along with intercropping, as an 'ecosystem service model'.

T6-A26

Vegetation dynamics under anthropogenic disturbances along an urbanization gradient in Ranchi, Eastern India

Purabi Saikia[1]
[1]Department of Botany, Institute of Science, Banaras Hindu University, Varanasi, India
Email: purabisaikia@bhu.ac.in

The present study investigated disturbance dynamics and their resultant impact on plant communities across an urbanization gradient (urban, peri-urban, and natural vegetation) in Ranchi, Eastern India. The research utilized 167 transects (0.5 ha) for trees and 501 quadrats for shrubs (5m x 5m) and herbs (1m x 1m), respectively, for comprehensive phytosociological analysis. We recorded a total of 346 plant species (85 families, 274 genera), with 75% native. Overall species richness decreased towards the urban region (Natural: 254 spp. > Peri-urban: 188 spp. > Urban: 183 spp.). Disturbance patterns varied significantly across gradients ($F_{2,456}$=3.74, $p<0.05$). Peri-urban and natural areas were characterized by severe anthropogenic disturbances, including a high incidence of logging (73%), fuelwood collection (73%), and grazing (60%). Logging disproportionately affected *Shorea robusta* C.F. Gaertn. (82%) a keystone species in the region. Disturbances were highly correlated with reduced density and dominance (logging index vs. dominance: $r=-0.245$, $p<0.05$). In

contrast, urban vegetation exhibited a distinct profile dominated by non-biodegradable waste and invasive species. While urban regions showed comparatively higher ∝-diversity for adult trees (H': 3.98, ENS: 54), this diversity was partly driven by the prevalence of rare (41%) and exotic (39%) species from intentional social forestry and personal introductions. The overall Floristic Quality Index (101.34) suggests high regional importance, yet the ecological integrity is threatened by a high proportion of high-conservatism species (47%) and poor regeneration, with 36.14% of trees showing no regeneration across the entire gradient. The identification of eight IUCN Red-listed species (1 Endangered, 3 Vulnerable, 4 Near Threatened) further underscores conservation urgency. The findings confirm a significant shift in floristic composition and structure due to differential anthropogenic pressures. Integrated conservation strategies and sustainable resource management are urgently needed to mitigate the adverse impacts of urbanization, support local livelihoods, and ensure the long-term stability and resilience of plant resources of Eastern India.

T6-A27

Assessing physicochemical characteristics and surface water quality along the course of the Gomti River for irrigation and drinking purposes

Fauzia Khan[1], Bhanu Pratap Bhaskar[1], Vertika Shukla[1], Sanjeev Kumar[1*], Narendra Kumar[2]

[1]Department of Geology, Babasaheb Bhimrao Ambedkar University, Lucknow, India | [2]Department of Environmental Science, Babasaheb Bhimrao Ambedkar University, Lucknow, India

Email id: sanjivk845@gmail.com

River water is a key water source for domestic and irrigation purposes. Various industrial activities are known to affect the quality of river water. The present study was planned to investigate the suitability of water for domestic and irrigation purposes in areas along the Gomti river course. Sodium Absorption Ratio (SAR), Permeability Index (PI), and Percentage Sodium(%Na) were evaluated for irrigational purposes. On the other hand, physicochemical parameters, namely, pH, total hardness (TH), electrical conductivity (EC), Total Dissolved Solids (TDS), salinity, total alkalinity, F^-, SO_4^{2-}, HCO_3^-, Cl^-, NO_3^-,Na^+, K^+, Ca^{2+} and Mg^{2+} were measured. The ranges of pH, total Hardness (TH), Electrical Conductivity (EC), Total Dissolved Solids (TDS), Salinity, Total Alkalinity were 7.06-9.03,134-329.67 (mg L^{-1}), 262.73-634.68 (µS cm^{-1}), 203.66-492 (mg L^{-1}), 1.65-4.20 (mg L^{-1}) and 30.66-413 (mg L^{-1}), respectively. The ranges of F^-, SO_4^{-2}, HCO_3^-,Cl^-,NO_3^-,Na^+,K^+,Ca^{2+} and Mg^{2+} were between 0.13-0.4 (in mg L^{-1}), 85.33 - 191.64 (in mg L^{-1}), 8.55- 85.19(in mg L^{-1}), 1.69-24.81(in mg L^{-1}), 4.33 - 42 (in mg L^{-1}), 0.33 - 71 (in mg L^{-1}), 15.43 - 127.54 (in mg/L), 5.96 - 57.92 (in mg/L), respectively. It has been observed that major sources of pollution for the Gomti river are surface water runoff and the release of domestic and industrial wastewater from residents and industries, respectively. This study will act as baseline data and help policymakers to ensure sustainable practices and reduce negative impacts on the availability and quality of water, allowing for the most efficient use of the Gomti River.

T6-A28

Combined effects of heat stress and fly ash on morphophysiological responses and phytoremediation potential of *Ipomoea carnea* Jacq.

Ashutosh Pandey[1,2], Vivek Pandey[1,3*]

[1]Plant Ecology and Climate Change Science Division, CSIR- National Botanical Research Institute, Lucknow, Uttar Pradesh, India | [2]Department of Botany, K S Saket P G College, Ayodhya, Uttar Pradesh, India | [3]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, India

Email: apandeymsb@gmail.com

The present study investigated the morphophysiological responses and phytoremediation potential of *Ipomoea carnea*

exposed to combined heat and fly ash (FA) stress. *I. carnea*, an invasive species frequently observed abundantly growing in the FA dumps, was grown on. soil amended with different FA concentrations (0%, 25%, 50%, and 100% w/w) under both ambient and elevated temperature conditions using a Free Air Temperature Enrichment (FATE) facility. During the experiment, the average ambient temperature ranged between 16 and 39.2 °C, while that of the elevated temperature ranged between 17.7 and 41.6 °C. Under ambient conditions, FA amendment up to 50% significantly enhanced plant growth and physiological performance, suggesting the beneficial effects of moderate FA incorporation. However, prolonged exposure to elevated temperature significantly inhibited growth parameters, including root and shoot length, leaf area, stem diameter, and overall biomass across all FA treatments. These reductions were closely associated with reduced photosynthetic rates and chlorophyll content, indicating impaired photosynthetic efficiency under heat stress. A notable decline in plant growth biomass, yet a marginal decline in metal accumulation was observed under elevated temperature, implying that the phytoremediation capacity of *I. carnea* remained relatively stable. Given the scarcity of climate-resilient green technologies for FA remediation, *I. carnea* demonstrated considerable potential as a promising candidate for sustainable phytoremediation of FA-contaminated sites under projected climate change scenarios.

T6-A29

Impact of Radioactive Isotopes on non human & human biota, around the nuclear power Plant in India: A Radioecological study

Devi Deen Pandey[1]*
[1]BRNS,Mumbai, Indian Nuclea Society, Project Square, Anushaktinagar, Mumbai-400094, Mumbai.
Email: pandeydevideen43@gmail.com

The present study carried out at NAPS- Narora under supervision of ESL- BARC in & out of power plant within 30 km vicinity. This NAPS consist of CANDU reactor which produce , different types of Isotopes eg tritium, caesium. , strontium, etc. Which are able to shows the Bioaccumulation in human & non human body through food chain and deposited in the different part of body emit harmful beta& gamma ionizing radiation which cause mutation, chromosome break, DNA Damage , activation of protooncogene in to onco gene ,. Which can be estimated by MN Assay, SCGE Assay, SCEs Assay, by using Daphnia, Channa Spp., Danio Rario, Drosophila, *Esinia foetida* (earth worm) , & human blood , urine, tooth, hairs etc followed by biomonitoring studies by using Liquid Scintillating Analyzer, alpha counters, beta counters, gamma counter, in ESL& Radioecology lab .by which Environmental Risk Assessment of Narora Atomic Power Station carried out with significant out come like tritium in surrounding vegetation very comman, teeth with beta activity, water are potentially carcinogenic up to 50 km of flow in LGC& PLGC , in Bulandshaher.

T6-A30

Title Comparative analysis of carbon and nitrogen content across three major forest types in Similipal Biosphere Reserve

Irfan Ali Ansari[1], Soumit Kumar Behera[1]
Plant Ecology and Climate Change Science Division: CSIR-National Botanical Research Institute Lucknow-226001
Email: irfanevn78@gmail.com

Carbon (C) and nitrogen (N) are fundamental elements regulating physiology function and ecosystem processes. In leaves, C provides structural and energy-rich compounds, while N supports photosynthesis and metabolic activity. In soils, C forms the basis of organic matter that drives microbial processes, and N is a key nutrient controlling plant productivity and nutrient cycling. Together, C and N interactions shape soil dynamics, soil fertility, and the overall functioning of terrestrial ecosystems. The present study aimed to assess belowground carbon stocks and their

relationship with leaf nutrient composition across moist deciduous, semi-evergreen, and dry deciduous forests of the Similipal Biosphere Reserve (SBR), Odisha. Five dominant tree species—*Shorea robusta*, *Terminalia tomentosa*, *Xylia xylocarpa*, *Protium serratum*, and *Croton persimilis* were sampled for leaf and soil analysis. Results revealed clear variations in leaf carbon (C) and nitrogen (N) concentrations among species and forest types. In semi-evergreen forests, leaf C ranged from 33–38%, with moderately low N levels (1.0–1.4%), while in dry deciduous forests, C concentrations were slightly higher (35–40%) and N values varied between 1–2%. Moist deciduous forests exhibited the highest nutrient content, with *T. tomentosa* recording the maximum C (~48%) and N (~3%), followed by higher values in *C. persimilis* and *X. xylocarpa*. Across all sites, *S. robusta* and *T. tomentosa* showed consistently high C concentrations, reflecting their dominance and substantial biomass contribution, while *C. persimilis* displayed the lowest C content. Soil elemental composition also varied among forest types, with semi-evergreen soils showing the highest organic carbon (6.58%) and nitrogen (0.62%), followed by moist forests, while dry deciduous soils had comparatively lower organic carbon (1.94%) and nitrogen (0.32%). The findings highlight strong linkages between vegetation composition, leaf nutrient status, and belowground carbon dynamics in SBR. This study demonstrates that variations in carbon (C) and nitrogen (N) concentrations in both leaves and soils are strongly influenced by forest type and species composition within the Similipal Biosphere Reserve. Moist deciduous forests exhibited the highest leaf nutrient concentrations, particularly in *Terminalia tomentosa*, indicating greater productivity and nutrient availability. Semi-evergreen forests maintained moderate leaf C and N levels, while dry deciduous forests showed comparatively lower nutrient concentrations but reflected species-specific adaptability to drier conditions. Soil nutrient patterns further supported these trends, with semi-evergreen forests possessing the highest soil organic carbon and nitrogen, and dry deciduous forests showing the lowest values. Overall, the results reveal a clear interrelationship between vegetation characteristics, leaf nutrient content, and belowground carbon stocks, emphasizing the ecological significance of dominant species such as *Shorea robusta* and *T. tomentosa*. These findings contribute to understanding ecosystem functioning in SBR and underscore the importance of forest type and species composition in regulating carbon storage and nutrient cycling.

T6-A31

Distribution, Evaluation of Contamination, and Risk Analysis of Potentially Toxic Elements in The Pamba River

Anisha Ganguly[1], Ruchika Sah[1], Pooja Choudhary[1], Sachin Kavattu[1], Pawan Patel[1], Gajendra Kumar[1], Aakash Maurya[1], Ruchi Badola[1], Syed Ainul Hussain[1]

[1]*Wildlife Institute of India, Chandrabani, Dehradun 248001, India*

Email: anishaganguly5@gmail.com

The Pamba River of Kerala face significant pollution challenges, largely due to human activities and natural processes. The region's densely populated areas, characterised by a scattered settlement pattern, result in increased waste production, much of which ends up in water bodies. However, there has been limited comprehensive research on Potentially Toxic Elements (PTEs) contamination in the river from its source to mouth. This study evaluates PTEs in the river during the pre-monsoon season. Sampling sites were selected based on elevation and land use. Water and sediment samples were collected following standard procedures and analysed for heavy metals using ICP–MS, with spatial interpolation in ArcGIS to identify pollution hotspots. The assessment of PTEs in the Pamba River showed that the levels of chromium (Cr), nickel (Ni), copper (Cu), zinc (Zn), arsenic (As), cadmium (Cd), and lead (Pb) in the water were within the limits set by the World Health Organization (WHO), the United States Environmental Protection Agency (US EPA), and Canadian guidelines for protecting aquatic

life and human consumption. However, the analysis of PTEs in the river's sediment revealed that Cr levels exceeded the established threshold limits. Furthermore, the Heavy Metal Pollution Index (HPI < 100) and Metal Index (MI < 1) confirmed that water quality was suitable for drinking at most sites, with only Thakazhi (Alappuzha district) exceeding the established thresholds. Risk Quotient (RQ) analysis showed negligible to medium risk, with nickel posing the only moderate ecological concern (0.1 ≤ RQ < 1). Non-carcinogenic health risks remained safe for both adults and children (HI < 1). Sediment analysis in the study area showed low metal contamination and minimal ecological risk. Contamination Factor (CF) values (0.03–0.86) and Pollution Load Index (PLI, 0.07–0.25) indicated minimal anthropogenic influence, with slightly higher contamination observed in the lower reach of the river. The Potential Ecological Risk Index (PERI, 2.12–9.41), modified Hazard Quotient (mHQ, ≤1.04), and Toxic Risk Index (TRI = 1.21) suggest low to very low ecological risk, while the Ecological Contamination Index (ECI = 0.99) and Multiple Probable Effect Concentrations Quality (mPECQs = 0.068) confirm that the sediments are generally non-toxic and pose negligible risk to the ecosystem. The Pamba River, which spans 176 kilometres, has spatial mapping and interpolation showing that around 42 kilometres (23.86%) of the river's water is contaminated with heavy metals. Additionally, approximately 60 kilometres (34%) of the river's sediment exhibits significant heavy metal accumulation, indicating long-term environmental persistence. These findings will aid in developing management strategies to address point and non-point pollution sources through improved wastewater treatment, better agricultural practices, and strict regulations to protect the river's ecological health.

T6-A32

Phyto-management of Contaminated Sites: Integrating Ecology, Economy, and Technology

Dr. Rashmi Mishra[1]
[1]Professor; Head, Department of Biotechnology, Noida Institute of Engineering & Technology (NIET) Greater Noida, India
Email: hodbiotech@niet.co.in

Soil contamination by heavy metals and organic pollutants represents a critical global environmental challenge, jeopardizing ecosystem integrity, food security, and public health. Conventional remediation methods, such as excavation and soil washing, are often economically prohibitive and environmentally destructive, leading to a growing interest in nature-based solutions. Phytomanagement has emerged as a sustainable, cost-effective strategy that utilizes plants and their associated microbial communities to manage, rehabilitate, and restore contaminated sites. This approach transcends mere decontamination by strategically integrating ecological principles with economic drivers and technological innovations. This review synthesizes the interdisciplinary framework of phyto-management, dissecting its three core pillars. Ecologically, it explores the selection of suitable plant species, the fundamental mechanisms of phytoextraction and phyto-stabilization, and the pivotal role of plant-microbe interactions in enhancing remediation efficiency and restoring ecosystem services. Economically, it analyzes the paradigm of the circular bioeconomy, where contaminated land is repurposed for the production of non-food biomass for bioenergy, industrial feedstocks, and even phyto-mining, thereby generating revenue and offsetting cleanup costs. Technologically, it examines advances in agronomic practices, genetic engineering for tailored plant traits, and sophisticated monitoring tools like remote sensing. Despite its promise, challenges remain, including remediation timeframes and contaminated biomass management. We conclude that the future of phyto-management lies in a synergistic, transdisciplinary approach that effectively bridges ecology, economy, and technology, transforming environmental liabilities into sustainable, productive assets.

Theme 7:

Geospatial technologies and modeling for environment and forest conservation

T7-A1

Geospatial intelligence for assessing plant vulnerability and ecosystem resilience under environmental pollution

Biswajeet Pradhan[1*]
[1]Director - Centre for Advanced Modelling and Geospatial Information Systems (CAMGIS), School of Civil and Environmental Engineering, Faculty of Engineering and IT, University of Technology Sydney, NSW 2007, Australia
Email: Biswajeet.Pradhan@uts.edu.au

The accelerating pace of environmental pollution, compounded by climate variability, poses critical challenges to plant health, biodiversity, and ecosystem resilience. Advances in geospatial intelligence, the synergistic integration of remote sensing, geospatial information systems (GIS), and artificial intelligence (AI), now offer unprecedented capabilities to monitor, model, and manage these complex environmental dynamics. This keynote will present cutting-edge applications of GeoAI and multi-source geospatial data, spanning satellite, UAV, and proximal sensing platforms, to assess plant vulnerability and ecosystem responses under climate stress. Drawing on case studies from diverse environmental settings—including drought-prone agricultural landscapes, coastal ecosystems, and forested biomes—the presentation will demonstrate how machine learning and deep learning frameworks can be leveraged to quantify vegetation stress, forecast soil erosion susceptibility, estimate crop yields, and evaluate ecosystem health. Integrative approaches coupling geospatial datasets with climatic and ecological models will be highlighted to showcase predictive mapping and degradation and recovery trajectories. The talk will further discuss the emerging paradigm of digital environmental twins, linking GeoAI-driven models with decision-support systems for adaptive resource management. Ultimately, this lecture underscores the role of geospatial intelligence as a transformative decision-support tool, bridging science, policy, and practice to foster climate-resilient, pollution-mitigated eco-systems. The talk concludes with a forward-looking vision of next-generation sensing technologies and data-driven environmental stewardship toward achieving sustainable planetary health.

T7-A2

From oceans to ecosystems: Harnessing AI and digital twins to understand and predict ENSO, IOD, monsoons, and climate extremes and their environmental impacts

Swadhin Behera[1*]
[1]Director, Application Laboratory, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Yokohama, Japan
Email: behera@jamstec.go.jp

The world's oceans and atmosphere are driving powerful climate phenomena such as the El Niño–Southern Oscillation (ENSO), the Indian Ocean Dipole (IOD), and the monsoons. These modes of variability influence not only global weather and extreme events—such as droughts, floods, and heatwaves—but also the health of ecosystems, agricultural productivity, air quality, and water resources. Understanding and predicting these interconnected processes remain major scientific challenges, especially as their impacts intensify under climate change.

Advances in artificial intelligence (AI) and digital twin technologies have transformed our ability to simulate and manage interactions within complex climate systems and with land surfaces and ecosystems. Digital twins, which integrate satellite observations, field measurements, and high-resolution model outputs, are emerging as virtual replicas of natural systems—from oceans to plant canopies—that allow us to test scenarios, predict outcomes, and design adaptive responses. AI-enabled digital twins can accurately predict droughts, floods, and heat waves; track ecosystem degradation; monitor air pollution; and quantify blue carbon resilience in coastal habitats. For the Indian subcontinent in particular, linking oceanic drivers to monsoon and environmental responses opens new pathways to protect ecosystems and ensure food, water, and

ecological security in a rapidly changing climate.

T7-A3

Projected climate-change impacts on the distribution of *Camellia sinensis* in the Western Ghats, India

Shipra[1*], Pujarini Samal[1], Prem Prakash Singh[1], Dibyendu Adhikari[2]
[1]Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India
Email: shipra3838@gmail.com

Tea (*Camellia sinensis;* Family: Theaceae) is among the most widely consumed non-alcoholic beverages and a key contributor to producer-country economies. India is the world's second-largest tea producer, making it essential to assess current climatic suitability and future vulnerability under climate change. The Western Ghats account for ~17% of India's tea production and span the states of Kerala, Karnataka and Tamil Nadu. This study quantifies present-day suitability for *C. sinensis* across the Western Ghats and projects shifts for the 2050s and 2090s using the HadGEM3-GC31-LL general circulation model under three Shared Socioeconomic Pathways (SSP1-2.6, SSP2-4.5 and SSP5-8.5). This study implements an ensemble ecological niche modelling framework that integrates multiple algorithms viz. MaxEnt, Random Forest, Boosted Regression Trees, and 19 bioclimatic predictors to estimate baseline suitability and scenario-specific futures. Ensemble projections indicated a marked contraction of habitats having high climatic suitability relative to the baseline, with concomitant redistribution of suitability within the range under higher-emissions pathways. The results highlight potential exposure of established tea landscapes to warming and climate change and identify relatively resilient pockets that could sustain cultivation or guide climate-smart expansion. By mapping persistence and loss of suitability under multiple futures, our analysis demonstrates the utility of ENM for targeting adaptation measures such as site selection, clone choice, shade and water management, and for informing long-term planning for sustainable tea cultivation in the Western Ghats.

T7-A4

Assessing regeneration potential and environmental suitability of *Garcinia pedunculata* for conservation planning in India

Benerjit Wairokpam[1], V.V. Wagh[1], TS Rana [1,2]
[1]Plant Diversity, Systematics and Herbarium Division, CSIR National Botanical Research Institute, Lucknow-226001, Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India | [2]Central Government Enclave, CSIR-Human Resource Development Centre (Council of Scientific and Industrial Research, Uttar Pradesh, Ministry of S & T, Govt. of India, New Delhi) Sector 19, Kamla Nehru Nagar, Ghaziabad, India,
Email: ranatikam@gmail.com,
vijaywagh65@gmail.com

Anthropogenic climate change is a major driver of biodiversity loss, altering temperature and precipitation regimes and leading to extreme climatic events such as heatwaves, floods, and droughts. These changes disrupt species distributions by causing range expansions, contractions, or shifts, posing severe threats to habitat specialists with narrow ecological ranges. *Garcinia pedunculata* Roxb. ex-Buch.-Ham., a dioecious tree species with high medicinal and economic value in Southeast Asia and Northeastern India, faces such challenges. Its populations are currently small and highly fragmented due to unsustainable harvesting and poor natural regeneration, resulting in its classification as Critically Endangered in India. Given its restricted distribution in a region highly sensitive to climate change, understanding its regeneration ecology and climatic niche is crucial. In this study, we assessed the natural regeneration status of *G. pedunculata* across its native range, identifying sites with high regeneration potential. Ecological niche modelling (ENM) was performed using 21 environmental predictors through an ensemble approach integrating four algorithms-Random Forest (RF), Maximum Entropy (MaxEnt), Boosted Regression Trees (BRT), and Support

Vector Machine (SVM) within the SDM platform. Among all predictors, precipitation of the driest month (Bio14), annual precipitation (Bio12), and soil pH were the most influential variables determining the species' distribution. Finally, the modelled suitable habitat was overlaid with high-regeneration sites to identify priority areas for conservation. This integrative approach, combining ENM and field regeneration data, provides a more biologically realistic basis for identifying optimal conservation zones for *G. pedunculata*.

T7-A5

Projected shifts in the climatic suitability and distribution of *Tectona grandis* L.f. in India under future climate scenarios

Prem Prakash Singh[1*], Athira S Nair[1], Pujarini Samal[1], Soumit Kumar Behera[1], Dibyendu Adhikari[1]
[1]Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow
*Email: prem12flyhigh@gmail.com

Global climate change is a major threat to biodiversity and ecosystem stability. As climate conditions shift, species distributions also change, making it essential to predict future suitable habitats for effective conservation planning. However, such predictions carry uncertainties due to assumptions and variables underlying the climate scenarios, which can result in divergent trajectories of change. Thus, exploring multiple scenarios helps identify strategies for sustainable species management. In this study, we modelled the current and future climatically suitable habitats of *Tectona grandis* across India using the MaxEnt algorithm and 19 bioclimatic variables. Future climate projections were derived from the HadGEM2-ES model under two Representative Concentration Pathways (RCP 2.6 and RCP 8.5) for 2050 and 2070. The model showed high accuracy (AUC = 0.825; TSS = 0.94). Key variables influencing the distribution of *T. grandis* include isothermality (Bio3), annual mean temperature (Bio1), annual precipitation (Bio12), and mean diurnal range (Bio2). Currently, about 28% of India's area is climatically suitable for *T. grandis*. Future projections suggest a potential threefold increase in suitable areas under RCP 2.6 and a twofold increase under RCP 8.5, indicating an expansion driven by climate variability. While present suitability is highest along southern coastal regions, future distributions are expected to shift towards northeastern India. These findings highlight the likely redistribution of *T. grandis* habitats under climate change and underscore the need for long-term conservation and sustainable management, particularly in southern India, where suitability is expected to remain stable.

T7-A6

Spatio-temporal Assessment of land use change in sacred groves of Madhya Pradesh using spectral indices (NDVI)

Pranjal Jain[1*], Laxmi Sharma[2], Dr. Charu Lata[3]
[1]CSIR-National Institute of Science Communication and Policy Research (NIScPR), Dr K S Krishnan Marg, New Delhi, India, Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India | [2]J.C. Bose University of Science and Technology, YMCA, Faridabad, Haryana-121006, India | [3]CSIR- National Institute of Science Communication and Policy Research, Dr K S Krishnan Marg, New Delhi, India
Email: pranjaljain141@gmail.com

Sacred groves are patches of forests traditionally protected by native communities for religious reasons. Even in rapidly transforming landscapes due to converting surrounding matrix in many regions, sacred groves stand as isolated patches representing mature-native forest, often in its climax seral stage. The significance of sacred groves has long been established. The last decade has seen increasing use of remote sensing and GIS to understand the temporal changes in the landscapes surrounding sacred groves and the impact of such changes. However, there remains a vast scope of such studies in the sacred groves of districts in western Madhya Pradesh; districts dominated by the Bhil community and related sub-castes, including Bhilalas, Patelias, and Barelas. On ground pilot study in the region revealed anthropogenic

pressure on these ecological relics, especially from agriculture. This study used LANDSAT images to understand the spatio-temporal changes from 2014 to 2024 using LULC maps and spectral indices (NDVI) calculation. Open source QGIS software was used to create the maps. LULC classification was done using supervised classification and value for NDVI was calculated. The sacred grove at Kallipura in Jhabua district shows very little to no change in the past decade; the landscape majorly categorized as 'agricultural land'. The sacred grove at Khairmal in Jhabua, however shows the surrounding matrix transformation from forest land to agricultural land with almost no change inside the sacred grove area. The studied sacred groves in Dhar and Alirajpur showed very little change from 2014-2024. However, the forest within the sacred grove at Alirajpur has denser vegetation. Further, the Change Detection Index (CDI) value was also calculated for these sacred groves. The sacred groves in Dhar and Jhabua (Kallipura) showed degradation in vegetation. The Khairmal sacred grove was found to have mostly stable vegetation. Dungari Mata sacred grove in Alirajpur was the only one that falls mainly within light green to yellow colours, implying stable vegetation with minor positive change around the shrine/deity region. The study shows the importance of sacred groves as stable patches of forest land in otherwise human-dominated landscapes under immense resource utilization pressures.

T7-A7

Assessing ecological niches: A study on bryophyte habitat suitability in the semi-arid region, Gujarat

Bhagyashri Dangar[1,2], Rajesh Raviya[1*]
[1]Department of Life Sciences, Bhakta Kavi Narsinh Mehta University, Junagad, Gujarat, India | [2]Centre of Excellence for Wildlife and Conservation Studies, Bhakta Kavi Narsinh Mehta University, Junagadh, Gujarat
Email: rdraviya@gmail.com

Bryophytes serve as vital components of terrestrial ecosystems, particularly in microhabitats sensitive to environmental change. However, their distribution and habitat preferences remain poorly understood in semi-arid regions such as Gujarat, India. This study applied MaxEnt species distribution modelling to assess habitat suitability for rare bryophyte species, including regionally rare taxa. Using field-collected GPS points from Girnar Wildlife Sanctuary and environmental predictors such as bioclimatic variables, elevation, and land cover, we generated habitat suitability maps across Gujarat. Model performance was evaluated using the area under the curve (AUC), with values ranging from 0.81 to 0.92, indicating strong predictive ability. Results revealed that precipitation of the driest quarter, altitude, and land cover were the most influential variables. Additionally, a combined species richness map identified key bryophyte diversity hotspots in southern and central Gujarat. This research provides a geospatial foundation for bryophyte conservation planning in arid landscapes and demonstrates the utility of ecological niche modelling for lower plants in data-deficient regions.

T7-A8

Decoding forest cover transformation in the Dakshina Kannada District: A multi-temporal Landsat analysis using random forest and Google Earth Engine

Sowmya[1]*, Rekha S.[2], Raghudas J.[1], Athishri A. N.[1], Raju Krishna Chalannavar [1]
[1]Department of Applied Botany, Mangalore University, Mangalagangotri-574199, Karnataka, India | [2]Department of Studies and Research in Applied Geology, VSK University, PG Centre, Nandihalli, Sandur-583119, Karnataka, India
Email: sowmyachouhan99@gmail.com

Forests play a vital role in maintaining ecological balance and supporting sustainable development; however, increasing anthropogenic activities have intensified land use and land cover (LULC) alterations, particularly in biodiversity-rich regions like the Western Ghats. Despite numerous studies, consistent long-term monitoring of forest dynamics remains limited due to challenges such as cloud interference, inconsistent datasets, and inadequate ground truth

information. This study hypothesizes that integrating machine learning with cloud-based geospatial platforms can enhance the accuracy and temporal consistency of forest LULC assessments. The objective is to quantify and analyze the spatio-temporal forest cover changes in the Dakshina Kannada district, a part of the Western Ghats, Karnataka, India, from 2000 to 2024 using satellite-based time-series data. Multi-temporal Landsat images (ETM+ and OLI) with 30 m resolution were processed in the Google Earth Engine (GEE) environment using the Random Forest (RF) classifier. Six LULC categories-evergreen forest, deciduous forest, swampy/mangrove forest, scrubland, water body, and non-forest area-were mapped and evaluated through post-classification comparison (PCC). The classification achieved overall accuracies above 85% and Kappa values exceeding 0.81. Results indicate a notable decline in swampy/mangrove (-36.90%), evergreen (-15.42%), and deciduous (-6.50%) forests, accompanied by increases in scrubland (+131.83%) and non-forest areas (+5.44%), primarily due to agriculture and urban expansion. The study concludes that forest degradation and canopy loss are accelerating, signalling ecosystem stress. These findings provide crucial insights for regional forest management, supporting evidence-based policy formulation aligned with sustainable development and conservation goals in the Western Ghats.

T7-A9

Land surface temperature in Prayagraj using geospatial technology: Implications for sustainable development goals (SDGs)

Puneeta Pandey[1*]
Centre of Environmental Studies, Institute of Interdisciplinary Studies, University of Allahabad, Prayagraj
Email: puneeta@allduniv.ac.in, puneetapandey@gmail.com

Rapid urbanization, population expansion, and changes in land use are causing surface temperatures in metropolitan areas to rise, intensifying the Urban Heat Island (UHI) effect. This work uses multi-temporal satellite data and geospatial tools to examine the distribution of land surface temperature (LST) in Prayagraj, a rapidly expanding urban area in northern India. Landsat 8 OLI/TIRS satellite image from 2025 was used in this study, and LST was retrieved using the Normalized Difference Vegetation Index (NDVI), Proportional Vegetation Cover (PV), and emissivity. The findings suggest a clear spatiotemporal increase in LST, with built-up areas consistently exhibiting higher values than vegetative and water-dominated areas. These results validate that the main causes of thermal stress in Prayagraj are urbanization and a decrease in greenery. This study advances knowledge of urban thermal environments in medium-sized Indian cities by offering a thorough evaluation of LST patterns and the factors that influence them. It also provides policymakers with insights for achieving climate resilience and sustainable development goals, specifically SDG 11 (Sustainable Cities and Communities) and SDG 13 (Climate Action).

T7-A10

Assessing potential biomass production on Urban Marginal Lands in Indian megacities using Geospatial technologies

Vivek Verma[1,2*], **Sheik Adil Edrisi**[2]
1Department of Energy and Environment, Thapar Institute of Engineering & Technology, Patiala-147004, Punjab, India
2School of Liberal Arts and Sciences, Thapar Institute of Engineering & Technology, Patiala-147004, Punjab, India
Email: vverma_phd22@thapar.edu; vivekverma.kmc@gmail.com

Rapid urbanization and population growth are causing continuous pressure on Earth's land systems and sustainability boundaries. About >50% of the global population resides in urban areas, which account for more than 75% of global energy consumption. This concentration of people and resources has resulted in alarming levels of land degradation and loss of green spaces within cities, compromising ecological health and quality of life. To address these challenges, the United Nations

Sustainable Development Goals (UN-SDG), particularly goals 6, 7, 9, 11, 13 and 15, target sustainable development primarily focusing on better resource management to combat land degradation. In this regard, revitalizing urban marginal land (UML) can help to alleviate the increasing pressure of urbanization and resilience. Consequently, this concept becomes even more important in light of the UN's declaration of 2021–2030 as the 'Decade of Ecosystem Restoration,' a global initiative to transform degraded land to generate ecosystem services. Given this, judicious restoration and management of UML in metropolitan areas may contribute to better ecological conditions in vibrant social environments. A total of 1,05,661 ha of prospective UML has been identified. According to the vegetation survey in the study area, leguminous tree species like Leucaena and Albizia have significant potential for biomass production and sustainable growth. Restoring UML holds immense potential, serving as a vital resource for ecosystem services and making substantial contributions. Furthermore, investing in UML enables local bodies and government authorities to create and implement integrated waste-to-energy policies, which benefit multi-dimensional ecological and socio-economic growth. It advances India's progress directly toward achieving the UN-SDG targets. Consequently, integration of UML into development plans of urban areas aligns with the objectives outlined in Agenda 2030. Therefore, the current study aims to explore the diverse potentials of UMLs in India's megacities, emphasizing their role in nurturing dynamic ecosystems and urban resilience.

Theme 8:
Nature-based solutions, biofuels and green technologies

T8-A1

Designing novel below-ground and above-ground biodiversity for enhanced productivity and quality of products with ecological sustainability

Rana Pratap Singh[1*]
[1]Director (Hon), Centre for Sustainable Agriculture and Environment, R&D Centre, PHSS Foundation for Science and Society, Eldeco Xpress Plaza, Lucknow-226025, India
Email: dr.ranapratap59@gmail.com

A novel below-ground rhizosheric niche of different combinations of climate resilient beneficial soil microbes, isolated from the roots of native plants of a dry plateau of Maharashtra, India, was created along with different above-ground crop diversity to assess the effects of bio inputs and diverse cropping on soil properties, carbon sequestration, crop yield, and product quality. Our findings demonstrate that the designed bio inputs effectively support soil fertility, carbon sequestration, high yield of crops, and product quality enhancing the ecological and economic benefits of the grower. An inter-kingdom communication between plants and microbes using exosomal miRNA has also been explored in Wheat (Triticum aestivum L.) using the microarray method. The results revealed that PGPM-treated wheat showed a 5.4-fold decrease in tae-miR5086 miRNA, which regulates the Glu-1D-1d gene responsible for high molecular weight glutenin synthesis, and a 3.3-fold decrease in tae-miR1120a miRNA, which regulates gamma gliadin in comparison to the chemical fertilizers fed plants.

T8-A2

Plant-Nanoparticle interaction: Physiological, biochemical and metabolic alterations in medicinal plants under the influence of titanium oxide and copper oxide nanoparticles

Poornima Vajpayee[1*], **Subodh Kumar**[1], **Archana Dwivedi**[1], **Vippan Kaur**[1], **Akanksha Dubey**[1]
[1]Ecotoxicology, Bioremediation and Nanotoxicology Laboratory, Department of Botany, University of Lucknow, Lucknow, India
Email: devpoornima@rediffmail.com

Nanotechnology has become an alternative approach for its transformative potential in agriculture; thus, the use of nanomaterials has also increased. The excessive use of nanomaterials results in elevated bioavailability in crop plants. Various plants respond differentially under different nanoparticle exposures. Nanoparticles may impose physiological, biochemical, and metabolic alterations in medicinal plants of economic importance. We evaluated the responses of *Mentha arvensis* and *Ocimum basilicum* under different concentrations of titanium oxide (TiO_2: 0, 0.5, 1.0, 2.5 and 5.0 µg ml^{-1}) and copper oxide (CuO: 0, 0.2 and 0.4 µg ml^{-1}) nanoparticles exposure in a hydroponic growth chamber, respectively. The accumulation of TiO_2 and CuO nanoparticles were observed at all the concentrations in plant tissues (leaves, stems and roots) of *M. arvensis* and *O. basilicum*, respectively. The elevated oxidative stress markers (MDA and H_2O_2) and non-enzymatic antioxidants (cysteine and non-protein thiols) were observed at all the concentrations of TiO_2 nanoparticles in *M. arvensis* with respect to the control. The alterations in enzymatic antioxidants (SOD, CAT, GPX, APX, AO and GST) were also observed. Further, the dose-dependent decrease in relative peak area of α-pinene, β- pinene, Sabinene, Limonene, β-Myrcene was also recorded. Moreover, the level of MDA, H_2O_2 and antioxidant enzymes (SOD, CAT) was found to increase in roots and leaves of *O. basilicum* on CuO exposure in concentration dependent manner. Major essential oil components of *O. basilicum* (caryophyllene, germacrene D, eugenol, ocimene, methyl-chavicol, geraniol and nerol) were also affected after CuO nanoparticles application. These findings highlighted the physiological, biochemical and metabolic alterations in medicinal plants under various levels of nanoparticle exposure. Hence, excessive use of TiO_2 and CuO nanoparticles in agri-technologies should be regulated for sustainable agriculture.

T8-A3

Bacillus amyloliquefaciens modulates autophagy pathways to control *Rhizoctonia solani* infection in rice

Mohd Mogees Ansari[1,2], Nikita Bisht [1], Tanya Singh[1,2], Puneet Singh Chauhan [1,2]*
[1]Microbial Technology Division, CSIR-National Botanical Research Institute, Lucknow, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India
*Email: puneet@nbri.res.in, puneetnbri@gmail.com

Rhizoctonia solani, a necrotrophic fungus, poses a significant threat to rice production by causing sheath blight disease, thereby impacting crop yield and agricultural sustainability. This study explores the potential of the plant growth-promoting rhizobacterium *Bacillus amyloliquefaciens* (SN13) as a biocontrol agent in the susceptible rice variety Swarna *against R. solani* infection. Disease incidence assessments show that untreated plants are severely affected by the pathogen, whereas SN13 treatment effectively suppresses fungal growth. Detached leaf assays further confirm that SN13 reduces tissue damage caused by *R. solani*, while physiological and biochemical analyses demonstrate improved growth in treated plants. Importantly, the application of chloroquine, an autophagy inhibitor, leads to increased disease incidence, whereas SN13 enhances autophagosome formation as revealed by Mono Dansyl Cadaverine (MDC) staining and confocal microscopy, suggesting a role for autophagy in plant defense. Gene expression studies highlight upregulation of autophagy-related (*ATG*) and defense genes (*BZ1, 5H5*, and *8A1*), supporting the activation of autophagy pathways by SN13. Additionally, metabolite profiling using GC-MS reveals the accumulation of defense-signaling molecules, including gluconic acid, arabitol, glucopyranoside, ribose, xylopyranose, and arabinofuranoside. Collectively, the findings demonstrate that *Bacillus amyloliquefaciens* SN13 triggers autophagy and modulates key defense mechanisms, offering an effective strategy to manage sheath blight disease in rice.

T8-A4

Supercritical CO_2 and hydrodistilled extracts of *Valeriana jatamansi* Jones: A green approach to bioactive compound recovery

Jyoti[1], Kirti Agrahari[2], Narayan Prasad Yadav[2], Ram Swaroop Verma[1], Sudeep Tandon[1]*
[1]Phytochemistry Division, CSIR-Central Institute of Medicinal and Aromatic Plants, P. O. CIMAP, Kukrail Road, Lucknow, India | [2]Bio-prospection and Product Development Division, CSIR-Central Institute of Medicinal and Aromatic Plants, Kukrail Road, Lucknow, India
*Email: s.tandon@cimap.res.in

Valeriana jatamansi Jones (formerly known as *Valeriana wallichii* DC), which is commonly known as Sugandhbala or Tagar or Indian Valerian, is a perennial herb that belongs to the Caprifoliaceae family. The different species of genus 'Valeriana' are well known for their diverse medicinal and therapeutic roles in the traditional system of medicine (TSM). Extracts and active compounds show activities such as antitumour, cytotoxic, and antiviral effects, and the species is also used in agriculture, food products, and cosmetics. In recent years, the fragrance, flavour, and food industries have increasingly focused on plant-based essential oil extraction due to their commercial and therapeutic value. Traditional methods such as solvent extraction and steam distillation are still common but raise health, environmental, and quality concerns. Solvent extraction involves toxic organic solvents. To address these issues, eco-friendly or "green" extraction technologies—like microwave-assisted, ultrasound-assisted, and supercritical fluid extraction—have emerged. Among them, supercritical CO_2 extraction is preferred for its efficiency, selectivity, and environmental safety. Chemical investigation and bioprospection of supercritical Fluid (CO_2) Extract (SCFE) and hydrodistilled essential oil of *Valeriana jatamansi for* antidiabetic activity. The dried rhizomes of *Valeriana jatamansi Jones* were purchased from the commercial market and the plant was authenticated by the Department of Pharmacognosy, CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow, Uttar Pradesh, India (Voucher No.

V003). Extraction and chemical analysis of *Valeriana jatamansi* were carried out using two techniques—hydro/steam distillation and supercritical CO_2 extraction. The resulting essential oil (VJEO) and supercritical fluid extract (VJSFE) obtained from the rhizomes were analyzed using gas chromatography–flame ionization detection (GC-FID) and gas chromatography–mass spectrometry (GC-MS) to determine their chemical composition. A total of sixty-six compounds were identified from the hydrodistilled essential oil (VJEO) and the supercritical CO_2 extract (VJSFE) of *Valeriana jatamansi*, accounting for 58.4–88.0% of the total composition. The major constituents of the hydrodistilled oil were patchouli alcohol (24.5%), β-patchoulene (9.1%), α-guaiene (7.6%), and α-bulnesene (5.7%), while the predominant compounds in the supercritical CO_2 extract (at 250 bar) included isovaleric acid (12.0%), patchouli alcohol (10.5%), maaliol (4.2%), (Z)-caryophyllene (4.9%), and 3-methyl valeric acid (3.4%).VJEO and VJSFE of *V. jatamansi* have shown significant improvement ($p < 0.05$) in glucose uptake in the skeletal muscle cell line when compared with untreated cells against the high glucose-induced L6 cell line in a dose-dependent manner. In effective concentration, there was no toxicity observed. VJSFE was observed to be the most potent extract for improving glucose concentration in the L6 cell line in hyperglycemia-induced impairment, thereby exhibiting potential antidiabetic activity. The above findings indicate that the tested essential oil (VJEO) and extract (VJSFE) possess significant antidiabetic potential, warranting further investigation for potential therapeutic applications.

T8-A5

Endophytic *Bacillus australimaris* mediates biocontrol and bioactive enhancement in *Gloriosa superba* under *Alternaria alternata* infestation

Neha Yadav[1,2], Pradeep Semwal[1,2], Shashank Kumar Mishra[1], Puneet Singh Chauhan[1,2]*

[1]Microbial Technologies Division, Council of Scientific and Industrial Research-National Botanical Research Institute (CSIR-NBRI), Rana Pratap Marg, Lucknow, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India

Email: puneet@nbri.res.in

Gloriosa superba L. is an important medicinal plant rich in bioactive compounds, including colchicine and gloriosine, known for its antimicrobial, anticancer, antimitotic, and anti-inflammatory properties, and traditionally used to treat arthritis, gout, rheumatism, and hemorrhages. However, leaf blight caused by *Alternaria alternata* is a severe disease of *G. superba*, resulting in 45-50% yield loss. The present study investigates the bioprotective and growth-promoting activity of the endophytic bacterium *Bacillus australimaris* (NBRI GS34) against *A. alternata*. Inoculation with *B. australimaris* not only inhibited fungal growth but also enhanced plant growth and the enhancement of bioactive metabolites. Co-cultivation of *B. australimaris* with *A. alternata* resulted in a significant increase in protease (30-50%) and chitinase (6-28%) activities, indicating strong antifungal interactions. Scanning electron microscopy revealed structural deformities in fungal hyphae, while GC-MS analysis detected antifungal compounds such as undecanoic acid and benzene carboxylic acid in treated samples. Greenhouse results demonstrated a 78% reduction in disease incidence, improved vegetative growth, and upregulation of defense-related genes. Furthermore, HPLC analysis showed significant increases in gloriosine (52%) and colchicine (33%) content in *B. australimaris*-treated plants compared to controls. These findings suggest that *B. australimaris* NBRI GS34 functions as an efficient biocontrol and plant growth-promoting endophyte. Its application offers a sustainable and eco-friendly strategy for disease management in G. superba, while simultaneously enhancing the production of pharmaceutically valuable metabolites.

T8-A6

Impact of plant growth-promoting rhizobacteria (*Ochrobactrum* sp.) on Maize (*Zea mays*) tolerance towards water stress

Shashank Kumar Mishra[1,2], Pradeep Semwal[1,2], Puneet Singh Chauhan[1,2]*
[1]Microbial Technologies Division, Council of Scientific and Industrial Research-National Botanical Research Institute (CSIR-NBRI), Rana Pratap Marg, Lucknow, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India
Email: puneetnbri@gmail.com

Plant growth-promoting rhizobacteria (PGPR) have usually considered economical and eco-friendly biofertilizers for the past few decades, suggesting their potential for future sustainable agriculture. The rationale behind this is that they improve plant health facing various biotic and abiotic stresses by influencing nutrient uptake, several morpho-physiological changes that eventually enhance the latter's stress tolerance ability. However, their putative involvement with underlying mechanisms in drought stress (WS) in plants has never been understood holistically and therefore needs immediate attention. This study was carried out to unearth the different mechanisms led by the potential impact of PGPR on the plant response towards WS. For the same, we considered previously established PGPR (*Ochrobactrum* sp. NBRISH6) for its effect on Maize (*Zea mays* "Maharaja") under WS conditions. A mélange of morphological, physiological, biochemical, metabolical, molecular, and ecological approaches was contemplated for PGPR-treated plant response to WS. The results suggested that PGPR significantly enhances the WS tolerance ability in Maize with the influence on the combination of the mentioned mechanisms. The outcome shall strengthen our understanding of PGPR influence on plants by providing an insight into the multiple mechanisms involved in relieving environmental stresses such as WS. The integrated approach used in the study shall become a robust scaffold for the commercial usage of PGPR in further agricultural purposes.

T8-A7

Synergistic role of biochar and *Trichoderma yunnanense* in mitigating Chromium toxicity and enhancing growth and oil yield of *Ocimum basilicum* L.

Anju Patel[1*], Priya Dubey[1], Pankaj Kumar Srivastava[1]
[1]CSIR - National Botanical Research Institute, Lucknow-226001, India
Email: patel7anju@gmail.com

Chromium (Cr) contamination, particularly from tannery sludge, severely affects soil fertility, plant physiology, and crop productivity. Hexavalent chromium [Cr(VI)] is highly toxic and persists in agricultural soils, leading to reduced nutrient uptake and oxidative damage in plants. While biochar and plant growth-promoting fungi (PGPF) have individually shown potential for soil improvement and Cr immobilization, their combined effect remains underexplored, especially in aromatic plants like *Ocimum basilicum* L. (basil). Previous remediation studies often focused on non-economic crops and did not assess secondary metabolite production. This study addresses this gap by investigating a sustainable, dual-purpose strategy that integrates sugarcane bagasse biochar (SBC) and *Trichoderma yunnanense* (NBRICRF_97) to reduce Cr toxicity while improving soil quality and essential oil yield. It was hypothesized that the synergistic application of SBC and *T. yunnanense* would alleviate Cr-induced phytotoxicity, enhance soil nutrient dynamics, and improve plant physiological and biochemical functions. The objectives were to (1) evaluate the effects of biochar (sugar bagasse) and *T. yunnanense* on growth, photosynthetic pigments, antioxidants and metal uptake capacity of *O. basilicum* under chromium stress; and (2) assess changes in essential oil yield and composition. A 90-day pot experiment was conducted using two soil types: uncontaminated and Cr-contaminated collected from Kanpur's tannery region. Treatments included biochar (0.5% SBC), *T. yunnanense* inoculation, and their combination, applied to *O. basilicum* seedlings under controlled conditions. Physiological parameters (root and shoot length), biochemical markers (chlorophyll, carotenoids, proline, MDA), and antioxidant enzymes (SOD, CAT, APX, GPX) were quantified. Essential oils were extracted via hydro-distillation and analyzed by GC for linalool

and methyl chavicol content. Soil samples were assessed for organic carbon, nitrogen, phosphorus, microbial biomass, and Cr(VI) reduction using ICP-MS. The combined treatment (Cr + SBC + *T. yunnanense*) significantly improved plant performance compared to Cr-stressed controls. Root and shoot lengths increased by over 70%, while chlorophyll and carotenoid contents rose by 49%. Oxidative stress indicators (MDA and proline) decreased by more than 50%, and antioxidant enzyme activities normalized. Soil nutrient levels showed notable improvement in N, P and K. N, P, and K increased by 0.28%, 25.57 mg·kg^{-1}, and 71.5%, respectively. Cr(VI) concentration declined by 84.8%, indicating strong detoxification. Essential oil yield improved by 112%, with higher linalool (20.22%) and methyl chavicol (75.45%) contents, confirming enhanced metabolic activity. The integration of SBC and *T. yunnanense* effectively mitigated chromium toxicity, revitalized soil health, and enhanced both growth and oil productivity in *O. basilicum*. The combined amendment reduced metal bioavailability, restricted Cr translocation to shoots, and improved microbial activity and nutrient cycling. This eco-friendly and low-cost approach demonstrates high potential for reclaiming heavy metal-contaminated soils.

T8-A8

Evaluation of Neem (*Azadirachta indica*) and Tea (*Camellia sinensis*) leaf residues as biological nitrification inhibitors (BNIs) in rice cultivation of Assam

Jasmine Sultana[1], Anushree Baruah[1]
[1]Department of Botany, Royal School of Life Sciences, The Assam Royal Global University, Guwahati, Assam
Email:abaruah@rgu.ac,
anushree611.official@gmail.com

The intensification of agricultural practices in recent decades, particularly the overuse of nitrogen (N)-based fertilizers, has led to substantial environmental and agronomic challenges. In flooded rice ecosystems, accelerated microbial processes such as nitrification and denitrification contribute to significant N losses, reduced soil fertility, and elevated nitrous oxide (N_2O) emissions, along with nitrate-N leaching into groundwater. These issues underscore the urgent need to improve nitrogen use efficiency (NUE) and reduce N losses by regulating soil microbial processes. Conventional synthetic nitrification inhibitors (NIs), although effective, are often costly and environmentally persistent. Thus, plant-derived biological nitrification inhibitors (BNIs) offer an eco-friendly, cost-effective alternative. However, limited field-based evidence exists on the efficacy of such plant residues in tropical rice ecosystems, especially under the agroecological conditions of Assam, India. It was hypothesized that the incorporation of plant residues possessing antimicrobial properties, such as neem and tea leaves, in combination with inorganic nitrogen fertilizers, could reduce nitrogen losses, mitigate N_2O emissions, enhance NUE, and improve grain yield in rice cultivation offering a sustainable alternative to synthetic NIs and reduce the dependence on chemical fertilizers. Given the rich antimicrobial secondary metabolites in these plant residues, this study aimed to evaluate the potential of neem (*Azadirachta indica*) and tea (*Camellia sinensis*) leaf residues as BNIs in rice agroecosystems. The objectives included assessing their effects on soil physicochemical and microbial properties, nitrogen transformations, NUE, and yield performance under tropical field conditions. Field experiments were conducted during two consecutive rice-growing seasons (Boro and Sali) in the Central Brahmaputra Valley Zone (CBVZ) of Assam, India. Two rice varieties per season were tested—Arize 6129 and Sona Mashuri (Boro); Kola Joha and Bahadur (Sali). Treatments included: (T1) 100% NPK (control), (T2) 50% urea + 100% P_2O_5 + 100% K_2O + neem leaves (5 t ha^{-1}), and (T3) 50% urea + 100% P_2O_5 + 100% K_2O + used tea leaves (5 t ha^{-1}). Soil, plant, and microbial parameters were periodically analyzed for ammonium (NH_4^+-N), nitrate (NO_3^--N), microbial biomass, and nitrifier-denitrifier populations, along with yield and NUE indices with standard methods of analysis. Neem and

tea residue amendments (T2 and T3) significantly improved soil properties ($p < 0.05$), including pH, soil organic carbon, NH_4^+-N, and available macronutrients. A shift from NO_3^--N to NH_4^+-N dominance indicated strong nitrification inhibition, with inhibitory effects ranging from 7–88% across both seasons. Enhanced NUE values (up to 48.3%) and agronomic nitrogen recovery (ANR up to 34.9%) were observed in T2 treatments. Nitrate reductase activity declined under T2, indicating reduced nitrification, while microbial biomass carbon and nitrogen remained stable. Yield performance peaked under T2, particularly for Bahadur (6.1 t ha^{-1}) and Arize 6129 (3.7 t ha^{-1}), demonstrating superior nutrient assimilation and productivity. The incorporation of neem leaf residues at 5 t ha^{-1} (T2) emerged as an effective biological nitrification inhibition strategy, improving soil quality, nutrient efficiency, and rice yield while curbing microbial nitrification. This low-input, nature-based approach enhances agronomic performance and mitigates nitrogen losses without compromising productivity, representing a promising, sustainable, and scalable solution for tropical rice ecosystems in Assam and similar agroclimatic regions.

T8-A9

Unveiling Glomalin's Legacy: Its role in soil remediation and feedback to climate change

Ashutosh Kumar Singh[1*]
[1]Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Menglun Town, Mengla County, Yunnan Province, China 666303
Email: ashutosh.evst11@gmail.com

The severe threat posed by soil degradation to global food security is directly linked to an expanding human population. A strategic, essential solution is soil repair via beneficial microorganisms, notably arbuscular mycorrhizal fungi (AMF). AMF synthesize glomalin (glomalin-related soil protein; GRSP), which is critical for reversing soil degradation. Our preceding work highlights glomalin's broad impact: it enhances soil structure and fertility, stabilizes pollutants, drives microbial activity, and, crucially, contributes to soil organic carbon (SOC) sequestration by persisting in the soil matrix for decades (≥ 42 years). GRSP achieves this through multiple mechanisms, acting as a binding agent for aggregates, a chelator of heavy metals, and a foundation for long-term SOC. GRSP production is optimizable and can be managed in ecosystems by targeting specific components: plants (e.g., maximizing rhizodeposition), soil (e.g., optimizing nutrient availability), and microbes (e.g., enhancing community diversity). Despite the well-documented importance of GRSP in soil remediation and carbon storage, knowledge regarding its sensitivity to anthropogenic global change factors (GCFs) remains sparse. To close this gap, we conducted a comprehensive global meta-analysis encompassing 530 data points from 107 published studies. We examined the effects of diverse GCFs, including land-use change (LUC), urbanization, wildfire, plant invasion (PI), climate change (elevated CO_2, warming, drought), and nutrient addition (N, P, K), on the two key functional GRSP pools: easily extractable (EE-GRSP) and total (T-GRSP). Our analysis revealed distinct and powerful GCF impacts on GRSP stocks. GCF impacts were most robust when applied at higher intensities and sustained over medium-to-long durations (3–10+ years), especially in humid, clay-rich soils. However, sandy soils were more prone to T-GRSP losses during LUC. Increases in T-GRSP showed strong positive correlations with AMF root colonization, SOC content, and soil mean-weight diameter. Furthermore, our structural equation model demonstrated that GCFs exert a direct influence on SOC levels by modulating the AMF-GRSP production pathway and the subsequent formation and protection of soil aggregates. This evidence underscores the critical strategy of optimizing GRSP production to enhance global SOC sequestration.

T8-A10

Bacterial assisted heavy metals phytoextraction potential of native plants and their histological observation growing

on distillery sludge: A novel green technology tool for in-situ phytoremediation of hazardous industrial waste management for eco-restoration

Ram Chandra[1*]
[1]Department of Environmental Microbiology, School of Earth and Environmental Sciences, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow-226 025
Email: prof.chandrabbau@gmail.com

The pollutants discharged from sugar mills and distilleries are a major threat to the environment due to their complex organometallic waste. The study revealed that distillery sludge contains not only a mixture of complex organic pollutants but also retains a high quantity of Fe (5264.49), Zn (43.47), Cu (847.46), Mn (238.47), Ni (15.60), and Pb (31.22 mg kg−1), which aggravate the toxicity of sludge to the environment. The major identified organic pollutants were benzene, 1-ethyl-2-methyl, benzene, 1-ethyl-4-methyl benzoic acid, 3,4,5-tris(TMS oxy), TMS ester; hexanedioic acid, dioctyl ester; stigmasterol TMS ether; 5α-cholestane,4-methylene; campesterol TMS; β-sitosterol and lanosterol. These compounds are listed under EDCs as emerging pollutants by the U.S. Environmental Protection Agency (USEPA). The phytoextraction potential of growing native weeds and grasses i.e., *Argemone mexicana, Saccharum munja, Saccharum arundinaceuym, Cynodon dactylon, Pennisetum purpureum, Chenopodium album, Cannabis sativa, Parthenium hysterophorus, Ricinus communis, Rumex dentatus, Tinospora cordifolia, Calotropis procera,* and *Basella alba,* revealed the high accumulation of Fe, Zn, Cu, Mn, Ni, and Pb in their root and leaves compared to the shoot. The rhizosphere of these plants was dominated by *Bacillus albus (MN793207), Bacillus cereus (MW793498), Bacillus paranthracis (CP045777),* and plant growth-promoting activities, i.e., IAA production, HCN production, organic acid production, phosphate-zinc-potassium solubilizing, and nitrogen-fixing ability, were noted as positive. Further, metagenomics analysis revealed *Proteobacteria* (50%), *Bacteriodetes* (33%), *Firmicutes* (5%), *Gemmatimonadetes* (2%), *Chlorofexi* (2%), and *Tenericutes* (2%). Three dominant genera were detected as *Rheinheimera* (21%), *Sphingobacterium* (17%), and *Idiomarina* (8%). In addition, other minor genera such as *uncultured Bacillu*s (4%), *Acidothermus* (4%), *Bacillus* (3%), *Pseudomonas* (2%), *Flavobacterium* (2%), *uncultured bacterium* (2%), *Parapedobacter* (2%), *Alcanivorax* (2%), *Acholeplasma* (2%), *Hyphomonas* (1%), and *Aquamicrobium.* This indicated high accumulation and translocation capabilities of these plants due to bacterial communities growing in the rhizosphere of the tested plant. Further, the bioaccumulation coefficient factor (BCF) and translocation factor (TF) were found to be>1 for the majority of plants for various metals. Furthermore, the ultrastructural observations of root tissues also revealed the deposition of heavy metals at various cellular components without any apparent toxic effects. This indicated the variable adaptive characteristics of these plants growing at a hazardous waste-polluted site. Thus, the study gives strong evidence for the application of these weeds and grasses as a green technology for the eco-restoration of polluted sites.

T8-A11

Bio-adsorbents by transforming plant waste for efficient arsenic removal from contaminated water

Sampurna Nand[1]*, Anju Patel[1], Siddhartha Shukla[2], Pankaj Kumar Srivastava[1]
[1]Environmental Technologies Division, CSIR-National Botanical Research Institute, Lucknow, India | [2]Dr. Ram Manohar Lohia Avadh University, Ayodhya, India
*Email: nandsam1005@gmail.com

Arsenic (As)is a metalloid and geogenic in nature. An excess concentration of As above 10 ppb in drinking water adversely affects human health, cattle, and other aquatic biota. Recently,

various technologies such as oxidation, coagulation, flocculation, and reverse osmosis have been explored for arsenic treatment and have drawbacks such as high operational cost, energy consumption, and sludge generation. The biosorption method has gained significant attention for its environmental friendliness and effective removal of organic and metal pollutants from water. Biochar is a carbonaceous material, primarily composed of amorphous, aromatic carbon. Modification of biochar (Fe-modified) increased the surface area, and provided a multitude of sites for efficient contaminant adsorption. India produces about 39,000 metric tons of Mentha oil annually, generating nearly 20 tons of waste per acre. Much of this biomass is burned, causing air pollution and environmental harm. Converting this waste into biochar provides a sustainable, low-cost solution for water treatment, soil enhancement, and climate change mitigation. The study aimed to utilize de-oiled Mentha waste biomass to prepare Fe-modified biochar (MMBC) and evaluate its adsorption dynamics for arsenic removal from contaminated water and elucidate the mechanism of biosorption. In the study, Fe-modified biochar has been prepared at a temperature of 500°C via pyrolysis. Characterization techniques (SEM-EDX, XRD, FTIR, TGA, CHNS) confirmed a desirable porous structure, favourable chemical composition, and surface functionality for As(V) adsorption. MMBC exhibited a significantly larger surface area, providing more active sites (378.08 m^2 g^{-1}). Proximate analysis revealed MMBC's stability (low moisture: 6.48%, high fixed carbon: 54.7%) and high adsorption potential (low volatile matter: 9.77%). Concerning operational conditions, the optimal As(V)removal of 83.6% was achieved at pH 7.5 with a 25 mg/50 mL MMBC dosage in a 24 h contact time. Kinetic modelling indicated a pseudo-second-order mechanism, suggesting chemisorption as the dominant process. However, isotherm (Freundlich model) studies revealed favourable multilayer adsorption. These findings highlight MMBC's potential as a promising biochar-based adsorbent for efficient As(V) removal from contaminated water for sustainable remediation.

T8-A12

Role of fulvic acid in enhancing physio-logical and antioxidant responses of rice under salt stress

Umme Kulsum Sabiha[1*], Kamrun Nahar[1], Mirza Hasanuzzaman[2]

[1]Department of Agricultural Botany, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh | [2]Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh

E-mail: ummekulsumsabiha18@gmail.com

Exogenous application of fulvic acid (FA), a low-molecular-weight component of humic substances, shows salt stress mitigation effects in plants. In Bangladesh, the *boro* season is dry and the salt concentration increases significantly to hamper plant growth. This study aims to investigate the potential role of FA to better mediate nutrient absorption in rice by improving the regulation of ion transport, photosynthetic efficiency, and antioxidant activities under salinity while mitigating the damaging effects and increasing crop productivity. Rice seeds (*O. sativa* cv. BRRI dhan89) were collected from the Bangladesh Rice Research Institute (BRRI), Bangladesh. Healthy, vigorous, uniform, and disease-free seedlings of 30-day-old were transplanted in 14-L plastic pots supplemented with the recommended dose of fertilizers (BRRI, 2020), maintaining two hills in each pot at a uniform distance. After four weeks of transplantation, the plants were irrigated with 50 mM, 75mM and 100 mM NaCl solutions at seven-day intervals, whereas the control group was irrigated with only water and Fulvic acid group was sprayed with only 0.25 ml L^{-1} fulvic acid solution. Results from this experiment suggest that electrolyte leakage (EL), malondialdehyde (MDA), hydrogen peroxide (H_20_2), and proline content were alleviated due to salinity, while biomass, chlorophyll, and relative water content decreased. However, FA spray played an important role in overcoming the effects of

salinity. The activities of glyoxalase and antioxidant enzymes, including dehydroascorbate reductase, catalase, glutathione peroxidase, glutathione *S*-transferase, and superoxide dismutase, were also impaired. This study shows FA's efficacy in conferring tolerance against salinity, showcasing its potential in modulating antioxidant defense, glyoxalase systems, and osmotic adjustments.

T8-A13

Synergistic effect of *Adathoda vasica* plant-derived biostimulant and PGPR on *Zea mays* L. for drought stress management

Abhilasha Mishra[1*]
[1]Microbial Technology Division, CSIR-National Botanical Research Institute, Lucknow-226001, U.P.
E-mail: abhilasha120797@gmail.com

Drought represents a major abiotic constraint that severely disrupts the physiological and biochemical functions of crops, thereby limiting agricultural productivity. In this study, the potential of a plant-derived biostimulant (PDB) in combination with plant growth-promoting rhizobacteria (PGPR) strains—*Pseudomonas putida* (RA) and Paenibacillus lentimorbus (CHM12) was evaluated for mitigating the adverse effects of drought stress in Zea mays (maize). Among the seven tested medicinal plant extracts, Adathoda vasica leaf extract (ADLE) demonstrated the highest biostimulant potential. The synergetic effect of ADLE and RA enhances plant vegetative growth as well as significantly modulates drought-induced oxidative stress, as indicated by biochemical content and reduction of defense enzyme. The expression of defense-related (ZmAPX, ZmSOD, and ZmCAT) and transcription factor (ZmNAC, ZmWRKY, and ZmMYB) genes further supported the beneficial effects of this synergism under drought conditions. Furthermore, metabolite profiling through GC-MS analysis showed significant alterations in metabolites such as carbohydrates and fatty acids when PDB and PGPR were applied together. Overall, the findings of the present study affirm that the combined application of plant-derived biostimulant ADLE and PGPR can effectively alleviate the adverse effects of drought on maize, providing an eco-friendly and sustainable solution for improving productivity under stress.

T8-A14

Phytoextraction efficacy of *Helianthus annuus* L. and *Tagetes erecta* L. for Sustainable Remediation of heavy metals from industrially polluted soil

Jyoti Mathur[1*]
[1]Department of Bioscience and Biotechnology, Banasthali Vidyapith, Rajasthan, India
Email: jyotimathur@banasthali.in

Heavy metal pollution has become one of the most serious environmental problems in India and worldwide. The contamination of toxic metals like lead, cadmium, zinc and arsenic in crop plants is a global concern due to its high toxicity, non-biodegradability and accumulation in the food chain, affecting plants and human health. Industrial effluents from various industries such as dye, textile, paper, plastic, paint and leather industries are becoming the most common source of heavy metal pollution in soil. A green technology and a sustainable approach are required to get the solution of this problem. Two hyperaccumulator plant species *Helianthus annuus L.* and *Tagetes erecta*L. Were selected. Objectives of the present study were: (i)to investigate the phytoextraction efficiency of *Helianthus.* and *Tagetes* for the accumulation of heavy metals (Pb, Cd, Zn &As) in plant tissues. (ii) To evaluate physiological, biochemical, anatomical and molecular changes in plants due to heavy metal stress. (iii) Plantations of these selected plant species in the industrially contaminated soil for the remediation of heavy metals. Soil samples were collected from various industrial regions of plastic, paper, dye, and textile and leather industries of three different states Rajasthan, Uttarakhand and Uttar Pradesh. The determination of heavy metals in the soil was performed using an Atomic Absorption Spectrophotometer (AAS). Further evaluation

of growth parameters, physiological, biochemical parameters, and enzymatic and non-enzymatic antioxidants analysis in plants grown under heavy metal-contaminated soil. Microscopic observations were recorded through FE-SEM with EDX and fluorescence microscopy and light microscopy. Real-time PCR was performed for the expression of metal-induced expression of genes phytochelatin synthase (PCS), glutathione reductase (GR), and glutathione (GSH). Soil samples collected from industrial sites contain high amounts of heavy metals. Heavy metal transportation in plant tissues was confirmed by ultrastructural analysis of root, stem& leaf tissues using FE-SEM with EDX and fluorescence microscopy and light microscopy. *H. annuus* could survive at various concentrations of 50, 100, 300, 500, 700 and 1000 mg $kg^{-1}$of lead and cadmium. Higher accumulation of Pb (693.69 mg kg^{-1}) in H. annuus was observed at 1000 mg kg^{-1} after 60 days. The levels of proline and polyphenol31.16 µmol g^{-1} and 7.15 mg $g^{-1,}$ respectively, were increased in leaves by increasing heavy metal concentration in soil. Molecular studies confirm the abilities of *H. annuus* and *T. erecta* to modulate RNA expression and increase in fold changes of defense-related gene expression during heavy metal stress. *Helianthus annuus L.* and *Tagetes erecta* proven to be good hyperaccumulating plant species**,** can be used as an alternate cropping system to clean up industrially contaminated sites through an eco-friendly green sustainable approach. This will reduce the risk of entry of toxic heavy metals into the edible crop plants and restricts the entry into the food chain and biomagnification.

T8-A15

Genetic synergy: Tailoring fungal strains to alleviate arsenic toxicity by modulating Arsenic Speciation

Mariya Naseem[1*], Pankaj Kumar Srivastava[1]
[1]CSIR- National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001
Email: mariyanaseem01@gmail.com

Arsenic (As) is a toxic metalloid that exists in inorganic as well as organic forms and is introduced into the environment by both natural and anthropogenic sources. It is a systemic toxicant that manifests its toxicity on various organ systems and is also a human carcinogen. Arsenic contamination has a negative influence on plant physiology, reducing crop growth and yield, ultimately resulting in huge economic loss. A characteristic example is the “straight head disease” in paddy, where the seed setting is hampered, causing the panicles to remain empty. Arsenic contamination of groundwater and its recurrent use over several years leads to As buildup in the agricultural soil, facilitating its entry into the food chain and endangering sustainable agriculture as a whole. Mycoremediation has been considered an effective strategy to mitigate As toxicity, as fungi possess mechanisms like biosorption, bioaccumulation, biotransformation, biomethylation/ biovolatilization, which can be utilized for As remediation. As remediation potential of the promising fungal strains can be enhanced using genetic improvement techniques such as protoplast fusion. Fungal protoplast fusion has been successfully used in industrial microbiology, but its use for environmental remediation is scarce. The study was based on the hypothesis that protoplast fusion can be used as an effective tool to combine different As detoxification traits of diverse groups of fungi to develop robust fusant strains better equipped for As remediation as compared to the parent strains. The study was carried out to enhance the As remediation potential of the parent fungal strains using intergeneric protoplast fusion by combining their respective traits of arsenic-methylation and arsenite-oxidation, to get a single novel fusant strain. The protoplasts were generated from the parent fungal mycelia by enzymatic digestion of the cell wall and fused using polyethylene glycol (PEG). The fusants were selected and further screened on the basis of traits like improved As volatilization, arsenite oxidation, and plant growth promotion. The impact of the fusant inoculation in reducing plant As uptake was

studied using *Spinacia oleracea* grown under As stress in a mesocosm study. The fusant strains exhibited a substantial increase in As volatilization and arsenite oxidation compared to either of the parent strains. Plant seed treatment with the fusant strains was observed to alleviate As stress to *Spinacia oleracea* grown in As-contaminated soil (20 mg kg^{-1}). The fusant inoculation also altered the As species dynamics due to methylation of inorganic As species to less toxic pentavalent methylated forms (MMA and DMA). These organic forms were taken up by the test plant from the rhizosphere and detected in plant parts like the petiole and leaf. The fusant strains also exhibited several PGP traits like auxin production, siderophore production, ammonia production, silicon solubilization, and phosphate solubilization, which substantially improved the overall plant growth and physiology even under As stress offering a win-win situation. The results of this study advocate the use of the protoplast fusion technique for fungal strain improvement to develop novel fusants with combined traits of genetically diverse fungi for improved detoxification of As in plants growing in As-contaminated soils.

T8-A16

Bioprospection of indigenous cyanobacteria for scytonemin production in conditions of high salinity

Soujanya Shekhar Rana[2]*, Sachitra Rath[1]
[1]Phycology Laboratory, CSIR-National Botanical Research Institute, Lucknow, 226001, India | [2]Algal Biotechnology Laboratory, Department of Botany, Central University of Punjab, Bathinda, 151401, India
Email:sachitraratha78@gmail.com; soujanyasekhar.b2@gmail.com

Solar radiation is one of the environmental factors primarily responsible for skin aging and carcinogenesis. Numerous types of sunscreens, featuring both inorganic and organic constituents, are produced globally each year to protect against UV radiation and prevent skin aging and carcinogenesis. The adverse effects related to the inclusion of inorganic ingredients in sunscreens have led to an increased interest in organic alternatives in cosmetic products. Scytonemin, a UV protective pigment, is gaining worldwide scientific interest as a significant green alternative for the production of new UV-filters and medications in the cosmetic and pharmaceutical industries. In this investigation, the cyanobacterial strain *Symploca cartilaginea* was isolated from the soil crust of the semi-arid region of Punjab and examined for scytonemin production at different levels of salinity stress. The scytonemin maximum output was observed at 100 mM NaCl (2.66 mg g-1), 6.5-fold higher than the control. The growth, biomass, chlorophyll a, and carotenoid content of *S. cartilaginea* were negatively impacted under salinity stress. In contrast, the total phenolic content was significantly elevated under stress and notable morphological changes in the cyanobacterium after treatment were revealed by CLSM investigations. CLSM analysis of *S. cartilaginea* cultures showed an increase in the thickness of the exopolysaccharide layer, indicating the possible increase in production of scytonemin. FTIR analysis of the dried cyanobacterial biomass revealed changes in the biochemical composition under salinity stress, and prominent peaks between 1500-1600 cm^{-1} and at 2927 cm^{-1} signify the presence of phenol and indole groups, respectively. The scytonemin crude extracts were further characterized by a para-substituted phenol, visible at 7.4 ppm through NMR to confirm the presence of scytonemin. GC-MS analysis of the cyanobacterial extracts revealed commercially important compounds with potential antioxidant, antitumor, and emollient properties. The present study successfully established the potential of *Symploca cartilaginea* for scytonemin production and salinity stress as a potential strategy for enhancing its production. The study paved the way for future investigations on the commercial-scale production of UV-protectant compounds for the cosmetic industry using indigenous cyanobacteria.

T8-A17

Calcium and magnesium ions influence diversity and density of bacteriophage and

sustaining the self-purification of river Ganga

Ruchi Agnihotri[1,2]*, Seema Mishra[3], Vishnu Kumar[1], Pragya Sharma[1], Sarvesh Kumar[1], Ravi Kumar Tiwari[1], Sanjay Dwivedi[1,4#], Geetgovind Sinam[1], and Vivek Pandey[1]

[1]Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, India

[2]Department of Microbiology, Dr. Ram Manohar Lohia Avadh University Ayodhya- 224001, India

[3]Department of Chemistry, University of Lucknow, Lucknow-226007, India

[4]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India

Email: agnihotri.ruchi1994@gmail.com

The role of bacteriophages in purifying river water by predating upon bacterial populations is well established. Cations and anions play diverse and crucial role in bacteriophages growth. Thus, ion chemistry of rivers may be an important factor in bacteriophage mediated bacterial population control and self-purificatory characteristic of the river. Present study show that bacteriophage/bacteria ratio is directly related to changes in concentration of major divalent ions (Ca^{2+} and Mg^{2+}) in different stretches of river Ganga; the historic and largest river of the Indian sub-continent originating from Himalayas. The upper stretch of Ganga is enriched in divalent ions (1.6 and 2.6 folds) and has significantly higher phage/bacteria ratio (>24 and >3 folds) in comparison to other studied rivers; i.e. Yamuna (of Himalayan origin) and Narmada (of non-Himalayan origin) at their respective upper stretches. While middle and lower stretches of Ganga is relatively depleted of major divalent ions, and there was a drastic increase in the level of anions. The phage/bacteria ratio also drastically declined. These findings were validated under *in vitro* conditions. Enhanced growth of bacteriophages were observed in presence of Ca^{2+} and Mg^{2+}, with Mg^{2+} being several folds more effective than Ca^{2+}. In contrast, anions were detrimental to bacteriophage growth. Thus, the change in ion chemistry in the middle and lower stretch of Ganga due to high anthropogenic intervention may have hampered phage growth causing increase in bacterial density. Whereas in lower stretches of Yamuna and Narmada the level of cations as well as phage/bacteria ratio increased (~10 folds and ~1.5 folds) in comparison to their respective upper stretches. However, the phage/bacteria ratio was still lower in Yamuna and Narmada than Ganga. Also, the bacterial density increased more radically in these rivers in comparison to Ganga. High chemical denudation rate of tributaries of Ganga leading to affluent divalent ions, along with other factors such as pH, alkalinity and DO, conducive for bacteriophages growth, may have contributed in maintaining high phage/bacteria ratio eventually incorruptible nature of Ganga water. However, massive increase in sewage and industrial discharge in middle and lower stretches of Ganga disrupted the ion chemistry causing depleted phage/bacteria ratio leading to loss of its self-purificatory characteristics.

T8-A18

Modulating microalgal growth under nitrogen limitation through phytohormone application

Harsh Vardhan[1], Esha Goyal[2], Nirmal Renuka[2], Sachitra Kumar Ratha[1*]

[1]Phycology Laboratory, CSIR-National Botanical Research Institute, Lucknow, 226001, India; [2]Algal Biotechnology Laboratory, Department of Botany, Central University of Punjab, Bathinda, 151401, India

Email: sachitraratha78@gmail.com; harshvardhancharan200@gmail.com

A well-established strategy for boosting lipid production in microalgae is nitrogen limitation, but there is a trade-off: it lowers total biomass productivity, which has a detrimental effect on lipid yield. According to recent research, phytohormones can boost biomass and lipid production in microalgae by reducing oxidative stress. The present study, evaluated the lipid biosynthetic efficiency of microalga, *Desmodesmus multivariabilis* under the effect of varying classes and concentrations of phytohormones (IBA, GA3, and Kinetin) with common nitrogen starved concentration of N100 (100 mg L^{-1} $NaNO_3$). Phytohormones, especially IBA (5mg L^{-1}), gave the highest biomass of 1.3 g L^{-1} compared to 1.27 g L^{-1} in

the standard BG11 control. The decolouration of cultures and quantitative data of N starved with phytohormone-supplemented treatments implied that the photosynthetic performance decreased from the late log phase to the stationary phase, compared to BG11, where HT9 (5 mg L^{-1} K + N100) exhibited the highest accumulation of chl a and chl b during the early stationary phase, reaching 2.79 mg L^{-1} and 2.50 mg L^{-1}, respectively, compared to control. GA3 provided consistent performance up to day 14, resulting in the highest carotenoid accumulation (0.6 mg L^{-1}) among the treatments. Optimised concentrations of PGRs (HT1, HT5, HT9) were selected for protein, lipid, and carbohydrate estimation. The highest lipid productivity was reported in HT9 at 46.39% DW compared to the control (24.12% DW), which is 1.9-fold higher. In contrast, a decrease in protein and carbohydrate content was reported in all the treatments. The FTIR spectra reveal strong signals for fatty acids, proteins, and carbohydrates in phytohormone-treated cultures and BG11 control. Notably, BG11 shows a protein-related peak at 1521.2 cm^{-1}, while the N100 treatment exhibits a unique peak at 557.32 cm^{-1}, indicating possible brominated derivatives. From the analytical data of GC-MS for biochemical compounds, a high proportion of SFA (saturated fatty acids), such as palmitic acid (C16:0), and stearic acid (C18:0), was reported in all the treatments as compared to the control. In contrast, omega-9-(C18:1) fatty acids were found to be most abundant in nitrogen-starved cultures with optimized phytohormone supplementation. In conclusion, this study demonstrated that phytohormones under nitrogen limitation could be a promising candidate for enhancing lipid production in microalgae culture systems.

T8-A19

Unravelling Biochar's Function in Hexavalent Chromium (VI) Removal from Contaminated Water

Priyanka Umar[1]*, Sudhakar Srivastava[1]
[1]Institute of Environment Science and Sustainable Development, Banaras Hindu University, Varanasi, India
Email: priyankaumar@bhu.ac.in

The rapid pace of development and industrialization has led to increased pollution across the environment. Untreated industrial waste often contains toxic metals, microplastics, and various chemical pollutants that pose serious threats to aquatic life, soil biota, and ultimately human health. This study investigated the removal of chromium [Cr (VI)] from contaminated water through a batch adsorption process using biochar. The optimal conditions for Cr(VI) removal were determined by evaluating several parameters, including pH (2–10), biochar dosage (1–5 g L^{-1}), initial Cr(VI) concentration (5–25 mg L^{-1}), contact time (30–150 minutes), and agitation speed (50–250 rotations per minute), while maintaining a constant temperature of 37°C. The result showed that at pH 2, using 5 g L^{-1} dose of biochar for 60 minutes, 91.8% Cr (VI) was removed when the concentration was 25 mg L^{-1}. Furthermore, when contact time was increased to 120 min, removal efficiency was increased significantly to 97.3% removal at the same concentration. When the Cr concentration was 10 mg $L^{-1}$and a 2 g L^{-1} dose of biochar was used with shaking for 60 minutes, the removal percentage ranged from 82% to 43% at pH 2–10, which indicates pH 2 is the optimum pH for better Cr removal. Cr (VI) can be adsorbed in the pores of biochar, or it can also be removed through electrostatic interactions, redox reactions, and specific functional group interactions with the chromium present on the biochar. The present study suggests that biochar-based adsorbents can be used for sustainable Cr(VI) removal from contaminated water.

T8-A20

Global Patent Landscape of Plant-Based Air Purification Systems for Indoor Air Quality Enhancement

Vivek Srivastava[1], Preeti Umarao[1] and Richa Rai[1]
[1]CSIR-National Botanical Research Institute, Lucknow
Email: vivek@nbri.res.in

Indoor air pollution, primarily due to volatile organic compounds (VOCs), particulate matter

(PM), and microbial contaminants, poses critical health and environmental challenges. Conventional mechanical or electrostatic purifiers are energy-intensive and expensive in maintenance. In contrast, plant-based air purification systems harness phytoremediation, microbial biofilters, and bioactive substrates to sustainably degrade indoor pollutants. Despite growing academic interest, the global patent landscape of such biohybrid air purification systems remains underexplored. This study hypothesizes a rising global patenting trend in bioengineered, plant-integrated air purification systems incorporating smart and microbial technologies. Objectives include identifying leading patent assignees, mapping innovation clusters, and highlighting emerging research gaps in hybrid phytoremediation. Patent data from WIPO, USPTO, EPO, and IP India were analyzed using keywords "plant-based air purifier," "phytoremediation," "biofilter," and "green wall." Key patents include WO2020217261A1, WO2020260550A1 (PCT/EP2020/067971), US2019013561A1, KR102695553B, IN202211009892, and IN201841046909. The findings reveal that hybrid systems integrating plant-root biofilters, IoT monitoring, and algal photobioreactors dominate post-2018 filings. European and Indian filings emphasize structural biofiltration units for façades and interiors. A notable research gap persists in microbial–plant and plant-plant synergistic pollutant degradation optimization.

The patent landscape underscores a shift toward biohybrid purification technologies uniting plants, microorganisms, and smart sensors for energy-efficient VOC and PM reduction. This study highlights bioengineered plant-based purifiers as a sustainable frontier for future green building standards and smart city applications.

T8-A21

Influence of leguminous trees on adjacent grass biomass and soil properties in arid and semi-arid regions of Rajasthan

Binay Kumar Mahato[1,2*], Sanjay Anand[2], Richa Rai[1], Nivedita Chaudhary[2]

[1]CSIR- National Botanical Research Institute (NBRI), Rana Pratap Marg, Lucknow, India | [2]Central University of Rajasthan, Ajmer, Rajasthan, India
Email: binaykumar620@gmail.com

Arid and semi-arid regions of Rajasthan are known for their fragile soils and limited vegetation, making plant–soil interactions crucial for ecosystem sustainability. This study explores trees of the leguminous family may influence nearby grass biomass and soil health in these dry landscapes. The research aimed to understand the presence of leguminous trees affects soil carbon and nitrogen storage and also their association with grasses contributes to overall soil fertility. Soil and vegetation samples were collected from areas beneath leguminous and non-leguminous trees at selected sites. The findings showed clear differences in both soil quality and grass growth between the two tree types. Soils under leguminous trees contained higher levels of organic carbon and nitrogen, indicating better nutrient cycling and improved fertility. Grasses growing near these trees also showed greater biomass, likely supported by nitrogen fixation, leaf litter decomposition, and increased microbial activity. Overall, the results emphasize the vital ecological role of leguminous trees in enriching soils and supporting vegetation in arid environments. Promoting the inclusion of leguminous species in rangeland management could help restore soil health and enhance sustainable forage productivity across Rajasthan's drylands.

Theme 9:

Bioeconomy and sustainable development goals

T9-A1

Agroforestry enabled food security and environmental sustainability

Ayyanadar Arunachalam[1*]
[1]Director, ICAR-Central Agroforestry Research Institute, Jhansi 284003, Uttar Pradesh, India
Email: arun70@gmail.com

An agroforestry system can be conceptualized and designed for different conditions and needs; it can be done at the farm level or landscape level. At the farm level in the existing agricultural lands, agroforestry can be promoted in the form of bund planting, boundary plantation, alley cropping, incorporation of nitrogen-fixing trees, etc. At the landscape level, agroforestry practices can be aligned towards the reclamation of degraded lands. Inevitably, any agroforestry system offers more than one output (comprising both tangible and intangible outputs). Thus, the term 'multifunctional agroforestry' seems to be neither dictum nor jargon. Henceforth, there is a need for an appropriate definition for new terminologies *per se*. It is stated that the term 'multifunctional' should be used as a prefix to those agroforestry systems where it is able to provide more than one or several functions apart from it intended primary function. In short, the multifunctional Agroforestry has been explained as 'a concept. The concept of multifunctional agroforestry recognizes agroforestry as a multi-output activity producing not only commodities (food, wood/timber, fibres, flowers, agrofuels, medicinal products and ornamentals), but also non-commodity outputs such as environmental services (nutrient cycling, soil formation and retention, carbon sequestration, pollination, water quality and regulation), landscape amenities and cultural services (agroforestry tourism, walking, educational and scientific knowledge, spiritual value, meditation, *etc*.) (Parthiban et al., 2021). Further, it is stated that the four major functions of an agroforestry system are: a) provisional services; b) regulating services; c) cultural services, and d) supporting services. There is an incongruity in explaining multifunctional agroforestry as a concept, as stated earlier. Since all agroforestry systems and agroforestry practices provide more than one output and it provides both commodity (tangible) as well as non-commodity (intangible) outputs. Overall, agroforestry caters to the futuristic requirements of climate-resilient food production and also meets industrial requirements per se.

T9-A2

Novel approaches of plant biology for sustainable development within the planetary boundaries

Elina Oksanen[1*]
[1]Dept. Environmental and Biological Sciences, University of Eastern Finland, Finland
E-mail: elina.oksanen@uef.fi

Earth is outside the safe operating space for humanity. We have exceeded six of nine planetary boundaries: Climate change, biosphere entity, land system change, freshwater change, modification of biogeochemical flows and novel entities (synthetic chemicals and substances such as microplastics). Climate change, biodiversity loss and pollution are the greatest risks affecting food and water security and human health. These processes are deeply interconnected. While climate change is a direct driver of biodiversity loss, it amplifies biodiversity decline also indirectly e.g. through floods, drought and wildfires. It is estimated that 40% of global plant species are threatened with extinction due to changes in land use, direct exploitation, climate change, environmental pollution and invasive alien species. Biodiversity loss is seen not only in the natural ecosystems, but also in the agricultural systems. At the same time, there are a vast number of unknown plant species in the globe. Besides biodiversity values, plants provide us ecosystem services such as food, feed, energy, raw materials, medicine, clear air and water, aesthetic and recreational value, which are weakened due to rapid decline in

biodiversity. It seems that most international societal and environmental goals, e.g. those in the 2030 Agenda for Sustainable Development, will not be achieved. The use of arable land is one of the most difficult challenges for the growing human population of the globe, and we essentially need transformative change in the plant production. With novel multi-omics and phenotyping approaches and breeding pipelines we can produce more resistant plants against multiple environmental stresses with lower requirements for fertilizers and pesticides. Diversity of local varieties and crop wild relatives represent critical reservoirs of genes and superior adaptive traits for resistance breeding. While innovative space-efficient farming and agroecological approaches are developing for food production and regenerative agriculture, advanced breeding programmes exist for only a handful of forest trees. For example, in Europe there is urgent need for high-quality seedling materials suitable for various geographical and climatic conditions to reach the EU's goal to plant 3 billion additional trees by 2030. In addition to agricultural and forest ecosystems, urban greens are increasingly important for human health. Biodiversity in urban environments can be increased by diverse and novel green infrastructures, such as rooftop and rain gardens, green belts and aqua/hydro/aeroponics, promoting multispecies cities. Learning and co-development of Nature Based Solutions (NBS) for climate change mitigation and adaptation, food and water security and nature positive actions (i.e. increased biodiversity) is a new challenge. Fighting against harmful invasive species requires more attention in all natural and man-made ecosystems. Therefore, novel tools for early detection of biological invasions, and remote sensing with AI are being developed. In Europe, the implementation of the EU restoration law is reinforcing the biodiversity and climate actions, but similar approaches should be worldwide. In summary, novel approaches in plant biology form a core part of integrated solutions to tackling climate change, biodiversity loss and environmental pollution.

T9-A3

Rethinking to rebuilding- stepping towards environment, sustainability and ecosystem services

Mohammed Latif Khan[1*]
[1]Dr. Harisingh Gour Vishwavidyalaya (A Central University), Sagar, India
Email: khanml61@gmail.com

The presentation “Rethinking to Rebuilding-Stepping Towards Environment, Sustainability and Ecosystem Services” describes how humans have entered a new age where we control and change the Earth’s natural systems more than ever before. The author explains that, even with all our technology, people still depend on healthy ecosystems for water, food, shelter, fuel, clothes, and medicines. To build a better future, we must learn to balance growth and conservation and change the way we use natural resources. The author begins by describing how this change happened quietly but very fast over the last century. Human actions have now become the major factor affecting climate, forests, and biodiversity. Solving these global problems needs strong teamwork between science, law, and ethics. The author shares examples from many parts of India, especially the Eastern Himalayas, Northeast India, and Central India to show how climate change is already visible. People have noticed that plants are flowering earlier, some species are moving to higher mountains, invasive plants are spreading, and many pollinators are disappearing. Local communities in Arunachal Pradesh have also observed changes in snowfall timing and fruit taste, showing clear signs of a warming climate. The research team has done detailed mapping of plants and forests in different landscapes. In Central India, they found 430 plant species, and in the Eastern Himalayas, 482 species. They also found that many areas face high disturbance, and more than one-third of the tree species are on the IUCN threatened list. Another part of the study focused on

sacred groves old forest patches protected by local traditions in Manipur, Arunachal Pradesh, and Central India. These groves are rich in biodiversity and carbon storage, but many are now under threat because of human activities. For example, 59 groves in Central India had 109 tree species, while in Manipur, almost 90% of groves are either partly threatened or degraded. The author also recorded new or rare plant species like *Rhododendron* and *Primula* in Arunachal Pradesh, and rediscovered some that were not seen for years. Studies on endangered trees such as Rudraksha, *Gymnocladus assamicus*, and *Taxus wallichiana* showed that their populations are falling because of habitat loss, poor regeneration, and overuse. The team tried different conservation methods, such as bamboo plantation and seedling distribution to restore these species and degraded forests. The author's work helps forest officers and local people make better plans for protecting nature. It also improves understanding of climate change and supports the livelihoods of tribal and rural communities. The main message is that protecting native plants and forests makes nature stronger and more resistant to change. The author reminds us that the Earth gives enough for everyone's needs, but not for human greed. By rethinking our actions and rebuilding our relationship with nature, we can move towards a healthier and more sustainable world.

T9-A4

Sustainable agricultural intensification for advancing food, nutrition, and ecosystem health

P.V. Vara Prasad[1*]
[1]University Distinguished Professor, R.O. Kruse Endowed Professor and Director, Center for Crops, Climate and Communities, Department of Agronomy, College of Agriculture, Kansas State University, Manhattan, Kansas 66506, USA
E-mail: vara@ksu.edu

Our global agri-food systems have many grand challenges, such as food insecurity, nutrition insecurity, and climate insecurity. At present, about 823 million people are food insecure, and about 2 billion are malnourished. Climate change and climate variability with extreme events are threatening agricultural productivity and ecosystem health. The challenge of food and nutrition insecurity is multidimensional with four key pillars: availability; access; use and utilization; and stability of nutritious, safe, and healthy food. To meet the demands of a growing population, food production and access must be improved under the current and future threat of climate change, climate variability, market pressures, and the cost of production. Our natural resources and biodiversity are depleting rapidly and must be protected and regenerated. Addressing all these challenges will require a holistic and systems approach. Sustainable agricultural intensification (SAI) provides one such platform with a goal to provide access to safe, nutritious, and healthy food at all times to all people from existing farmland and without damaging our natural resources and ecosystem health. The three major components of SAI include genetic intensification, agroecological intensification and socio-economic intensification. Together, these provide comprehensive nutrition-smart, climate-smart, and resource-smart agricultural practices. These practices advance food, nutrition, climate and ecosystem health. Some examples of these practices include integrated crop-livestock systems; diversification of our farming systems; integrated cereal-legume systems; agroforestry systems; integration of perennial trees; crop production using principles of conservation agricultural practices; integrated nutrient, water, and pest management; commercial diversified home-gardens; biofortification of food through crop management and crop breeding. Diverse examples of SAI practices from around the world, the current status of funding, and future needs to address some of the key sustainable development goals will be presented and discussed.

T9-A5

Living with water: Ecological and economic pathways to resilience in Barak Valley, Assam

Tapati Das[1*]
[1]Professor, Department of Ecology and Environmental Science, Assam University, Silchar, India
Email: das.tapati@gmail.com

Drawing on two decades of research and community engagement, this talk examines how the floodplains and wetland mosaics in Barak Valley, which were once the backbone of agrarian and wetland-based livelihoods, are being reshaped by interacting ecological and socio-economic pressures. Three linked drivers now dominate the landscape: (i) more frequent and disruptive seasonal/flash floods driven by altered monsoon dynamics, and inadequate drainage; (ii) rapid expansion of invasive aquatic macrophytes (e.g., *Eichhornia crassipes*, *Ipomoea carnea*, *Alternanthera philoxeroides*) that disrupt hydrological connectivity, elevate trophic status, and displace native biota; and (iii) progressive conversion of productive lands into wastelands. Together, these forces erode ecosystem services, undermine fisheries and agriculture, intensify livelihood precarity and migration, and weaken traditional ecological knowledge and local institutions. The talk presents an integrated evidence base combining ecological assessments with socio-economic analyses to identify practical pathways for adaptation and regeneration. Nature-based solutions highlighted include restoration with native wetland vegetation, community-based wetland management committees, and value-addition strategies that (a) bring selected wetland plants into safe, commercial food chains, and (b) repurpose invasive biomass into biofertilizers, biogas, and handicrafts. Framed as a community-centred resilience agenda, the discussion distils design principles and governance levers for scaling that align restoration with hydrological reality, pair ecological gains with livelihood diversification, and institutionalize co-management at local levels. Ultimately, the Barak Valley's resilience depends on transforming intertwined risks into opportunities for ecological renewal and inclusive growth. By coupling ecological insight with appropriate technologies, participatory governance, and market linkages, a regenerative development model can restore wetland vitality, revitalize rural economies, and strengthen the human-nature relationships foundational to the region's identity and future.

T9-A6

Restoring Degraded Lands in India to Achieve the UN Sustainable Development Goals

P.C. Abhilash[1*]
[1]Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi 221005, India
Email: pca.iesd@bhu.ac.in

Land is a critical life-support system on this planet. Besides its various bio-physical significance, land is also an important socio-cultural and production system. Therefore, sustainable land management practices are crucial for preserving terrestrial biodiversity, maintaining nutrient cycles, and ensuring food and nutritional security. However, the latest synthesis reports from various intergovernmental agencies such as the Food and Agriculture Organization of the United Nations, Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, and the Intergovernmental Panel on Climate Change clearly show that land degradation is widespread, leading to an unprecedented decline in ecosystem services and nature's contributions to people worldwide. Land degradation affects the livelihoods of around 3.2 billion people globally. Like many other countries, India faces serious concerns with land degradation, with over one-third of its land severely degraded due to multiple driving factors. The sustainable restoration of degraded land supports the UN Sustainable Development Goals by increasing agricultural productivity, promoting soil carbon sequestration, boosting biomass and bioenergy production, and

enabling agroforestry practices. Moreover, such restoration efforts also help India fulfill its international commitments to conserve biodiversity, restore degraded lands, reduce greenhouse gas emissions, and achieve Land Degradation Neutrality. This lecture highlights various strategies for restoring degraded lands in India to achieve the UN Sustainable Development Goals.

T9-A7

Prospects, predictions and processes for recycling rare earth and precious elements from E-waste for a circular economy

Shekhar Mallick[1*]
[1]Professor, School of Environmental Science, JNU, New Delhi, India
Email: shekharm@mail.jnu.ac.in

The escalating global generation of electronic waste (e-waste) represents a significant environmental and economic challenge, yet it presents an opportunity to "urban mine" for critical rare earth elements (REEs) and precious metals. This lecture explores the multifaceted landscape of recovering these valuable materials from e-waste to foster a sustainable circular economy. It begins by outlining the current state and future predictions for e-waste volumes, highlighting the geopolitical and resource security drivers propelling the need for alternative supply chains. The core of the presentation reviews the key processes involved in e-waste recovery, including conventional methods like pyrometallurgy and hydrometallurgy, which use high temperatures, and hydrometallurgical techniques, and employ chemical leaching. Special attention is given to emerging, more eco-friendly approaches, such as bioleaching, ionic liquid extraction, supercritical fluid extraction, and bio-inspired peptides derived from proteins like lanmodulin. The lecture will analyze the scalability and efficiency of these technologies, drawing on recent case studies involving neodymium magnets and precious metals from circuit boards. Case studies on recovering REEs from permanent magnets in hard drives and precious metals from printed circuit boards illustrate the technical advancements and complexities involved. The lecture concludes by discussing the future prospects for the e-waste recycling industry, addressing challenges such as infrastructure gaps, policy and regulatory hurdles, and market dynamics. It argues that a collaborative, innovative, and systemic approach is essential to unlock the full potential of e-waste as a sustainable secondary resource for a truly circular economy.

T9-A8

The climate change and sustainable development: Issues and challenges with special reference to environmental protection laws

Faisal Ali Khan[1]*
[1]Professor, DBS Global University, Dehradun-248011
Email: fakmoon@gmail.com

The concept of climate change and global warming related issues are concerned with the interaction of human beings with nature, is so extensive that the environmental issues have assumed such proportions as to affect all humanity. Besides, industrialisation, urbanisation, population explosion, overexploitation of natural resources, depletion of traditional sources of energy, and the search for new ones, disruption of natural ecological balances, as well as the destruction of a multitude of animal and plant species for economic reasons, are the major factors that have contributed to environmental deterioration. Nature provides the most hygienic and healthy environment for the survival of mankind, but this environment has been changed by mankind for selfish ends by adding concrete, charcoal, plastics, toxic chemicals, hazardous wastes and many more objects, ecosystems and is primarily responsible for environmental pollution and consequent health hazards. All these factors are responsible for climate change and global warming because industrialization would develop chemical gases, smoke, pollution, etc. which leads to disturb our ecological balance, as a result we face the problem of climate

change and global warming. No doubt at all, industrialization is the backbone of our economy and commerce, but we should always keep in mind to follow the standards and mechanisms of the control of pollution-by-Pollution Control Board. The concept of sustainable development, defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987) has always been a part of the indigenous ethos. Ignorance, though not blissful in this context, is largely responsible for generating erroneous conceptions, projecting the natives of Mother Earth as the enemies of the procreator. One often comes across administrators and forest officers telling stories about how tribal have destroyed the virgin forests. Intellectuals and the so-called friends of the supposedly downtrodden, underprivileged, and ignominious are not far behind. They plan strategies that are supposedly eco-friendly but have remained hitherto unavailable to the tiller of the land. The United Nations has stated that the agenda of Sustainable Development Goals 2030 (SDG) on 25-27th September, 2015 at United Nations Headquarter in New York by adopting the 17 Sustainable Development Goals with 169 associated targets which says that "to eradicate the extreme poverty & hunger amongst the peoples, they should reside with peace and dignity and to protect the planet as well as natural recourses from degradation". The policy should be designed in such a manner that to develop the partnership amongst the stakeholders to achieve the target of the (SDG). The Parliament has enacted various legislations for the protection of environment, pollution and maintains the ecological system of our nature but the implementation of these laws hasn't achieved the require result, it may be a failure of our function and functionary. But it can get the required result with the aid of "Strong Political Will of the State" and NGOs can play a vital role for awareness of the environment and pollution-free atmosphere among the common people.

T9-A9

Outreach Activities Impact Analysis Under EIACP At CSIR-NBRI and Mission Life

Anamta Nafees Warsi[1*], Anju Patel[1], Pankaj Kumar Srivastava[1]
[1]NBRI EIACP – Programme Centre, CSIR- National Botanical Research Institute, Lucknow-226001, India
Email: anamtanafees83@gmail.com

With climate change being a massive global challenge, India's Mission LiFE (Lifestyle for Environment) is pushing for simple, sustainable changes in daily life. NBRI-Environmental Information, Awareness, Capacity Building and Livelihood Programme (EIACP) at CSIR-NBRI ran a big outreach program to get people thinking and acting environmentally. The program focused on seven themes: Save Energy, Save Water, say no to Single-Use Plastic, Adopt Sustainable Food System, Reduce Waste, Reduce E-waste, and Adopt Healthy Lifestyles. Currently, robust empirical studies are scarce on how different communication methods, specifically contrasting passive lectures with highly interactive activities, impact diverse demographic groups. This analysis looks at how well these different awareness methods worked. We hypothesize that the fun, hands-on sessions (activity-based learning, like games and rallies) would be much better at creating lasting knowledge and commitment compared to conventional, passive awareness sessions. The main goal was to check how much our diverse activities affected people's awareness and desire to adopt LiFE principles across the entire spectrum of participants. We used a mixed approach across various places, including Government schools, Colleges, NGOs, and community parks. We blended traditional methods like talks and online meetings with engaging activities such as dart games, drawing, quizzes, debates, and walkathon rallies. To measure the true impact, we gathered detailed participant data, including their state, age, gender, job role, and education level. This segmentation lets us see exactly what worked for different groups of people. The initial results clearly showed that activity-

based learning grabbed people's attention right away and did a much better job of getting them to commit to new habits, especially the younger participants (students). Awareness went up across the board for themes involving easy, concrete actions, like getting rid of plastic or dealing with old electronics. Interestingly, a person's job title and educational background had a big influence on what environmental topics they found most important and how well they understood the content. We concluded that the best strategy isn't one or the other, but a mix: use informative talks to get the basic knowledge across, and then use fun, interactive events to turn that knowledge into a real commitment. These findings are super important for the EIACP at CSIR-NBRI and other organizations. They help us stop wasting resources on less effective methods and start focusing on outreach policies that can genuinely mobilize citizens to support India's journey toward sustainability.

T9-A10

Influence of Zinc Sulfate and Boron on Growth, Yield and Quality of Broccoli

Kamal Pal[1,2], Dinesh Singh[2*], Ranjan Kumar Jadon[1], KJ Singh[2], Soumit K. Behera[2]
[a]Department of Horticulture science, College of Agriculture, J.S. University, Shikohabad, U.P. 208002 India. [b]CSIR- National Botanical Research Institute, Lucknow, U.P. 226001 India.
Email: palkamal441@gmail.com

Broccoli is a high-value cole crop sensitive to micronutrient deficiencies, particularly boron (B) and zinc (Zn), which play crucial roles in vegetative growth, curd development, and quality attributes. Despite their importance, optimum dosage of B and Zn in combination with recommended NPK fertilization remains insufficiently explored, especially under the conditions of Western Uttar Pradesh. Identifying the right micronutrient combinations can significantly enhance yield and nutritional quality. It was hypothesized that supplementing NPK with appropriate levels of boron or zinc sulfate would significantly improve the growth, yield, and quality of broccoli. This study aimed to evaluate the effect of soil-applied boron and zinc sulfate on growth parameters of broccoli. Assess their influence on yield and quality traits. Determine the nutrient uptake of boron and zinc under different treatments. A field experiment was conducted with seven treatments and three replications. Treatments consisted of recommended dose 120:60:40 NPK kg ha^{-1} combined with varying levels of boron {10 (T_1), 15 (T_2), 20 (T_3) kg ha^{-1}} and zinc sulfate {10 (T_1), 15 (T_2), 20 (T_3) kg ha^{-1}} applied at 15 DAT, along with an untreated control. Boron at 15 kg ha^{-1} (T_2) recorded the maximum plant height (22.83 cm at 30 DAT; 29.31 cm at 60 DAT) and maximum stem diameter (3.09 cm and 4.10 cm). Minimum days to curd formation (53 days), the highest curd length (14.25 cm), curd weight (328.66 g), yield per plant (974.6 g), and marketable yield (27.56 t ha^{-1}) were also achieved with T_2. Quality parameters such as TSS (11.15°Brix) and vitamin C (86.88 mg/100 g) were highest in T_2. Boron uptake was maximum (30.86 ppm) in T_2. Zinc uptake was highest (32.00 ppm) under T_5 ($ZnSO_4$ @ 15 kg ha^{-1}), followed by T_4. Application of boron at 15 kg ha^{-1} along with recommended NPK proved most effective in enhancing growth, yield, and quality of broccoli. Zinc sulfate at 15 kg ha^{-1} optimized Zn uptake. The study highlights the critical role of micronutrients in improving productivity and nutritional value, providing a practical recommendation for farmers aiming for higher and quality broccoli yields under similar agro-climatic conditions.

T9-A11

Bioresource utilization of an emerging invasive vine *Delairea odorata* Lem., in the north-western Himalayas

Raashi Gupta[1], Shalini Ojha[1], Bhupender Singh[1] and Daizy R. Batish[1*]
Department of Botany, Panjab University, Chandigarh 160014
E-mail: daizybatish@yahoo.com

Invasive plant species are widely recognized as ecological threats due to their ability to dominate ecosystems and displace native flora,

resulting in significant declines in biodiversity, altered ecosystem services, and reduced environmental distinctiveness, ultimately leading to biotic homogenization. The invasive plant *Delairea odorata* Lem. from South Africa has also been seen to have detrimental impacts on environment. This research explores the scientific aspects along with ecological consequences of the plant *D, odorata*. Just like other invasive species, the plant spreads quickly enough to colonize native plants and disrupt local ecological activities. The experiments were conducted to extract and characterize the essential oil from the flowers of the plant. The oil was found to be rich in *β*-ocimine and other mono-terpenes. In addition, biochar was prepared from the leftover flower residue at 450° C. The biochar was also prepared and characterised, which was found to be promising for dye-absorption and improvement in soil quality. The study concludes that management of *D. odorata* could be achieved through its utilisation. Furthermore, the economic incentives derived from biomass utilization can encourage community participation, enhance livelihood opportunities, and transform local perceptions of invasive plants from nuisance to resource. This study concludes that the management of *D. odorata* can be accomplished by investigating its potential for the synthesis of green products.

T9-A12

Digital resource centre (DRC) of MoEF & CC for environmental science and society interface

Manish Chaudhary[1*], Anju Patel[1], and Pankaj Kumar Srivastava[1]
[1]NBRI-EIACP-Programme Centre, CSIR- National Botanical Research Institute, Lucknow, India
Email: manishchaudhary941286@gmail.com

The Environmental Information Awareness, Capacity Building, and Livelihood Program Centre (EIACP) launched a Digital Resource Centre (DRC) across the country as a decentralized yet integrated network of centres. Under this vision, the DRC developed functions as an integrated digital platform, connecting data, decision-making, and communities for effective environmental governance. Before the Digital Resource Centre (DRC), environmental data across various EIACP centres in India remained scattered, making it hard for policymakers, researchers, and teachers to access and collate a PAN-India Trend. The DRC is based in the premise that an integrated, digitally accessible environmental information system enhances awareness, knowledge dissemination, and sustainable practices. The DRC integrates environment data and digital content from 54 EIACP Program Centres (PC), including 21 hubs that focus on the environmental status and related issues of the Indian state/union territories, and 33 Resource Partner (RP) centres that focus on different thematic areas such as biodiversity, waste management, renewable energy, and climate change. Such a centre maintains its individual DRC portal according to its specific focus area. These decentralized individual portals continuously share selected information reports, training materials, best practices, and awareness contents. The main EIACP-MoEF&CC DRC portal, will serve as a central hub connecting all centres data on a common platform. The main portal complies, verifies, and displays the consolidated data, ensuring standardization, accessibility and regular updates for users PAN-India. DRC has emerged as an important platform that enhances transparency, accessibility, and collaboration in environmental governance. It provides easy access to information on activities, latest updates, thematic maps, media gallery, best practices, expert profiles, and training programs. By offering structured learning materials and success stories, this platform promotes environmental literacy and the development of green skills. It integrates the key elements, knowledge products, capacity building, GSDP, and Mission Life. Through capacity-building and GSDP, it provides practical and vocational training in emerging green sectors (environment and forestry), thereby promoting sustainable livelihoods and employment. Mission LiFE also encourages

sustainable lifestyles and environmentally conscious behaviour. The Centralized EIACP–DRC portal represents a transformative step in linking digital technology with environmental awareness. It strengthens the relationship between scientific knowledge and social initiatives and promotes informed and responsible citizenship. Aligning with national Sustainable Development Goals (SDGs), its sets a benchmark for digital environment governance, making it clear how technology can drive inclusive, sustainable, and knowledge-based environmental transformation.

T9-A13

Lifestyle for Environment (LiFE)'s Waste Reduction (Swachhata Action) theme urges individual actions to conserve the environment

Sandhya Mishra[1*], Anju Patel[1], Pankaj Kumar Srivastava[1]
[1]NBRI-EIACP Programme Centre, CSIR-National Botanical Research Institute, Lucknow, India
Email: sandhyamanshi@gmail.com

India produces 62 million tonnes of waste per year from various sectors, and out of this, only 70% is collected. Literature surveys have revealed that only 12 million tonnes of these wastes are treated, while 31 million tonnes of waste are being used in landfills. The overall generation of municipal solid waste is estimated to increase to 165 million tonnes by 2030 due to the changing patterns of consumption and rapid growth in the economy. Recognizing the urgent need for behavioural transformation, the Government of India launched Mission LiFE (Lifestyle for Environment) as an eco-centric initiative to integrate sustainability into everyday life and build Pro-Planet people. One of the Mission LiFE themes is "Reduced Waste (Swachha Action)". This theme emphasizes a circular economy, treating waste not as garbage but as a valuable resource to be repurposed and reused. This study follows a qualitative approach to analyze different case studies belonging to 11 action points under the Waste Reduction theme of Mission LiFE. Ten case studies were selected year 2001 to 2004, representing diverse geographical regions and sectors across India, ensuring coverage of urban, rural, institutional, and community-based waste reduction initiatives. Data were collected from Mission LiFE and MoEF&CC reports, and other credible, authentic sources. Under the GOBARdhan initiative, encourage the conversion of organic waste (such as cow dung, agricultural waste) into valuable resources such as biogas, compressed biogas (CBG), and compressed natural gas (CNG) or Bio CNG, which reduces open dumping, decreases methane emissions, and generates clean energy for household use. Indore's biogas plant prevents an estimated 130,000 tonnes of carbon dioxide from entering the atmosphere each year. These types of case studies validate that Mission LiFE's waste reduction actions, when implemented collectively, yield substantial environmental, economic, and social benefits. These outcomes directly contribute to advancing SDG 11 (Sustainable Cities), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action), reinforcing Mission LiFE's vision of transforming individual behaviour into a national movement for environmental sustainability.

T9-A14

Mission LiFE and Sustainable Development Goals: Individual Actions to achieve Environmental Sustainability

Vartika Singh[1*], Anju Patel[1], and Pankaj Kumar Srivastava[1]
[1]NBRI-EIACP-Programme Centre, CSIR- National Botanical Research, Institute, Lucknow, India
Email: vartikasingh378@gmail.com

Mission LiFE (Lifestyle for Environment) is a global movement launched by the Hon'ble Prime Minister of India and first announced in COP26 held at Glasgow (Scotland). The decision for environment LiFE aspires to transform the habit of adopting environmentally friendly persons into 'Pro-Planet People', who would adopt sustainable

lifestyles for the Environment. Adopting a sustainable lifestyle is essential to curb environmental degradation, climate change, natural resource depletion, greenhouse gas emissions and environmental pollution while maintaining ecological balance. The vision for LIFE goes beyond just combating Climate Change and it emphasizes mindful and eco-friendly lifestyle adaptation to promote environmental restoration and the achievement of the Sustainable Development Goals (SDGs). Principles of 7R's Rethink, Refuse, Reduce, Reuse, Repair, Regift, and Recycle and the circular economy are aimed through adoption of Mission LIFE. Mission LiFE progresses through three phases: Change in Demand, encouraging eco-friendly lifestyle choices; Change in Supply, motivating industries to adopt sustainable production in response to shifting consumer behavior; and Change in Policy, driving long-term reforms that support sustainable consumption and production. It was initiated the MOEFCC, GOI in the nodal ministry of Mission LIFE in the country. The mission aligns closely with the UN (SDGs), particularly those focusing on clean energy (SDG 7), clean water and sanitation (SDG 6), responsible consumption and production (SDG 12), climate action (SDG 13), and life on land (SDG 15). The Mission LIFE is structured around 7 thematic areas, each comprising 75 individual actions that encourage mindful consumption, save energy, save water, Say No to Single Use Plastic, Adopt sustainable Food System, Reduce Waste, Adopt Healthy Lifestyle, Reduce E-waste. For example, As of October 2016, the distribution of around 180 million LED lamps across India has led to a daily reduction of 50,000 tonnes of CO_2 emissions. If the projected 4 million AC units sold in a year are all 5-star rated, it could further prevent 800,000 tonnes of CO_2 emissions annually. Maintaining the AC thermostat at 24°C with a ceiling fan optimizes comfort and energy efficiency. Given that a tree absorbs about 10 kg of CO_2 per year, these measures collectively represent the carbon-saving potential of millions of trees, promoting a sustainable and energy-efficient lifestyle. The concept of "Pro Planet People" will drive systemic change at the grassroots level. Thus, Mission LiFE serves as a bridge between policy and practice, demonstrating how collective lifestyle transformation and that of individuals can accelerate achieving of the SDGs and ensuring a resilient, equitable, and sustainable future for all.

T9-A15

Harnessing biomass for carbon sequestration: Bioeconomy's role in achieving SDG 13 (Climate Action)

Anand Kumar[1*]
[1]Allahabad State University, Prayagraj, India
Email: anandkumar@gmail.com

The transition to a low-carbon and resource-efficient economy is central to achieving the United Nations Sustainable Development Goal 13 (Climate Action). The bioeconomy offers a promising pathway by utilizing renewable biological resources to mitigate greenhouse gas emissions and enhance carbon sequestration. Biomass-based systems—ranging from sustainable forestry and crop residue management to bioenergy, biochar production, and biobased materials—serve as vital carbon sinks while simultaneously generating economic and social co-benefits. This study explores the potential of biomass valorization within the circular bioeconomy framework as a climate mitigation strategy. It emphasizes the integration of nature-based solutions with technological innovations such as biorefineries, carbon capture, and soil carbon enhancement through organic amendments. The paper also discusses the life-cycle carbon balance of bio-based products compared to fossil-derived alternatives, highlighting how sustainable biomass utilization contributes to long-term carbon storage in soils, vegetation, and durable goods. A holistic assessment approach is proposed, linking biomass productivity, carbon sequestration potential, and policy interventions to create synergies between environmental sustainability and rural development. By aligning bioeconomic practices with climate targets, countries can not only reduce emissions but also foster

resilience, biodiversity conservation, and inclusive green growth—making the bioeconomy a cornerstone of climate action.

T9-A16

Enhancing turmeric (*Curcuma longa* L.) cultivation through integrated farming approaches in Bihar under CSIR-Aroma Mission

Himanshu Sharma[1]*, Bikarma Singh[2]
[1]CSIR-National Botanical Research Institute, Lucknow 226001, Uttar Pradesh | [2]Academy of Scientific and Innovative Research (AcSIR), New Delhi
Email: drbikarma.singh.nbri@csir.res.in

The present study focuses on enhancing turmeric (*Curcuma longa* L.) cultivation, especially the Kesari variety, through integrated farming approaches in Bihar under different phases of the CSIR-Aroma Mission project. Bihar possesses favorable agro-climatic conditions for turmeric production, yet productivity remains below potential due to fragmented landholdings, poor agronomic practices, and limited access to quality planting material. The integrated farming model promoted under the mission emphasizes crop diversification, efficient resource utilization, and the inclusion of livestock and organic inputs to ensure sustainability and higher income generation. High-yielding and disease-resistant varieties of *Curcuma longa* L. were introduced along with scientific interventions such as improved rhizome selection, organic nutrient management, and post-harvest processing techniques. Turmeric rhizomes were distributed free of cost among the progressive 165 farmers of district Bhojpur, Muzzafarpur and Buxar. Data were collected and analysed for various parameters. It has been observed that the rhizome yield was increased by 8.7% in a farmer's field. Capacity-building programs and field demonstrations were organized to strengthen farmers' technical knowledge and market linkages. The integrated approach not only improved soil fertility and resource use efficiency but also enhanced farm profitability and resilience. Overall, the initiative successfully demonstrated that integrated farming systems, coupled with aromatic crop promotion, can significantly boost rural livelihoods and sustainable turmeric cultivation in Bihar.

T9-A17

Impact of frontline demonstration on french bean variety *Arka Komal* in West Kameng Arunachal Pradesh.

T.S. Mishra[1], Nilesh Mishra[2] and Pem Thinley[3]
[1]KVK West Kameng, Dirang Arunachal Pradesh | [2]Indian Institute of Toxicology Research, Lucknow (CSIR-IITR) | [3]KVK West Kameng, Dirang Arunachal Pradesh
Email: tarashankarmishra2015@gmail.com

French bean (*Phaseolus vulgaris* L.) is the most important leguminous vegetable crop known for its short duration and nutritive values. Its production enhances soil fertility and best suitable for intercropping. The efforts have been made to conduct front line demonstrations and dissemination of pertinent knowledge to French bean growers about improved technologies (Arka Komal). The present study ascertains impact of frontline demonstration conducted by Krishi Vigyana Kendra (KVK), West Kameng of Arunachal Pradesh on french bean variety Arka Komal. It is a photoinsensitive, stringless high yielding variety suitable for irrigated conditions. Total of 15 demonstrations were conducted in 15 farmers field in an area of 3.0 ha during 2023-24 to 2024-25. The results indicated that marked difference between Arka Komal and local variety being adopted by farming community. Arka Komal comes to harvest earlier than local variety. The duration to first harvest incase of Arka Komal 50-55 days after sowing while it was 60 days in case of local variety. In terms of number of harvests, it is more in case of Arka Komal (7) compared to control (5). The time interval between successive harvests is 8 days in case of Arka Komal and 10 days in case of local variety. In terms of pod weight, farmers expressed that pod weight is 36 percent higher in case of Arka Komal compared to local variety. The profitability in terms of B:C ratio was 3.0 in case of Arka Komal as compared to 1.6 in case

of local. The significant achievement of frontline demonstration is the magnitude of technology dissemination which is to the Quintal of 175 ha in 2023-24 and180 ha in 2024-25. It could be further observed that about 35 sample farmers have adopted this technology during 2023-24 and 80 during 2024-25.

T9-A18

Comparative Phytochemical Profiling and Bioactivity Evaluation of *Lantana camara* Leaf and Flower Essential Oils: In Vitro and In Silico Insights

Shiwa Chaubey[1,2,3], Nisheeth Rastogi[2], Manjoosha Srivastava[1]*

[1]Phytochemistry Division, CSIR-National Botanical Research Institute, Lucknow 226001, Uttar Pradesh, India
[2]Department of Chemistry, Dr. W. E. Bauer Research Laboratory, Lucknow Christian Degree College, Lucknow 226018, Uttar Pradesh, India
[3]Department of Chemistry, University of Lucknow, 226007, Uttar Pradesh, India
Email: m.srivastava.nbri@csir.res.in

Lantana camara essential oils (EOs) have long been used in traditional medicine, yet their organ-specific composition and multifunctional pharmacological potential remain underexplored. Most prior studies examined individual activities in isolation without integrated in-vitro and in-silico correlation. Furthermore, the antidiabetic potential of *L. camara* flower oil through α-amylase and α-glucosidase inhibition had not been previously reported. It was hypothesized that variations in chemical composition between leaf and flower EOs of *L. camara* could significantly influence their antioxidant, antidiabetic, and antimicrobial activities. This study aimed to (i) characterize and compare the phytochemical composition of the oils, (ii) assess their multifunctional bioactivities, and (iii) validate these findings using molecular docking, ADMET, and GUSAR toxicity predictions.Essential oils were extracted from leaves (LL) and flowers (LF) via hydrodistillation and analyzed by GC–MS. Biological activities were evaluated using antioxidant (DPPH, ABTS, hydroxyl, nitric oxide, Fe^{2+}-chelating), antidiabetic (α-amylase and α-glucosidase inhibition), and antimicrobial assays (agar well diffusion and MIC). Computational studies using AutoDock Vina, SwissADME, and GUSAR software predicted enzyme binding affinities, pharmacokinetic behavior, and toxicity profiles. GC–MS analysis revealed 45 constituents in LL and 40 in LF oils, with β-caryophyllene as the major compound (14.19% and 15.84%). LL oil showed stronger antioxidant capacity (DPPH IC_{50} = 32.07 µg/mL), higher enzyme inhibition (α-amylase IC_{50} = 13.73 µg/mL; α-glucosidase IC_{50} = 22.90 µg/mL), and broader antimicrobial efficacy, particularly against *Staphylococcus aureus* (MIC = 0.5 mg/mL). Docking and ADMET analyses identified nerolidol and 11-tetramethyl bicyclo[8.1.0]undeca-2,6-diene as potent, low-toxicity enzyme inhibitors, supporting their potential as safe therapeutic agents. This study establishes *L. camara* leaf oil as a superior bioactive source with strong antioxidant, antidiabetic, and antimicrobial potential. Integrating in-vitro and in-silico evaluations underscores its value for developing eco-friendly phytopharmaceuticals. Valorization of *L. camara*—a widely available invasive species—within the bioeconomy framework supports Sustainable Development Goals (SDGs) by promoting biodiversity utilization, green innovation, and sustainable healthcare solutions.

T9-A19

Skill development and promotion of mushroom consumption in certain villages of Gujarat

Anil Satpathy[1] and S.N. Tyagi[1], Arun Arya[2]*
[1]Rista Foundation, C8 Navyug Society, Vadodara, India |
[2]Department of Botany, MS University Vadodara
Email: aryaarunarya@rediffmail.com

Mushrooms are foods that have been commonly consumed since the earliest history; ancient Greeks believed that mushrooms were a source of strength for warriors in battle; the Romans regarded mushrooms as the “Food of

the Gods" and served them only on festive occasions. For centuries, the Chinese culture has treasured mushrooms as a health food, an "elixir of life". In India, consumption of *Agaricus bisporus* (button) is more than *Pleurotus sajor-caju* (oyster). But considering the availability of agro-substrate and climatically, it is easy to cultivate the oyster mushroom for most part of the year. The vitamin C content of *Pleurotus* species ranged from 51.3 to 70.3 mg per 100 g with a mean value of 61.4 mg per 100g on a dry weight basis. It is estimated that in nature, there are approximately 700 species of mushrooms exhibiting therapeutic properties. The popular medicinal mushrooms include species like, *Lentinus edodes*—shiitake, *Hericium erinaceus* (Lion's Mane Mushroom), *Pholiota nameko* (Nameko), *Gandoderma lucidum* (Lingzhi or Reishi Mushroom), *Cordyceps sinensis*, *Auricularia auricula* (Wood ear), and *Coriolus versicolor* (Turkey tail) etc. Mushrooms are originally defined as achlorophyllous macrofungi with a distinctive fruiting body, which is large enough to be seen with the naked eye and picked by hand. The enzymes present enable them to degrade complex organic matter into soluble substances i.e., stubbles, plant waste, which can be absorbed for nutrition, and proteinaceous fruiting bodies are produced. An effort was made to provide skill of mushroom cultivation to the villagers of Ghoghamba in Panchmahal and of Chota Udaipur in Gujarat. Oyster mushroom spawn was provided to them, and cultivation techniques were demonstrated. This effort was found useful to reduce the bulk of paddy straw waste in the villages, and consumption of mushrooms was found to substitute the nutrition in the rural population. The paper will highlight the results of efforts made by villagers, and this can be a role model for other districts as well, where ladies can be taught to cultivate the mushroom for their consumption or as their additional source of income. Efforts were also made to increase the yield by the addition of wheat and gram flour along with paddy straw.

T9-A20

Repurposing of industrial wastes for meeting the challenges of soil degradation and achieving sustainable development goals

Ananya Singh[1], Shekhar Mallick[1*]
[1]School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, India
Email: shekharm@mail.jnu.ac.in

India, as one of the fastest-developing economies, faces the dual challenge of achieving sustainable growth while maintaining environmental integrity. Rapid industrialization and intensive agricultural practices have significantly altered several environmental parameters, particularly soil quality. According to NAAS-ICAR (2021), nearly 37% of India's land area is affected by various forms of soil degradation. Soil, being an important environmental resource, is increasingly being degraded due to an increase in salinity, sodicity, depletion of micronutrients, desertification and contamination from unregulated industrial waste disposal as well as intensive agricultural practices. On an average, 36.5% of Indian soils are currently deficient in available Zn as compared to 12.8%, 4.2%, 7.1% and 23.4% deficiency in case of Fe, Cu, Mn, and B, respectively, severely affecting crop productivity. India annually generates 62 million tonnes of waste, which includes 7.9 million tonnes of hazardous waste, 1.5 million tonnes of e-waste. As per statistics by CPCB, annual waste generation in India will increase to 165 million tonnes by 2030. Industrial wastes containing multiple compounds/elements can be repurposed to offer a solution to restore soil health while advancing the circular economy, waste management and sustainable development goals (SDGs). Waste emanating from paper and pulp industries can help mitigate soil sodicity by improving organic matter content. Electroplating and galvanizing wastes rich in

Fe and Zn can enhance micronutrient availability in deficient soils, while red mud from alumina refining, rich in Fe and Al metal oxides, may be used to treat heavy metal contamination in soils by stabilizing metals through adsorption and precipitation. Similarly, fly ash from thermal power plants, steel slag and ground granulated blast furnace slag from steel production and manufacturing industries, respectively prove as a potential soil amendment/s as they may increase the pH of acidic soils, improves water-holding capacity, enhance soil strength and stability and is rich in nutrients such as P, Fe, K, Mg, Mn, Zn, Si, S.
With a prior toxicological assessment of these wastes, they can prove to be an asset for soil amendment in combination with other agri-residues. Sush approach has the potential to i) reduce the burden of waste management while on the other hand ii) enhance soil fertility, nutrient repletion, and promote overall soil health management. Repurposing of these industrial wastes directly contributes to SDG 3 (Good health and Well-being) and SDG 12 (Responsible Consumption and Production).

T9-A21

Intelligent Agriculture for a Progressive Agricultural Future

Ravin Singh[1*], Dr. Puneet Singh Chauhan[2*]
CSIR-National Botanical Research Institute, Lucknow
Email: raghavrajpoot247@gmail.com

The domestication of animals and the cultivation of plants by implementing organized farming techniques, along with the green revolution was triggered by the creation of chemical fertilizers and the launch of hybrid varieties several decades ago, represent only a handful of the transformations that have taken place in farming. We are currently in the stage of the agriculture revolution 4.0. Prompted by the rapid rise in ICT utilization within agriculture. Intelligent agriculture utilizing ICT technologies. May present potential solutions to the issues encountered in the agricultural sector, such as resource scarcity and climate. Alteration, etc. The aim of this study was to assess the output and nutrient needs (NPK) for growing sweet potato (Ipomoea batatas) under smart agriculture and farmer practices as a test field in a farmer's land at Nedumangad division of Thiruvananthapuram district. Within smart farming approaches, the agricultural guidance for growing the farmers received crop updates via SMS every ten days. The advisory was created based on the sector's contemporary weather conditions, growth phase of crops, and preliminary soil assessment. Results showed that smart farming areas documented increased production with reduced nutrient input. This technology can be duplicated in any crop, including rice.

T9-A22

Heavy Metal Transfer from Maternal Sources to Infants via Breastmilk: Current Status and Preventative Strategies

Meghna Jaiswal[1] Rajveer Singh Chauhan[1] and Sudhakar Srivastava[2]
[1]Department of Botany, Deen Dayal Upadhyaya Goralhpur University, Gorakhpur -273009, Uttar Pradesh India
[2]Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi -221005, Uttar Pradesh, India
Email: sudhakar.iesd@bhu.ac.in, chauhanrajveersingh@gmail.com

Human populations are constantly at high risk from the ubiquitous presence of hazardous metals and metalloids in the environment, such as arsenic, cadmium, chromium, lead, and mercury. The transfer of these metal(loid)s through breast milk has become a crucial issue for public health investigation among many other exposure routes. According to recent research, breast milk can unintentionally serve as a conduit for the spread of metal(loid)s during critical early developmental stages, even though it is an indispensable source of nutrition and immune protection for infants.
This review proposes that the neurodevelopmental and metabolic traits of babies are adversely impacted by significantly increased burden of metal(loid)s in breast milk especially in regions with elevated environmental pollution. The proportion of these elements in breast milk is greatly

influenced by maternal factors, including dietary habits, exposure to contaminated water, and residential proximity to industrial facilities, according to data from recent epidemiological and biomonitoring studies. Results from recent meta-analyses suggest that newborns in areas with ongoing industrial emissions had greater levels of exposure to lead and arsenic, which are linked to higher chances of growth retardation and cognitive impairment. The study conducted highlights the critical need for region-specific surveillance systems and focused mitigation methods. Though the numerous benefits of nursing typically outweigh the possible hazards brought about by pollutant exposure. Findings suggest that systematic breast milk screening, environmental remediation, and nutritional treatments could significantly lower baby exposure to dangerous metals (loids). Collaborative research projects and policy initiatives aimed at safeguarding the health of mothers and children in vulnerable groups are necessary for progress in this field.

T9-A23

Biomolecular function of micro-nutrients and crops production: Management strategies under climatic changes

S.N. Pandey[1*]
[1]Department of Botany, University of Lucknow, Lucknow-226007
Email: snpandey511@gmail.com

Under the changing climate global food security through sustainable crops production is a big challenge. Climatic stresses such as increasing temperature, drought, excess salts and essential nutrients deficiency in the soil, low/ high precipitation etc. are major causes to decline crop production. To maintain the external and internal harmony of plants, tolerance adaptation against climatic stresses must be increased via regulation of biomolecular functions for metabolism, and strengthening cellular defense system against stresses. A key strategy to achieve the sustainable crops production goal is the management of micronutrients (Zn, Cu, Mn, Fe, Mo, B etc,) in soil-plant system. Micronutrients required in very low amount, but play essential role in enzymatic and non-enzymatic defense mechanism, reproductive production, as being constituent of organic structures, behave as electron carriers, osmoregulatory functions, involved in biosynthetic pathway of plant growth hormone, interactive role with signaling molecules (hormone like ethylene and cytokinin, nitric oxide and other reactive oxygen species) for their homeostasis. Homeostasis of micronutrients at cellular, tissue and organ levels is mainly regulated by efflux and influx processes recognized by transcription factors. Various genes regulated in response to micronutrients deficiency signaling to homeostasis in plants. Abiotic stresses conditions are increasing day by day due to climate change greatly influence the molecular and physiological functions of plants. In addition to this, soil factors also affect the micronutrients availability to plants, thus make severe abnormality of micronutrients in plants. The evaluation of climatic stresses, soil-plant factors, and micronutrients status are the main tools to follow the management strategies of micronutrients.

Theme 10:

Ethnobotany and plants for food and nutritional security

T10-A1

Restoration of productivity of salt affected agro-ecosystems using novel microbial technology: a lab to land approach for food security

Naveen Kumar Arora[1*]
[1]Department of Environmental Science, School of Earth and Environmental Sciences Babasaheb Bhimrao Ambedkar University, Lucknow, India
Email: nkarora.bbau@gmail.com

Soil salinity poses a severe threat to soil productivity and global food security. Soil restoration can be achieved by several methods; however, salt-tolerant plant growth-promoting microbescan play a crucial role in a sustainable manner. Soil microbes can combat salinity stress by producing exopolysaccharides that bind sodium ions, reducing their uptake by plants. Salt-tolerant beneficial soil microbes produce osmoprotectants and antioxidant enzymes, enhancing plant tolerance. Soil microbes, particularly the plant growth promoting rhizobacteria restore soil health by fixing atmospheric nitrogen, solubilizing insoluble phosphates, and producing siderophores, thereby improving nutrient availability and soil fertility. These microbes help in improving organic matter, soil carbon and improved soil structure, leading to the sustainable restoration of saline ecosystems for productive agriculture. While microbial inoculation presents a promising bioremediation strategy, the transition from laboratory to field-level efficacy is a big hurdle. We developed a consortia-based bioinoculant using selected HT-PGPR due to their synergistic plant growth-promoting traits, including exopolysaccharide production, nitrogen fixation, and phosphorus solubilization. The composite microbial inoculant was optimized with different carriers to enhance its shelf-life and soil survivability. A rigorous field-evaluation was conducted over two growing seasons in a severely saline-degraded agricultural plot. The inoculant facilitated improved nutrient uptake and osmotic stress tolerance in plants and resulted in improved productivity of both *rabi* and *kharif* crops. The novel microbial inoculants proved to be a sustainable technology for restoring productivity of saline-degraded lands, offering a sustainable pathway towards agricultural resilience and food security.

T10-A2

Phytochemical profiling of *Cucumis callosus* fruit residues for sustainable valorization and potential nutraceutical applications

Shelly Chauhan[1*], **Jitendra Panwar**[1], **Pankaj Kumar Sharma**[1]
[1]Department of Biological Sciences, Birla Institute of Technology and Science (BITS), Pilani Campus, Pilani, (Rajasthan) 333031, India
Email: p20230003@pilani.bits-pilani.ac.in

Cucumis callosus (kachri) is a drought-tolerant cucurbit from the arid regions of Rajasthan. Its peels and seeds, though often thrown away as waste, contain valuable phytochemicals like phenolics and flavonoids. Exploring these waste parts not only provides a sustainable approach to resource utilization but also supports the circular bioeconomy and the goals of SDG 12 (Responsible Consumption and Production). Valorization of *C. callosus* residues thus aids in reducing greenhouse gas release while promoting a sustainable bioeconomy by converting agri-waste into valuable nutraceuticals, generating farmer income, reducing reliance on synthetic products, and ensuring a low-carbon footprint and circular resource use. The objectives of the study are: (i) to evaluate TPC, TFC, and DPPH of all parts (seed, peel, pulp) of desert cucurbit(s) processed at different temperatures, and (ii) to purify and characterize bioactive polyphenols from selected fruit parts. The study demonstrated that tender peels, seeds, and pulp of *Cucumis callosus* consistently exhibited the highest TPC, TFC, and antioxidant activity (lowest EC_{50}) across all drying methods, while old tissues showed the lowest values. Controlled drying at 35 °C preserved phenolics and flavonoids most effectively, whereas higher temperatures (40–45 °C) and sun-drying caused significant losses. Shade-drying moderately retained

bioactives. Peels were the richest source of phenolics and flavonoids, followed by seeds and pulp. Overall, immature tissues and low-temperature drying optimally conserve antioxidant compounds, highlighting tender peels as the most potent source for nutraceutical applications and agri-waste valorization. Industrially, these findings provide a sustainable approach for converting underutilized desert crop residues into nutraceuticals, functional foods, and natural antioxidant formulations, supporting waste valorization, enhancing product quality, and promoting health benefits. Optimized postharvest handling and processing can thus unlock the full commercial and therapeutic potential of *C. callosus*.

T10-A3

From Wild to Plate: Exploring Wild and Lesser Utilized Plants for Nutritional Security and Dietary Diversification in Central India

Amit Kumar Bundela[1], P.C. Abhilash[1]
[1]Institute of Environment & Sustainable Development, Banaras Hindu University, Varanasi 221005, India
E-mail: amitbundela@bhu.ac.in

Wild edible plants can contribute significantly towards food and nutritional security, agrobiodiversity conservation, and enhance the overall ecosystem resilience and services. Despite their varied role, the knowledge pertaining to their utilization, use frequency, and cultural relevance remains understudied. Therefore, the present study employs a spatio-temporal data collection method using a structured questionnaire for personal interviews, focus group discussions, along with free listing and field observations supplemented through a referral method. The current study was conducted in different seasons between 2022-2024 in the districts of Chhattisgarh and Madhya Pradesh, Central India. The study was conducted in 4 districts, each from Chhattisgarh and Madhya Pradesh, Central India, wherein we recorded over 140 wild and lesser-utilized plants (WLP) edible species. The study revealed that people used these local edibles with positive perception, with varying frequency and patterns. The rapid market assessment with the triangulation method revealed the presence of a local value chain for various species with decent market value. Our study ranked land use change primarily driven by agricultural expansion, along with the declining knowledge on the use of these species as a threat to their declining diversity. The cultivation of these species in small settings i.e., home garden/backyard garden, was reported as a sustainable strategy for their conservation. These species serve as a local solution for food and nutritional security and securing livelihood security for the locals of the region. The sustainable utilization of these locally available wild and lesser utilized edible plants advances the attainment of various global biodiversity and sustainable goals i.e., United Nations - Sustainable Development Goals, Kunming-Montreal Global Biodiversity Framework. Therefore, utilization and conservation measures of WLPs need to be prioritized, supported by research and development with suitable policy interventions.

T10-A4

Enrichment and purification of ω-fatty acids from Ocimum seed oil for use as a nutraceutical to ailment chronic disorders

Naziya Syed[1]*, Abhishek Kumar Yadav[1], Prasant Kumar Rout[1], Sarita[2], Kavita Singh[2], Dnyaneshwar U. Bawankule[2], Debabrata Chanda[2]
[1]Phytochemistry Division, CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow, India | [2]Bio-prospection and Product Division, CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow, India
Email: nazia1794syed@gmail.com

The medicinal plant *Ocimum basilicum* is widely adopted for the extraction of essential oil. *CIM-Soumya* is one of the improved *O. basilicum* varieties, and this crop can produce about 500 kg of seeds per hectare. The ocimum, a non-explored seed contains fatty acids (ω -6-fatty acid: 24.8%, and 3-fatty acid: 51.4%). It was composed of saturated fatty

acids (SFA: 12.0%), monounsaturated fatty acids (MUFA: 10.7%) and polyunsaturated fatty acids (PUFA: 76.2%). The process has been optimized for the production of free fatty acids (FFAs) from Ocimum oil using aqueous-alkali solution at a temperature (80 ^{o}C), agitation (200 rpm), time (4 h), and aqueous alkali-FFAs ratio (5:1) with 94.2% of total FFAs yield. The SFA was almost separated from unsaturated fatty acids (UFAs) through a complexation process at optimized conditions, such as FFAs: ethanol ratio (1:10), crystallization temperature (10 ^{o}C), crystallization time (120 min), reflux temperature (80 ^{o}C), and reflux time (60 min) with a yield of 78.2%. The enriched UFAs were composed of -6-fatty acid (27.8%) and -3-fatty acid (61.5%). The UFAs displayed better glucose uptake (166.6 g/dl) and insulin resistance reversal potential (IRRP: 68.6%) at 10 g/mL concentration. Also, UFAs have been displayed vasorelaxation (72.4%) and antihypertensive activity as compared to the endogenous vasorelaxant acetylcholine (92.2%). This enrich UFA from Ocimum fatty oil will be promoted as a super food with ameliorating glycaemic and hypertension ailments.

T10-A5

Dried *Aloe* flower tea: Traditional uses and modern phytochemical validation

Sudesh Kumar Banyal[1], Shweta Singh[1], Suresh Kumar Sharma[1], Devendra Singh[1], Lal Bahadur[1*]

[1]Division of Plant Conservation and Agrotechnology, CSIR-National Botanical Research Institute, Lucknow, 226001, India

Email: lb.yadav.nbri@csir.res.in

Aloe species have long been established for their therapeutic and medicinal qualities, especially *Aloe vera* (L) Burm. F. *Aloe* gel and leaves have received a lot of attention, but dried *Aloe* flowers are becoming a new source for herbal infusion in the form of *Aloe* flower tea. This tea is made by steeping dried *Aloe* flowers in hot water, sometimes mixed with aromatic spices. It is mostly consumed in wellness and herbal groups around the world. The tea is regarded as a calming drink with numerous health advantages because it contains no caffeine. This infusion has long been used for its digestive properties, such as intestinal cleansing and easing stomach pain including constipation and acidity. Additionally, it is thought to have anti-inflammatory and immunomodulatory qualities that help with joint problems and internal inflammation. The tea has gained popularity among consumers looking for natural and holistic health cures because to its calming, mellow flavor and antioxidant qualities. *Aloe* flowers include important bioactive chemicals, such as phenolic acids (like chlorogenic and caffeic acids), flavonoids (like quercetin and luteolin), anthraquinones (like aloe emodin), tannins, and other antioxidants, according to recent phytochemical studies. Many of the traditional medicinal claims linked with the tea are supported by these chemicals' well-known antioxidant, antibacterial, and anti-inflammatory properties. Research indicates that tissues exposed to *Aloe* flower extracts have increased levels of antioxidant enzymes such as glutathione peroxidase, catalase, and superoxide dismutase, indicating protective activities at the cellular level. The growing pharmacological and phytochemical evidence provides a promising basis for more focused research, even if there are still few clinical trials specifically for infusion. Thus, the infusion presents itself as a wonderful natural herbal infusion that combines ancient knowledge with modern scientific validation, meriting additional investigation for its possible uses in wellness and health.

T10-A6

Plants for feeding the future: The role of neglected and underutilized plants in local food security in Eastern U.P.,

Ajeet Singh[1], Amit Kumar Bundela[1], and P.C. Abhilash[1*]

[1]Institute of Environment & Sustainable Development, Banaras Hindu University, Varanasi 221005, India

Email: pca.iesd@bhu.ac.in

The global food system faces a significant challenge due to its heavy reliance on a limited number of staple crops, highlighting the need for diversification to ensure regional and global food security as well as to meet various environmental goals. Neglected and underutilized species (NUS) are seen as future, climate-smart crops because of their nutraceutical and adaptability traits, yet their widespread use is limited by a lack of knowledge about how to utilize them. Therefore, this study aims to document traditional knowledge related to the use, seasonal availability, economic aspects, and general perceptions of NUS in Mirzapur and Sonebhadra districts of eastern Uttar Pradesh. The reported NUS were assessed based on parameters such as use category, mode of consumption, and frequency of use, and a food calendar was created for the region. The food availability calendar shows that some species, mainly leafy vegetables, are used throughout the year, while others are season-specific. Interactions with respondents revealed a generally positive attitude toward NUS, due to their cultural, ethnomedicinal, nutritional, and economic importance. Therefore, innovative strategies are essential to increase the production and usage of nutritionally and culturally significant plant species at the local level, to achieve food and nutritional security.

T10-A7

Gamma irradiation–driven improvement in Kalanamak rice (*Oryza sativa* L.): Agronomic advances across M_1–M_3 and comprehensive grain quality profiling in M_3 generation

Tanmai Mishra[1*], Rajveer Singh Chauhan[1]
[1]Department of Botany, Deen Dayal Upadhayaya, Gorakhpur University, Gorakhpur-273009, (U.P), India
Email: tanmay21mishra@gmail.com

Kalanamak rice is an intermediate grain size aromatic rice traditionally cultivated in the eastern part of Uttar Pradesh, particularly in Siddharthnagar and neighbouring districts, prized for its distinctive aroma and cultural heritage. It's tall stature, susceptibility to lodging, and long maturity duration have reduced its large-scale cultivation. To improve plant architecture without compromising grain quality, seeds were treated with 150 Gy gamma irradiation and evaluated from M_1 to M_3 generations under field conditions. The M_1 population showed typical chimeric responses, including reduced height, narrower leaves, increased tillering, and denser panicles, but with lower grain filling and reduced thousand-grain weight. In the M_2 generation, plants shifted toward a predominantly semi-dwarf phenotype (mean ≈116.6 cm) and displayed considerable variation for productive tillers, spikelets, and secondary branches, while seed weight remained stable. ANOVA confirmed significant genotypic variation for most traits, and heritability with genetic advance was moderate for key yield components. Ward-linkage clustering separated the population into three groups, with Cluster 1 exhibiting superior tiller production, panicle length, and branching, making it the most promising for advancement. By M_3, plant height stabilized at a semi-dwarf stature (≈122.9 cm compared to 179.1 cm in the control), with significantly higher tiller number, improved grain filling, and unchanged thousand-grain weight, indicating enhanced source–sink balance. Biochemical analysis revealed stable protein levels, higher total carbohydrates in dwarfs, and amylose content in semi-dwarfs comparable to the control. Overall, gamma irradiation effectively generated semi-dwarf Kalanamak mutants with improved agronomic traits while preserving essential grain quality across M_1–M_3 generations.

T10-A8

Ethnobotanical potential of pteridophytes through the lens of tribal communities of eastern Madhya Pradesh.

Sandhya Barfal[1], Ajit Pratap Singh[1]
[1]Pteridology Laboratory, CSIR-National Botanical Research Institute, Lucknow-U.P., India, Email: ajitpsingh2000@gmail.com

Ethnobotany of pteridophytes emphasise uses of these plants for materialistic and spiritual purposes by aboriginal people. Pteridophytes

used practices for medicine and food stuff are prevalent across the subtropical to tropical region of the world, where ethnic practices and tribal communities prevail. Madhya Pradesh in India is known with richest tribal communities, and diverse plant use practices. The eastern Madhya Pradesh region is one of the main dwelling areas for Bhaiga, Kol, Gond, Bhil, Korku, Panika, Agaria, Bhariya tribal communities, and their diverse and unveiled plant use practices. Present study aims to document the pteridophytes, plant use practices of tribal communities, purpose of uses, parts of plant used, process of preparation of the useful materials, application and use practices, and the associated traditional knowledge of the aboriginal people of the eastern Madhya Pradesh. The study also aims to discourse potentials of pteridophyte in health, food, and other sectors to open an opportunity to develop strategies for discovery of new medicinal and nutritional compounds. We have surveyed the study area, made interaction with the local communities, collected information on pteridophyte use practices, and also gathered additional information on ethnobotany. We found that the *Adiantum philippense* L. is used for treatment of asthma, bronchitis, dysentery, epilepsy, and ulcer, whereas, *Cheilanthes farrinosa* (Forssk.) Kaulf. and *C. tenuifolia* (Burm. *f.*) Sw. is used for wound healing, and in witchcraft practices by the Bhaiga and Gond tribes. Tribal communities use *Cyathea gigantea* (Wall. *ex* Hook.) Holtt. for treatment of epilepsy and migraine, *Dryopteris cochleata* (D. Don.) C. Chr. for blood purification, *Equisetum debile* Roxb. *ex* Vaucher for fractured bone, *Lygodium flexuosum* (L.) Sw. for rheumatism, and *Selaginella bryopteris* (L.) Baker for heat stroke. The *Ophiglossum reticulatum* L.*, Diplazium esculentum* (Retz.) Sw.*,* and *Adiantum capillus-veneris* L. is used as delicious food stuff. We provide herewith ethnobotanical information on about 42 species of pteridophytes belonging to 25 genera under 20 families encompassing their purposes of use, parts of plant used, process of preparation of the decoction or poultice, application and use practices, and the associated traditional knowledge on pteridophytes.

T10-A9

Differential physiological and nutritional responses of Proso-millet varieties to future climate change

Richa Rai[1*], Binay Kumar Mahato[1]
[1]CSIR-National Botanical Research Institute, Lucknow
Email: bivhaykumar620@gmail.com

Climate change is one of the most pressing global challenges, altering ecosystems and agricultural productivity worldwide. The rising levels of CO_2, O_3, and temperature significantly influence plant growth, physiology, and yield. This study explored differential response of two varieties of Proso millet (*Panicum miliaceum* L.) TNAU 145 and TNAU 202 exposed to future climate change conditions in elevated carbon dioxide (550 ppm), ozone (ambient +20 ppb), and temperature (ambient +2°C), individually and in combination in Free Air Concentration Enrichment (FACE) and Free Air Temperature Enrichment (FATE). From germination to maturity, the plants were grown under these controlled conditions to evaluate their physiological performance, biochemical responses, yield and nutritional quality of Proso-millet varieties. Significant varietal differences were observed across treatments. TNAU 202 showed stronger resilience, marked by higher proline levels and more efficient use of ascorbic acid to neutralize oxidative stress, even under higher membrane damage. In contrast, TNAU 145 experienced lower lipid peroxidation and stronger antioxidant responses but suffered greater yield losses. Elevated CO_2 promoted biomass production, while the combined stress of increased CO_2, O_3, and temperature led to declines in photosynthesis and grain yield. Elevated ozone caused the most membrane damage, whereas higher temperature enhanced photosynthesis and water use efficiency. Variation in the nutritional quality of Proso-millet was also observed. Overall, TNAU 202 demonstrated better adaptability and tolerance to changing

climate conditions. This pioneering research provides critical insights into response of C_4 crops like Proso-millet adjust to future climate change scenario. The findings contribute to climate-smart agricultural strategies by identify climate-resilient varieties that support food security in the face of global climate change.

T10-A10

Theme: Ethnobotany and Plants for food and nutritional security Ethnobotanical and Nutritional Evaluation of *Madhuca longifolia* (Mahua) Seed Oil

Swati Srivastava[1], Priyanka Agnihotri[2], Sanjeeva Nayaka[2] and Manjoosha Srivastava[1*]
[1]Phytochemistry Division, CSIR-National Botanical Research Institute, Lucknow 226001, Uttar Pradesh, India
[2] Plant Diversity, Systematics and Herbarium (PDSH) CSIR-National Botanical Research Institute, Lucknow 226001, Uttar Pradesh, India
Email: m.srivastava.nbri@csir.res.in

Madhuca longifolia (Mahua) is an ethnobotanically important tree of the Sapotaceae family, widely valued for its nutrient-rich seed oil and multifaceted traditional applications in India. Present study focuses on the extraction, characterization, and nutritional profiling of *M. longifolia* seed oil to explore its potential as a sustainable edible and industrial resource. Oil was extracted from seed accesions using cold and hot extraction methods with oil yield ranged from ~ 1% - 35%. Physiochemical parameters of oil was also evaluated. Major fatty acids such as oleic (10 -34%), stearic (25–42%), palmitic (11–40%), and linoleic acids (6–12%) was identified by GC-MS profiling, indicating high nutritional and energy value. Oil also exhibited notable antioxidant potential due to the presence of tocopherols and phytosterols. Ethnobotanical surveys revealed its traditional use in food preparation, skincare, and medicinal formulations, as well as in soap and biodiesel production. The findings highlight *M. longifolia* seed oil as a versatile and sustainable natural resource that contributes to food and nutritional security, rural livelihood enhancement, and bioeconomic development.

T10-A11

Stress-Responsive Insights into Root-Tuberization of Winged Bean (*Psophocarpus tetragonolobus* (L.) DC.)

Chandra Sekhar Mohanty[1*]
[1]Plant Genetic Resources and Improvement division, CSIR-National Botanical Research Institute, Lucknow, India
Email: cs.mohanty.nbri@csir.res.in

Psophocarpus tetragonolobus (L.) DC. is a climate-resilient, underutilized legume with high nutritional value with edible root-tubers. Despite of its potential as a sustainable food source, the molecular and biochemical mechanisms governing its root-tuberization process remain poorly understood. This limits its agronomic improvement and broader adoption. We hypothesize that root-tuberization in *P. tetragonolobus* is regulated by calcium-mediated signaling pathway and stress-responsive proteins, supported by a rich repertoire of bioactive metabolites. Integrative approaches of transcriptomic, proteomic and metabolomic were followed to elucidate the regulatory networks and functional compounds associated with tuber development and stress adaptation. Transcriptome sequencing of root and tuber tissues was performed using Illumina NovaSeq, followed by *de novo* assembly and differential gene expression analysis. Eight calcium/calmodulin-dependent protein kinase (CaMK) transcripts were validated via qRT-PCR. Proteomic profiling was conducted by using LC-MS/MS and metabolite analysis via GC-MS. Antioxidant and antimicrobial assays of root-tuber were carried out using DPPH, β-carotene bleaching and biofilm inhibition activities. Molecular docking was used to predict protein-ligand interactions. CaMK1 and CaMK5 showed >5 log fold upregulation in tuber tissues, indicating their role in tuber induction. Gene ontology and Kyoto Encyclopedia of Genes and Genomes (KEGG) pathway analysis revealed enrichment in calcium signaling, hormone transduction and carbohydrate metabolism. During comparative proteome analysis total of 2,678 proteins were identified; small heat shock proteins (sHsps) constituted 13%, with Hsp91 and sHsp

transcripts showed higher expression rate under drought stress. These proteins might be helpful in maintaining cellular homeostasis and enhancing stress tolerance. 120 metabolites were detected, including dimethylamine, cyclopropylamine and hydroxylamine hydrochloride—compounds known for stress amelioration. Essential minerals such as iron, zinc and copper were also abundant, contributing to antioxidant potential. High phenolic (456.58 µg GAE/mg) and flavonoid (586.27 µg QE/mg) content was observed; quercetin was the most abundant compound. HPLC confirmed the presence of gallic acid, catechin, epicatechin and rutin, supporting strong antioxidant activity.

T10-A12

Assessment of Lesser Explored Plant Composition and Local Medicinal Practices of Bhallesa Hills and Valleys of Pir Panjal Mountain of the Himalaya Biodiversity Hotspot"

Opender Surmal[1,2] and Bikarma Singh[1,3*]
[1]Academy of Scientific & Innovative Research (AcSIR), Ghaziabad 201002, Uttar Pradesh, India.
CSIR-Indian Institute of Integrative Medicine, Canal Road, Jammu, Jammu & Kashmir, India
[2]Botanical Garden, Plant Conservation and Agrotechnology Division, CSIR-National Botanical Research Institute, Lucknow 226001, Uttar Pradesh, India.
Email: drbikarma.singh.nbri@csir.res.in

The vegetation composition of Himalaya is renowned worldwide for its exceptional biodiversity and ecological significance. Bhallesa hills and valleys of the Pir Panjal mountain range in Jammu and Kashmir is a relatively unexplored zone characterized by diverse altitudes and climatic variations. To explore its floristic diversity and traditional ethnomedicinal practices, the systematic field surveys were conducted between 2017 and 2022 across various seasons. The collected plant specimens were identified through standard national and regional floras, authenticated using herbarium reference vouchers deposited at RRLH Jammu, and analyzed for their ecological and cultural significance. The result indicated 473 plant species belonging to 306 genera and 84 families. Family Poaceae, Asteraceae and Lamiaceae recorded as as the most dominant representatives of Pir Panjal mountain range. Twenty-seven families were represented as monotypic, while *Impatiens*, *Nepeta* and *Potentilla* emerged as the most species-rich genera of the study area. Cross-cultural analysis revealed 161 species as the local plants having wide application in traditional system of medicine for treating different ailments. Outcome of the study also indicated a total of 67 ailments categorized into 16 disease groups resulted from 2,427 therapeutic use reports. Based on ICPC-II disease classifications, 83 species were recorded as the highest category utilized for skin problems and gastro-intestinal treatment. But in recent past, several high-value medicinal plants are declining due to overharvesting and illicit trade. These findings underscore the urgent need for sustainable conservation measures and effective management strategies to safeguard Bhallesa's unique floristic and ethnobotanical heritage.

Theme 11:

Floriculture under changing climate

T11-A1

Flori-apiculture model: A catalyst for rural empowerment and sustainable livelihoods

Sushree Sunandita Patel[1*], Sandip Kumar Behera[1], Khuraijam Jiban Kumar Singh[1], Chandra Sekhar Mohanty[1], Soumit Kumar Behera[1], Abhilash Padhan[2]

[1]CSIR- National Botanical Research Institute, Rana Pratap Marg, Lucknow, India | [2]ICAR- National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi, India

Email: sunanditap2105@gmail.com

Globally, floriculture has evolved into a key sector, appreciated for its beauty, expanding commercial prospects, and capacity to create jobs while enhancing farmers' earnings. With the increasing influence of climate change, floriculture is now closely linked with apiculture due to the symbiotic relationship between flowers and bees, where bees derive nectar while enhancing pollination, thereby improving flower quality and yield. Recognizing this synergy, the Government of India launched the CSIR-Floriculture Mission to promote ornamental plant cultivation, strengthen rural livelihoods, and foster sustainable practices. Under this mission, the CSIR-National Botanical Research Institute (NBRI), Lucknow, has distributed quality planting materials of marigold, jasmine, tuberose, chrysanthemum, gladiolus, rose, and other ornamentals adapted to changing climates. In Odisha, such efforts have led to farming of flowers in more than 100 acres over the past two years, with successful cultivation of Lisianthus flower under protected cultivation in the tropical conditions of Odisha for the first time. Further integration of floriculture with apiculture has empowered rural women farmers by creating sustainable income streams. In Mushakani village of Sambalpur District, 30 tribal women farmers have received 150 bee boxes along with live colonies during October 2024, which led them to harvest more than 200 kg of organic honey worth 800 rupees per kg within a period of 10 months, while the return from floriculture alone is up to 1 lakh rupees per season (3-4 months). The return from investment in floriculture during 2024- 25 has reached 70 %. Looking ahead, farmers aim to scale honey production with distinct floral flavors, positioning Mushakani as a hub for integrated floriculture-apiculture in Odisha. Planned initiatives include quality certification, branding, market expansion for honey exports, and training in dry flower craft are needed of the hour to reduce post-harvest losses. Collectively, these measures exemplify how an integrated floriculture-apiculture farming system can uplift rural livelihoods, promote sustainable agriculture, and advance national self-reliance in this sector.

T11-A2

Micropropagation for conservation and sustainable use of floriculture crops

Waseem Siddique[1,2,*], Jibankumar Singh Khuraijam[2,3] and Debasis Chakrabarty[1,2]

[1]Molecular Biology and Biotechnology Division, CSIR-National Botanical Research Institute, Lucknow 226001, India | [2]Academy of Scientific and Innovative Research (AcSIR), Gaziabad 201002, India | [3]Botanic Garden Division, CSIR-National Botanical Research Institute, Lucknow 226001, India

Email: waseemsiddique84@gmail.com

For thousands of years, flowering and ornamental plants have always been intimately linked with humans to cheer and comfort in every moment of life. Indeed, it helps reduce anxiety and stress with its fragrance and colourful appearance. In the past few decades, there has been a resurgence of interest in the study and use of ornamental plants in human civilisation and in recognition of the importance of floriculture plants to the human system. This awakening has led to a sudden rise in demand for the floriculture market, followed by a belated growth in international awareness about the dwindling supply of the world's flower plants. Hence, there is a strong need for proactive understanding in the cultivation, conservation and sustainable usage of floriculture crops for future use. Thus, the plant tissue culture systems are elements of strategic importance for the mass propagation and conservation of floriculture crops. The present study provides an improved protocol

for micropropagation through the use of various explants (shoot tip, flower bud, nodal segments, and leaf petiole) forseveral ornamental and flowering plant species (Begonia, Carnation, Gerbera, Gladiolus, Iris and Hoya). In the case of Begonia species, leaf petiole segments were more responsive, while the basal node of gerbera and Iris gave the maximum regeneration. Nodal segments of carnation and Hoya attain the highest shoot multiplication. Among the cytokinins tested, Murashige and Skoog (MS) basal medium augmented with 2.5 to 5.0 µM 6-benzyl adenine (BA) was optimum in bud break in all the used species explants. Cytokinin-auxin combinations enhanced the multiplication rate; however, the supplementation of 0.25-0.5 µM α-naphthelene acetic acid (NAA) and Indole-3-acetic acid (IAA) significantly improved both the regeneration frequency and overall growth of the shoot system. Microshoots were best rooted on half-strength MS medium supplemented with 0.25-0.5 µM Indole-3-butyric acid (IBA), both in semi-solid and liquid media. Complete plantlets (with shoot and root) were successfully acclimatised and established in the field, where they grew well without any detectable variation.

T11-A3

Environmental significance and quality gaps in commercial *Magnolia champaca* oils

Sudhanshu Shahi[1], MM Pandey[1], Vivek Srivastava[2*] and K. J. Singh[3]
[1]Parijaat-Fragrance Lab, CSIR-National Botanical Research Institute, Lucknow, India | [2]Planning Division, CSIR-National Botanical Research Institute, Lucknow, India | [3]Botanic garden, CSIR-National Botanical Research Institute, Lucknow, India
Email: vivek@nbri.res.in

Magnolia champaca L. (Magnoliaceae), commonly known as Champa, is native to the Himalayas and widely distributed across India, South China, Southeast Asia, and Pacific regions. Traditionally valued in Ayurvedic and Siddha medicine for treating fever, colic, leprosy, postpartum disorders, and ocular ailments, the species has recently gained attention for its antibacterial, antifungal, antidiabetic, anti-inflammatory, antioxidant, and antidepressant properties. Its essential oil is a high-value aromatic derived from a climate-resilient evergreen tree that plays an important ecological role in tropical ecosystems. In the context of environmental sustainability and the increasing demand for natural aromatics, ensuring the authenticity of essential oils has become critical. In this study, essential oil was extracted from freshly collected flowers of *M. champaca* from the CSIR-NBRI garden using a Clevenger-type apparatus and compared with six commercially available samples using GC-MS profiling. The genuine sample exhibited the expected natural major volatile markers such as linalool, ocimene, caryophyllene, benzyl benzoate, cis-nerolidol, eucalyptol, germacrene-D, germacrene-A, globulol and other characteristic sesquiterpenes. In contrast, all commercial samples showed only four major volatile markers-linalool, benzyl benzoate, methyl benzoate, and terpineol. Caryophyllene was detected in only two commercial samples, cis-nerolidol in one sample, D-limonene in three samples and geraniol in two samples. The majority of the commercial samples also showed additional aroma chemicals or unnatural compounds consistent with synthetic reconstruction or reconstitution. These findings indicate widespread adulteration of *Magnolia champaca* oil in the market, which not only misleads consumers but also discourages the sustainable cultivation of this ecologically important species. Ensuring authenticity through chemical profiling is therefore essential for supporting environmentally responsible production, protecting biodiversity and promoting the genuine use of climate-resilient aromatic resources.

T11-A4

Phytochemical diversity and ecological adaptation: Secondary metabolites as drivers of sustainable agroecosystems

Shashi Pandey-Rai[1*]
[1]Laboratory of Morphogenesis, Department of Botany, Banaras Hindu University, Varanasi
Email: shashi.bhubotany@gmail.com

Plants synthesize a vast array of secondary metabolites that function as ecological mediators and adaptive tools for survival under dynamic environmental conditions. Medicinal plants serve as a significant reservoir of bioactive natural phytochemical compounds, which they synthesize as a result of various biotic and abiotic stimuli. These compounds arise from the diversion of primary metabolic pathways toward specialized metabolism in response to abiotic stresses such as temperature fluctuations, ultraviolet radiation, elevated carbon dioxide, salinity, and water limitation. The resulting phytochemical diversity not only enhances stress tolerance but also shapes complex interactions among plants, microbes, herbivores, and pollinators. Acting as chemical signals, these metabolites facilitate symbiosis, defense, and competition, influencing ecosystem resilience and productivity. Shifts in environmental cues modulate photosynthetic efficiency and resource allocation, thereby altering metabolic fluxes and phytochemical profiles across landscapes. Controlled manipulation of growth conditions offers potential for optimizing the synthesis of high-value bioactive molecules while contributing to sustainable agriculture through reduced dependency on synthetic inputs. However, such interventions must consider the ecological trade-offs and evolutionary dynamics inherent in plant chemical responses. Understanding the interplay between environmental stimuli, metabolic regulation, and ecological function of secondary metabolites is crucial for fostering resilient cropping systems and conserving biodiversity in the face of climate variability. Nevertheless, it is crucial to acknowledge that these actions also yield ecological ramifications and embody adaptive traits that hold significant value in the context of natural selection during the process of evolution.

T11-A5

Genomic Landscape and Evolutionary Insights of the Indian Sacred Lotus

Garima Saxena[1,2*], Yogeshwar V. Dhar[3], Khuraijam J. Singh[1,2], Ajit K. Shasany[1,2], Mehar H. Asif[1, 2]*

[1]CSIR-National Botanical Research Institute, CSIR-NBRI, Rana Pratap Marg, Lucknow, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India | [3]International Centre for Genetic Engineering and Biotechnology, Aruna Asaf Ali Marg, New Delhi, India
Email: garimasaxena6@yahoo.co.in

The sacred lotus (*Nelumbo nucifera*) holds global significance as an ornamental, medicinal, edible, and culturally symbolic plant. In this study, we present a high-quality, chromosome-level, gapless genome assembly of the elite Indian lotus variety NAMOH108, produced through a hybrid sequencing strategy integrating PacBio HiFi long reads, Illumina short reads, and Hi-C data. The resulting 858.3 Mb assembly is organized into eight chromosomes (N50 = 122 Mb; Chr1 = 216.47 Mb) and encompasses 29,119 predicted protein-coding genes, with repetitive sequences accounting for approximately 45% of the genome. Comparative genomic analyses identified gene family expansions associated with carbohydrate machinery, as well as pronounced divergence from the China Antique cultivar. Supported additionally by transcriptomic evidence, this high-resolution reference genome provides a robust foundation for future genetic, evolutionary, and agronomic investigations of *N. nucifera*.

T11-A6

Exploring the effect of Gamma radiation on morphological, cytological and biochemical parameters of *Clitoria ternatea* L.

Netra Kesharwani[1] and Vaibhav Srivastava[1*]
[1]Naithani Plant Genetics and Ecotoxicology Laboratory
Email: vaibhavsri921@gmail.com

Powerful electric fields, during thunderstorms accelerate electrons to high energies. These electrons collide with air molecules, producing bursts of terrestrial cosmic gamma rays. Likewise, anthropogenic activities such as nuclear power production and nuclear accidents where certain elements undergo reactive disintegration, tend to elevate the radiation level in the environment. When terrestrial environments get contaminated with

long-lived gamma emitting radionuclides, plants that grow in these areas are exposed to gamma radiation and are affected. The gamma radiation is known to cause damage by interacting directly with macromolecules leading to lipid oxidations, enzyme inactivation and DNA lesions. In addition, through the radiolysis of water, results in formation of reactive oxygen species (ROS) such as superoxide radicals (O^{2-}), hydroxyl radicals (OH^{-}) and hydrogen peroxides (H_2O_2) which potentially disturbs cellular metabolism leading to cellular damage and death via the oxidation of macromolecules and proteins. There are gaps, uncertainty and lack of information on the radiation dose–effect relationship for different plants in this context, therefore, present study elucidates the gamma irradiation induced morphological, cytological (meiotic) and biochemical changes in *Clitoria ternatea* L. (2n=16), a perennial leguminous herb, known for its high medicinal value and natural blue food colourant. The germplasm of *Clitoria ternatea* L. was being irradiated with 4 different treatments of gamma rays viz., 0 (T_0), 100Gy (T_1), 200Gy (T_2), 300Gy (T_3) and 400Gy (T_4) (determined in accordance with the LD_{50} value) in gamma cell at NBRI, Lucknow where Cobalt-60 served as the source of gamma rays. The treated seeds were sown in different labelled pots filled with loam soil and farm yard manure in the ratio of 7:3 in triplicates using the Completely Randomized Block Design (CRBD) method. The results showed that the germination percentage was recorded highest i.e. 77.78% in the control set and minimum (22.22%) at the highest dose (400Gy) of gamma irradiation. Various morphological variations in the emerging leaves and flowers were observed. Also, a number of meiotic abnormalities could be observed at various stages of meiosis in the PMCs of all the treatments. The prominent ones were unorientation, stickiness and scattering etc. The experiments for certain biochemical parameters such as photosynthetic pigments, proline, thiol, lipid peroxidase and protein were also performed and the analysis demonstrated that the total chlorophyll and carotenoid content was observed highest for the plants of seeds under T_1 followed by the plants of seeds under T_0, T_2, T_3 and T_4 respectively whereas proline content was minimum under T_1 and found to increase by 1.4 times under T_4 ($p<0.05$) with respect to control. Also, lipid peroxidase content increased 2 folds under T_4 with respect to T_0. Thiol content decreased by 46% in the plants under T_4 with respect to plants under T_0 ($p<0.05$). Total protein content was found to be minimum under T_0 and increase by 33% under T_4. The fact that lethality and chromosomal damage increased with the increasing doses of gamma radiation, low doses of gamma radiations can be used to produce a variant with an ability of tolerance against environmental stress or other extreme weather conditions.

T11-A7

Comparative Dye Yield and Dyeing Efficiency of Control and Phosphate solublising *Pseudomonas putida* Treated Marigold (*Tagetes erecta*) Flowers on Silk Fabric

Vaishali Mishra[1], Ambuj Shukla[2], K. J. Singh[3], Puneet Singh Chauhan[2] and Manjoosha Srivastava[1*]

[1]Phytochemistry Division, CSIR-National Botanical Research Institute, Lucknow 226001, Uttar Pradesh, India

[2] Plant Ecology & Environmental Technologies, CSIR-National Botanical Research Institute, Lucknow 226001, Uttar Pradesh, India

[3]Botanical Garden, Plants Conservation Agrotechnologies

Email: m.srivastava.nbri@csir.res.in

Marigold (*Tagetes erecta*) is an important floricultural species widely cultivated for ornamental, religious, and industrial applications, including natural colour extraction for textile use. The flower pigments, largely carotenoids and flavonoids, are influenced by environmental and climatic conditions, which often result in fluctuating dye yield and variable colour performance on natural fibres. With increasing interest in sustainable, biodegradable textile colourants as substitutes for synthetic dyes, optimizing pigment production through climate-

responsive floriculture is crucial. The present study aimed to evaluate the effect of specific agronomic and environmental treatments on pigment enhancement in marigold flowers and to compare the dyeing characteristics of extracts obtained from control versus PSB *Pseudomonas putida* treated marigold flower varieties on silk fabric. Fresh flowers were collected from standard floriculture fields where, the treated group received PSB. Marigold plants roots treated with PSB exhibited more number of branches, increased flower size, and more yield of flowers as compared to control. Colour was extracted using aqueous organic solvents, and silk fabric was mordanted with alum before dyeing to improve dye-fibre affinity. Silk dyeing was performed at controlled temperatures. Colour characteristics and fastness properties were evaluated. Correspondingly, silk dyed with treated flower extracts displayed, improved shade uniformity, and better wash and light fastness compared with silk dyed using control flower extracts, which produced comparatively lighter shades with weaker fastness. These findings confirm that climate-responsive floriculture practices can directly enhance colour yield and improve the functional textile applicability of marigold-derived dyes.

T11-A8

Soil Nutrient Status of Miyawaki Forest: A sustainable approach for environment conservation under sodic waste land

Devendra Singh[1,2]*, R.C. Nainwal[1,2]
[1]Botanical Garden, Plant Conservation and Agrotechnology Division, CSIR-National Botanical Research Institute, Lucknow 226001, Uttar Pradesh, India | [2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, Uttar Pradesh, India
Email: dev.singh.nbri@csir.res.in

Sodic wastelands, characterized by high pH and low fertility due to elevated exchangeable sodium, pose a significant challenge to land restoration and ecosystem recovery. Sodium dominance in sodic soils leads to nutrient deficiencies and poor infiltration and structural quality. The Miyawaki forest method, known for its dense, multi-layered plantations and rapid biomass accumulation, offers a promising strategy for rehabilitating such degraded landscapes. At Banthra, a field site characterized by sodic subsoil, a Miyawaki-style plantation was established using a high-density mixture of native tree and shrub species, along with soil amendments to improve the initial substrate conditions. The study evaluated the potential of the Miyawaki forest of dense native-species afforestation to rehabilitate sodic waste land, through an assessment of soil nutrient status (soil parameters including pH, EC, organic carbon, available nitrogen, phosphorus, potassium, and micronutrient dynamics) on previously sodic terrain, and comparison to non-treated sodic reference plots. Soil pH and EC values also showed signs of improvement (a moderate lowering of pH from extreme alkaline toward neutral, and reduced surface EC compared to control), suggesting that vegetation cover and organic matter accumulation may help buffer sodicity effects. The afforested plots exhibited enhanced nutrient cycling and retention, likely through improved litter-root interactions and microbial activity promoted by the mixed native vegetation. The synergistic effects of species diversity, root architecture, and elevated organic matter inputs obtained from leaf litter, contributed to enhance nutrient cycling and reduced sodicity. The findings support the hypothesis that high-density native vegetative afforestation using the Miyawaki method can serve as a sustainable environment-conservation approach on sodic waste lands by gradually improving soil nutrient status and structural conditions. The approach thus holds promise for degraded land management strategies in salt-affected and waste-land settings.

T11-A9

Global trend of floriculture productivity under changing climate: Impact and adaptive strategies

Rakesh Chandra Nainwal[1*]
[1]Botanical Garden, Plant Conservation and Agrotechnologies, CSIR-National Botanical Research Institute, Lucknow, India
Email: nainwal.rakesh@gmail.com

Floriculture, a combined approach of art and science for cultivating ornamental plants, has developed into a thriving and valuable global industry with considerable social, economic, and ecological significance, enhancing livelihoods, aesthetics, and artistic traditions. The industry is fuelled by increasing consumer interest in potted plants, cut flowers, and landscaping inventories; the sector has rapidly grown in both temperate and tropical areas.

Nevertheless, the business is facing rising challenges from climate change, which is affecting the productivity, quality, and geographic distribution of the crops while threatening its sustainability and profitability and disrupting established floriculture zones and cultivation practices. Rising temperatures, variable rainfall, an increased frequency of extreme rainfall events, and changes in photoperiod are disrupting flowering schedules, lowering yields, and increasing pest and disease challenges. These differences impact flowering patterns, color development, post-harvest quality, and marketability, particularly for sensitive ornamental species like roses, gerberas, lilies, and chrysanthemums. Although the demand for cut flowers is always on the rise, especially in urban and peri-urban areas, climatic aberrations are leading to indigenous product imbalances and supply issues. In response, new floriculture regions are being created in Eastern Europe, Southeast Asia, and high-altitude areas where microclimatic conditions still support cultivation practices. Export-oriented nations are increasingly adopting climate-smart technologies and incentive programs to sustain their competitiveness and address changing consumer demands for sustainably cultivated flowers. Across the value chain, adaptive strategies are being implemented. At the genetic level, breeding efforts are concentrated on developing cultivars that can tolerate heat and other stresses. In terms of agronomy, protected agriculture systems, like climate-controlled glasshouses, shade nets, and fogging systems, are aiding in mitigating environmental stress. Precision irrigation methods, such as drip systems and hydroponics, are enhancing water-use efficiency, while integrated nutrient management is being adapted to accommodate changing soil dynamics caused by climate variability. Post-harvest practices are also being improved to maintain flower aesthetic quality in response to varying temperature and moisture levels during transportation and storage. In summary, the global floriculture sector is at a critical juncture where climate change serves both as a challenge and a catalyst for innovation. Integrating floriculture into broader climate adaptation and biodiversity conservation practices can enhance ecosystem services and rural livelihoods. To conclude, the floriculture industry is at a significant crossroad, with climate change offering both risks and opportunities. A comprehensive approach, combining scientific innovations, sustainable practices, and inclusive programs, is vital for securing floriculture productivity and quality in a changing world. Therefore, research should concentrate on localized adaptation, collaborative breeding, and circular economy principles to advance a flexible and environmentally smart floriculture business.

Theme 12:

Emerging environmental issues including microplastic pollution & mitigation strategies

T12-A1

Microplastics: A Threat to Sustainability

Pankaj Kumar Srivastava[1*]
[1]Plant Ecology & Environmental Technology, CSIR-National Botanical Research Institute, Lucknow–226001
Email: pankajk.nbri@csir.res.in, drpankajk@gmail.com

The "plastics boom" following World War II led to the widespread use of durable, low-cost synthetic polymers, but the lack of effective end-of-life management has resulted in massive accumulation in the environment (air, water, and soil). Microplastics persist for extended periods and act as carriers for toxic persistent organic pollutants and heavy metals, facilitating their transfer through the food web. Microplastics, tiny plastic particles generally < 5 mm in diameter, have emerged as a significant global environmental threat, impacting ecosystems, wildlife, and human health, and thereby posing a major challenge to sustainability goals. This pervasive contamination stems from the slow degradation of large plastic debris and the direct release of primary microplastics from sources like synthetic textiles and personal care products. Presence of microplastics in food chain and human body parts make these tiny particles with highest level of threats to sustainability. Despite extensive research, significant knowledge gaps remain which include the lack of standardized methodologies for sampling, extraction, and quantification of microplastics across different environments, making data comparison difficult at local, regional and global levels. There is also a need for further research on the long-term toxicological effects and mechanisms of microplastics not only in human bodies, especially regarding their ability to cross biological barriers like the blood-brain barrier, but also in agriculture perspectives. Furthermore, a more in-depth understanding of the impacts on terrestrial ecosystems, including soil biota and plant life, is urgently required. This study aims to provide a comprehensive overview of microplastic pollution sources, their prevalence in different ecosystems, and their detrimental impacts on the environment and human health. Specific objectives are to synthesize current knowledge on the pathways of microplastic entry into various environmental compartments; to highlight the ecological and health risks associated with microplastic exposure and bioaccumulation; to identify key research gaps and propose future research directions for effective mitigation strategies and policy development toward achieving environmental sustainability. Microplastics are ubiquitous, found in all spheres, air, drinking water, and food products (seafood, salt, crops). Ingestion causes physical harm (internal blockages, tissue damage, malnutrition) and chemical harm (inflammation, oxidative stress, potential endocrine disruption) in a wide range of marine and terrestrial organisms, disrupting food chains and biodiversity. In humans, exposure through ingestion and inhalation can lead to various health issues, including cell injury, inflammation, and potential chronic diseases, although more research is needed to fully understand the mechanisms. Microplastics significantly alter the physico-chemical properties of soil (water retention, pH) and negatively affect plant growth and microbial communities. Current waste management and recycling methods are insufficient, as only a small fraction of plastic is effectively recycled globally. The pervasive presence and persistent nature of microplastics present a substantial, multifaceted threat to global environmental sustainability and human well-being. A comprehensive and collaborative approach is essential, involving reduced plastic production and consumption, improved waste management, development of sustainable alternatives (e.g., truly biodegradable plastics), and stricter policy enforcement to mitigate this escalating issue and safeguard the planet for future generations.

T12-A2

Hidden danger beneath the soil: Assessing the risks of microplastics in agricultural fields of Uttar Pradesh, India

Ekta Gupta*[1,2], Virendra Kumar Mishra[2], Pankaj Kumar Srivastava[1]

[1]Environmental Technologies Division, CSIR-National Botanical Research Institute, Lucknow-226001, India | [2]Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi, India
Email: ekta2215@gmail.com

India stands as one of the leading producers and consumers of plastic worldwide, resulting in the generation of significant plastic waste that ends up contaminating the soil system. Despite this, there has been a relatively limited exploration into the distribution, behavior, diversity and risk analysis of microplastics (MPs<5mm size) within agricultural soil, when compared to the extensive research carried out in marine and coastal environments. The economy, livelihood, and food security of India are highly dependent on the agricultural sector. Moreover, the diverse array of agricultural products from India are exported globally, including rice, pulses, fruits, vegetables, spices and tea. Soil MPs contamination is one of the invisible threats that pose a grave danger to food security and the quality of agricultural exports. It was hypothesized that intensive agricultural activities and proximity to sources contribute higher MP load in soil. The primary objectives of this study were to quantify and characterize the extent of MP contamination in agricultural soils situated in proximity to potential pollution sources. Additionally, the study aimed to evaluate the potential ecological risks associated with the presence of MPs in this agricultural soil. This study investigated MPs in agricultural soils of Lucknow and Barabanki districts, Uttar Pradesh, India. Soil samples were processed through wet peroxide oxidation (H_2O_2) and sequential density separation using NaCl and NaBr solutions. The extracted MPs were filtered and characterized (visually and chemically) for shape, size, color, and polymer type. Furthermore, the potential ecological risks were evaluated using risk indices based on abundance and polymer composition. The findings indicate a widespread occurrence of MPs in all agricultural fields, showing notable differences in their composition, size distribution, and source-related characteristics. Abundance of MPs in agricultural soil ranged from 120-880 particles/Kg. Predominant shapes were fragments (53.05%), fibers (35.86%), films (5.74%), and the particle sizes majorly belonged to 10-300µm and 300-500µm. Low-density polyethylene (LDPE), high-density polyethylene (HDPE) and polypropylene (PP) were the most abundant polymers in all the agricultural fields. The risk evaluation using the Polymer Hazard Index (PHI) identified high ecological risk levels (Level 4-5) in agricultural soils, particularly those located near municipal dumping zones and urban regions. Hazardous polymers including polyvinyl chloride (PVC), polyurethane (PU), polyamide (PA), and polystyrene (PS) were the main contributors to this risk. This study fills the major geographical and contextual void of MPs baseline data in soil samples of agroecosystems integrated with diversity and risk indices. Findings highlight significant ecological risks from hazardous polymers and emphasize the need for targeted mitigation strategies and policy interventions. The study will guide the decision-making processes, policy development that aims to address and prevent the MPs pollution in agricultural soil leading to the sustainable soil ecosystem and ensuring food security.

T12-A3

Microplastic pollution in terrestrial ecosystems: impacts on soil health and environment

Ruchi Chauhan[1*], Anju Patel[1], and Pankaj Kumar Srivastava[1]
Environmental Technologies Division, CSIR-National Botanical Research Institute, Lucknow, India
Email: chauhan11ruchi@gmail.com

Background and research gap- Microplastics are emerging as one of the most pervasive pollutants in the terrestrial environment. Their accumulation through sewage sludge, compost, atmospheric deposition, and plastic mulching threatens soil health, crop productivity, and food safety. However, compared to marine environments, the occurrence, fate, and ecological implications of MPs in soil remain underexplored, especially concerning

interactions with soil biota, nutrient cycling, and pollutant co-transport. Microplastic contamination alters soil's physical, chemical, and biological properties, thereby affecting soil health and plant performance. The first aim of the study was to identify and characterize the shape, size, and types of microplastics in agricultural and dumping sites near agricultural land. Secondly, the physicochemical and biological impacts of MPs on soil health were examined. Soil samples were collected from multiple agricultural and dumping sites near agricultural land in the vicinity of Lucknow. MPs were extracted using density separation (NaCl/ZnCl2 solutions) and analysed through Fourier-transform infrared spectroscopy (FTIR). Soil physicochemical parameters, microbial counts (CFU), and heavy metal concentrations (ICP-MS) were also measured to study interrelationships between microplastic presence and soil health indicators. MPs were detected in all soil samples, with higher abundance near agricultural soil in the vicinity of dumping sites. Predominant polymers were in the size range of 100–1000 μm, with the majority as fragments (49.45%), followed by fibres (41.86%) and films (8.67%). Increased MP concentration correlated with reduced bulk density, lower microbial count, and decline in soil organic carbon (SOC). Soils with higher MP loads also showed decreased water-holding capacity, lower cation exchange capacity (CEC), and increased electrical conductivity (EC) due to disrupted soil aggregation. Additionally, a noticeable reduction in enzyme activities such as dehydrogenase activity, was observed, indicating microbial stress and impaired nutrient cycling. Overall, microplastic accumulation led to deterioration of soil structure, fertility, and biological activity, posing potential risks to soil productivity and ecosystem balance. Microplastic pollution is an emerging threat to terrestrial ecosystems, with clear evidence of its accumulation and negative effects on soil health. This study highlights the urgent need for improved waste management and reduced plastic use in agriculture. The findings help bridge existing research gaps on soil microplastics and offer insights into managing plastic contamination in terrestrial environments.

T12-A4

Emerging contaminants in natural water resources and their fate in the environment

Sejal Shukla[1*], Ruchi Agnihotri[1], Sanjay Dwivedi[1], Seema Mishra[1]
[1]Department of Chemistry, University of Lucknow, Lucknow226007, India
Email: sejalshukla506@gmail.com

Emerging contaminants have become a growing environmental concern due to their persistence, potential to transform into more toxic forms, and long-term effects on aquatic ecosystems and human health. These include a wide range of substances such as pharmaceuticals, personal care products, synthetic dyes, pesticides, plasticizers, microplastics, and nanoparticles that are continuously introduced into water systems through domestic, industrial, and agricultural activities. Rivers flowing through urban and industrial regions are increasingly burdened with a mixture of conventional and synthetic pollutants that alter their natural composition and degrade water quality. Variations in water characteristics reflect the influence of rapid urbanization, industrial effluents, and agricultural activities. Elevated values of electrical conductivity, total dissolved solids, turbidity, and hardness indicate excessive ionic and particulate loading, largely attributed to untreated discharges and surface runoff. The presence of trace and toxic elements, including zinc, arsenic, chromium, cadmium, and lead, highlights significant contamination from industrial sources such as tanneries, metal plating, and chemical processing units. Compounds like *p*-aminophenol, *p*-phenylenediamine, and *p*-toluenediamine, along with their oxidative transformation products, persist in the environment and exhibit strong potential for toxicity and mutagenicity. Their continuous release and transformation under natural conditions raise serious ecological and public health concerns,

as they may interfere with aquatic bodies and the river system struggling under the pressure of human activities. These findings underline the need for sustainable management approaches, effective wastewater treatment, and strict pollution control measures to restore water quality and protect the health of aquatic ecosystems.

T12-A5
Microplastics interaction with dissolved organic matter

Swati Verma[1*], Anju Patel[1], Pankaj Kumar Srivastava[1]
[1]Environmental Technologies Division, CSIR-National Botanical Research Institute, Lucknow, India
Email: swati94127@gmail.com

Microplastics act as dynamic carriers that adsorb and transport various pollutants, including heavy metals, organic compounds, dyes, and pharmaceuticals, through mechanisms such as hydrophobic interactions, electrostatic attraction, and π–π stacking. Owing to their hydrophobic nature, microplastics can also interact with dissolved organic matter (DOM), a component of soil organic matter. Soil DOM, which constitutes less than 2% of the total soil organic matter, represents its most dynamic and reactive fraction. The abundance of functional groups and the amphiphilic nature of DOM enable strong interactions with microplastics, thereby altering their surface chemistry and influencing their mobility and transport within the soil environment. We hypothesized that dissolved organic matter interacts with microplastics, and that this interaction varies depending on polymer type and soil chemistry. This study aims to elucidate the interaction behavior between dissolved organic matter and microplastics through adsorption experiments. Batch experiments were conducted under controlled conditions to determine the adsorption capacity and kinetics of the adsorption reaction (DOM + Microplastics). Characterization has been performed using FTIR spectroscopy and SEM-EDS. MPs showed interaction with the DOM, and the results were confirmed by evaluating the adsorption capacity, FTIR, and SEM-EDS spectra. The major interaction was observed due to the polar surfaces of microplastics (generated by aging and interaction with DOM), as well as the availability of oxygen-containing functional groups in dissolved organic matter, which facilitate hydrogen bonding, π–π interactions, and hydrophobic interactions. The findings demonstrate that polymer type strongly governs DOM adsorption through specific surface interactions, influencing microplastic aggregation, mobility, and potential for contaminant transport in the soil. This mechanistic insight provides a foundation for predicting the environmental behavior of microplastics and its interactions with natural organic matter.

T12-A6
Microplastic Remediation through Nanobiochar

Tanushree Nandy[1*], Anju Patel[1], Pankaj Kumar Srivastava[1]
[1]Environmental Technologies Division, CSIR-National Botanical Research Institute, Lucknow, India
Email: nandytanu16@gmail.com

Microplastics are polymer particles of size less than 5mm, which have become a significant concern to our ecosystem. Nanobiochar is produced from bulk biochar through the use of various physical and chemical methods. Nanobiochar ranges from 100nm to 1nm. It should be <100nm. Nanobiochar mainly reduces the mobility and bioavailability of microplastics in soil and plants. Although Nanobiochar possess a higher surface area, greater porosity and high adsorption capacity but it is considered to be less stable compared to traditional biochar under environmental conditions. The lack of understanding regarding the interactive mechanism between nanobiochar and microplastics, influence of environmental factors on its stability, represents a significant research gap that this study aims to address. Nanobiochar, due to its high surface area, high cation exchange activity, high functional groups, and high

porosity, can be promising for the adsorption of microplastics through various interactions like hydrophobic interaction, π–π interaction, electrostatic interaction, etc. This study focused on exploring possible mechanistic remediation by applying nanobiochar in contaminated matrices for microplastic removal. This study aims to assess the adsorption and removal efficiency of nanobiochar for different types, sizes, and shapes of microplastics (e.g., PE, PS, PET). It was aimed to investigate the physicochemical interactions (hydrophobic, electrostatic, π–π, pore trapping) between Nanobiochar and microplastics under varying environmental conditions (pH, salinity, organic matter). Biochar produced by the method of slow pyrolysis at temperature 500-700 ℃. Mostly Nanobiochar produced through bulk biochar through ball milling method. Batch experiment was conducted to determine how effectively nanobiochar removes microplastics under specific conditions. Isotherm models like langmuir and freundlic are applied to determine the adsorption capacity of nanobiochar for microplastics at different concentrations. Various characterization methods like scanning electron microscopy (SEM), transmission electron microscopy (TEM), Fourier transform infrared spectroscopy (FTIR), X-ray photoelectron spectroscopy (XPS), Raman spectroscopy (DXR), and X-ray diffraction (XRD) can be used for nanobiochar – microplastics complexes.

Recent studies suggest that nanobiochar showed more efficiency for the remediation of microplastics compared to bulk biochar. According to Huaguo Xia et.al 2025, removal efficiency of Poly-3-hydroxybutyrate-co-3-hydroxyvalerate (PHBV) by Magnetic nanobiochar composite could reach 98.53% under optimal conditions (pH = 7, adsorbent dosage of 1.5 g/L). Adsorption was mainly driven by surface complexation and hydrogen bonding. Recent studies showed the highest removal percentages of polystyrene microplastics were characterized at 60°C, giving 64.8 and 67.0 % by oxalic acid modified pineapple and artichoke waste nanobiochar, respectively, and the lowest were detected at 25 °C to confirm Polystyrene adsorption onto Oxalic acid modified nanobiochar. Nanobiochar is effective in the removal of various pollutants due to its large surface area, more functional groups, etc. But its long-term trials, toxicity assessment must be analysed. Future work should be focused on stability, long-term assessment in real environmental conditions.

T12-A7

Macroalgae associated bacteriomes across environmental substrates: Functional insights and emerging pollution linkages

Vitasta Jad[1], Cathrine S Manohar[1*]
[1]CSIR- National Institute of Oceanography, Dona Paula, Goa, India, Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India
Email: cathrine@nio.res.in

Macroalgal habitats form the ecological backbone of coastal ecosystems. Far beyond marine greenery, they function as microbial powerhouses that mediate nutrient cycling, organic matter transformation, and pollutant degradation. Despite their ecological prominence, the taxonomic diversity and functional potential of microbial consortia harboured by these living bio-architectures remain poorly resolved, particularly across interacting substrates. This study employed high-throughput targeted amplicon sequencing to comprehensively profile the bacteriome across seawater, sediments, and macroalgae (*Sargassum* and *Padina* sp.) from three seaweed-dominated intertidal sites along the Goan coast namely Anjuna, Hawaii, and Bogmollo. Phylogenetic analysis revealed extensive taxonomic diversity encompassing 51 bacterial phyla, dominated by Proteobacteria, Actinobacteria, Cyanobacteria, and Bacteroidetes. Substrate-linked differentiation in community composition was evident, with distinct biomarker taxa reflecting habitat-specific ecological pressures and metabolic specialization. Predictive functional analyses indicated substrate-specific enrichment of pathways associated with

nutrient regeneration, energy metabolism, and xenobiotic degradation. Seaweed-associated microbiomes exhibited functional attributes consistent with nitrogen cycling and degradation of algal-derived compounds, while seawater bacteriomes reflected enhanced pollutant degradation potential, including plastics, hydrocarbons, and xenobiotic metabolism. The study underscores the intertwined effects of natural substrate heterogeneity and anthropogenic stressors in shaping microbial community assembly and function, emphasizing the need for microbiome-informed monitoring frameworks to safeguard coastal ecosystem health in an era of accelerating environmental change.

T12-A8

Microplastic-Arsenic Co-contamination: Microplastics as vector for Arsenic

Garima Yadav[1*], Pankaj Kumar Srivastava[1], Anju Patel[1]
[1]Environmental Technologies Division, CSIR-NBRI, Lucknow, India
Email: garimay491@gmail.com

Microplastic (MPs) pollution has emerged as a global environmental concern due to its persistence and wide distribution across different environmental matrices. Instead of persisting as inert debris, aged microplastics bear certain functional groups that provide reactive surfaces, adsorbing and transporting a range of other contaminants, including toxic heavy metals such as Arsenic. Arsenic is a widely occurring metalloid, known for its high mobility and bioavailability, resulting in higher arsenic toxicity. Arsenic contamination in soil leads to its acquisition in food chain through contaminated plant products. The co-occurrence of microplastics and arsenic in soil can influence each other's fate, transport and toxicity. The surface properties of MPs depend on polymer type, aging, and oxidation state, which in turn affect sorption-desorption of As, influencing its fate and transport in soil. Moreover, environmental factors like pH, redox potential, organic matter content and soil microbes influence the fate of these co-contaminants, making it a highly dynamic process threatening agroecosystem and human health. Despite the rising recognition of MPs as vectors for other pollutants, the interaction between MPs and arsenic species under varying soil conditions remains largely unexplored. In order to predict risks and to design effective mitigation strategies, more research and field trials are required. This study aims to bring together current knowledge on Microplastic-Arsenic interaction and how different soil physicochemical and biological factors may affect arsenic sorption-desorption dynamics on the surface of different polymer types. This study also aims to discuss emerging mitigation strategies, including the use of biochar, biodegradable polymers and microbial bioremediation, to address key areas of further research. Peer-reviewed articles, studies, reports, and reviews published between 2010 and 2025 were retrieved from databases including Scopus, Web of Science, and ScienceDirect using keywords such as "microplastic", "arsenic", "co-contamination", "sorption-desorption", "mitigation strategies" and VOSviewer was applied. Analysis of earlier publication yields a future perspective of As-MP co-contamination R&D. MPs and arsenic interact with each other primarily through electrostatic interactions, hydrogen bonding, and forming complexes with oxygen-containing functional groups on MP surface. With aging, MP surface becomes exposed and more hydrophilic due carbonyl and hydroxyl groups upon oxygenation during weathering which provides active sites for the binding of arsenic. Environmental factors such as pH, ionic strength and redox potential govern the oxidizing and reducing conditions of soil which influence the sorption-desorption dynamics of As on MP. Changes in redox potential lead to arsenic speciation between As(III) and As(V), thereby altering its affinity for different polymer types. The presence of dissolved organic matter and biofilms either provides additional binding sites or competes for them with As, thereby further modulating these interactions. The combined presence of MPs and As has a huge impact on the mobility and bioavailability of As in soil, impacting

human health via food-chain contamination. Understanding the nature and behaviour of these interactions under dynamic soil conditions is crucial for accurate risk assessment and appropriate mitigation measures.

T12-A9

A dual approach to unravel microplastic-induced stress in soil–plant ecosystems

Shweta Yadav[1*], Poonam C. Singh[1]
[1]Microbial Technology Division, CSIR-NBRI, Lucknow, India
Email: syvns55555@gmail.com

Microplastic contamination within agricultural soils has become a significant emerging threat to agroecosystem functioning. With nearly 12.5 million tons of microplastics incorporated into agricultural activities worldwide, concerns regarding their potential to disrupt soil biochemical processes and plant nutrition. Yet, mechanistic insights into their interactions with soil enzymes, essential nutrients, and plant systems remain limited. To elucidate these mechanisms, in-silico docking was employed to characterize the chemical interactions of polyethylene terephthalate (PET) and low-density polyethylene (LDPE) microplastics with key soil enzymes and plant-relevant nutrients. Complementary ecotoxicological assays were conducted on *Cicer arietinum*, *Trigonella foenum-graecum*, *Vigna mungo*, and *Vigna radiata* to assess microplastic-induced physiological and nutritional alterations. Docking simulations identified β-glucosidase as the most responsive enzyme, exhibiting the strongest affinity for PET and LDPE, followed by protease, phosphatase, dehydrogenase, and urease. Enzyme–polymer interactions mediated through van der Waals forces, hydrogen bonding, and other intermolecular effects. Experimentally, exposure to 1% PET and LDPE caused substantial suppression of β-glucosidase (25–70% and 11–52%), dehydrogenase (25–72% and 22–74%), and protease (4–13% and 2–59%) activities, mirroring the computational predictions. Microplastic exposure triggered physiological stress responses in plants, as reflected by elevated proline and soluble sugar content. Although organic matter increased, the availability of essential soil nutrients—nitrogen (8–14%), phosphorus (4–43%), potassium (4–81%), magnesium (3–56%), and iron (20–88%) decreased. Microscopic observations further indicated microplastic adhesion to the root epidermis, likely obstructing root pores and impairing nutrient uptake, leading to reduced macro- and micronutrient accumulation in plant tissues. Overall, computational and experimental findings converged to show that microplastics disrupt soil enzymatic functioning and plant nutrient acquisition through direct molecular interactions. These insights provide critical mechanistic evidence of polymer-specific microplastic toxicity within soil–plant systems.

T12-A10

Emerging Nano-Biochar Approaches for Mitigating Heavy Metal Stress in Rice, Wheat Agroecosystems: Mechanistic Perspectives and Future Challenges

Garima Awasthi[1*], Kumud Kant Awasthi[1], Mahipal Singh Sankhla[1], Anjali Awasthi[2], RD Tripathi[3], Sudhakar Srivastava[4]
[1]School of Basic and Applied Sciences, K.R. Mangalam University, Gurugram, India | [2]Department of Zoology, University of Rajasthan, Jaipur, India | [3]CSIR- National Botanical Research Institute, Lucknow, India | [4]Institute of Environment & Sustainable Development, Banaras Hindu University, Varanasi, India
Email: gariimaa21@gmail.com

Heavy metal (HM) contamination in ecosystems and their transfer through the food chain have emerged as critical global environmental issues. Activities associated with agriculture, industrial processing, and sewage disposal are major anthropogenic drivers of HM accumulation in agricultural soils and irrigation water. These HMs can have detrimental effects on the metabolism and growth of plants, thereby reducing yield of crops like rice (*Oryza sativa*) and wheat (*Triticum aestivum*). Conventional biochar amendments have been successful in immobilizing heavy metals in soil and reducing their uptake by crops, but there are limitations in consistency, and long-term stability. Nanotechnology holds a promising future

in the field of sustainable agriculture by not only conserving natural resources but also by promoting tolerance to stress conditions, including those caused by HMs. Nano-biochar, modified to nanoscale particles, offers enhancements in biochar properties in terms of specific surface area, reactive functional groups availability, and sorption capacity and might improve its performance in plants. The research shows greater efficacy of nano-biochar (or nanoparticle-modified biochar) over standard biochar in reducing heavy metal uptake, enhancing plant growth under metal stress, and improving plant interactions with microbial communities. This work focuses on the preparation, properties, mechanisms of action, and application of nano-biochar in rice and wheat crops for the mitigation of toxicity and accumulation heavy metals. This also addresses environmental risks, and scale-up challenges of nano-biochar and gives future directions in the area.

T12-A11

Microplastics: Small particles, big problems

Rohit Chandravanshi[1], Sudhir Kumar Pandey[1*]
[1]Department of Botany, Guru Ghasidas Vishwavidyalaya, (A Central University), Koni, Bilaspur, 495009, Chhattisgarh, India

Microplastics (MPs) pollution is an emerging contaminant in aquatic environments as well as soil and air matrices, due to its pervasive nature and very small size it can easily enter in food chain and various trophic levels and at the end it comes into the contact with human body through drinking, consumption and inhalation. Exposure of this MPs to human causes several alterations in the organisms including respiratory disorders like lung cancer, asthma and hypersensitivity pneumonitis, neurological symptoms such as fatigue and dizziness, inflammatory bowel disease and even disturbances in gut microbiota. Industrial manufacturing, vehicle tyre weathering, textile industries are the several sources for MPs pollution in water bodies. Wastewater Treatment Plants (WTPs) is one of the major sources for the invasion of these MPs in aquatic bodies, due to lack of removal techniques for MPs, the water filtration systems are not well equipped to remove MPs from the inlet water. Biochar (BC) is carbon rich charcoal obtained from the combustion process of organic feedstocks like forest residues, wood chips, crop residues and green wastes, due to its excellent surface properties, economic feasibility and environmental sustainability it can be used as an adsorbent for MPs generated from wastewater treatment plants. In this study we will explore the potential of BC prepared from organic wastes for the removal of various types MPs from WTPs. For the lab scale removal studies involves Batch and Column adsorption treatment methods, the results from various articles are also summarized in detail

International Society of Environmental Botanists (ISEB)

Executive Body

President

Dr. Ajit Kumar Shasany
(Director, CSIR-NBRI, Lucknow)

Vice-Presidents

Prof. Madhoolika Agrawal
(Varanasi)

Dr. Vivek Pandey
(Lucknow)

Secretary

Dr. Soumit Kumar Behera (Lucknow)

Additional Secretary

Dr. Chandra Sekhar Mohanty (Lucknow)

Joint Secretaries

Dr. Dibyendu Adhikari (Lucknow)

Dr. Richa Rai (Lucknow)

Treasurer

Dr. Dalip Kumar Upreti (Lucknow)

Additional Treasurer

Dr. Sandip Kumar Behera (Lucknow)

Executive Councillor

Prof. Renee Maria Borges (Bangalore)
Prof. Daizy Batish (Chandigarh)
Dr. Penna Suprasanna (Mumbai)
Dr. Rudra Deo Tripathi (Lucknow)
Prof. Naveen Arora (Lucknow)
Dr. Nandita Singh (Lucknow)
Dr. Umesh Chandraa Lavania (Lucknow)
Dr. Pankaj Kumar Srivastava (Lucknow)
Dr. Pramod Arvind Shirke (Lucknow)
Dr. Purushothaman C. Abhilash (Varanasi)
Dr. Ayyanadar Arunachalam (Jhansi)
Dr. Purabi Saikia (Varanasi)
Prof. Rana Pratap Singh (Lucknow)

Advisors

Dr. Prafullachandra Vishnu Sane (Lucknow)
Prof. Chandra Kumar Varshney (New Delhi)
Dr. Khwaja Jalaluddin Ahmad (Lucknow)
Prof. Arun Arya (Baroda)
Prof. Ravinder Kumar Kohli (Chandigarh)
Prof. Mohd Latif Khan (Sagar)
Prof. Saroj Kanta Barik (Shillong)
Prof. Lena Q. Ma (China)
Prof. Pramod Tandon (Lucknow)
Prof. Elina Oksanan (Finland)

International Journal of Plant and Environment

Chief Editor

Dr. Rudra Deo Tripathi (Lucknow)
Dr. Prafullachandra Vishnu Sane (Lucknow)
Prof. Albert Reif (Germany)

Environews

Chief Editor

Dr. Nandita Singh (Lucknow)
Dr. Vivek Pandey (Lucknow)

Editor

Dr. Sudhakar Srivastava (Varanasi)
Dr. Seema Mishra (Lucknow)

Contact for Membership of Society:
Secretary
International Society for Environmental Botanists
CSIR-National Botanical Research Institute, Lucknow - 226001, India
Email: isebnbrilko@gmail.com; Website: isebindia.in
Phone: 0522-2297821 / +91-7376679779

ICPEP-7
7th International Conference on Plants and Environmental Pollution

Sponsors

CSIR-Human Resource Development Group (HRDG), New Delhi

Anusandhan National Research Foundation (ANRF), DST, New Delhi

International Union of Biological Sciences (IUBS), Paris

Uttar Pradesh State Biodiversity Board, Lucknow

National Bank for Agriculture and Rural Development (NABARD), Mumbai

CSIR-National Botanical Research Institute (NBRI), Lucknow

CSIR - Indian Institute of Integrative Medicine (IIIM), Jammu

CSIR-Institute of Himalayan Bioresource Technology (IHBT), Palampur

CSIR- Central Institute of Mining and Fuel Research (CIMFR), Dhanbad

CSIR – Indian Institute Of Toxicology Research (IITR), Lucknow

CSIR - Central Food Technological Research Institute (CFTRI), Mysuru

CSIR-North East Institute of Science and Technology (NEIST), Jorhat

CSIR-Indian Institute of Petroleum (IIP), Dehradun

CSIR-Advanced Materials and Processes Research Institute (AMPRI), Bhopal

CSIR - Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow