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SALINITY NEWS

From Directors' Desk

The ICAR-CSSRI established in 1969 is an esteemed centre of excellence in salinity research, focusing on reclamation and management of saline and alkali soils. Apart from its achievements in reclamation of vast areas of saline and alkali soils in the country, the institute has offered a number of alternative technologies for reclamation and management of salt affected soils. The institute has developed site-specific technologies for reclaiming salt-affected lands, including salt-tolerant crop varieties, gypsum-based amendments, alternatives to gypsum, subsurface drainage technology, agronomic interventions, and use of poor-quality water for agriculture. ICAR-CSSRI has a focused mandate of developing and deploying technologies for productive utilization of salt affected soils and poor-quality water for agricultural purposes. Nearly 2.20 million ha salt affected lands have been reclaimed and put to productive use. It has been estimated that reclaimed area is contributing more than 15 million tonnes foodgrains to the national pool. CSSRI is actively involved in addressing salinity and sodicity stress through the dissemination of appropriate location–specific strategies. Recent advancements are introducing novel approaches to land reclamation, grounded in innovative biological and chemical strategies that have not been previously explored. These innovations present valuable opportunities for enhancing the productivity of salt-affected soils. However some complex challenges have also emerged across both regional and national contexts. To effectively address these, continued research and the refinement of technologies is essential for advancing toward sustainable food security.

This volume of Salinity News (July-December, 2024) includes following listed major research achievements: Development of fungal consortia bioformulation "Halo-CaRe" for in-situ and ex-situ crop residue decomposition and recycling soil carbon, From salinity to sustainability: building capacities for date palm cultivation in Haryana, Challenges for precise genome editing in wheat using CRISPR/Cas system, Spatial analysis of waterlogged sodic soils in Sharda Sahayak canal command of Pratapgarh district using Sentinel-2 satellite images and Abundance of arbuscular mycorrhizal fungal community in different rice varieties. This newsletter also contains brief details of different programs organized during this period: Hindi Pakhwada 2024, Swachhta Pakhwada and Kisan Diwas 2024 Celebration. This issue also includes gallery of images of differennt events & activities of the Institute during the period.

(R.K. Yadav)
Director

In This Issue.....

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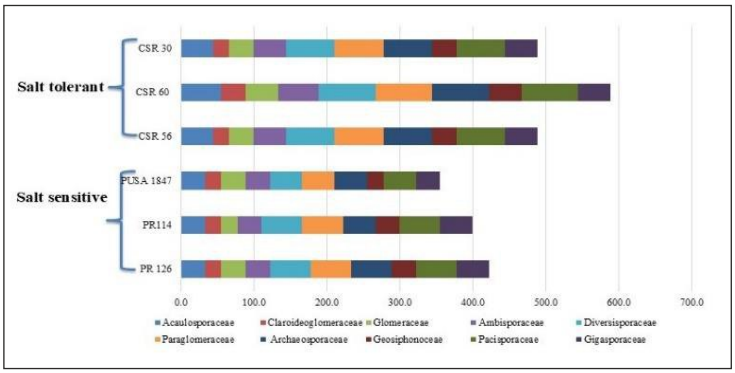
Abundance of arbuscular mycorrhizal fungal community in different rice varieties

Arbuscular mycorrhizal fungi (AMF) play a crucial role in nutrient uptake, particularly phosphorus. However, the advantages of AMF symbiosis for the host plant depend on various factors, including the plants species and variety, as well as the AMF involved. Most plant species, including crops, exhibit responsiveness to mycorrhizal symbiosis. The extent of this response is influenced by factors such as crop variety, physiological stages of the host plant (*i.e.* seedling, tillering, heading and ripening), root traits. AMF colonization is also dependent on soil properties such as pH and management practices. Traditionally, AMF abundance and diversity have been assessed through spore extraction and morphological identification of spores. The molecular techniques, particularly PCR-based methods, have helped in revealing ecological diversity and complexity among AMF and their interactions with host plants. In this study, AMF community abundance has been estimated through molecular approaches in different rice varieties. The abundance of AMF varied with different rice varieties and distinct difference was observed in between salt-tolerant and salt-sensitive cultivars. A significantly higher abundance and diversity of AMF families were observed in the salt-tolerant varieties (CSR 30, CSR 60, and CSR 56) compared to the salt-sensitive varieties (PUSA 1847, PR114, and PR 126) (Figure). CSR 60 exhibited the highest AMF abundance, followed by CSR 56 and CSR 30, indicating a strong symbiotic association that may contribute to their enhanced salt tolerance. Predominant AMF families such as *Glomeraceae*, *Pacisporaceae*, and *Ambisporaceae* were consistently more abundant in these tolerant varieties. In contrast, salt-sensitive varieties showed lower AMF abundance and less diverse AMF community. Salt-tolerant varieties associate with more diverse AMF community under salt stressed conditions, potentially aiding their resilience through enhanced nutrient uptake and stress tolerance mechanisms.



The variation of AMF abundance in different rice varieties

Priyanka Chandra, Pooja Dhuli, Arvind Kumar Rai, Parul Sundha and Nirmalendu Basak

From salinity to sustainability: Building capacities for date palm cultivation in Haryana

A RKVY funded research project "Development of sustainable production system for the date palm in salt affected soils of Haryana" aims to address the identification of date palm varieties suitable for Haryana. The project mandates to understand the physiological bases of salt tolerance in date palm and to promote sustainable production strategies for date palm cultivation through capacity building and exposure visit programmes. This pioneering initiative was conceived in response to the growing need for high-value horticultural crops that can thrive under the challenging agro-climatic conditions of Haryana, particularly in regions burdened with salinity and sodicity. The date palm (Phoenix dactylifera L.), a resilient and economically viable fruit crop, holds immense promise due to its exceptional adaptability to arid and semi-arid environments and its moderate to high tolerance to salinity. The Date palm orchards have been established at six locations (one acre at each site) in different parts of Haryana. Similarly the planting of the date palm has been done on reclaimed sodic soils of CSSRI Experimental Farm, Karnal. While

Dohki, Bhiwani

Barwas, Bhiwani

Kathura, Sonipat

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IIWBR Farm, Hisar

Sajuma, Kaithal

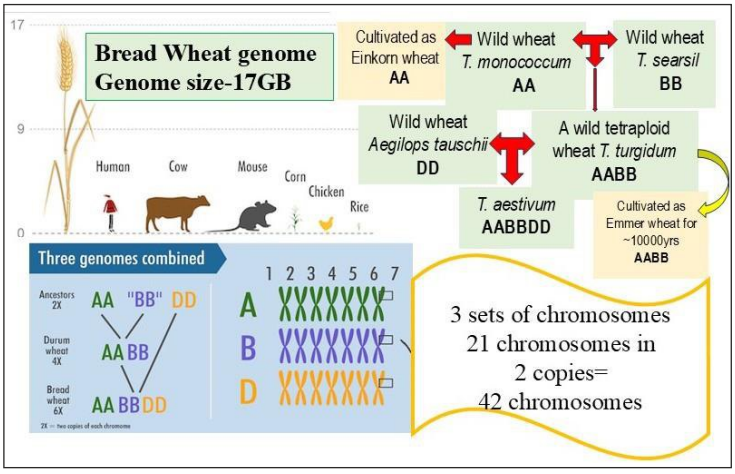
CSSRI, Karnal

under saline soils, the plantations were made at ICAR- IIWBR Farm (Hisar); under subsurface sodicity at Sajuma (Kaithal), under waterlogged saline soils of Kathura (Sonipat), normal soil and saline water irrigation of Dohki & Barwas (Bhiwani) and dry land salinity in sand dunes of Madhogarh (Mahendergarh), respectively. Comprehensive physiological assessments encompassing parameters such as osmotic potential, ion regulation (Na^+ and K^+ dynamics), chlorophyll content, stomatal conductance, photosynthetic rate, and proline accumulation are being monitored from time to time to decipher the salt tolerance mechanisms and to determine varietal performance. In addition to varietal identification and physiological evaluations, the project emphasizes the dissemination of sustainable agronomic and soil reclamation practices such as the application of organic amendments (e.g., farmyard manure, press mud), use of gypsum and bio-fertilizers, efficient drip irrigation systems, and proper planting techniques for improving soil health and enhancing date palm productivity. The project outcomes have not only contributed to the diversification of agriculture in Haryana but also laid a foundation for transforming saline lands into productive horticultural hubs, thereby aligning with the broader goals of sustainable agriculture, resource conservation, and rural livelihood enhancement.

Rajkumar, Suresh Kumar, Ashwani Kumar, Arvind Kumar, Nirmal Singh and RK Yadav

Challenges for precise genome editing in wheat using CRISPR/Cas system

Gene editing, especially using CRISPR-Cas systems, has revolutionized plant science by enabling researchers to modify DNA with unprecedented accuracy. Genome editing holds great promise for improving wheat varieties by enhancing yield and biotic or abiotic stress tolerance. However, several challenges hinder the effective application of these technologies in wheat with a complex genome. Wheat is not just a staple crop, its genome is a genetic giant as one of the largest among sequenced plant genomes, with an estimated size of around 16 to 17 gigabases (Gb). Unlike simpler diploid plants such as rice or maize, bread wheat (*Triticum aestivum*) carries a hexaploid genome composed of three distinct sub-genomes: A, B, and D, meaning it has three sets of homologous chromosomes each derived from different ancestral species (figure). As a result, most genes are present in three or more copies, known as homeologs. To achieve a complete knockout or desired modification of a gene, all these homeologous copies must be precisely targeted and edited. If even one copy escapes editing, the remaining functional gene can mask the intended effect, rendering the trait modification incomplete or ineffective. While this genomic redundancy contributes to wheat's adaptability and resilience, it also presents significant obstacles to precise gene editing. The polyploidy complexity makes it difficult to target and modify specific genes accurately without affecting similar copies, which can lead to unintended consequences or reduced effectiveness of edits. This makes it necessary to edit all homeologous copies simultaneously



Schematic diagram of the relationships between wheat genomes with polyploidization history and genealogy

to observe the desired trait, increasing the complexity of the editing task. Another challenge is for target specificity and designing CRISPR-Cas guide RNAs that can either target all gene copies or discriminate among them. High sequence similarity among homeologs raises the risk of off-target effects or inefficient targeting, complicating precise genetic modifications. Not all gene copies contribute equally to gene function or expression. Some homeologs may be more active or important for a particular trait, but distinguishing and selectively editing these requires detailed knowledge of gene expression and function, which is another research target. Editing multiple copies can lead to chimeric or incomplete mutations, where some copies are edited and others are not. This variability can make it difficult to analyze results or breed stable lines without extensive genotyping and backcrossing. Further, editing multiple copies means more screening is required to identify lines where all relevant copies have been successfully mutated. Addressing these challenges through advanced delivery systems like multiplexing, prime or base editing offer new possibilities for introducing precise edits in wheat. In view of the aforementioned challenges, we at ICAR-CSSRI are focusing on the *TaSal1* and *TaTre1* genes to enhance salt tolerance in wheat. *TaSal1* has 12 homeologous copies on 4A, 5A, 5B, 5D, 7A chromosomes while *TaTre1* has three homeologous copies on 1A, 1B & 1D chromosomes. For *TaTre1*, guide RNAs (gRNA) have been designed, and the corresponding four gene constructs has been cloned into *E.coli*. This construct is currently being utilized for *Agrobacterium*-mediated transformation of wheat embryos, aiming to generate gene-edited lines with improved salt tolerance.

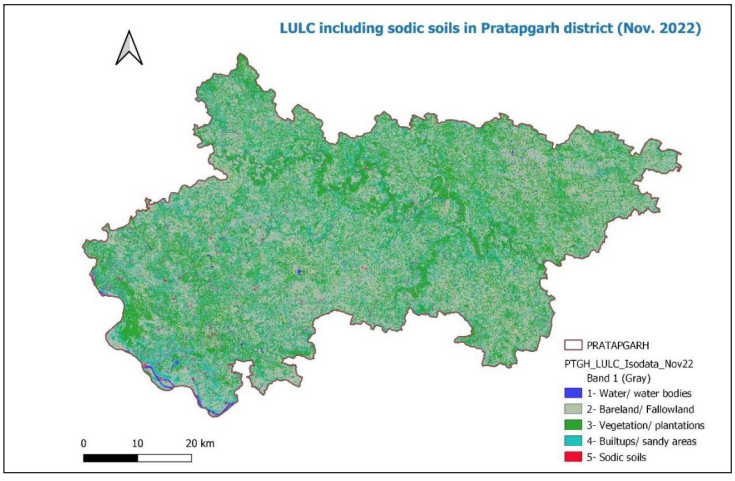
Anita Mann, Noyonika, Poonam, Priti, Sujata, Harish, Avni, Ashwani Kumar, Arvind Kumar and SK Sanwal

Spatial analysis of waterlogged sodic soils in Sharda Sahayak canal command of Pratapgarh district using Sentinel-2 satellite images

Depthwise geo-referenced soil samples have been collected from 15 sites in the Sharda Sahayak Canal Command from Pratapgarh district of Uttar Pradesh. These were analysed for assessment of sodicity. It was observed that in surface soil, the pH ranged from 7.58 to 10.73 and the pH generally decrease with soil depth with some exceptions. Soil EC varied from 0.48 to12.89 dS m^{-1} with more than 50% samples having EC of more than 4 dS m^{-1} indicating occurrence of salinity along with sodicity in the area. Soil organic carbon content was in between 0.11 to 0.80% in surface soil. Sodium content ranged from 7.304 to 716.52 meq L^{-1} in saturation extract and its relation was found to be exponential with pH (R^2=0.64). The sodium content generally decreases with increase in soil depth at all the sites indicating flushing of salts with canal water seepage. Potassium content also behaved similar to Na having higher content in surface soil (0.25 to 18.37 meq L^{-1}) and decreased with depth at all the locations. Sentinel-2B remote sensing data was downloaded for Nov. 2022 and pre-processed, analysed using an open source software Quantum GIS. Remote sensing images were classified for mainly five land uses and land covers (LULC): Vegetation/plantation, fallow/ bare land, water/ water bodies, built-ups/ sandy areas and sodic soils. Unsupervised method of classification (ISODATA) was applied and then desired classes were identified with the help of false colour composite and ground check points. Preliminary estimates showed that area under sodic soils was 6494.10 ha in Pratapgarh district, which is about 0.87 % of district area (Table). Vegetation/ plantation and fallow/ bare land accounted for about 21.6 and 60.5 percent area, respectively. The accuracy of the area under sodic soils was done with the help of GPS points collected in May-June, 2023.

LULC of Pratapgarh district using Sentinel-2B data for Nov. 2022

Class #	LULC Class	Area (ha)	Area (%)
1	Sodic soils	6494.10	0.87
2	Vegetation/ plantations	161965.40	21.65
3	Builtups/ sandy area	122990.82	16.44
4	Bareland/ fallow land	452590.37	60.50
5	Water/ water bodies	4012.07	0.54
		748052.76	



LULC mapping of Pratapgarh district in Sharda Canal command

R.H. Rizvi, Sanjay Arora, C.L. Verma, and Shailendra Verma

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Halo-CaRe: Fungal consortia bioformulation for in-situ and ex-situ crop residue decomposition and soil carbon recycler

Lignocelluloytic fungal strains were isolated from sodic soils and were screened and characterized following standard protocol. The strains were tested for their efficacy in-vitro and in-vivo for decomposing residues of rice, wheat and sugarcane. In field experiments with rice and wheat crop residues, it was observed that fungal consortia was more effective upto 19.8% in residue decomposition over Halo-CRD in terms of crop yields and recycling of nutrients. Decomposition rate was maximum of 72.6% in 21-24 days with consortia of four efficient and compatible fungal strains. The results affirmed that microbially mediated in-situ degradation of paddy and wheat crop residues can be a viable option to combat residue burning. The liquid formulation "Halo-CaRe" of efficient fungal consortia was developed in standardized carrier media for rapid crop residue decomposition and recycling soil carbon. The developed formulation was found useful for recycling of soil carbon mediated through decomposition of residues of crops in sodic soils.

Halo-CaRe

Sanjay Arora, Atul K. Singh and Madhu Choudhary

Hindi Pakhwada 2024

Hindi Pakhwada was organized at the Institute from 17 to 30 September 2024. It was organized by the committee of Dr. Ashwani Kumar, Sr. Scientist, Dr. Raj Kumar, Sr. Scientist, Dr. Avni, Scientist and Shri Brahm Prakash, Administrative Officer. Hindi Pakhwada was inaugurated on 17th September 2024 by Shri Neeraj, Commissioner Municipal Corporation, Karnal. Shri Neeraj, the chief guest at the *Hindi Pakhwada* inauguration ceremony, stated that since India's independence, the influence of Hindi has steadily grown across various fields, including cinema, print media, and especially on social media platforms. He encouraged everyone to express their thoughts and emotions in Hindi, highlighting it as a strong and expressive medium. As part of the Hindi Pakhwada celebrations, a total of 12 competitions were organized for all staff and students of the Institute. Officers and employees participated in these events with great enthusiasm and interest, showing their active involvement and support for promoting the use of Hindi. The closing ceremony of *Hindi Pakhwada* was organized on 30th September 2023 in which Smt. Mansi, Principal, Beanstalk Junior School, chief guest stated that it is very important to work in the mother tongue for the progress and unity of the country. The *Rajbhasha* Hindi is the supreme medium to unite all the countrymen. Dr. RK Yadav, director, emphasized upon the importance of Hindi language and encouraged all the employees of the institute to work in Hindi language as much as possible.

Shri Neeraj addressing the audience

District Level Hindi Note & Draft Writing Competition

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Swachhta Pakhwada and Kisan Diwas 2024 Celebration

Like every year, Swachhta Pakhwada was celebrated by the institute from 16th to 31st December 2024, incorporating Kisan Diwas celebrations on 23rd December 2024.The observance commenced on 16th December with the Swachhta Pledge Day at the institute. Dr. S. K. Sanwal, Director (A), ICAR-CSSRI, led the staff in taking the cleanliness pledge, emphasizing the institute's commitment to hygiene and environmental responsibility. The event saw active participation from scientific, technical, administrative, and supporting staff, as well as RAs, SRFs, and students. Dr. Rajkumar, Nodal Officer for Swachhta Pakhwada, briefed attendees about the planned activities and awareness drives scheduled throughout the fortnight. In continuation of the Pakhwada activities, a Kisan Diwas cum Swachhta Awareness Programme was organized on 23rd December 2024 in Kathura village under the Farmer FIRST Project (FFP). The event, led by Dr. Rajkumar (PI, FFP) along with Dr. Suresh and Dr. Ashwani Kumar, engaged 35 enthusiastic farmers from the village. The programme aimed to promote sustainable farming practices and highlight the importance of cleanliness in agricultural settings. As part of the initiative, farmers received essential agricultural inputs such as spray pump machines, nano-urea, and zinc supplements to boost crop productivity and soil health. An interactive Kisan Goshthi was held where farmers discussed field challenges and received expert advice on efficient resource utilization, soil management, and the benefits of nano-fertilizers. The celebration also emphasized the integration of Swachhata awareness with agricultural development. Farmers took a cleanliness pledge and were educated on waste management, hygienic practices, and eco-friendly farming methods. The distribution of inputs and the knowledge-sharing sessions were well-received, reflecting the farming community's readiness to adopt advanced and sustainable agricultural practices.The combined efforts of ICAR-CSSRI and the Farmer FIRST team reinforced the message that cleanliness and modern agriculture go hand in hand in building a healthier, more sustainable rural future.

Employees gathered for Swachhta Pledge

Farmer-Scientist interaction on Kisan Diwas

Distribution of agricultural items to farmers

Swachhta Pakhwada Celebration with Farmers

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Institute Events & Activities

Farmer awareness program (11 October 2024)

Employees taking Oath during Vigiliance Awareness Week (28 Oct 2024)

Director, CSSRI welcoming Japanese Scientists (12 July 2024)

Independence Day 2024 celebration

IJSC Online Meeting with staff (10 December 2024)

School students exposure visit (23 July 2024)

Training program on farm and lab management (17-23 October 2024)

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Institute Events & Activities

13th Advanced International Course on Conservation & Regenerative Agriculture (3-23 Dec, 2024)

Hindi Timahi Baithak (25 November 2024)

Quinquennial Review Team meeting (8-10 July 2024)

Institute Management Committee Meeting (9 July 2024)

Dr. Himanshu Pathak, DG, ICAR visited CSSRI on 26th October 2024 - delivered lecture in National Dialogue on Paddy Straw Management (left) and interacted with the Institute Staff (right)

Published by :
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ICAR-Central Soil Salinity Research Institute, Karnal

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