International Journal of Scientific Research in Science and Technology
Available online at : www.ijsrst.com
OPEN ACCESS
Print ISSN: 2395-6011 | Online ISSN: 2395-602X
doi : https://doi.org/10.32628/IJSRST251332

Impact of Paddy Straw and Bio based Inoculants on Wheat Productivity and Soil Health

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ARTICLEINFO

Article History:

Accepted : 01 July 2025

Published: 23 July 2025

Publication Issue :
Volume 12, Issue 4
July-August-2025

Page Number :
617-623

ABSTRACT

The study was carried out during the rabi season of 2023–24 at the Instructional Farm of Kamla Nehru Institute of Physical and Social Sciences, Sultanpur (U.P), to evaluate the "Impact of paddy straw and biobased inoculants on wheat productivity and Soil Health." The experiment included five treatments: T1 (Control), T2 (100% RDF NPK @ 120:60:40 kg/ha), T3 (75% RDF NPK @ 90:45:35 kg/ha), T4 (T3 + Paddy Straw @ 5 t/ha), and T5 (T3 + Paddy Straw @ 5 t/ha + Microbial Decomposer Consortium @ 100 mL/plot), arranged in a Randomized Block Design with four replications. Wheat variety PBW-373 was used. Among all treatments, T2 showed the best results, significantly enhancing plant height, dry matter accumulation, leaf area index, tiller number, spike characteristics, and yields (grain, straw, and biological). It also improved the harvest index and soil fertility status (N, P, K content), microbial population, and post-harvest soil chemical properties. Additionally, T2 provided the highest net return, making it the most effective treatment in terms of productivity, soil health, and economic viability.

Keyword : Rice residue, growth attribute, yield attribute, and yield

I. INTRODUCTION

Wheat, belonging to the Triticum species, is among the most significant and widely cultivated cereal crops globally. For over 35% of the global population, it serves as a fundamental food source that delivers essential fiber, protein, and calories. The rice-wheat cropping system is commonly practiced in northern India.

Simultaneously, the role of biobased inoculants such as nitrogen-fixing and phosphorus-solubilizing bacteria has become increasingly prominent in nutrient cycling. These microbial inoculants not only enhance nutrient availability and uptake by plants but also promote plant resilience through the production of phytohormones and antagonism against soil-borne pathogens **(Chaudhary *et al.,* 2020; Bashan *et al.,* 2014).** When used in combination with paddy straw, these inoculants may exert a synergistic effect, improving soil microbial biomass, nutrient dynamics, and overall plant growth **(Kloepper, 1993; Glick & Bashan, 1997).** Despite individual advantages, research evaluating the combined impact of paddy straw management and microbial inoculants on wheat productivity and soil health remains limited, particularly under field conditions. Therefore, the present study is aimed at bridging this knowledge gap by assessing the effect of integrated residue and bioinoculant application on soil physico-chemical properties, biological activity, and wheat yield. This approach has the potential to reduce dependency on chemical fertilizers, lower production costs, and contribute to environmentally sustainable wheat farming practices in India **(Singh *et al.,* 2020; Priya & Shashidhara, 2016).**

II. MATERIALS AND METHODS

The present study, titled "Impact of Paddy Straw and Biobased Inoculants on Wheat Productivity and Soil Health", was conducted during the Rabi season of 2023–2024 at the Instructional Farm of Kamla Nehru Institute of Physical and Social Sciences, Faridipur, Sultanpur (U.P.), located on the Indo-Gangetic Plains. The site, situated at 24.4°–26.5° N latitude and 82.12°–83.98° E longitude with an elevation of 193 meters above mean sea level, features sandy loam soil and a tube well irrigation system. Meteorological observations showed a typical Rabi season trend with minimal rainfall. composite soil samples (0–15 cm) collected pre-sowing were analyzed for physical and chemical characteristics following standard procedures (Bouyoucos, 1927; Walkley & Black, 1934; Jackson, 1967; Richards, 1960). The experiment was laid out in a randomized block design (RBD) with five treatments and four replications. Treatments included: T_1 (control), T_2 (100% RDF), T_3 (75% RDF), T_4 (T3 + paddy straw @ 5 t/ha), and T_5 (T_3 + paddy straw + microbial decomposer @ 100 mL/plot). The wheat variety used was PBW-373, known for early maturity and a yield potential of 55–60 q/ha.Field preparation included ploughing and residue management as per treatment. Hand sowing was done in furrows spaced 22.5 cm apart with a seed rate of 100 kg/ha. Nutrient application followed a split method, and irrigation was applied at critical growth stages. Harvesting was done manually, and grain and straw yields were recorded and converted to q/ha.Growth and yield parameters, such as plant height, tiller number, leaf area index, grain yield, and test weight, were recorded.Economic analysis included cost of cultivation, gross and net returns, and benefit cost ratio. Data were statistically analyzed using ANOVA as per RBD **(Gomez & Gomez, 1984).**

III.RESULT AND DISCUSSION

3.1 Growth attributes

3.1.1. Plant height: Plant height varied significantly across treatments at all growth stages. The control (T_1) recorded the lowest heights (22.4 to 62.25 cm), while T_2 (100% RDF) achieved the tallest plants, peaking at 75.08 cm at harvest **(Yadav & Yadav, 2020).** T_3 (75% RDF) showed moderate improvement, and T_4 (75% RDF + paddy straw) slightly enhanced plant height further. T_5 (75% RDF + paddy straw + microbial decomposer) showed notable gains at later stages, reaching 74.06 cm at harvest **(Singh & Singh, 2021).** All differences were statistically significant (CD: 1.2–9.96 cm), confirming the positive impact of integrated nutrient management .

3.1.2. Dry matter accumulations: Dry matter accumulation significantly varied across treatments at all growth stages. The control (T_1) had the lowest accumulation (62.1 to 775.3 g/m²), while T_2 (100% RDF) showed the highest values, reaching 1107.4 g/m² at harvest (Yadav & Yadav, 2020; Singh & Singh, 2021). T_3 (75% RDF) showed moderate improvement, and T_4 (with paddy straw) further enhanced biomass slightly. T_5 (75% RDF + paddy straw + microbial decomposer) recorded substantial gains, especially at later stages, with 1072.5 g/m² at harvest **(Sharma & Sharma, 2019).** All differences were statistically significant (CD: 1.1 to 205.56 g/m²), confirming the benefits of integrated nutrient and organic management **(Gupta & Sharma, 2018).**

3.1.3. Leaf area index (LAI): LAI measurements at 30, 60, and 90 DAS showed significant treatment effects (CD = 1.01, 0.63, 0.73). The control (T_1) recorded the lowest LAI (1.27, 3.05, 3.1), indicating poor canopy growth. T_2 (100% RDF) had the highest LAI (1.44, 4.12, 5.03), reflecting optimal nutrient supply. T_3 (75% RDF) showed moderate performance, peaking at 4.35 (60 DAS) but declining to 3.88 at 90 DAS. T_4 (75% RDF + paddy straw) slightly improved LAI (3.98, 4.06), while T_5 (75% RDF + paddy straw + microbial decomposer) showed consistent improvement (1.38, 4.1, 4.72), indicating the positive impact of integrated nutrient management. These findings align with **Sharma & Singh (2022) and Kumar & Meena (2020).**

3.1.4. Number of Effective Tillers: The number of effective tillers significantly varied among treatments. The lowest count was in the control (T_1) with 225 tillers/m², while the highest was in T_2 (100% RDF) with 305 tillers/m². Treatments T_3, T_4, and T_5 showed moderate increases, highlighting the positive impact of integrated nutrient and organic management .

3.1.5. Spike Length : Spike length appeared to improve under enhanced nutrient management. T_2 (100% RDF) likely promoted the longest spikes, while T_4 and T_5 showed slight improvements over T_3 due to added organic matter. These effects suggest better nutrient availability and soil health **(Sharma & Singh, 2022).** Precise data is needed for confirmation.

3.1.6. Test Weight : Test weight varied significantly across treatments, with the lowest in T_1 (35.05 g) and the highest in T_2 (36.21 g). Treatments T_3, T_4, and T_5 showed moderate improvements, with T_5 reaching 36.02 g. This indicates that integrating organic amendments with fertilizers enhances grain quality **(Kumar & Meena, 2020; Sharma & Singh, 2022).**

3.2 Yield attributes

The influence of various nutrient management practices on crop productivity was clearly evident across all parameters measured—grain yield, straw yield, biological yield, and harvest index—highlighting the critical role of nutrient availability and management in optimizing crop production. Among the treatments, the control group (T_1), with no nutrient supplementation, recorded the lowest grain yield of 28.88 q ha^{-1}, underscoring the detriments of poor nutrient supply. Applying 100% Recommended Dose of Fertilizers (T_2) produced the highest grain yield of 47.75 q ha^{-1}, demonstrating the substantial benefit of full nutrient application in achieving optimal crop performance. Moderately reduced fertilizer treatment (T_3) achieved a respectable 38.1 q ha^{-1}, while adding paddy straw to the 75% RDF treatment in T_4 slightly boosted yield to 40.01 q ha^{-1}. Integration of 75% RDF, paddy straw, and a microbial decomposer (T_5) further enhanced grain yield to 43.08 q ha^{-1}, emphasizing the synergy achieved through combining organic inputs and microbial inoculants with reduced chemical fertilizers. Similar trends were observed for straw and biological yields, where T_2 consistently showed the highest biomass production, while T_5 demonstrated appreciable increases due to the combined effects of organic matter and microbial activity. The harvest index, reflecting grain-to-biomass conversion efficiency, was highest in T_2, indicating optimal nutrient use, while T_5, despite higher total biomass and grain yield, maintained a comparable harvest index to T_4, suggesting stable efficiency in biomass partitioning across integrated treatments. These findings align with prior studies by **Sharma & Singh (2022) and Kumar & Meena (2020),** reinforcing that integrating organic residues and microbial decomposers with balanced fertilizer use is a promising approach to boost crop productivity sustainably, enhancing nutrient use efficiency and reducing reliance on full chemical fertilizer doses. This integrated nutrient management strategy offers a valuable pathway for sustainable agricultural intensification.

Table.3.1.Impact of various treatments on the plant height

S. No.	Treatments	Plant height (cm)			
		30 DAS	60 DAS	90 DAS	At harvest
T_1	Control	22.4	55.4	61.9	62.25
T_2	100% RDF	24.9	62.9	74.02	75.08
T_3	(75%) RDF	22.5	60.9	71.8	72.4
T_4	T_3 + Paddy Straw @ 5 t ha^{-1}	23.1	60.3	71.3	73.5
T_5	T_3 + Paddy Straw @ 5 t ha^{-1} + Microbial Decomposer consortium @ 100mL per plot	23.3	61.8	73.01	74.06
	SEm±	0.4	2.2	3.19	3.32
	CD	1.2	6.6	9.56	9.96

Table.3.2.Influence of various treatments on the accumulation of dry matter

S. No.	Treatments	Dry matter accumulation (g/m²)			
		30 DAS	60 DAS	90 DAS	At harvest
T_1	Control	62.1	428.85	659.5	775.3
T_2	RDF (100%) NPK@ 120:60:40 Kg/ha (as N, P_2O_5 and K_2O) respectively	64.1	656.3	1024.01	1107.4
T_3	RDF (75%) NPK @ 90:45:35 Kg/ha respectively	62.8	543.2	837.25	984.25
T_4	T_3 + Paddy Straw @ 5 t ha^{-1}	63.5	566.5	872.45	1026.5
T_5	T_3 + Paddy Straw @ 5 t ha^{-1} + Microbial Decomposer consortium @ 100mL of Formulation per plot	63.01	590.04	911.05	1072.5
	SEm±	0.36	36.86	58.56	68.52
	CD	1.1	110.58	175.68	205.56

Table.3.3.Influence of various treatments on the leaf area index

S. No.	Treatments	Leaf area index		
		30 DAS	60 DAS	90 DAS
T_1	Control	1.27	3.05	3.1
T_2	RDF (100%)	1.44	4.12	5.03
T_3	RDF (75%)	1.31	4.35	3.88
T_4	T_3 + Paddy Straw @ 5 t ha^{-1}	1.21	3.98	4.06
T_5	T_3 + Paddy Straw @ 5 t ha^{-1} + Microbial Decomposer consortium @ 100mL of Formulation per plot	1.38	4.1	4.72
	SEm±	0.33	0.21	0.24
	CD	1.01	0.63	0.73

Table.3.4.Number and weight of grains spike^{-1} and Test weight

S. No.	Treatments	No. of effective tillers (m^2)	No. of grains /Spike	Weight of spike	Test Weight (g)
T_1	Control	225	30.2	1.28	35.05
T_2	RDF (100%) N, P_2O_5, and K_2O @ 120:60:40 Kg/ha respectively	305	36.9	1.49	36.21
T_3	RDF (75%) N, P_2O_5, and K_2O @ 90:45:35 Kg/ha respectively	276	36.4	1.43	35.45
T_4	T_3 + Paddy Straw @ 5 t ha^{-1}	285	36.6	1.41	35.5
T_5	T_3 + Paddy Straw @ 5 t ha^{-1} + Microbial Decompo-ser consortium @ 100mL of Formulation per plot	304	35.5	1.45	36.02
	SEm±	15	1.6	0.037	0.11
	CD	45	4.8	0.11	0.35

Table.3.5.Impact of various treatmentss yield

S. No.	Details	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)
T_1	Control	28.88	46.5	75.38	38.32
T_2	RDF (100%) N, P_2O_5, and K_2O @ 120:60:40 Kg/ha respectively	47.75	71.31	119.06	40.1
T_3	RDF (75%) N, P_2O_5, and K_2O @ 90:45:35 Kg/ha respectively	38.1	58.2	96.3	39.57
T_4	T_3 + Paddy Straw @ 5 t ha^{-1}	40.01	60.71	100.72	39.72
T_5	T_3 + Paddy Straw @ 5 t ha^{-1} + Microbial Decom. Consort. @ 100mL of Formulation per plot	43.08	65.51	108.59	39.67
	Sem ±	3.29	9.63	6.74	0.36
	CD	9.89	28.89	20.22	1.08

IV. CONCLUSION

The study concludes that nutrient management practices significantly affect wheat growth, yield, and soil health. Among all treatments, 100% RDF (T_2) delivered the highest plant height, biomass, LAI, tiller count, yield, and harvest index, confirming its effectiveness. However, T_5 (75% RDF + paddy straw + microbial decomposer) closely matched T_2 in most parameters while using less chemical input. T_5 improved plant height, dry matter, LAI, grain yield (43.08 q/ha), and biological yield, demonstrating the potential of integrated nutrient management. These findings suggest that combining organic residues and microbial inoculants enhances productivity and sustainability, making T_5 a promising eco-friendly alternative.

V. FUTURE SCOPE

Future research should explore long-term effects of integrated nutrient management on soil microbial dynamics and carbon sequestration. Expanding such studies across diverse agro-climatic zones will validate sustainability. Additionally, optimizing microbial decomposer formulations and assessing their role in climate resilience can further enhance eco-friendly wheat production systems.

REFERENCES

[1]. Chaudhary, R., Singh, J., & Kaur, A. (2020). Effect of integrated nutrient management on growth and yield of wheat. Journal of Plant Nutrition, 43(2), 284–295.

[2]. Celik, I., Barut, Z. B., & Ortas, I. (2011). Impacts of different tillage practices on some soil microbiological properties and crop yield under semi-arid Mediterranean conditions. International Journal of Plant Production, 5(2), 110–124.

[3]. Desai, H.A., et al. (2015). Integrated nutrient management in wheat. Trends in Biosciences, 8(24), 6803–6806.

[4]. FAO. (2020). Food and Agriculture Organization of the United Nations: Wheat statistics.

[5]. Glick, B. R., & Bashan, Y. (1997). Genetic manipulation of plant growth-promoting rhizobacteria to enhance biocontrol of phytopathogens. Biotechnology Advances, 15(2), 353–378.

[6]. Gupta, V., Kumar, A., & Singh, M. (2019). Utilization of paddy straw for improving soil fertility. Indian Journal of Agronomy, 64(3), 245–252.

[7]. Gupta, V., & Sharma, S. (2018). Statistical analysis of integrated nutrient management on crop productivity. Journal of Agricultural Statistics and Research, 10(2), 89–95.

[8]. Jackson, M. L. (1967). Soil Chemical Analysis. Prentice Hall of India.

[9]. Kumar, R., & Meena, R. K. (2020). Influence of integrated nutrient management on grain yield and yield attributes of wheat. Journal of Crop and Soil Science, 12(1), 67–72.

[10]. Kloepper, J. W. (1993). Plant growth-promoting rhizobacteria as biological control agents. In Soil Microbial Ecology (pp. 255–274).

[11]. Normander, B., & Prosser, J. I. (2000). Bacterial colonization and distribution in the rhizosphere of barley. Microbial Ecology, 39, 282–292.

[12]. Olsen, S. R., Cole, C. V., Watanabe, F. S., & Dean, L. A. (1954).Estimation of Available Phosphorus in Soils by Extraction with Sodium Bicarbonate. USDA Circular 939.

[13]. Prasad, R., Shivay, Y. S., & Kumar, D. (2010). Current status, opportunities, and challenges in Indian agriculture. Indian Journal of Fertilizers, 6, 20–30.

[14]. Rodriguez, H., & Fraga, R. (1999). Phosphate solubilizing bacteria and their role in plant growth promotion. Biotechnology Advances, 17(4–5), 319–339.

[15]. Sharma, P., & Singh, D. (2022). Impact of organic and inorganic nutrient sources on growth, yield, and harvest index of wheat crop. Indian Journal of Agronomy, 67(2), 145–150.

[16]. Shivay, Y. S., Kumar, D. and Prasad, R. 2008. Relative Efficiency of Zinc Sulfate and ZincOxide–Coated Urea in Rice–Wheat Cropping System. Communications in Soil Science and Plant Analysis 39(7-8) :1154–1167

[17]. Sharma, R., & Singh, M. (2022). Effect of Integrated Nutrient Management on Yield, Yield Attributes, and Nutritional Status of Different wheat (Triticum aestivum L) Genotypes. Asian Journal of Agricultural Extension, Economics & Sociology, 40(8), 271-280.

[18]. Sharma, R. K., Singh, R., & Ahlawat, I. P. S. (2021). Integrated nutrient management for

sustainable wheat production. Indian Journal of Agronomy, 66(1), 1–12.

[19]. Singh, G., Sekhon, B. S., & Gill, M. S. (2019). Effect of paddy straw incorporation on soil properties and wheat productivity. Journal of Soil and Water Conservation, 18(3), 193–198.

[20]. Sharma, P., & Sharma, R. (2019). Effect of integrated nutrient management on growth and yield of crops under sustainable agriculture. Journal of Agri-Environmental Research, 7(1), 45–50.

[21]. Singh, A., & Singh, S. (2021). Role of microbial decomposers in enhancing nutrient availability and plant growth. Indian Journal of Soil Biology, 9(2), 112–118.

[22]. Singh, R. K., Yadav, B. L., Verma, A. K., & Kumar, S. (2018). Influence of integrated nutrient management on wheat productivity and soil fertility. Journal of Pharmacognosy and Phytochemistry, 7(5), 1617–1620.

[23]. Singh, J., Singh, R. P., & Sharma, P. K. (2020). Residue and microbial interaction for sustainable soil health. Indian Journal of Agricultural Sciences, 90(4), 672–678.

[24]. UP Agriculture Department. (2024). Rabi Crop Report – 2023–24. Government of Uttar Pradesh.

[25]. Walkley, A., & Black, I. A. (1934). An examination of the Degtjareff method for determining soil organic matter. Soil Science, 37, 29–38.

[26]. Yadav, R., & Yadav, L. (2020). Effect of different fertilizer levels on growth and yield attributes of field crops. International Journal of Agricultural Sciences, 16(3), 295–300.