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Effects of rice straw and nitrogen management on growth and yield of wheat under Rice-Wheat cropping system

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Abstract
A field experiment was conducted on crop Residue and Nitrogen Management under Rice-Wheat cropping System to determine the influence of Nitrogen and rice straw management on growth, yield, and yield attributes of wheat crop at farmer's field near VKSCOA, Dumraon, Buxar during the Kharif season of 2020-21 and 2021-22. The experiment was laid out in split plot Design with sixteen treatment Combinations and three replications in which there were four levels of rice straw management (S1-Straw Incorporated (SI), S2-Straw Incorporated + EM 1% Spray (SIE), S3- Straw Retention & Surface Mulching (SR), S4-Straw Retention & Surface Mulching + EM 1% Spray (SRE) and four levels of Nitrogen (N1-Control (No Nitrogen), N2-75% RD of N, N3- 100% RD of N, N4-125% RD of N). Among the rice straw management significantly highest plant height (97.4cm), no. of tillers (325 per m^2),no. of grain per ear head (318) and wheat yield (38.75 q/ha) under Straw Retention & Mulching +EM 1% and under Nitrogen Management yield was significantly found higher (43.18) in 125% RD of N.

Keywords: Nitrogen Management, straw management, EM, Rice, Wheat

Introduction
The recycling of crop residues has the advantage of converting the surplus farm waste into useful product for meeting nutrient requirement of crops. It also maintains the soil physical and chemical condition and improves the overall ecological balance of the crop production system. However, management of the rice straw is a major challenge as it is considered to be a poor feed for the animals owing to high silica content. Rice residue management is important in rice-wheat cropping system as machines are increasingly used for harvest. Several management options available to farmers for the management of rice residues are burning, incorporation, surface retention and mulching and removing the straw. Farmers use different straw management practices as per the situation. In some areas rice and wheat yields under these practices are similar. Rice-wheat, a dominant cropping system practiced essentially under irrigated conditions, is spread over 10 million ha in Indo-Gangetic Plains (IGP) of India (Timsina and Connor 2001) [6]. Both rice and wheat are exhaustive feeders, and the double cropping system is heavily depleting the soil of its nutrient content. Many soils under rice-wheat system in the IGP are poor in organic matter and nutrient supplies. From long-term studies, Bhandari *et al*. (2002) [2] and Yadvinder-Singh *et al*. (2004a) [7] showed that depletion of soil N and K under rice-wheat cropping are the key factor for declining rice-wheat productivity in the IGP. The future increases in the productivity of rice-wheat systems will greatly depend upon improvements in soil productivity through proper management and utilization of crop residues and other agricultural wastes.
Incorporation of the remaining stubble and straw into the soil returns most of the nutrients and helps to conserve soil nutrient reserves in the long- term. Short-term effects on grain yield are often small (compared with straw removal or burning) but long-term benefits are significant. Where mineral fertilizers are used and straw is incorporated, reserves of soil N, P, K, and Si are maintained and may even be increased. Incorporation of straw and stubble into wet soil (during ploughing) results in temporary immobilization of N and a significant increase in

methane (CH_4) emission from rice paddy, a practice that contributes to greenhouse gases. Incorporation of large amounts of fresh straw is either labour-intensive or re- quires suitable machinery for land preparation and may result in the build-up of disease problems. Transplanting should be carried out two to three weeks after straw incorporation.

The concept and technology of Effective Microorganisms (EM) was developed by Professor Dr. Teruo Higa, at the University of Ryukyus, Okinawa, Japan in 1970s. The fundamental principle of this technology was the introduction of a group of beneficial microorganisms to improve the soil condition, suppress putrefying (disease inducing) microbes and improve the efficacy of organic matter utilization by crops. EM is a fermented mixed culture of beneficial microorganisms. These are Lactic acid bacteria, phototropic bacteria and Yeast. These microorganisms exist in nature and are utilized for food processing and probiotic for livestock. The culture of EM contains these species, in an acidic medium. This solution does not contain any genetically modified microorganisms. In soil, EM does not displace existing microorganisms, such as actinomycetes or N-fixing or P solubilizing organisms. EM acts as a stimulus for higher enzymatic activity. A positive feature of effective microorganisms is that they secrete large amounts of chemicals such as amino acids, organic acid, chelated minerals, antioxidants, polysaccharides and vitamins when in contact with organic crop residues. They decompose aerobically & an aerobically and ferment organic crop residues of the soil system converting into humus containing nutrients while releasing hormones that facilitate plant growth.

Methods & Material

An Experiment was conducted during the year 2020-22 at farmer's field in V. K. S. College of Agriculture Dumraon (Buxar) Bihar jurisdiction having the latitude of Dumraon, Bihar, India is 25.550114 and the longitude is 84.150017. Experiment was conducted in split plot design and having replication three. The soil of the Experiment was clay loam, pH 6.8, EC. 16 ds/m, organic carbon (%) of the soil 0.44 Wakley & Black Titration method, available P_2O_5 (kg/ha) 20.6, available K_2O(238 kg/ha) and available Nitrogen (226 Kg/ha).Treatments were applied to wheat crop after harvesting of paddy crop and direct influence of different treatments was examined on wheat crop and their residual effect on rice crop and approx. 50 cm crop residues maintained of paddy crop.Paddy variety: Rajendra Shweta & Wheat Variety: HD 2967.

Treatment Details

Table 1: Treatment details showing rice straw and nitrogen management practices in main and subplots

Rice Straw Management (Main Plot: 4 Nos.)		Nitrogen Management (Sub Plot: 4 Nos.)	
S1	Straw Incorporated (SI)	N1	Control (No Nitrogen)
S2	Straw Incorporated + EM 1% Spray (SIE)	N2	75% RD of N
S3	Straw Retention & Surface Mulching (SR)	N3	100% RD of N
S4	Straw Retention & Surface Mulching + EM 1% Spray (SRE)	N4	125% RD of N

Result & Discussion

Plant height was recorded significantly higher (97.9 cm) in straw retention and mulching along with EL solution 1% in wheat crop under rice wheat cropping system. No. of tillers per metre square at maturity was recommended significantly more (325) under straw retention and mulching along with EM 1% solution in rice wheat cropping system. Effect of rice straw and nitrogen management on yield attributes like test weight, grain per ear head were recorded significantly higher in straw retention plus rice straw mulching along with EM 1% solution. Under nitrogen management 125% recommended dose of nitrogen, yield attributes also recorded significantly higher. Grain and straw yield of wheat crop under rice wheat cropping system in straw retention and mulching along with EM 1% solution and 125% recommended dose of nitrogen. Yadvinder Singh *et al*. 2004b) [8] reported that incorporation of rice residue before sowing wheat did not show any residual effects in the succeeding rice crop after wheat. However, Thuy *et al*. (2008) [5] suggested that there could be an opportunity to save fertilizer N for rice when residues of the preceding rice crop are incorporated before wheat. Application of EM supposedly leads to increases in the microbial biodiversity of soils which enhances their quality and the growth, yield, and quality of crops (Higa and Parr, 1994) [14]. Crop residues may be incorporated partially or completely into the soil depending upon methods of cultivation. Ploughing is the most efficient residue incorporation method. Incorporation of rice residues before wheat planting compared to incorporation of wheat straw before rice planting is difficult due to low temperatures and the short interval between rice harvest and wheat planting.

Table 2: Effects of rice straw and nitrogen management on growth and Yield Attributes parameters of wheat

Treatments	Plant Height (cm)at maturity	Number of tiller m^2 at maturity	Ear head /m^2	Grains / Ear head	Test Weight (gm.)	Grain Yield (q/ha)	Straw Yield (q/ha)
Rice Straw Management							
Straw Incorporated	93.7	294	292	38.5	39.2	34.54	60.91
Straw Incorporated +EM 1%	96.0	308	302	39.4	39.5	36.14	57.00
Straw Retention & Mulching	96.6	315	309	39.5	40.0	37.23	55.31
Straw Retention & Mulching +EM 1%	97.9	325	318	40.6	40.6	38.75	5.51
S.Em±	0.9	5.5	5.6	0.34	0.14	0.53	0.89
CD at 5%	2.7	19.3	NS	1.2	0.49	1.88	3.13
Nitrogen Management							
Control (No-N)	93.1	240	238	35.7	37.4	25.05	48.03
75% of RD of N	96.1	308	301	38.8	38.5	36.19	55.71
100% RD of N	96.5	342	335	41.4	41.0	42.25	62.88
125% RD of N	98.4	354	348	42.2	40.5	43.18	63.18
SEm±	0.7	7.1	6.9	0.44	0.15	0.54	0.91
at 5%	2.2	20.9	20.5	1.3	0.48	1.60	2.66

Conclusion

Grain yield of wheat was found significantly higher under straw retention as well as straw mulch along with decomposer EM solution (1%) as compare to other treatments. While nitrogen management under 125% of RD of N was found significantly superior. EM can increase crop yields and improve crop quality as well as accelerating the breakdown of organic matter from crop residues.

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