Plant Archives Vol. 26, No. 1, 2026 pp. 1673-1680 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.no.1.230

IMPACT OF LIQUID BIOFERTILIZER AND NUTRIENT LEVELS ON YIELD AND ECONOMICS OF WHEAT (*TRITICUM AESTIVUM* L.)

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(Date of Receiving-07-02-2026; Date of Revision-30-03-2026; Date of Acceptance-12-04-2026)

ABSTRACT

Wheat (*Triticum aestivum* L.) is one of the most important staple cereal crops worldwide, playing a crucial role in ensuring food security and nutritional supply. It is a primary source of carbohydrates and protein for a large proportion of the global population, particularly in countries like India, where it forms a significant part of daily diets. With the increasing population and shrinking agricultural resources, enhancing wheat productivity in a sustainable manner has become a major challenge for modern agriculture. During the *Rabi* season of 2023-24 and 2024-25, the Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) conducted an experiment titled "Impact of Liquid Biofertilizer and Nutrient levels on yield and economics of Wheat (*Triticum aestivum* L.)". The soil was sandy loam in texture, moderately basic in reaction neutral pH (7.18), medium organic carbon (0.37%), available nitrogen (220.34 kg/ha), potassium (190.23 kg/ha), and low available phosphorus (12.44 kg/ha). The experiment was laid out in Randomized block design (RBD) with three replications. The results showed that significantly higher growth attributes of Wheat at Harvest, yield attributes *viz.*, number of effective tillers per running meter [[117.47 (2023-24), 122.53 (2024-25) and 120.00 (Pooled)], number of spikes/plants [23.30 (2023-24), 26.28 (2024-25) and 23.79 (Pooled)], number of Grain/spikes [51.60 (2023-24), 50.20 (2024-25) and 49.51 (Pooled)], grain yield [5.44 (2023-24), 5.72 (2024-25) and 5.58 (Pooled)] t/ha. straw yield [8.02 (2023-24), 7.62 (2024-25) and 7.82 (Pooled)] t/ha and harvest index [40.44 (2023-24), 42.86 (2024-25) and 41.65 (Pooled)] %. Among the different treatment combinations, maximum gross returns (` 183040/ha) and net returns (` 116582/ha) and B:C ratio (1.75) was recorded in (Treatment - 7) Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml kg^{-1}) + soil application (625 ml/ha) + 100% NPK during the experimentation of both the years (2023 and 2024) in Wheat Crop.

Key words : Biofertilizers, Growth, Economics, Wheat, Yield.

Introduction

Wheat (*Triticum aestivum* L.) is one of the most important staple cereal crops worldwide, playing a crucial role in ensuring food security and nutritional supply. It is a primary source of carbohydrates and protein for a large proportion of the global population, particularly in countries like India, where it forms a significant part of daily diets. With the increasing population and shrinking agricultural resources, enhancing wheat productivity in a sustainable manner has become a major challenge for modern agriculture. Compared to other cereals, it has a higher protein content. Wheat contains 60–68% starch, 8–15% protein, fat, sugar, cellulose, minerals, and vitamins Narayan *et al.* (2017). Approximately 220 million hectares of wheat are grown worldwide, with a record production of 763.06 million tons of grain. India has the largest area planted to wheat (14%), followed by Russia (12.43%), China (11.14%) and the USA (6.90%), which combined make up almost 45% of the world's total area. With a record production of 136 million tonnes, China is the leading producer of wheat, followed by India (98.51 mt), Russia (85 mt) and the United States (47.35 mt). Traditional wheat-growing nations like China, India, Russia, the United States, Canada, Ukraine and Pakistan have produced about 449 million tons of wheat, or 58% of the total. In India, the Rabi season is when wheat is grown. Typically, it is planted in November and harvested in March or April. At the national level, wheat cultivation has increased from 29.04 million hectares to 30.54 million hectares, representing a net gain in area of 1.5 million hectares (5%). With 9.75 million hectares (32%), Uttar Pradesh has the greatest area share, followed by Madhya Pradesh (18.75%), Punjab (11.48%), Rajasthan (9.74%), Haryana (8.36%), and Bihar (6.82%). The two main factors that significantly increased the area under wheat production were the government's procurement and the substantial increase in the minimum support price USDA (2025).

Conventional wheat production largely depends on the extensive use of chemical fertilizers to meet crop nutrient requirements. Although, these fertilizers have significantly increased crop yields, their continuous and imbalanced use has led to soil degradation, nutrient imbalance, reduced soil microbial activity and environmental concerns such as water pollution and greenhouse gas emissions. In this context, there is a growing interest in eco-friendly and sustainable nutrient management practices Khan *et al*. (2023).

Liquid biofertilizers have emerged as a promising alternative to supplement or partially replace chemical fertilizers. These biofertilizers contain beneficial microorganisms such as nitrogen-fixing bacteria, phosphate-solubilizing bacteria, and plant growth-promoting rhizobacteria, which enhance nutrient availability, improve soil health and stimulate plant growth. Compared to carrier-based biofertilizers, liquid formulations offer advantages such as longer shelf life, higher microbial population, ease of application, and better survival under field conditions was similar to Meier *et al*. (2024).

Nutrient management, particularly the optimization of nitrogen, phosphorus, and potassium levels, plays a vital role in determining wheat growth, yield and economic returns. Balanced fertilization not only improves crop productivity but also enhances nutrient use efficiency and reduces production costs. Integrating liquid biofertilizers with appropriate nutrient levels can potentially create a synergistic effect, improving both crop performance and soil fertility Kamal *et al*. (2016).

From an economic perspective, farmers are increasingly concerned with maximizing returns while minimizing input costs. The use of liquid biofertilizers, in combination with optimized fertilizer doses, may reduce dependence on costly chemical inputs and improve benefit–cost ratios. Therefore, evaluating both yield performance and economic viability is essential for recommending sustainable agricultural practices. In this context, the present study aims to assess the impact of liquid biofertilizers and different nutrient levels on the growth, yield, and economics of wheat (*Triticum aestivum* L.). The findings of this study are expected to contribute to the development of efficient, cost-effective, and environmentally sustainable nutrient management strategies for wheat cultivation.

Materials and Methods

During the *Rabi* season of 2023 and 2024 both Year, a field study on the Therefore, the present investigation entitled "Influence of Liquid Biofertilizer and Nutrient levels on growth and yield of Wheat (L.)" was conducted at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Faculty of Agriculture, Sam Higginbottom University of Agriculture, Technology and Sciences Prayagraj, U.P. The present two-year field experiments were carried out at Crop Research Farm (25.40º N latitude, 81.85º E longitude and 112.05 m above mean sea level) at SHUATS, Prayagraj, during *Rabi*, 2022-23 and 2023-24. The soil was sandy loam in texture, moderately basic in reaction neutral pH (7.19), medium organic carbon (0.37%), available nitrogen (220.34 kg/ha), potassium (202 kg/ha) and low available phosphorus (21 kg/ha). The experiment was laid out in Randomized Block Design (RBD) with three replications with twelve treatment combinations (T_1: Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + 100% NPK; T_2: Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + 85% NPK; T_3: Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + 70% NPK; T_4: Liquid bio fertilizer consortia (LBFC) soil application (625 ml/ha) + 100% NPK; T_5: Liquid bio fertilizer consortia (LBFC) soil application (625 ml/ha) + 85% NPK; T_6: Liquid bio fertilizer consortia (LBFC) soil application (625 ml/ha) +70% NPK; T_7: Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) + 100% NPK; T_8: Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) + 85% NPK; T_9: Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) +70% NPK; T_{10}: No use of Liquid bio fertilizer consortia (LBFC) +100% NPK; T_{11}: No use of Liquid bio fertilizer consortia (LBFC) + 85% NPK; T_{12}: No use of Liquid bio fertilizer consortia (LBFC) +70% NPK.). Using a hand hoe, 4-5 cm deep furrows were dug along the seed rows to deliver nutrients as a spreading technique. Once germination occurred, the gaps were closed by transplanting ten days following sowing. Seedlings were clipped off as needed to keep a distance of 25 cm by 10 cm. Intercultural operations were conducted between 25 and 45 DAS intervals to lower crop density and weed competition. Yield attributes characteristics, including number of effective tillers/plant, number of grain per spike, test weight, grain yield, stover yield and harvest index (%) and other hand economics of wheat crop *viz.*, gross return, net return and benefit cost ratio. The pre and post analysis of soil was recorded of experimental fields. The observed data of 12 treatments were statistically examined using analysis of variance (ANOVA) in relation to randomized block design (Gomez and Gomez, 1984).

Soil conditions of experimental field

The soil of the experimental site belongs to the Jamuna Khaddar & alluvial (loam and sandy loam type) agro-ecological situations, representing the minor soil group of central plain zone of Uttar Pradesh. These soils are lighter in color, with smooth texture containing fine soil particles and optimum porosity, highly fertile in nature due to deposition of new layer of alluvium due to flooding of rivers. The field was well-drained and levelled properly before sample collection. The soil samples were collected from 5 random spots at 0-15 cm depth from the experimental plot before the sowing of the first-year crop. The collected samples were mixed thoroughly and made into a representative composite sample of 500 grams through quarter method, processed and stored in perforated bag with a label for physico-chemical analysis. The separate composite soil sample for the biological analysis was collected from 10 random spots of the field in the labelled zip-lock bag and stored in the cool and dry place (Jackson, 1973).

Table 1 : Physical characteristics of experimental field soil (Before sowing of 1st year crop and 2nd year crop).

S. no.	Particulars	Values (2023-24)	Values (2024-25)	Method employed
I	**Mechanical composition**			
i	Sand (%)	61.5	61.5	**Bouyoucos method (Piper, 1966)**
ii	Clay (%)	20.7	20.7	
iii	Silt (%)	17.8	17.8	
iv	Texture	Sandy loam	Sandy loam	

The experimental soil was sandy loam in texture, almost neutral in reaction (pH 7.24 and 7.14), medium in organic carbon in both years (0.37% and 0.36%), medium in available nitrogen in 1st year (220.34kg/ha) and low in 2nd year (225.88 kg/ha), low in available phosphorus in both years (12.44 and 12.80 kg/ha), medium in exchangeable potassium (190.23 and 195.83 kg/ha in both year 2023-24 and 2024-25.

Results and Discussion

Yields and Yield attributes

Number of Effective tillers/m^2

The data provided indicates that the use of liquid biofertilizer consortia and varying Nutrient levels significantly influenced number of effective tillers per running meter during the periods of 2023-24 and 2024-25, in addition to the pooled data analysis.

Data pertaining to number of effective tillers per running meter revealed significant differences among various treatments. Treatment (T_7) Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) + 100% NPK was observed to have highest effect with [117.47 (2023-24), 122.53 (2024-25) and 120.00 (Pooled)] number of effective tillers per running meter.

This improvement in number of effective tillers per running meter can be attributes to the combined influence of chemical fertilizers and the biofertilizer consortia, which together enhanced nutrient dynamics, root development and plant vigor. The availability of readily accessible

Table 2 : Chemical characteristics of experimental field soil (before sowing of 1st and 2nd year crop, respectively).

II	**Chemical properties**	**2023-24**	**2024-25**	**Method and Referances**
i	pH (soil water, 1:2.5)	7.24	7.14	Glass Electrode p^H meter suspension method (Jackson, 1973)
ii	Electrical conductivity (ds/m)	0.38	0.35	Method No. 4 USDA, handbook No. 16 (Richard, 1954)
iii	Organic carbon (%)	0.37	0.36	Walkley and Black rapid titration method (Piper, 1950)
iv	Available Nitrogen (kg/ha)	220.34	225.88	Alkaline $KMnO_4$ method (Subbaih and Asija, 1956)
v	Available Phosphorus (kg/ha)	12.44	12.80	Olsens method (Olsen *et al.*, 1954)
vi	Available Potassium (kg/ha)	190.23	195.83	Flame photometer method (Jackson, 1973)
III	**Physical Properties**			
	Bulk density (Mg/m)	1.4	1.45	Core sample method

Table 3 : Effect of Liquid biofertilizer and Nutrient levels on Yields and yield attributes of wheat.

Treatment	Yield and Yields Attributes											
	No. of effective tillers/m²			Number of Spike /plant			Number of Grain/spikes			Test weight (g)		
	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled
T_1	104.80	108.87	106.83	21.10	21.54	21.32	43.40	42.27	41.74	38.37	38.78	38.58
T_2	103.13	107.07	105.10	21.00	21.39	21.20	38.60	41.53	41.04	38.30	38.68	38.49
T_3	102.00	106.87	104.43	20.59	20.90	20.74	42.00	40.87	40.36	38.23	38.58	38.41
T_4	109.07	113.33	111.20	21.61	22.24	21.93	41.60	45.27	44.68	38.60	39.11	38.85
T_5	107.93	112.27	110.10	22.51	22.09	21.80	45.40	44.33	43.80	38.53	39.01	38.77
T_6	106.00	110.20	108.10	22.21	21.70	22.69	39.80	43.27	42.71	38.44	38.88	38.66
T_7	117.47	122.53	120.00	23.30	26.28	23.79	47.60	50.20	47.51	39.01	39.61	39.31
T_8	113.07	117.67	115.37	21.91	25.66	22.89	47.30	49.93	47.30	38.86	39.43	39.14
T_9	110.53	115.20	112.87	22.80	25.50	22.15	47.40	49.87	47.44	38.69	39.23	38.96
T_{10}	100.00	103.67	101.83	20.49	20.74	20.62	35.80	38.73	38.27	38.09	38.41	38.25
T_{11}	98.80	102.13	100.47	20.40	20.60	20.50	38.80	37.67	37.23	38.04	38.33	38.19
T_{12}	91.33	94.27	92.80	18.47	18.48	18.47	33.60	36.27	35.90	37.99	38.25	38.12
F-test	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**NS**	**NS**	**NS**
SEm(±)	**3.6**	**3.84**	**2.63**	**0.54**	**0.52**	**0.38**	**0.12**	**0.12**	**0.09**	**1.46**	**1.74**	**1.14**
C.D 5 %	**10.56**	**11.27**	**7.5**	**1.58**	**1.54**	**1.17**	**0.34**	**0.36**	**0.24**	**-**	**-**	**-**

T_1: Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + 100% NPK; **T_2:** Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + 85% NPK; **T_3:** Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + 70% NPK; **T_4:** Liquid bio fertilizer consortia (LBFC) soil application (625 ml/ha) + 100% NPK; **T_5:** Liquid bio fertilizer consortia (LBFC) soil application (625 ml/ha) + 85% NPK; **T_6:** Liquid bio fertilizer consortia (LBFC) soil application (625 ml/ha) +70% NPK; **T_7:** Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) + 100% NPK; **T_8:** Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) + 85% NPK; **T_9:** Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) +70% NPK; **T_{10}:** No use of Liquid bio fertilizer consortia (LBFC) +100% NPK; **T_{11}:** No use of Liquid bio fertilizer consortia (LBFC) + 85% NPK; **T_{12}:** No use of Liquid bio fertilizer consortia (LBFC) +70% NPK.

nitrogen, phosphorus and potassium through the 100% NPK application ensured a favorable nutrient environment, while the microbial consortium facilitated improved nutrient solubilization and uptake, resulting in vigorous tiller initiation and greater survival of productive shoots (Wamalwa *et al.*, 2019). Biofertilizer consortia enriched with nitrogen-fixing and phosphate-solubilizing bacteria contribute not only to nutrient availability but also to hormonal regulation within plants. The production of auxins and gibberellins by these microbes promotes cell division in the basal nodes, stimulating the emergence of new tillers (Keswani *et al.*, 2021).

Number of spikes/plant

Data pertaining to number of spikes/plant revealed significant differences among various treatments. Treatment (T_7) Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) + 100% NPK was observed to have highest effect with [23.30 (2023-24), 26.28 (2024-25) and 23.79 (Pooled)] number of spikes/plant.

The analysis of the number of spikes/plant revealed that treatment (T_7) recorded the highest values among all treatments. The superior performance of this treatment in enhancing spike number can be attributed to the synergistic effect of the recommended NPK dose in combination with biofertilizer, which together ensured balanced nutrient availability and efficient uptake by the Wheat crop. Adequate nutrition, especially of nitrogen and phosphorus, plays a pivotal role in promoting tiller formation and spike initiation, contributing directly to an increased number of spikes per plant (Shende *et al.*, 2020). The positive influence of LBFC on spike production its enriched microbial community, which includes nitrogen-fixing, phosphate-solubilizing and plant growth-promoting rhizobacteria. These microbial groups enhance rhizosphere activity, improve root growth and facilitate greater absorption of essential plant nutrients.

Number of grains/spike

The data provided indicates that the use of liquid biofertilizer consortia and varying Nutrient levels significantly influenced number of grain/spikes during the periods of 2023-24 and 2024-25, in addition to the pooled data analysis.

Table 4 : Effect of Liquid biofertilizer and Nutrient levels on Yields of Wheat.

Treatment	Yields at Harvest								
	Grain Yield (t/ha)			Straw yield (t/ha)			Harvest Index (%)		
	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled
T_1	4.51	4.67	4.59	7.05	6.73	6.89	39.06	41.01	40.03
T_2	4.37	4.52	4.45	6.89	6.58	6.73	38.85	40.73	39.79
T_3	4.25	4.38	4.32	6.94	6.64	6.79	38.01	39.79	38.90
T_4	4.89	5.10	5.00	7.38	7.03	7.21	39.88	42.07	40.97
T_5	4.85	5.05	4.95	7.43	7.08	7.26	39.53	41.64	40.58
T_6	4.65	4.83	4.74	7.37	7.04	7.20	38.72	40.72	39.72
T_7	5.44	5.72	5.58	8.02	7.62	7.82	40.44	42.86	41.65
T_8	5.18	5.43	5.31	7.79	7.41	7.60	39.97	42.30	41.14
T_9	5.02	5.25	5.14	7.55	7.19	7.37	39.95	42.21	41.08
T_{10}	3.98	4.09	4.04	6.45	6.17	6.31	38.19	39.91	39.05
T_{11}	3.87	3.97	3.92	6.31	6.03	6.17	38.06	39.71	38.89
T_{12}	3.58	3.66	3.62	6.07	5.82	5.94	37.14	38.68	37.91
F-test	**S**	**S**	**S**	**S**	**S**	**S**	**NS**	**NS**	**NS**
SEm(±)	**0.19**	**0.22**	**0.15**	**0.24**	**0.27**	**0.18**	**1.81**	**2.07**	**1.38**
C.D 5 %	**0.57**	**0.64**	**0.41**	**0.71**	**0.8**	**0.52**	**-**	**-**	**-**

T_1: Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + 100% NPK; **T_2:** Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + 85% NPK; **T_3:** Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + 70% NPK; **T_4:** Liquid bio fertilizer consortia (LBFC) soil application (625 ml/ha) + 100% NPK; **T_5:** Liquid bio fertilizer consortia (LBFC) soil application (625 ml/ha) + 85% NPK; **T_6:** Liquid bio fertilizer consortia (LBFC) soil application (625 ml/ha) +70% NPK; **T_7:** Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) + 100% NPK; **T_8:** Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) + 85% NPK; **T_9:** Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) +70% NPK; **T_{10}:** No use of Liquid bio fertilizer consortia (LBFC) +100% NPK; **T_{11}:** No use of Liquid bio fertilizer consortia (LBFC) + 85% NPK; **T_{12}:** No use of Liquid bio fertilizer consortia (LBFC) +70% NPK.

According to the findings, significant differences were observed on number of grains/spike due to effect of different treatment combinations comprising of various levels of Liquid bio fertilizer consortia and NPK levels. Effect of treatment (T_7) Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) + 100% NPK was found statistically highest among other treatments observing [51.60 (2023-24), 50.20 (2024-25) and 49.51 (Pooled)] number of Grain/spikes.

This enhancement in number of grains/spike can be attributed to the synergistic interaction between the recommended NPK dose and biofertilizer consortia, which collectively improved the plant's nutrient uptake efficiency and photosynthetic performance. Adequate nitrogen and phosphorus availability, ensured through this integrated approach, plays a crucial role in spikelet development, pollination success and grain filling processes, thereby resulting in an increased number of grains per spike (Ullah *et al.*, 2018 and Mehdi *et al.*, 2025). The improved root growth and soil nutrient mobilization achieved through microbial interactions might also ensure sustained nutrient delivery during the reproductive phase, a critical period for grain development. The positive influence of LBFC on grain production may also be linked to its enriched microbial community, which includes nitrogen-fixing, phosphate-solubilizing and plant growth-promoting rhizobacteria Kumar *et al.* (2021).

Test weight (g)

The presented data unequivocally exhibits that the utilization of liquid biofertilizer consortia and varying Nutrient levels exerts a non-significant influence on test weight (g) throughout the temporal intervals of 2023-24 and 2024-25, as well as pooled basis. However, treatment (T_7) Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) + 100% NPK exhibited maximum test weight [39.01 (2023-24), 39.61 (2024-25) and 39.31 (Pooled)] g during both the years of study as well as pooled basis.

The improved root growth and soil nutrient mobilization achieved through microbial interactions might also ensure sustained nutrient delivery during the reproductive phase, a critical period for grain development. The positive influence of LBFC on grain

Table 5 : Effect of Liquid biofertilizer and Nutrient levels on Economics of Wheat.

Treatment	Economics Analysis											
	Cost of cultivation (Rs/ha)			Gross return (Rs/ha)			Net return (Rs/ha)			BC Ratio		
	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled
T_1	66218	66218	66218	149395	153622	151563	83177	87404	85345	1.26	1.32	1.29
T_2	65357	65357	65357	144877	148652	146819	79520	83295	81462	1.22	1.27	1.25
T_3	64489	64489	64489	141384	144736	143114	76895	80247	78625	1.19	1.24	1.22
T_4	66208	66208	66208	161464	167127	164350	95256	100919	98142	1.44	1.52	1.48
T_5	65347	65347	65347	160359	165616	163042	95012	100269	97695	1.45	1.53	1.50
T_6	64479	64479	64479	154243	158939	156645	89764	94460	92166	1.39	1.46	1.43
T_7	66458	66458	66458	179243	186732	183040	112785	120274	116582	1.70	1.81	1.75
T_8	65597	65597	65597	170976	177731	174407	105379	112134	108810	1.61	1.71	1.66
T_9	64729	64729	64729	165709	171890	168854	100980	107161	104125	1.56	1.66	1.61
T_{10}	65968	65968	65968	132302	135154	133782	66334	69186	67814	1.01	1.05	1.03
T_{11}	65107	65107	65107	128714	131201	130011	63607	66094	64904	0.98	1.02	1.00
T_{12}	64239	64239	64239	119541	121575	120610	55302	57336	56371	0.86	0.89	0.88

T_1: Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + 100% NPK; **T_2:** Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + 85% NPK; **T_3:** Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + 70% NPK; **T_4:** Liquid bio fertilizer consortia (LBFC) soil application (625 ml/ha) + 100% NPK; **T_5:** Liquid bio fertilizer consortia (LBFC) soil application (625 ml/ha) + 85% NPK; **T_6:** Liquid bio fertilizer consortia (LBFC) soil application (625 ml/ha) +70% NPK; **T_7:** Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) + 100% NPK; **T_8:** Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) + 85% NPK; **T_9:** Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) +70% NPK; **T_{10}:** No use of Liquid bio fertilizer consortia (LBFC) +100% NPK; **T_{11}:** No use of Liquid bio fertilizer consortia (LBFC) + 85% NPK; **T_{12}:** No use of Liquid bio fertilizer consortia (LBFC) +70% NPK.

production may also be linked to its enriched microbial community, which includes nitrogen-fixing, phosphate-solubilizing and plant growth-promoting rhizobacteria Kumar *et al.* (2021). The effect of biofertilizers and nutrients management which increased in the function in chlorophyll and enzyme activity also contributed to grain production. These findings are consistent with the findings by Saurabh *et al.* (2019) and Kumar *et al.* (2021).

Grain Yield (t/ha)

The data provided indicates that the use of liquid biofertilizer consortia and varying Nutrient levels significantly influenced grain yield (t/ha) during the periods of 2023-24 and 2024-25, in addition to the pooled data analysis. Data pertaining to grain yield (t/ha) revealed significant differences among various treatments. Treatment (T_7) Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) + 100% NPK was observed to have highest effect with 5.44 (2023-24), 5.72 (2024-25) and 5.58 (Pooled)] t/ha grain yield.

Straw yield (t/ha)

According to the findings, significant differences were observed on straw yield (t/ha) due to effect of different treatment combinations comprising of various levels of Liquid bio fertilizer consortia and NPK levels. Effect of treatment (T_7) Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) + 100% NPK was found statistically highest among other treatments observing [8.02 (2023-24), 7.62 (2024-25) and 7.82 (Pooled)] t/ha straw yield.

The enhanced straw yield under treatment (T_7) Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) + 100% NPK could be attributed to improved vegetative growth driven by the synergistic interaction between the biofertilizer microbes and balanced nutrient supply from NPK fertilizers. This combination likely enhanced photosynthetic efficiency, promoted tiller development and increased plant height, all contributing to higher total dry matter accumulation (Janardhan *et al.*, 2024). The microbial consortia present in LBFC, including nitrogen-fixing and phosphate-solubilizing bacteria, might have played a pivotal role in improving soil fertility and nutrient mobilization, thereby sustaining prolonged vegetative growth and greater accumulation of structural biomass before maturity (Allouzi *et al.*, 2022). Similar effects were also produced by Manjunath *et al.* (2023), Kumar *et al.* (2021) and Jain *et al.* (2021).

Harvest Index (%)

It provides an analysis of the impact of Liquid biofertilizer and Nutrient levels on the Harvest Index (%) of Wheat. A detailed analysis of variance is available in Table 2. The data clearly demonstrates that the use of liquid biofertilizer consortia and different Nutrient levels has a non-significant effect on the Harvest Index (%) during the periods of 2023-24 and 2024-25, as well as poold basis. In the study, treatment (T_7) Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) + 100% NPK demonstrated the highest Harvest Index [40.44 (2023-24), 42.86 (2024-25) and 41.65 (Pooled)] %. Comparable outcomes were noted by Reddy *et al*. (2025), Patra and Singh (2018) and Gudadhe *et al*. (2015).

Economics

Among the different treatment combinations, maximum gross returns (` 183040/ha) and net returns (` 116582/ha) and B:C ratio (1.75) were recorded in (Treatment - 7) Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml kg^{-1}) + soil application (625 ml/ha) + 100 % NPK during the experimentation of both the years (2023 and 2024) in Wheat Crop. This illustrates that despite higher input costs, the integration of LBFC with recommended NPK doses significantly enhanced economic efficiency and profitability by boosting yield performance and nutrient use efficiency.

Conclusion

The highest Grain yield, straw yield and gross return, net return and B:C ratio of wheat crop was found with application of Liquid bio fertilizer consortia (LBFC) seed treatment (6 ml/kg) + soil application (625 ml/ha) + 100% NPK in Treatment - 7.

Acknowledgement

The authors express their gratitude to Dr. Biswarup Mehera, Dean and Professor, Department of Agronomy, Naini Agricultural Institute, Prayagraj, Sam Higginbottom University of Agriculture Technology and Sciences, (U.P.), India, for providing the facilities required to carry out the research.

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