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

Comment [SB1]: Change this scientific name in italics. Title needs some changes.

ABSTRACT

*An experiment was conducted on "*Response of Inorganic, Organic Fertilizer and microbial inoculants on physico-chemical properties of soil in cultivation of wheat (*Triticum aestivum. L*) var. PBW-373"*during Rabi season 2022-2023 at the Research farm Department of Soil Science and Agricultural Chemistry, Naini Agriculture Institute , SHUATS, Prayagraj The design applied was randomized block design having 9 treatment combination of inorganic fertilizer, organic and biofertilizer.The results showed that the application of inorganic, organic, and microbial inoculants had a substantial impact on available N, P, and K as well as soil physical characteristics (bulk density, particle density, and water holding capacity).*

Keywords*: Wheat, Soil, FYM, PSB, Yieldetc.*

Comment [SB2]: Pls add relevant keywords related to title/research work

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'spopulations. It belongs to grass family *Poaceae*(*Graminae*). It is the most important staple foodof 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 about14% of the world wheat area and average productivity of 3377 kg ha^{-1}.**(MoA and FW 2018).**

Comment [SB3]: Pls mention the unit properly

Nitrogen (N) is major factor for yield of wheat (**Andrews *et al*., 2004**). Wheat is an important cereal crop and requires a good supply ofnutrientsespeciallnitrogen foritsgrowth**(Mandal *etal*.,1992)**andyield(**Krylovand Pavlov, 1989**).

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

Potassium controls the permeability of cellular membranes, maintaining correctprotoplasmic hydration, and stabilizing emulsions with high colloidal characteristics, all of whichcontribute to the preservation of cellular organization. Potassium stabilizes numerous enzymesystemsandhasaconsiderablebufferingeffect. Potassium is known as "quality element" and itwas considered as a key factor in crop production (**Moussa, 2000**).

Comment [SB4]: Pls mention it properly

Judicious use of FYM with chemicalfertilizers improves soilphysical, chemicalandbiological properties and improves the cropproductivity**(Sharma*etal*.,2007).** Biofertilizerenhancesoilfertilityalsocropproductivitybyfixingatmospheric nitrogen, mobilizing sparingly soluble P and by facilitating the release of nutrientsthroughdecompositionofcropresidues. Phosphate solubilizing bacteria (PSB) as bio-fertilizershave been found effective in solubilizing the fixed soil P and applied phosphates resulting inhigher crop yields**.**SeedorsoilinoculationwithPSB,particularlybelongingtothegeneraPseudomonasandBacillus,havebeenknowntoimproveplantuptake of nutrients and thereby increase the use efficiency of applied chemical fertilizers **(Panhwar*etal*., 2014a &b).**

Comment [SB5]: Italics

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^{0}47’69” N latitude and 81^{0}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 with both the extreme in temperature i.e., the winter and the summer.

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%).

Table1.Treatmentcombinationofwheatvar.PBW-373

S.No.	**Treatmentcombination**
T_1	AbsoluteControl,
T_2	(RDF @ N: P: K (120:60:40),
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. RESULTSANDDISCUSSION

Comment [SB6]: Discussion part not mentioned. .pls do it separately.

3.1 SoilParameters

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 41.76were recorded in treatment T1's 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. Shown that the verbal diagram of the proper rising depending upon Table 2.

Table 3 shown 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 0.53dS 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.

Table 4 shown 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 199.64kg ha^{-1} recorded in T9 respectively in 0-15cm and 15-30cm depth of soil. Fig. 3. Revealed that the chemical properties details rising of Table 4.

Fig.1.**Response of Inorganic, Organic Fertilizer and microbial inoculants on physical properties 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	49.40	43.98	46.85	43.43
F-Test	NS	NS	NS	NS	S	S	S	S
S.Em. (±)	0.01	0.01	0.01	0.01	0.18	0.36	0.06	0.37
C.D. at 5%	0.02	0.02	0.38	0.31	0.52	1.06	0.19	1.08

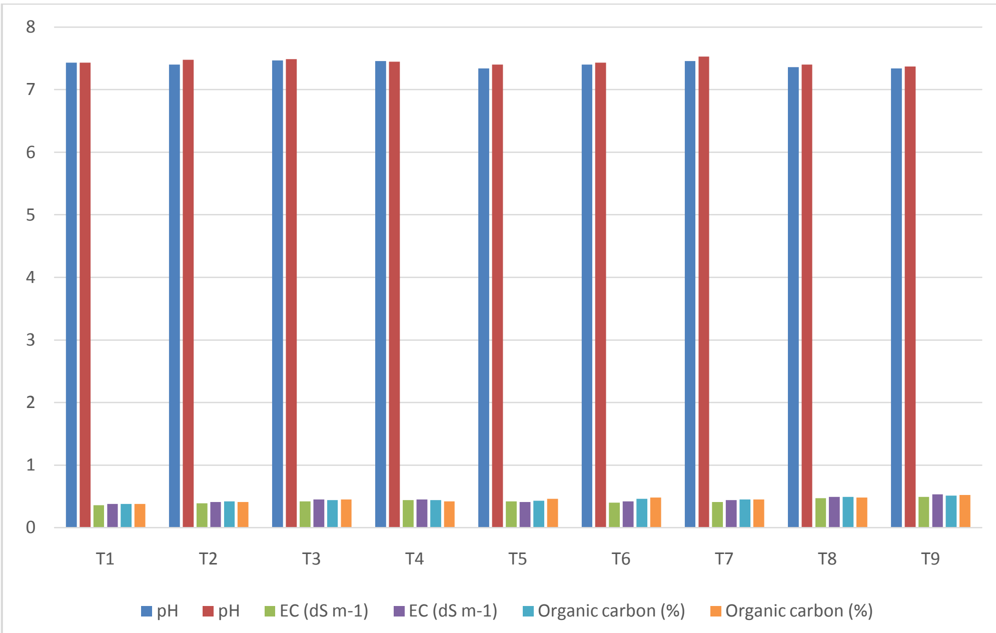

Fig.2.**Response of Inorganic, Organic Fertilizer and microbial inoculants on chemical properties of soil**

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

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

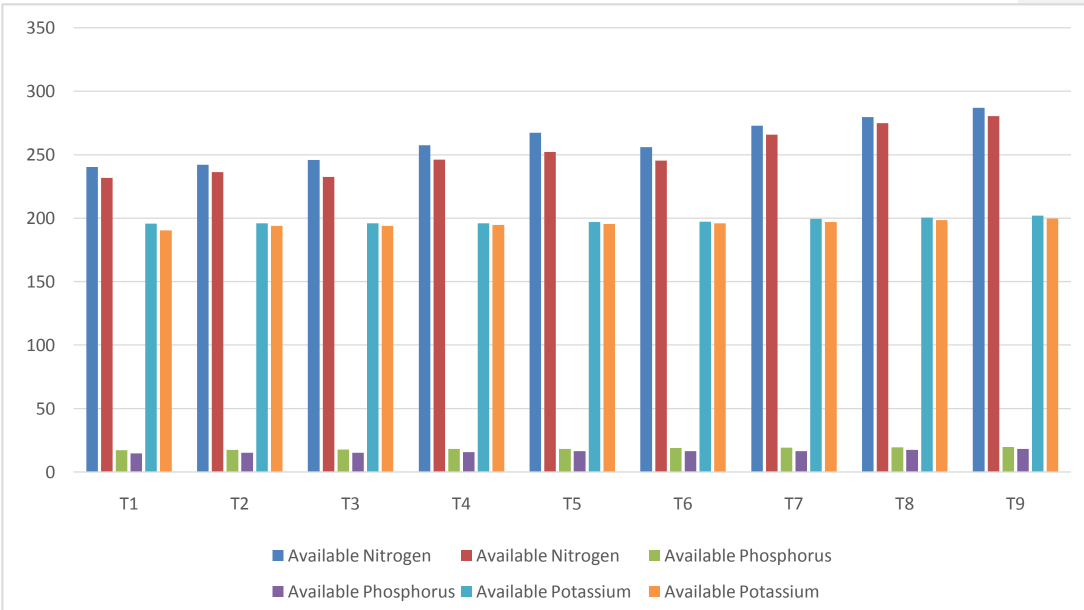

Fig. 3. Response of different levels of inorganic fertilizer, organic fertilizer and microbial inoculants on chemical properties of soil.

CONCLUSION

Application of inorganic fertilizers, organic fertilizers and microbial inoculants in the field can improve soil parameters and wheat yield. Treatment combination T9 (100% NPK + FYM @ 15 t ha-1 + PSB6 kg ha^{-1}) is the best for significant improvement of soil physical and chemical properties. It also contributes to soil fertility and soil resource management.

Comment [SB7]: Need to include some more clarity in conclusion part

REFERENCES

Comment [SB8]: Need to include some more refence with recent year like 2023 and 2024 .

1. Andrews, M., Lea, P.J., Raven, J.A., and Lindsey, K. (2004). Can Genetic Manipulation of Plant Nitrogen Assimilation Enzymes Result in Increased Crop Yield and Greater N-Use Efficiency. An Assessment. Annals of Applied Biology, 145: 25-40.
2. Mandal, N.N., P.P. Chaudhry and Sinha, D. (1992). Nitrogen, nitrogen and potash uptake of wheat (var. Sonalika). Environ. Econ., 10: 297-297.
3. Ziadi, N., Bélanger, G., Cambouris, A.N., Tremblay, N., Nolin, M.C., and Claessens, A. (2008). Relationship between phosphorus and nitrogen concentrations in spring wheat. Agron. J., 100 (1): 80- 86.
4. Mehrvarz, S., andChaichi, M.R.(2008).Effect of phosphate solubilizing microorganisms and phosphorus chemical fertilizer on forage and grain quality of barely (Hordeumvulgare L.). Am-Euras. J. Agric. & Environ. Sci., 3 (6): 855- 860.
5. Moussa, B.I.M. (2000). Response of wheat plants growth in sandy soils to K and some micronutrients fertilization. Egypt J. Soil Sci., 40 (4):481-493.
6. Sharma, M., Mishra, B. and Singh. R. (2007). Long-term effects of fertilizers and manure on physical and chemical properties of a mollisol. J. Indian Soc. Soil Sci., 55: 523–524.
7. Panhwar, Q.A., Shamshuddin, J., Naher, U.A., Radziah, O., and Razi, I.M. (2014b). Changes in the chemical properties of an acid sulfate soil and the growth of rice as affected by biofertilizer, ground magnesium limestone and basalt application. Pedosphere., 24(6):827-835.
8. Panhwar, Q.A., Shamshuddin, J., Naher, U.R., Radziah, O., and MohdRazi, I. (2014 a). Biochemical and molecular characterization of potential phosphate solubilizing bacteria

in acid sulfate soils and their beneficial effects on rice production. PLOS ONE., 9(10): e 97241

9. Muthuvel P, Udayasoorian C, Natesan R, Ramaswami PR. Introduction to Soil Analysis, Tamil Nadu Agricultural University, Coimbatore; 1992.
10. Jackson ML. Soil Chemical Analysis. Prentice-Hall Inc., Englewood Cliffs, NJ. 1958;498.
11. Wilcox LV. Electrical Conductivity. Am. Water works Assoc. J. 1950;42:776.
12. Walkley A, Black IA. An examination of Degtjareff method for determining soil organic matter, and proposed modification of the chromic acid tritation method. Soil Science. 1934;37:29-38.
13. Subbiah BV, Asija GL. A Rapid Procedure for the Estimation of Available Nitrogen in Soils. Current Science. 1956;25:259-260.
14. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodiumbicarbonate. USDA Circular 939. US Government Printing Office, Washington DC; 1954.
15. Toth SJ, Prince AL. Estimation of cation exchange capacity and exchangeable calcium, potassium, and sodium contents of soils by flame photometer techniques. Soil Sci. 1949;67:439-445.
16. Lindsay WL, Norvell WA. Equilibrium relationship of $Zn^{2}+$, $Fe^{2}+$, Ca2+ and Hwith EDTA and DTPA in soils. Soil Sci. Soc. Amer. Proc. 1969;35:62-68.
17. Bouyoucos GJ. The Hydrometer as a New Method for the Mechanical Analysis of Soils. Soil Science. 1927;23:343-353.
18. NHB. National Horticulture Database- 2018-19. National Horticulture Board GovernmentofIndia,Gurgaon,India;2018- 19.
Available:www.nhb.gov.in