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Effect of microbial inoculated crop residue recycling on soil properties and field pea yield

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ABSTRACT

Experiments were conducted to study the effects of crop residue (CR) recycling and microbial culture application on the yield and nutrient uptake in field pea crop. The experiments were designed in factorial RBD with 15 treatments consisting of three crop residues and five microbial treatments to crop residue having two replications each. Application of paddy straw @ 5.0 t/ha and inoculating *Trichoderma viridi* with 1% nitrogen increased the crop yield by 11.75% over the control, enhanced the total nutrient uptake, and improved the soil's properties. Thus, crop residue application with microbial inoculation and nitrogen supplementation can be an effective in situ residue management approach in field pea.

Key words: *Crop residue, Field pea, Microbial inoculation, Soil properties, Yield*

Introduction

Crop residues are a vital source of major and minor plant nutrients, and their role is crucial in providing essential soil organic carbon (Choudhary *et al.*, 2020). About 25% of N and P, 50% S and 75% of K uptake by cereal crops are retained in crop residue, making them viable nutrient sources. Most farmers burn crop residues due to problems related to their disposal. Although crop residues are essential sources of plant nutrients, their natural decomposition is slow due to biochemical compounds like cellulose, lignin, etc. Microbes play a crucial role in breaking the above complex compounds into simple ones (Kumar *et al.*, 2022). Although residue-degrading microbes are already present in the soil, their population varies significantly from place to place and field to field depending on the management, edaphic and environmental conditions. Some of the isolated soil fungi (*Trichoderma spp* and *Aspergillus spp*), which are efficient lignocellulose decomposers, can be used for in-situ crop residue management as well as to enhance CR decomposition rate and soil fertility (Shinde *et al.*, 2022a). Therefore, data and information are required to assess whether applying different straws along with microbial cultures could restore the soil health and increase the yield of crops. Thus, the study was undertaken on the effect of crop residue application and decomposing culture on soil properties and field pea yield.

Materials and Methods

The experiments were conducted in the research farm of ICAR-Research Complex for Eastern Region, FSRCHPR, Ranchi, located in Jharkhand State of India. The experimental soil was acidic (pH 5.50), belonging to the Alfisols order. The experiments were designed in factorial RBD with 15 treatments consisting of 3 crop residue sources (C1-paddy straw @ 5.0 t/ha, C2- black gram straw @ 2.5 t/ha, and C3-ragi straw @ 5.0 t/ha) and five microbial treatments to crop residue (T1-control, T2- CR treated with *Aspergillus niger* culture, T3- CR treated with *Trichoderma viridi* culture, T4 -CR treated with *A.niger* culture along with 1% nitrogen T5- CR treated with *T.viridi* culture along with 1% nitrogen) with two replications. The microbial culture viz., *T. viridi* and *A. niger* were applied to straw at 2 kg per ton of crop residue. The Field pea ('Dhantwada- Field Pea-1') was sown in the last week of October at a spacing of 45 x 7 cm in the field. The crop cultural practices were carried out according to the standard practices.

A composite soil sample was collected from 0-15 cm depth harvest of field pea, processed, and analyzed in a laboratory for soil pH by pH meter and organic carbon by rapid titration method (Walkley and Black, 1934), available soil nitrogen by alkaline potassium permanganate method (Subbiah and Asija, 1956), available soil phosphorus by Bray's method (Bray and Kurtz, 1945) and available soil potassium by neutral normal ammonium acetate (Hanway and Heidel, 1952). The plant sample was analyzed for total N by Kjeldahl digestion, total P by vanadomolybdate method on a spectrophotometer, and total K by a flame photometer (Jackson, 1973). All the data were subjected to statistical analysis.

Results and Discussion

Crop yield and nutrient uptake

A perusal of data, presented in Table 1, revealed that variations in grain and straw yield due to the application of crop residues and microbial decomposing cultures treatments were found significant at the crop harvest. Among the crop residues sources, the highest grain yield (16.12 q/ha) and straw yield (24.97 q/ha) was recorded in treatment C1 (application of paddy straw @ 5.0 t/ha), recorded 13.84% higher grain yield and 10.21% higher straw yieldcompared to C2 (application of black gram straw @ 2.5 t/ha). Among the microbial inoculation treatments, the grain yield varied from 14.48 to 16.18 q/ha and straw yield from 23.21 to 24.92 q/ha with different treatments. Inoculation of *T. viridi*, along with nitrogen supplementation (T5), registered significantly higher grain yield (16.18 q/ha) and straw yield (24.92 q/ha) and was statistically superior over the control treatment. The inoculation of microbial culture and nitrogen supplementation increased grain yield by 11.74% and straw yield by 7.4% over the control (T1). The interaction effect between the crop residue sources and microbial decomposing cultures treatments on grain and straw yield of field pea was found to be non-significant. Total nutrient

Table 1. Effect of crop residues and microbial inoculation on yield and nutrient uptake of field pea

Treatments	Grain yield (q/ha)	Straw yield (q/ha)	Harvest Index (%)	Total uptake kg/ha		
				N	P	K
Crop Residue (CR) factor						
C_1- Paddy straw (PS)	16.12	24.97	0.39	68.29	14.14	31.93
C_2- Black gram straw (BS)	14.15	22.66	0.38	61.23	12.29	27.90
C_3- Ragi straw (RS)	16.06	25.05	0.39	68.21	13.94	31.95
CD (0.05)	1.03	2.10	NS	4.04	0.90	2.05
SEm±	0.34	0.69	0.3	1.33	0.29	0.68
Microbial Treatments to crop residue						
T_1- Control	14.48	23.21	0.38	56.56	11.66	26.22
T_2- CR + Asp	15.09	24.35	0.38	64.40	12.46	29.79
T_3- CR + Tri	15.63	24.36	0.39	69.01	13.24	30.95
T_4- CR + Asp + N	15.85	24.47	0.39	67.98	14.71	32.52
T_5- CR + Tri + N	16.18	24.92	0.40	71.59	15.20	33.49
CD (0.05)	1.33	2.72	NS	5.22	1.16	2.64
SEm±	0.43	0.89	0.3	1.72	0.38	0.87
Interaction (CR x N)						
CD (0.05)	NS	NS	NS	NS	NS	NS
SEm±	0.76	1.55	0.6	2.98	0.66	1.51
CV	10.968	11.072	12.896	6.39	6.98	7.01

uptake (NPK) was higher in paddy straw application @ 5t/ha treatment than in the application of ragi and black gram straw @ 2.5t/ha treatments. Maximum N, P, and K uptake were found in the treatment T5 where *Trichoderma* culture inoculation with nitrogen supplement was highly significant compared to other treatments in field pea.

The application of crop residue and its treatment with microbial culture increased the CR decomposition rate and nutrient availability in soil. The increase in the nutrient uptake and yield may be attributed to conversion of nutrient's organic forms into easily mineralizable form, which plant directly or indirectly take up from soil solution, during the microbial decomposition of CR (Shinde *et al.*, 2022b). The results are in agreement with the earlier findings in rice and toria crops (Choudhary *et al*., 2020; Kumar *et al*., 2022).

Soil Properties

There were no major changes in pH and EC values (Table 2) of the soil samples from crop residue and microbial inoculated treatments. Still, there was a slight increase in pH value (from 5.5 to 5.65) compared to the initial value. The highest soil organic carbon (SOC) was recorded in the C1 and T5. In contrast, the lowest SOC was recorded in treatment T1 (0.44%). The increased SOC in T5 treatment reflected stimulated degradation of the organic materials in the residue and N amended treatment.

The soil's available N, P, and K content were influenced by the crop residue application and microbial treatments (Table 2) compared to its initial values. Among the crop residue treatments, available soil nitrogen and phosphorous (257.58 and 36.03 kg/ha) were significantly high in the C1 treatment. In comparison, available soil potassium (322 kg/ha) was higher in C3 treatment. While in microbial inoculation treatments, available soil nitrogen, phosphorous, and potassium (264.43, 38.74, and 336.67 kg/ha, respectively) were significantly high in treatment T5. The increase in soil available nitrogen may be attributed to the enhanced microbial activities induced by inoculation of microbial culture and addition of N from the mineralization of crop residue (Kalkhajeh *et al.*, 2021; Thombare *et al.*, 2012). Application of organic residues resulted in high content of available P, indicating the beneficial effect of the crop residue degradation process on the mineralization of P to a greater extent in soil (Garg *et al.*, 2010). The increase in available potassium in soil was due to the application of crop residues containing high potassium (Shinde *et al.*, 2022c), as well as the reduction of potassium fixation. Similar findings were also observed in the earlier literature (Kumar *et al.*, 2022; Liu *et al*., 2019).

Conclusion

The Present study illustrated the application of crop residues, treated with decomposing microbial cultures like *T. viridi* and *A. niger*, along with 1% nitro-

Table 2. Effect of crop residue and microbial inoculation on soil chemical properties after harvest of Field Pea

Treatments	pH	EC dsm^{-1}	SOC %	Nkg/ha	P kg/ha	K kg/ha
Crop Residue (CR) Sources						
C_1- PS	5.58	0.749	0.48	257.58	36.03	319.40
C_2- BS	5.56	0.709	0.46	230.50	31.62	306.26
C_3- RS	5.57	0.772	0.51	255.74	34.02	322.20
CD (0.05)	NS	NS	0.035	5.16	0.77	11.59
SEm±	0.014	0.88	0.012	1.69	0.25	3.78
Microbial treatments to crop residue						
T_1-Control	5.52	0.721	0.44	228.50	30.58	291.05
T_2- CR + Asp	5.51	0.755	0.48	238.23	32.84	308.37
T_3- CR + Tri	5.56	0.702	0.48	251.50	33.41	317.35
T_4- CR + Asp +N	5.62	0.753	0.49	257.03	37.2	326.33
T_5- CR + Tri + N	5.65	0.732	0.52	264.43	38.74	336.67
CD(0.05)	NS	NS	0.045	6.67	1.09	14.96
SEm±	0.018	1.13	0.015	2.18	0.34	4.89
Interaction (CR x T)						
CD (0.05)	NS	NS	NS	NS	NS	NS
SEm±	0.031	1.96	0.026	3.78	0.58	8.46

gen spray, had improved the soil properties, and yield and nutrient uptake in the field pea crop. Hence, application of microbe inoculated crop residue with nitrogen supplementation can be a practical approach for *in situ* residue management of crop residue and for increasing the sustainability of soil and crop productivity.

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References

Bray, R. and Kurtz, l.T. 1945. Determination of total, organic, and available forms of phosphorus in soils. *Soil Science*. 59(1): 39–46.

Choudhary, G.D. and Meena, R.S. 2020. Crop residue and weed biomass incorporation with microbial inoculation improve the crop and soil productivity in the rice (*Oryza sativa* L.) -toria (*Brassica rapa* L.) cropping system. *Environmental and Sustainability Indicators.* 7(June), 100048.

Garg, A.K. and Aulakh, M.S. 2010. Effect of Long-Term Fertilizer Management and Crop Rotations on Accumulation and Downward Movement of Phosphorus in Semi-Arid Subtropical Irrigated Soils. *Communications in Soil Science and Plant Analysis.* 41(7): 848–864.

Hanway, J. J. and Heidel, H. 1952. Soil analysis methods as used in the Iowa State College Soil Testing Laboratory. *Iowa Agriculture*. 57: 1–31.

Jackson, M. L., 1973. *Soil Chemical Analysis* (Vol. 498). New Delhi, India: Pentice hall of India Pvt. Ltd.

Kalkhajeh, Y.K., He, Z., Yang, X., Lu, Y., Zhou, J., Gao, H. and Ma, C. 2021. Co-application of nitrogen and straw-decomposing microbial inoculant enhanced wheat straw decomposition and rice yield in a paddy soil. *Journal of Agriculture and Food Research*. 4: 100134.

Kumar, A., Singh, S., Kumar, P., Shivay, Y.S., Das, S., Pal, M., Jain, N. and Nain, L. 2022. Fungal consortium and nitrogen supplementation stimulates soil microbial communities to accelerate in situ degradation of paddy straw. *Environmental Sustainability*. 5(2): 161–171.

Liu, G., Ma, J., Yang, Y., Yu, H., Zhang, G. and Xu, H., 2019. Effects of Straw Incorporation Methods on Nitrous Oxide and Methane Emissions from a Wheat-Rice Rotation System. *Pedosphere.* 29(2): 204–215.

Shinde, R., Shahi, D.K., Mahapatra, P., Naik, S.K., Singh, C.S., Verma, S. and Singh, A. K. 2022a. Isolation of lignocelluloses degrading microbes from soil and their screening based on qualitative analysis and enzymatic assays. *Ann. Plant Soil Res.* 24: 347–354.

Shinde, R., Shahi, D.K., Mahapatra, P., Naik, S.K., Thombare, N. and Singh, A.K. 2022b. Potential of lignocellulose degrading microorganisms for agricultural residue decomposition in soil: A review. *Journal of Environmental Management.* 320: 115843.

Shinde, R., Shahi, D.K., Mahapatra, P., Singh, C.S., Naik, S.K., Thombare, N. and Singh, A.K. 2022c. Management of crop residues with special reference to the on-farm utilization methods: A review. *Industrial Crops and Products.* 181: 114772.

Subbiah, B. V. and Asija, J. L. 1956. A rapid procedure for the estimation of available nitrogen in soils. *Current Science*. 25: 259–260.

Thombare, N.S., Aggarwal, N., Kumar, R. and Gopal, M. 2012. Synthesis of 2-furyl-4-arylidene-5(4H)-oxazolones as new potent antibacterial agents against phyto-pathogenic and nitrifying bacteria. *Journal of Environmental Science and Health-Part B Pesticides, Food Contaminants, and Agricultural Wastes.* 47(4): 326–335.

Walkley, A. and Black, I.A. 1934. An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Science.* 37: 29–38.