

Response of Inorganic, Organic Fertilizer and microbial inoculants on physico-chemical properties of soil in cultivation of wheat (*Triticum aestivum. L*) var. PBW-373

ABSTRACT

The objective of the experiment was to evaluate the response of inorganic fertilizer, organic fertilizer and microbial inoculants on soil health of wheat. The design applied was 3x3 randomized block design. It was observed that treatment T₉ (100% RDF +FYM @ 15 t ha⁻¹ + PSB 6.0 kg ha⁻¹) improved the soil WHC, OC, available N,P and K resulted in a slight change in soil pH 7.34, EC 0.49 dS m⁻¹, bulk density 1.14 Mg m⁻³ and particle density 2.54 Mg m⁻³. In post-harvest soil of fertilizers observations were resulted in significant increase in pore space 48.97 %, water holding capacity 46.85 %, organic carbon 0.48 %, and available N 286.92 kg ha⁻¹, P20.05 kg ha⁻¹, K 201.87 kg ha⁻¹, significant increase in case of Nitrogen kg ha⁻¹, Phosphorus kg ha⁻¹, Potassium kg ha⁻¹ was found to be significant among other treatments in wheat cultivation.

Keywords: Farm Yard Manure, Inorganic fertilizers, Phosphorus Solubilizing bacteria, Soil health, Wheat, etc.

1. INTRODUCTION

In addition to providing nutrients, the soil serves as a natural habitat for plant growth. Certain soils are productive and allow for lush plant development with minimal human intervention, whereas other soils may not support any useful plant life at all even with extensive human intervention. The soil needs to be easily tillable and fertile, have all the nutrients needed in amounts that plants can easily access, be physically sound enough to support plants, and have the right amount of moisture and air content for healthy root development in order to be considered productive. The soil must consistently supply these requirements for the duration of the plant's life.

Wheat (*Triticum aestivum L.*) is the first important *Rabi* cereal crop for the majority of world's populations. It belongs to grass family *Poaceae* (*Graminae*). It is the most important staple food of about two billion people (36% of the world population). India is the second largest producer of wheat (99.70 million tons) next only to China (125.60 million tons) and cover the

largest area under its cultivation (29.58 mha), which is about 14 percent of the world wheat area and average productivity of 3377 kg ha⁻¹. (MoA and FW 2018).

Nitrogen (N) is major factor for yield of wheat (Andrews *et al.*, 2004). Wheat is an important cereal crop and requires a good supply of nutrients especially nitrogen for its growth (Mandal *et al.*, 1992) and yield (Krylov and Pavlov, 1989).

Phosphorus is essential for enhancing seed maturity and seed development (Ziad *et al.* 2008). Phosphorus plays a significant role in several vital functions such as photosynthesis, transformation of sugar to starch, protein synthesis, nucleic acid production, nitrogen fixation and formation of oil. It is also, the part of all biochemical cycles in plants (Mehrvarz and Chaichi, 2008).

Potassium controls the permeability of cellular membranes, maintaining correct protoplasmic hydration, and stabilizing emulsions with high colloidal characteristics, all of which contribute to the preservation of cellular organization. Potassium stabilizes numerous enzymes and has a considerable buffering effect. Potassium is known as "quality element" and it was considered as a key factor in crop production (Moussa, 2000).

Judicious use of FYM with chemical fertilizers improves soil physical, chemical and biological properties and improves the crop productivity (Sharma *et al.*, 2007).

Biofertilizer enhance soil fertility also crop productivity by fixing atmospheric nitrogen, mobilizing sparingly soluble P and by facilitating the release of nutrients through decomposition of crop residues. Phosphorus solubilizing bacteria (PSB) as bio-fertilizers have been found effective in solubilizing the fixed soil P and applied phosphates resulting in higher crop yields. Seed or soil inoculation with PSB, particularly belonging to the genera *Pseudomonas* and *Bacillus*, have been known to improve plant uptake of nutrients and thereby increase the use efficiency of applied chemical fertilizers (Panhware *et al.*, 2014a & b).

Inorganic fertilizers provide essential nutrients like nitrogen, phosphorus, and potassium, while organic fertilizers enrich the soil with organic matter, improving its structure and fertility. Microbial inoculants introduce beneficial microorganisms that enhance nutrient uptake and plant growth. Inorganic fertilizers, when used excessively, can lead to soil degradation, nutrient imbalances, and reduced microbial activity. Conversely, organic fertilizers and microbial inoculants promote soil health by increasing microbial diversity,

improving soil structure, and enhancing nutrient cycling. They also help in retaining soil moisture and reducing erosion. By reducing reliance on synthetic fertilizers, the study of organic fertilizers and microbial inoculants promotes sustainable agricultural practices. This approach minimizes the environmental impact of farming, including reducing greenhouse gas emissions, nitrogen runoff, and groundwater pollution. Building soil health through the use of organic fertilizers and microbial inoculants can enhance the resilience of wheat crops to climate change. Healthy soils are better able to withstand extreme weather events, such as droughts or heavy rainfall, and maintain productivity in changing environmental conditions. Optimizing fertilizer and inoculant use based on crop and soil requirements can lead to cost savings for farmers. Additionally, improved soil health and increased yields contribute to long-term economic sustainability in agriculture. (Smith *et al.*, 2016)

2. METHODOLOGY

The present experiment was conducted during winter season (2022-2023) at Department of Soil Science and Agricultural Chemistry Crop Research Farm of the Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh. Prayagraj is located at 25°47'69" N latitude and 81°85'74" E longitude at an elevation of 98 m from the mean sea level. This region has a sub-tropical climate prevailing in the South-East part of UP.

The soil of the experimental site is alluvial and falls under Inceptisol order. The soil samples were randomly collected from five different sites in the experimental plot prior to tillage operation from a depth of 0-15 cm (furrow slice layer). The soil sample will be reduced in volume by quartering and canning the composites. The soil sample will then be air dried and run through a 2 mm sieve in order to prepare it for chemical analysis (pH, EC, organic carbon, available nitrogen, phosphorus, and potassium, as well as physical analysis (bulk density, particle density, pore space%, water holding capacity%).

Table 1. Treatment combination of wheat var.PBW-373

S.No.	Treatment combination
T ₁	Absolute Control,
T ₂	(RDF @ N: P: K (120:60:40 kg ha ⁻¹),
T ₃	(100% RDF + FYM @ 5 t ha ⁻¹),
T ₄	(100% RDF + FYM @ 10 t ha ⁻¹),
T ₅	(100% RDF + FYM @ 15 t ha ⁻¹),
T ₆	(100 % RDF + FYM @ 5 t ha ⁻¹ + PSB 1.5 kg ha ⁻¹),
T ₇	(100% RDF + FYM @ 10 t ha ⁻¹ + PSB 3.0 kg ha ⁻¹),
T ₈	(100% RDF +FYM @ 15 t ha ⁻¹ +PSB 4.5 kg ha ⁻¹),
T ₉	(100% RDF +FYM @ 15 t ha ⁻¹ + PSB 6.0 kg ha ⁻¹).

3. RESULTS AND DISCUSSION

3.1 Soil Parameters

On the soil parameters, the composition of FYM, biofertilizer, and inorganic fertilizer has increased significantly. Table 2 showed that applying varying amounts of inorganic fertilizer and FYM had the following effects on soil: it increases pore space percentage, water holding capacity percentage, organic carbon, available nitrogen, phosphorus, potassium. Pore space 47.13 and 42.19% and water holding capacity 46.29 and 41.76 were recorded in treatment T₁ is lowest values. In the 0–15 cm and 15–30 cm depths of soil, pore space (48.97% and 43.84%) and water holding capacity 46.85 and 43.43 respectively. Fluctuations in soil bulk density and particle density observed across treatments with microbial inoculants contributing positively.

Fig.1. Shows the diagram of the proper rising depends on Table 2.

The data presented in Table 3 revealed that in Treatment T₉ have lowest pH 7.34 and 7.37 and T₁ have lowest EC 0.36 and 0.38 dS m⁻¹, Organic carbon 0.38 and 0.38 %. T₇ have highest pH 7.46 and 7.53 and T₉ has highest EC 0.49 and 0.53 dS m⁻¹ and organic carbon 0.51% and 0.52%.

Fig. 2. Revealed that the chemical properties (pH, EC, OC) details rising of Table 3.

The data presented in Table 4 revealed that nitrogen 240.32 and 231.75 kg ha⁻¹, phosphorus 17.22 and 17.39 kg ha⁻¹, Potassium 195.74 and 193.95 kg ha⁻¹ in T₁ and nitrogen 286.92 and 280.38 kg ha⁻¹, phosphorus 20.05 and 19.89 kg ha⁻¹, potassium 201.87 and 199.64 kg ha⁻¹ recorded in T₉ respectively in 0-15cm and 15-30cm depth of soil.

Table. 2. Response of Inorganic, Organic Fertilizer and microbial inoculants on physical properties of soil.

Treatment	BD (Mg m ⁻³)		PD (Mg m ⁻³)		Pore space (%)		WHC (%)	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Absolute Control	1.24	1.31	2.55	2.62	47.26	44.46	46.29	41.76
RDF @ N:P:K (120:60:40)	1.23	1.29	2.54	2.61	47.28	44.26	46.34	41.94
100% RDF + FYM @ 5 t ha ⁻¹	1.22	1.29	2.54	2.61	47.20	44.18	46.38	42.08
100% RDF + FYM @ 10 t ha ⁻¹	1.21	1.27	2.53	2.62	47.66	44.93	46.44	42.50
100% RDF + FYM @ 15 t ha ⁻¹	1.20	1.26	2.54	2.62	48.32	43.50	46.50	42.74
100 % RDF + FYM @ 5 t ha ⁻¹ +PSB 1.5 kg ha ⁻¹	1.19	1.25	2.53	2.62	49.39	43.46	46.57	42.97
100% RDF + FYM @ 5 t ha ⁻¹ + PSB 3 kg ha ⁻¹	1.18	1.24	2.54	2.62	49.13	43.21	46.64	43.19
100% RDF +FYM @ 10 t ha ⁻¹ + PSB 4.5 kg ha ⁻¹	1.16	1.22	2.54	2.61	48.94	43.78	46.73	43.35

100% RDF +FYM @ 15 t ha ⁻¹ + PSB 6 kg ha ⁻¹	1.14	1.19	2.54	2.62	49.4 0	43.98	46.85	43.43
F-Test	NS	NS	NS	NS	S	S	S	S
S.Em. (±)	–	–	–	–	0.18	0.36	0.06	0.37
C.D. at 5%	–	–	–	–	0.52	1.06	0.19	1.08

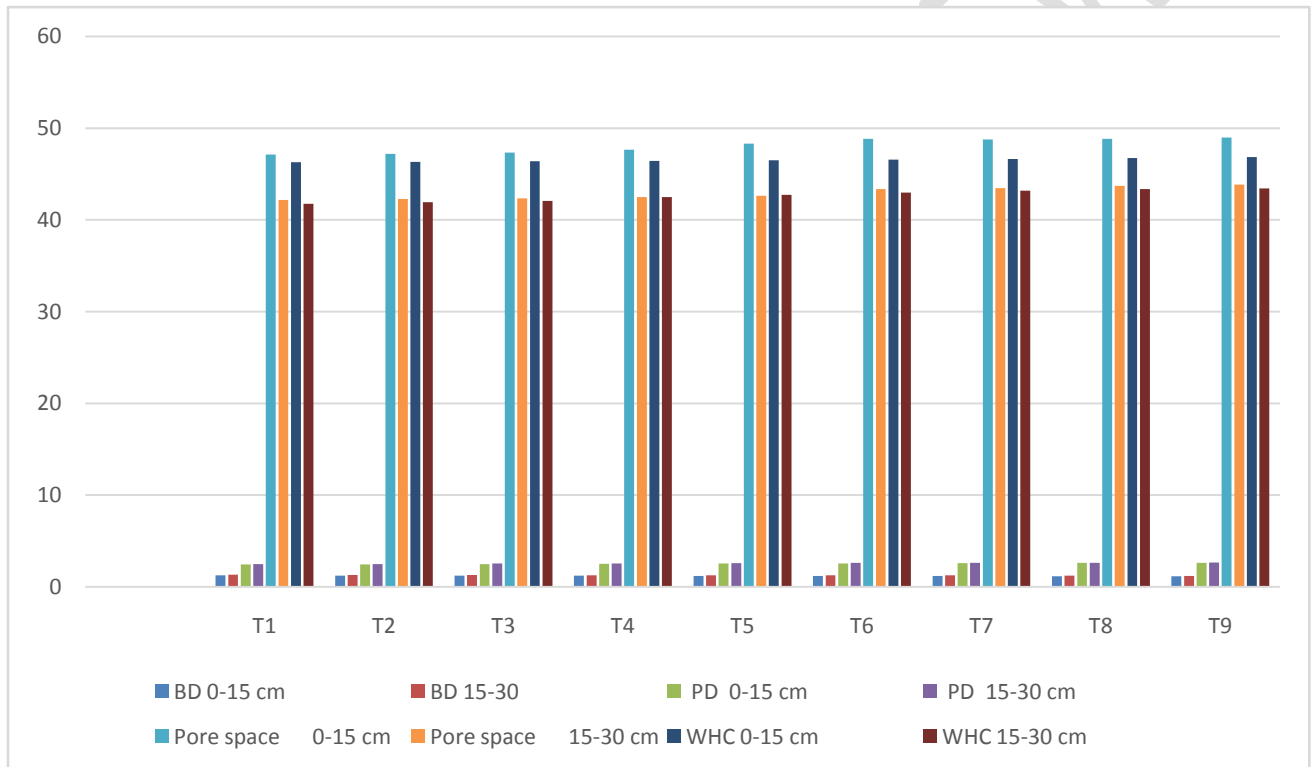


Fig.1. Response of Inorganic, Organic Fertilizer and microbial inoculants on physical properties of soil.

Fig.3. Revealed that the chemical properties details rising of Table 4.

Table 3. Response of different levels of inorganic fertilizer, organic fertilizer and microbial inoculants on chemical properties of soil.

Treatment	pH		EC (dS m ⁻¹)		Organic carbon (%)	
	0-15 cm	15 -30 cm	0-15 cm	15 - 30 cm	0-15 cm	15 - 30 cm
Absolute Control	7.43	7.43	0.36	0.38	0.38	0.38
RDF @ N:P:K (120:60:40)	7.40	7.48	0.39	0.41	0.42	0.41
100% RDF + FYM @ 5 t ha ⁻¹	7.47	7.49	0.42	0.45	0.44	0.45
100% RDF + FYM @ 10 t ha ⁻¹	7.46	7.45	0.44	0.45	0.44	0.42
100% RDF + FYM @ 15 t ha ⁻¹	7.34	7.40	0.42	0.41	0.43	0.46
100 % RDF + FYM @ 5 t ha ⁻¹ +PSB 1.5 kg ha ⁻¹	7.40	7.43	0.40	0.42	0.46	0.48
100% RDF + FYM @ 5 t ha ⁻¹ + PSB 3 kg ha ⁻¹	7.46	7.53	0.41	0.44	0.45	0.45
100% RDF +FYM @ 10 t ha ⁻¹ + PSB 4.5 kg ha ⁻¹	7.36	7.40	0.47	0.49	0.49	0.48
100% RDF +FYM @ 15 t ha ⁻¹ + PSB 6 kg ha ⁻¹	7.34	7.37	0.49	0.53	0.51	0.52
F-Test	S	S	S	S	S	S
S.Em. (±)	0.04	0.03	0.01	0.01	0.01	0.01
C.D. at 5%	0.10	0.10	0.02	0.02	0.02	0.03

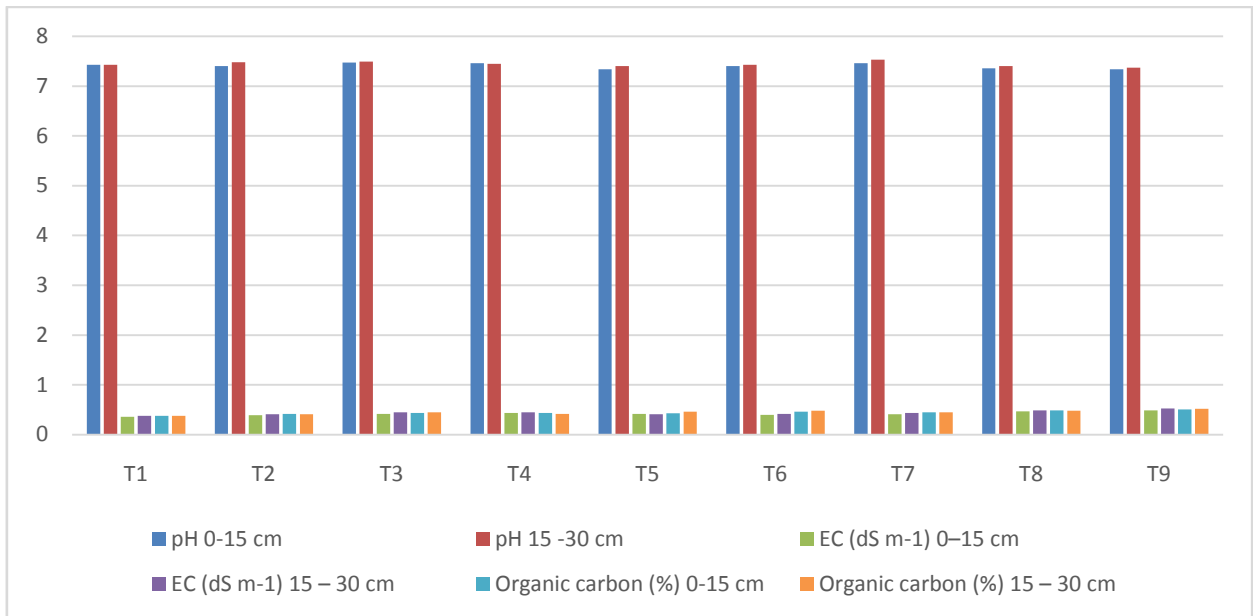


Fig.2. Response of Inorganic, Organic Fertilizer and microbial inoculants on chemical properties of soil

UNDER PEER REVIEW

Table 4. Response of different levels of inorganic fertilizer, organic fertilizer and microbial inoculants on chemical properties of soil.

Treatment	Available Nitrogen (kg ha ⁻¹)		Available Phosphorus (kg ha ⁻¹)		Available Potassium (kg ha ⁻¹)	
	0 – 15 cm	15-30 cm	0 – 15 cm	15 – 30 cm	15 – 30 cm	15 – 30 cm
Absolute Control	240.32	231.75	17.22	17.39	192.21	193.59
RDF @ N:P:K (120:60:40)	242.18	236.22	18.34	18.21	195.83	197.93
100% RDF + FYM @ 5 t ha ⁻¹	245.93	232.43	17.85	18.46	200.75	198.26
100% RDF + FYM @ 10 t ha ⁻¹	257.48	246.17	18.41	18.52	200.31	199.12
100% RDF + FYM @ 15 t ha ⁻¹	267.30	252.09	18.35	18.55	198.15	197.67
100 % RDF + FYM @ 5 t ha ⁻¹ +PSB 1.5 kg ha ⁻¹	255.98	245.26	18.75	18.80	203.13	198.45
100% RDF + FYM @ 5 t ha ⁻¹ + PSB 3 kg ha ⁻¹	272.88	265.74	19.21	19.34	205.94	199.26
100% RDF +FYM @ 10 t ha ⁻¹ + PSB 4.5 kg ha ⁻¹	279.76	274.77	19.53	19.79	203.37	201.52
100% RDF +FYM @ 15 t ha ⁻¹ + PSB 6 kg ha ⁻¹	286.92	280.38	20.05	19.89	218.14	200.64
F-Test	S	S	S	S	S	S
S.Em. (±)	1.09	1.14	0.29	0.27	3.40	0.38
C.D. at 0.5%	3.19	3.33	0.85	0.79	9.98	1.12

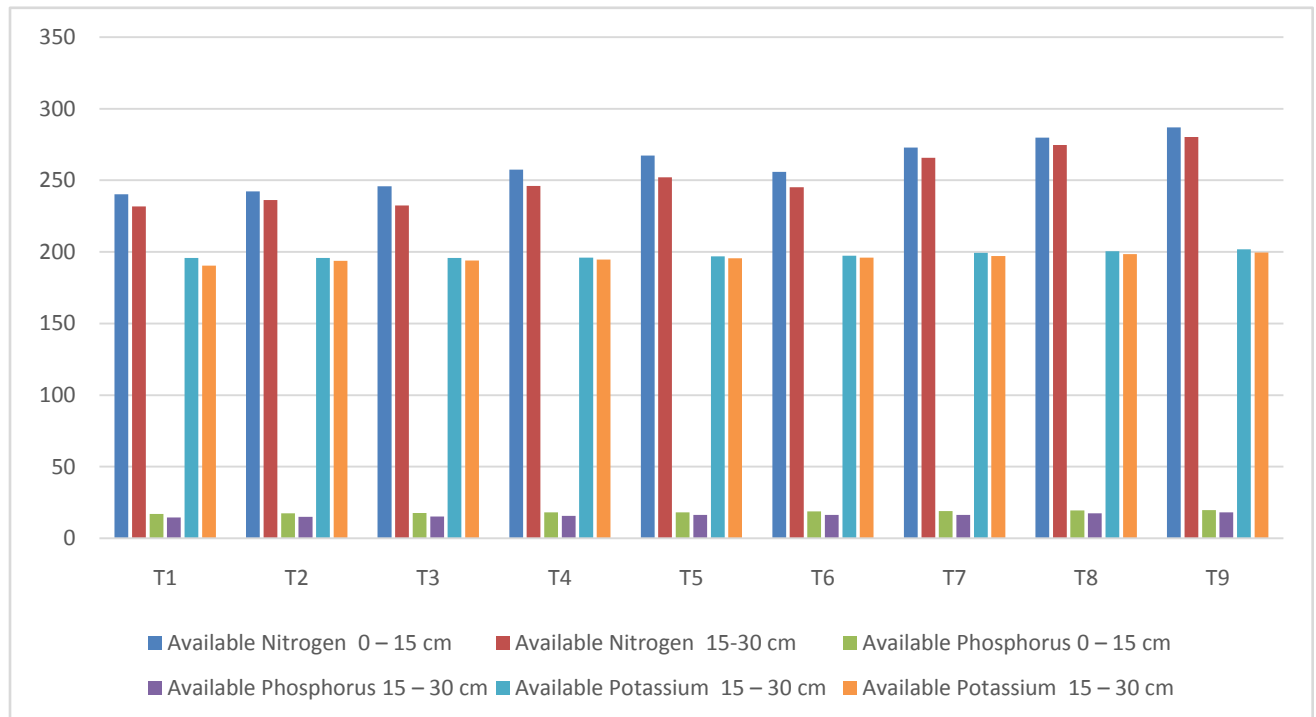


Fig.3. Response of different levels of inorganic fertilizer, organic fertilizer and microbial inoculants on chemical properties of soil.

CONCLUSION

Use of inorganic fertilizers, organic fertilizers and microbial inoculants in the field can improve soil parameters and crop production. The available NPK in soil increased with application of recommended dose of nitrogen through higher amounts of organic manures over application of recommended dose of nitrogen through inorganic fertilizers. The implementation of treatment T₉ (100% NPK + FYM @ 15 t ha⁻¹ + PSB6 kg ha⁻¹) has significantly increase pore space, water holding capacity. Treatment combination T₉ (100% NPK + FYM @ 15 t ha⁻¹ + PSB6 kg ha⁻¹) is the best for significant increase of soil physical and chemical properties. It also contributes to soil fertility and soil resource management.

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