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From President's Desk

Gene-Editing Breakthroughs: Pioneering Sustainable Technology in Crop Protection

Gene-editing technology, which involves precise modification of an organism's DNA to achieve desired traits, has revolutionized agriculture. This groundbreaking tool offers unprecedented potential for sustainable crop protection, enabling scientists to enhance crops resistance to pests and diseases while reducing reliance on chemical interventions. Among the various contemporary techniques, CRISPR-Cas9 stands out as a powerful tool, allowing precise targeting and editing of specific genes. By harnessing such advanced technologies, agriculture is moving toward a more resilient and sustainable future.

Traditional methods of improving disease resistance in crops relied heavily on breeding techniques or chemical inputs. While effective in many cases, these methods often lacked precision and efficiency, leading to unintended ecological and genetic consequences. By contrast, gene-editing tools like CRISPR-Cas9 offer a targeted, rapid, and precise alternative. These tools can introduce resistance traits at the molecular level, enhancing specific characteristics without altering unrelated genetic material. This innovation not only accelerates crop improvement but also reduces the environmental footprint of traditional farming practices.

CRISPR-Cas9 has proven transformative in developing crops with enhanced resistance to diseases and pests. Unlike broad-spectrum chemical solutions, CRISPR focuses on targeted genetic modifications to improve plant resilience.

For instance, rice has been engineered for resistance to bacterial blight through modifications to the *SWEET14* gene, while wheat varieties resistant to powdery mildew have been developed by altering the *TaMLO* gene. Similarly, tomatoes with resistance to bacterial wilt were created by targeting the *Pto* gene, and potatoes with immunity to late blight were engineered by modifying the *Rpi-vnt1.1* gene. These precise genetic interventions significantly reduce crop losses and dependence on chemical pesticides, marking a critical step toward sustainable agricultural practices.

Advanced CRISPR systems, such as CRISPR-Cas12 and Cas13, offer greater precision and enable applications in editing complex traits. These advancements make gene-editing tools more versatile and effective, fostering their adoption across diverse agricultural systems.

Gene-editing technology is not limited to improving disease resistance; it also enhances the nutritional value of crops to address global health challenges. For example, rice has been fortified with higher levels of iron and zinc to combat widespread micronutrient deficiencies. Similarly, CRISPR has been used to boost essential amino acids, antioxidants, and vitamins in staple crops, significantly improving their nutritional profiles and supporting human health worldwide.

Moreover, agriculture productivity has been a major focus in developing nations, including India. By targeting genes involved in growth and stress responses, scientists are engineering crops with enhanced yield and adaptability. CRISPR modifications to genes influencing flowering time, root development, and photosynthetic efficiency have yielded plants that perform better under diverse environmental conditions. This ensures food security and resilience amid climate change and global population growth.

Recent advancements in genome editing

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technologies have significantly transformed the landscape of plant breeding and genetic research. These tools have enabled precise and targeted modifications in plant genomes, offering solutions to global challenges such as food security, climate change, and sustainable agriculture.

India's regulatory framework has embraced scientific innovation in genome editing by exempting products developed through Site-Directed Nuclease 1 (SDN1) and Site-Directed Nuclease 2 (SDN2) technologies from the stringent regulations typically applied to genetically modified organisms (GMOs). Unlike SDN3, which involves inserting foreign DNA, SDN1/2 methods induce targeted edits or small nucleotide changes within the plant's native genome without introducing external genetic material. This exemption reflects India's recognition of these techniques as safe and comparable to traditional breeding methods, potentially accelerating the adoption of genome-edited crops that are more resilient, productive, and sustainable.

Base editing and *prime editing* are transformative genome editing tools. Base editing employs enzymes like cytidine or adenine deaminase to convert nucleotides, enabling precise point mutations without double-strand breaks (DSBs), ideal for correcting single nucleotide variations. Prime editing, using a reverse transcriptase enzyme and modified guide RNA, allows accurate rewriting of genetic sequences for targeted insertions, deletions, or substitutions. Both methods enhance crop traits such as drought resistance and nutritional profiles while minimizing off-target effects, offering powerful solutions for precision plant breeding.

Single guide RNA (sgRNA) is pivotal in CRISPR-Cas systems, directing the Cas nucleases to specific genomic sites. Recent innovations, such as the use of *tracr-L* (tracrRNA linkers), have improved the stability and efficiency of sgRNAs. These modifications enhance the precision of genome editing in plants, facilitating the creation of improved varieties with desired traits while maintaining their genetic integrity.

Gene-editing technology addresses growing concerns about the environmental impacts of traditional agriculture. By reducing dependence on chemical fertilizers and pesticides, genome-edited crops minimize soil and water contamination and protect non-target organisms. For example, editing genes to improve nitrogen-use efficiency reduces the need for synthetic fertilizers, lowering greenhouse gas emissions from agriculture. These advancements align with the goals of sustainable farming and climate resilience, making gene-editing a vital tool in mitigating environmental degradation.

Despite its promise, gene-editing faces challenges, including the potential for off-target effects where unintended genetic changes occur. Continuous improvements in precision tools like CRISPR-Cas9 aim to mitigate these risks. Ethical concerns also surround the use of genome-editing technologies, particularly in terms of accessibility and equity. Ensuring that smallholder farmers can benefit from these innovations is critical for global adoption. Additionally, harmonized regulatory frameworks are necessary to address public concerns and facilitate the commercialization of genome-edited crops.

In conclusion, advanced genome editing tools like CRISPR-Cas9, base editing, and prime editing, coupled with regulatory support such as SDN1/2, represent transformative solutions for sustainable agriculture. These technologies enable precision in developing crops with enhanced nutritional quality, higher yields, resilience to stresses, and resistance to diseases and pests, while accelerating breeding processes.

D.K. Ghosh
President
Indian Phytopathological Society

Research Highlights

Transcriptome analysis of *Bipolaris sorokiniana* - *Hordeum vulgare* provides insights into mechanisms of host-pathogen interaction

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Spot blotch disease incited by *Bipolaris sorokiniana* severely affects the cultivation of barley. The resistance to *B. sorokiniana* is quantitative in nature and its interaction with the host is highly complex which necessitates in-depth molecular analysis. Thus, the study aimed to conduct the transcriptome analysis to decipher the mechanisms and pathways involved in interactions between barley and *B. sorokiniana* in both the resistant (EC0328964) and susceptible (EC0578292) genotypes using the RNA Seq approach. In the resistant genotype, 6,283 genes of *Hordeum vulgare* were differentially expressed out of which 5,567 genes were upregulated and 716 genes were downregulated. 1,158 genes of *Hordeum vulgare* were differentially expressed in the susceptible genotype, out of which 654 genes were upregulated and 504 genes were downregulated. Several defense-related genes like resistant gene analogs (RGAs), disease resistance protein RPM1, pathogenesis-related protein PRB1-2-like, pathogenesis-related protein 1, thaumatin-like protein PWIR2 and defensin Tm-AMP-D1.2 were highly expressed exclusively in resistant genotype only. However, pathways involved in MAPK signaling, plant-pathogen interaction, and plant hormone signal transduction were highly enriched in resistant genotype. Further, a higher number of pathogenicity genes of *B. sorokiniana* was found in response to the susceptible genotype. The pathways encoding for metabolism, biosynthesis of secondary metabolites, ABC transporters, and ubiquitin-mediated proteolysis were highly expressed in susceptible genotype in response to the pathogen. 14 and 11 genes of *B. sorokiniana* as candidate effectors were identified from susceptible and resistant host backgrounds respectively. This investigation will offer valuable insights into unraveling the complex mechanisms involved in barley- *B. sorokiniana* interaction (Source: *Front. Microbiol.* 15:1360571. doi: 10.3389/fmicb.2024.1360571).

A method of preparing antibacterial spray botanical extract from *Lantana camara*

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Phytoplasma is an emerging plant pathogen that causes severe diseases in number of plant species in last two decades. In the view of its severity still management of phytoplasma is a big challenge among the researchers. No any effective control strategy has been developed to manage phytoplasmas. In this invention we are able to develop a method by using *Lantana camara* green unripe berries extract to mitigate the symptoms of phytoplasma and shows fast recovery in chilli plant associated with little leaf disease caused by 16SrVI group of phytoplasma. To our knowledge this is the novel work in the management of phytoplasma globally. Source: PATENT (IPR, Publication Date: 15/11/2024)

(a) (b)

Fig. 1. (a) shows result after first treatment with *Lantana* extract; and (b) after second treatment with *Lantana* extract on same symptomatic chili plant

Prosopis juliflora: Potential Carbohydrate Source for Optimized *Trichoderma harzianum* Growth

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Mesquite (*Prosopis juliflora*) serves as a versatile tree of arid and semi-arid regions. Mature trees yield approximately 50 kg of pods annually which are non-palatable for human consumption. These pods boast high carbohydrate content and contain the growth hormone triacontanol. In the present study, an attempt was made to utilize these pods as a substitute for

chemical sugar sources in culture media for the growth of *Trichoderma*. It was found that highest mycelial biomass yield of *Trichoderma harzianum* was obtained on *Prosopis juliflora* pods (PJP) (Fig. 1). It was further proved by counting the population of *T. harzianum* on Th selective media after 15 days (Fig. 2). Thus, through this investigation, it could be concluded that PJP pods would be helpful in enhancing the conidial growth of *T. harzianum* during mass multiplication of biocontrol agent thus minimizing the cost of production as these pods are abundantly available freely in environment. (Source: Indian Phytopathology https://doi.org/10.1007/s42360-024-00801-6)

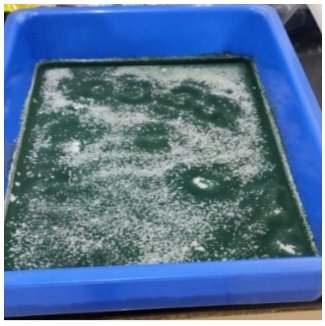


Fig. 1. Profuse sporulation of *T. harzianum* in *Prosopis juliflora* pods (PJP) extract

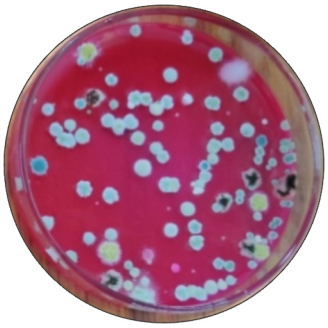


Fig. 2: Population count of *T. harzianum* at 10^{10} serial dilution on PJP extract

Awards/Honours

- **Dr. Pratibha Sharma**, Former President, Indian Phytopathological Society, New Delhi awarded with Aqua Foundation's Excellence Award 2024 for "Life Time Achievement" by Aqua Foundation, New Delhi on 18th November 2024 for her immense contribution in the field of Agriculture.
- **Dr. Dilip Ghosh**, Director, ICAR-Central Citrus Research Institute (CCRI), Nagpur has been recognized with an Honorary Fellow Award from the Korean Society of Citrus and Subtropical Climate Fruits (KSCSCF) for his significant contributions to global citrus research. He was also appointed as the first Indian Executive Member of the International Society of Citriculture (ISC) and participated in the ISC executive committee meeting, representing India's citrus research priorities on the global platform.

Symposia/Workshop: Attended

- **Dr. Dilip Ghosh**, Director, ICAR-Central Citrus Research Institute (CCRI), Nagpur and President of Indian Phytopathological Society, New Delhi, participated in the 15th International Citrus Congress (ICC) held in Jeju, South Korea, from November 10-15, 2024. The congress, jointly organized by the International Society of Citriculture (ISC), International Society for Horticultural Science (ISHS), and the Korean Society of Citrus and Subtropical Climate Fruits (KSCSCF), brought together nearly 600 researchers, policymakers, and industry stakeholders from across the globe to discuss sustainable citriculture under the theme "Human-healthily, Environment-friendly, Industry-productively."
- **Dr. Satish K. Sain**, Principal Scientist & Principal Investigator-AICRP on Cotton (Pathology) participated in the World Cotton Research Conference-8 (WCRC-8) organized by the International Cotton Advisory Committee (ICAC) in collaboration with the Ministry of Agriculture of the Republic of Uzbekistan, the ICAC, the International Cotton Genome Initiative (ICGI), and the International Cotton Researchers Association (ICRA) from 4-10 October 2024 at the International Hotel Tashkent, Tashkent, Uzbekistan. Dr Sain presented an oral paper "Selection of novel entomopathogenic fungi to manage Bemisia tabaci under integrated and organic cotton cultivation systems".
- ICAR Sponsored 21 days Winter School Training on "Recent Pest and Disease management tools and techniques for horticultural crops in Organic and Natural Farming through hands on experience" on 17 Jan 2025 to 06 Feb 2025. The program ICAR, New Delhi and Institute of Organic Farming, UAS, Dharwad, Karnataka. The coordinator of the training is Dr. Shripad Kulkarni, Professor (Plant Pathology) & Head, Institute of Organic Farming, UAS, Dharwad, Karnataka, India.

IPS Symposia 2024-25

IPS Northern Zone Symposium

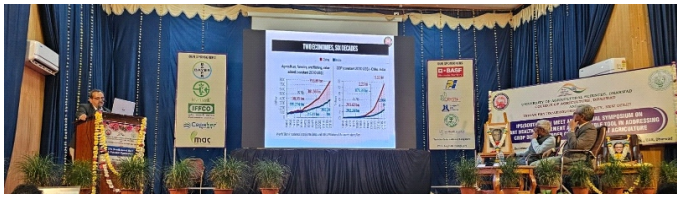
IPS North Zone Meet and National Symposium of Himalayan Pathological Society on "New Vistas in Plant Pathological Research" was held at CSK Himachal Pradesh Krishi Vishvavidyalaya during 7-8th November, 2024. The symposium was jointly organized by Indian Phytopathological Society-Northern Zone in collaboration with Himalayan Pathological Society, Department of Plant Pathology, UHF, Nauni, Solan, Himachal Pradesh, and 125 delegates participated in the conference. This conference was organized by Dr. Pardeep Kumar, Zonal President and Dr. Shikha Sharma of IPS-NZ.

IPS Eastern Zone Symposium

IPS Eastern Zonal Meet and National Conference on "Holistic Approaches for Biotic and Abiotic Stress Management in Crops for Sustainable Agriculture" was organized by ICAR-NRRI-Central Rainfed Upland Rice Research Station, Hazaribagh, Jharkhand, in collaboration with Indian Phytopathological Society, New Delhi during November 28-29, 2024 at ICAR-NRRI-CRURRS, Hazaribag campus, and 110 delegates participated in the conference. In this two-days conference, there were 04 Plenary Lectures, 01 Presidential Lecture, 12 Lead Lectures/Invited Lectures, 35 Oral Presentations and 14 Poster presentations covering four themes. This conference The conference was organized by Dr. Someshwar Bhagat, Zonal President and Dr. (Mrs) Amrita Banerjee, Zonal Councillor of IPS-EZ.

IPS Southern Zone Symposium

IPS South Zone Meet and National Symposium was organised by UAS Dharwad during 11-12 December, 2024. More than 200 delegates from seven different states & more than 10 different institutions/ SAUs/ Private Industries participated in the programme. During the symposium, 12 Invited talks, 10 Lead Lectures and 25 Oral presentations and 150 poster presentations were made in two days symposium spread over six themes. This conference was organized by Dr. Shamarao Jahagirdar, Zonal President and Dr. V.R. Kulkarni, Zonal Councillor of IPS-SZ.

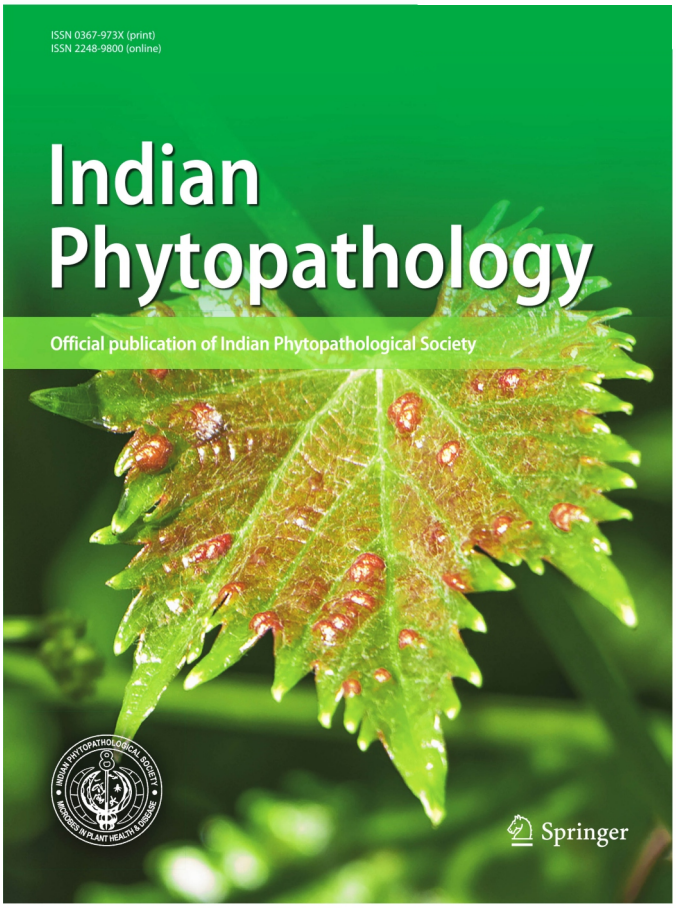


IPS Central Zone Symposium

IPS Central Zone Meet and Deccan Society of Plant Pathologists (DSPP) National Conference on "Recent Advances in Plant Pathology and Innovative Approaches in Plant Disease Management (RAPPID)" was organized by the IPS-Central Zone and the Deccan Society of Plant Pathologists (DSPP). The event was held on December 12-13, 2024, at the main auditorium of PJTAU, Hyderabad, Telangana. The conference witnessed active participation from 180 registered delegates and 50 additional participants, including 4 keynote speakers, 12 lead speakers, and 34 chairpersons and co-chairpersons. This conference was organized by Dr. B. Vidyasagar, Zonal President and Dr. G. Rajesha, Zonal Councillor of IPS-CZ.

Obituary

- **Dr. B.K. Giri**, former Principal Scientist, Division of Plant Pathology, ICAR-IARI, New Delhi passed away on 18th December, 2024 morning at Dwarka, New Delhi. Besides a plant virologist, he was a very noble person.
- **Dr. B.P. Singh**, Former Scientist F, Senior Deputy Director, CSRI-NBRI, Lucknow, Uttar Pradesh passed away on 28th December, 2024 evening in Medanta, New Delhi. Dr. Singh was a very senior Plant Virologist in India. He established Plant Molecular Virology Laboratory at NBRI, Lucknow and supervised about 35 PhD students and published about 250 research papers and six books.
- **Dr. G.D. Deshpande**, Former Head (Plant Pathology), VNMKV, Parbhani, Maharashtra passed away on 14th December, 2024 in Pune, Maharashtra. He worked in various positions in university and contributed a lot in Plant Pathology.



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