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Microbial assisted in-situ paddy straw residue management under Rice-Rice and Rice-Wheat Cropping system

P. Panneerselvam, Sandeep Sharma, Rajendra Singh Garhwal, P. K. Sahoo, Upendra Kumar, Anjani Kumar, Md. Shahid, Debasis Mitra, Ansuman Senapati, Satish D Lande and Roaf Ahmad Parray

ICAR- CENTRAL RICE RESEARCH INSTITUTE
CUTTACK – 753006, ODISHA, INDIA

Rice straw residue management has become more challenging with intensive agricultural operations in our country. There are many scientific bioprocessing methods available for transforming of rice straw from agricultural waste into value-added products. However, the disposal of rice stubbles and straw post-harvest remains a substantial challenge across various rice-growing regions. The improper management of paddy straw residues in field will lead to many issues such as nutrient immobilization, increase in pest and disease and GHGs emission etc. To address these challenges, sustainable agricultural practices those enhance the soil quality and crop productivity are essential. The microbial interventions for in-situ residue management would be one of the best alternatives for recycling of residues, which will enhance nutrient cycling, decomposition, and overall soil ecosystem services. In view of the above, ICAR-CRRI in collaboration with ICAR-IARI, New Delhi, PAU, Ludhiana and HAU, Haryana under National Agricultural Science Fund (ICAR-NASF) project developed the microbial assisted in-situ paddy straw residue management under Rice-Rice and Rice-Wheat cropping system.

Efficient lignocellulolytic microorganisms *viz*., *Trichoderma* sp. (NRRI-CPD-COMF6), *Aspergillus* sp. (NRRI-CPD-COMF10-5), *Streptomyces* sp. (NRRI-CPD-COMA4), and *Bacillus* sp. (PAU 5-B13) were isolated from soils cultivated with rice and wheat. These strains were selected based on their ability to produce lignocellulolytic enzymes,

their mutual compatibility, and beneficial traits such as nutrient and silicate solubilization. Following detailed characterization, a microbial consortium was formulated using sterilized talc as a carrier material, along with additional amendments. This formulation is referred to as the CRRI decomposing microbial consortium**,** designed for in-situ management of paddy straw residues. This integrated technology has been developed for efficient management of paddy straw residues in field itself.

Methods for application of CRRI decomposing microbial consortium

- Application of the CRRI decomposing microbial consortium at a rate of 2.0 kg per hectare**,** along with 30.0 kg of urea**,** 160.0 g of copper sulphate**,** 120.0 g of magnesium sulphate**,** and 150.0 g of manganous sulphate (used as enzyme activators), facilitates the decomposition of paddy straw by 40–45% within 21–25 days under the tropical climate of Odisha in a rice–rice cropping system**.** Whereas, under the climatic conditions of Punjab and Haryana, the decomposition efficiency was observed to be 20–25% in rice-wheat cropping system during winter season.

- Microbial consortium along with above said amendments should be suspended in 500 L water and then applied uniformly in paddy straw residues spread on field (@ around 6.0 t per ha). This integrated technology is very well suited for either residues

retention or incorporation of paddy straw residues management.

- In residue retention (RR), the residues from one ha field (@ 6 t) are spread uniformly and the above said culture suspension is applied through sprayer or microbial culture applicator and allowed for 21-25 days and then incorporated (by rotovator) into soil before field preparation.

- Residue incorporation involves incorporating crop residues into the soil using a rotovator immediately after applying the microbial culture. The residues are then left buried in the soil for 21–25 days before field preparation. To maintain optimal moisture levels for microbial activity under Odisha's climatic conditions, a light irrigation may be applied depending on soil dryness prior to field preparation. The standard recommended fertilizer dosage should be followed for both rice–rice and rice–wheat cropping systems.

- This technology intervention increases rice yield by 8.0-13.0 % under rice-rice cropping system. In rice-wheat cropping system, increases wheat yield by 7.0-9.0% in Punjab and Haryana condition. In addition, the regular recycling of paddy straw residues in field enhances soil organic carbon content.

- There was significant improvement in soil microbial properties in in-situ paddy straw residues inorporated field as compared to conventional practices.

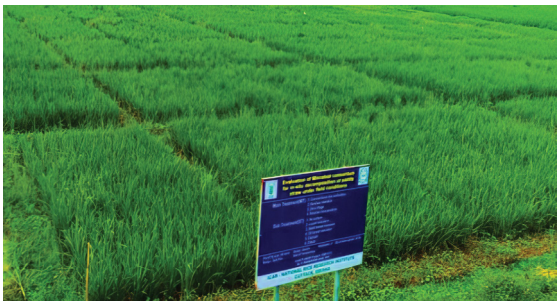
Uniqueness/ Novelty of the technology

- This product contains efficient cellulose, hemicellulose, lignin and silica degraders. The microbial stains also have good plant growth promoting activities and phosphate solubilizing abilities.
- Partial decomposition of paddy straw under in-situ conditions within 21–25 days not only facilitates timely field preparation, but also significantly improves soil microbial properties, organic carbon content and contributes to enhanced yields in subsequent crop cultivation. The lignocellulolytic enzymatic potential of microbial strains significantly improved through addition of enzymatic co-factors in the form of micronutrients.
- The microbial immobilization of soil nitrogen during decomposition of residues critically avoided by addition of minimum amount of urea (*i.e.* 30 kg per ha).
- This solid based formulation can be applied directly by skipping secondary level multiplication (around 5-7 days) at farmers' level.
- The regular recycling of paddy straw residues with help of microbial intervention enhances yield in subsequent crop cultivation apart from eliminating environmental hazards due to burning of crop residues.

Mixing of CRRI decomposing microbial consortium along with amendments in water

Application of microbial consortium along with amendments

Field preparation and transplanting after 25 days of microbial consortium application



Performance of rice growth in the field incoporated with partially decomposed paddy straw

Evaluation of CRRI decomposing microbial consortium for in-situ paddy straw residues management in rice-rice cropping system

Application of CRRI decomposing microbial consortium along with amendments through sprayer

Field preparation after 25 days of CRRI decomposing microbial consortium application

Performance of wheat growth in the field incoporated with partially decomposed paddy straw through microbial intervention

Evaluation of CRRI decomposing microbial consortium for in-situ paddy straw residues management in rice-wheat cropping system

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An ISO 9001: 2008 Certified Institute
Phone: +91-671-2367757; PABX: +91-671-2367768-783; Fax: +91-671-2367663;
Email: director.nrri@icar.gov.in | directorcrricuttack@gmail.com

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