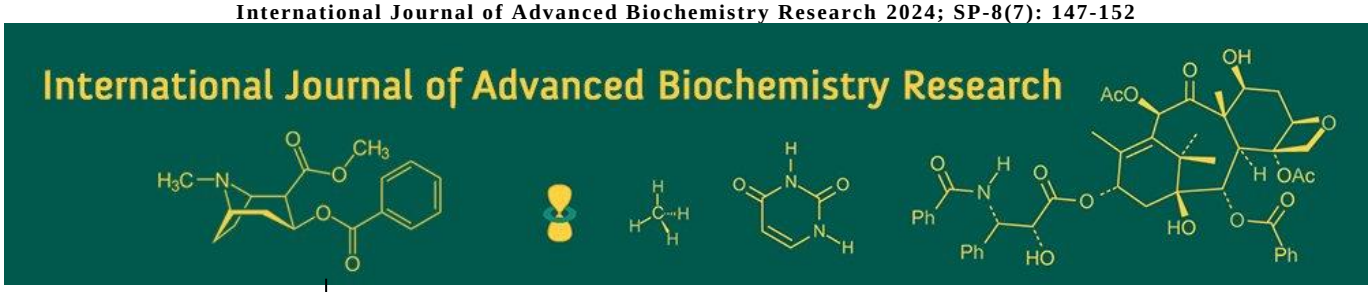

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(7): 147-152
www.biochemjournal.com
Received: 02-05-2024
Accepted: 05-06-2024

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Influence of NPK and poultry manure on physico-chemical properties of Cowpea (*Vigna unguiculata* L.) grown of soil Prayagraj district

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DOI: https://doi.org/10.33545/26174693.2024.v8.i7Sc.1475

Abstract
The research was conducted at the research farm of Department of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P. during the *Rabi* season in 2023-2024. The experiment was laid out in randomized block design with eighteen treatments and three replications with three levels of NPK and poultry manure and two levels of PSB respectively. The available nitrogen, phosphorus and potassium (kg ha^{-1}), (%) OC, (%) pore space and water holding capacity of soil after crop harvest was found significant except on bulk density (Mg m^{-3}), particle density (Mg m^{-3}), pH and EC (dSm^{-1}) of soil after harvest. The treatment T_{18} (@ 100% NPK + @ 100% Poultry Manure + @ 100% PSB) have significant findings which comprises yellowish brown and sandy loam textured neutral to lightly alkaline soil that is non- saline in nature. Physico-chemical properties of soil was found best in treatment T_{18} as compare with in treatment T_1 (Absolute control).

Keywords: NPK, poultry manure, cowpea, PSB, etc.

Introduction
Healthy soils are the foundation of the food system (Soil Science Society of America, 1970) [22]. Our soils are the basis for agriculture and the medium in which nearly all food-producing plants grow (Pulakeshi *et al.*, 2014) [18]. Healthy soils produce healthy crops that in turn nourish people and animals. Indeed, soil quality is directly linked to food quality and quantity (Chaudhary *et al.*, 2003) [3].

Cowpea [*Vigna unguiculata* (L.) Walp] is a valuable component of farming systems in many areas because of its ability to restore soil fertility for succeeding cereal crops grown in rotation with it (Carsky *et al.*, 2002; Tarawali *et al.*, 2002; Sanginga *et al.*, 2003) [2, 25, 21], atmospheric nitrogen fixing ability is extremely valuable when it is cultivated with cereal crops in crop rotation system (Timko *et al.*, 2007) [26].

Cowpea grows predominantly in peninsular and central India. The total coverage under cowpea in Uttar Pradesh is 23.61 lakh hectare with a production around 22.34 lakh tone. Phosphorus availability in Indian soils is poor to medium, however application of adequate amount of phosphorus has been recorded for higher formation of good quality nodules led to enhances growth and yield in legumes (Sammauria *et al.*, 2009) [20].

It is grown for its long green pods as vegetables, seeds as pulses, and leaf and plant residues as green manure, as well as green fodder. Cowpea seeds contain 54.5% carbohydrates, 24.1% protein and 0.1% fat. Moreover, it is a rich source of Phosphorus, calcium and iron. The protein in cowpea seed is rich in amino acids, *viz*, lycine and tryptophan as compared to cereal grains. However, it is deficient in methionine and cysteine as compared to cereals (Maheshbabu *et al.*, 2008) [12].

Nitrogen is vitally important for plant nutrient. Nitrogen is essential constituent of protein and is present in many other compounds of great physiological importance in plant metabolism. Nitrogen is called a basic constituent of life (Choudhary and Yadav 2017) [4]. Phosphorus is an essential constituent of majority of enzymes, which are of great importance in the transformation of energy, in carbohydrate metabolism, fat metabolism, in respiration,

photosynthesis, energy storage, cell elongation and improves the quality of crops of plants. It enhances the activity of rhizobium and increased the formation of root nodules (Sudharani *et al.*, 2020) [24].

Potassium also plays a vital role in carbon sequestration in soil. It helps in cell osmo-regulation, turgor maintenance and cell expansion. It imparts increased vigour and disease resistance to plant and function as an activator of numerous enzymes, regulates water conduction within the plant cell and water loss from the plant by maintaining the balance between anabolism, respiration and transpiration (Salem and Salam 2012) [19]. Poultry manure can improve soil fertility by adding microbes, nutrients and organic matter to the soil. It improves soil fertility and enhances the development of the roots system and the vigor of the plants and makes them less susceptible to diseases and pest attacks. Poultry manure with high proportion of organic carbon content improves organic matter of the soil and retains substantial amounts of soil water and this subsequently increases the water content of soil upon application of the manure (Mohamed *et al.*, 2010) [14].

Materials and Methods

The experiment was conducted at the Soil Science Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, during the *Rabi* season of years (2023-2024) growing cluster bean *Var*. Super Gomati applied three levels of NPK and poultry manure and two levels of PSB. The experiment is lead to observe the physical and chemical parameters.

Table 1: Treatment Details

S. No.	Treatment	Dosage
1.	Level of NPK	0%
		50%
		100%
2.	Level of Poultry Manure	0%
		50%
		100%
3.	Level of PSB	0%
		100%

Table 2: Methods for Analysis of Soil Samples

Sr. No.	Particulars	Scientist Name	Methods	Unit
I.	**Physical properties**			
1.	Bulk density	Muthuvel *et al.*,1992 [15]	Measuring cylinder	Mgm^{-3}
2.	Particle density	Muthuvel *et al.*,1992 [15]	Measuring cylinder	$Mg\ m^{-3}$
3.	Pore space	Muthuvel *et al.*,1992 [15]	Measuring cylinder	%
4.	Water holding capacity	Muthuvel *et al.*,1992 [15]	Keen's cup method	%
II	**Chemical properties**			
1.	Soil pH (1:2.5)	M. L. Jackson, 1958 [8]	pH meter	
2.	Electrical conductivity (1:2.5)	Wilcox, 1950 [30]	digital conductivity meter	dSm^{-1}
3.	Organic carbon	Walkley and Black, 1947 [29]	Walkley and Black Wet oxidation method	%
4.	Available nitrogen	Subbiah and Asija, 1956 [23]	Modified alkaline permanganate oxidation method	$kg\ ha^{-1}$
5.	Available phosphorus	Olsen *et al.*, 1954 [17].	Olsen's extraction followed by Spectro photometric method	$kg\ ha^{-1}$
6.	Available potassium	Toth and Prince, 1949 [27]	Neutral normal ammonium acetate extraction fallowed by Flame photometric method	$kg\ ha^{-1}$

Result and Discussion

Physical Properties of Soil

The data presented in table 3 and depicted in fig. 1 clearly shows the bulk density (Mg m^{-3}) of soil as influenced by NPK and poultry manure. The response of bulk density of soil was found to be non-significant in levels of NPK and manure. The maximum bulk density of soil 1.322 Mg m^{-3} and 1.326 Mg m^{-3} at 0-15 cm 15-30 cm was recorded in treatment T_{18} (@ 100% NPK + @ 100% Poultry Manure + @ 100% PSB) followed by 1.320 Mg m^{-3} and 1.323 Mg m^{-3} at 0-15 cm and 15-30 cm in treatment T_{17} (@ 100% NPK + @ 50% Poultry Manure + @ 0% PSB) and minimum bulk density of soil 1.275 Mg m^{-3} and 1.279 Mg m^{-3} at 0-15 cm and 15-30 cm was recorded in treatment T_1 (absolute control) respectively (Mawo *et al.*, 2016 and Karikari *et al.*, 2015) [13, 11].

The maximum particle density of soil 2.484 Mg m^{-3} and 2.488 Mg m^{-3} at 0-15 cm and 15-30 cm was recorded in treatment T_{18} (@ 100% NPK + @ 100% Poultry Manure + @ 100% PSB) followed by 2.482 Mg m^{-3} and 2.485 Mg m^{-3} at 0-15 cm and 15-30 cm in treatment T_{16} (@ 100% NPK + @ 50% Poultry Manure + @ 100% PSB) and minimum particle density of soil 2.434 Mg m^{-3} and 2.437 Mg m^{-3} at 0-15 cm and 15-30 cm was recorded in treatment T_1 (absolute control) respectively (Daramy *et al.*, 2017 and Jadhav *et al.*, 2011) [5, 9].

The maximum pore space of soil 50.88% and 46.65% at 0-15 cm and 15-30 cm was recorded in treatment T_{18} (@ 100% NPK + @ 100% Poultry Manure + @ 100% PSB) followed by 49.46% and 46.11% at 0-15 cm and 15-30 cm in treatment T_{17} (@ 100% NPK + @ 50% Poultry Manure + @ 0% PSB) and minimum pore space of soil 41.16% and 37.54% at 0-15 cm and 15-30 cm was recorded in treatment T_1 (absolute control) respectively (Daramy *et al.*, 2017 and Jadhav *et al.*, 2011) [5, 9].

The maximum water holding capacity of soil 41.30% and 38.07% at 0-15 cm and 15-30 cm was recorded in treatment T_{18} (@ 100% NPK + @ 100% Poultry Manure + @ 100% PSB) followed by 40.82% and 37.50% at 0-15 cm and 15-30 cm in treatment T_{17} (@ 100% NPK + @ 50% Poultry Manure + @ 0% PSB) and minimum pore space of soil 32.65% and 31.28% at 0-15 cm and 15-30 cm was recorded in treatment T_1 (absolute control) respectively (Daramy *et al.*, 2017 and Jadhav *et al.*, 2011) [5, 9].

Chemical Properties of Soil

The data presented in table 4 and depicted in fig. 2 clearly shows the pH of soil as influenced by NPK and poultry manure. The response of pH of soil was found to be non-significant in levels of NPK and poultry manure. The maximum pH of soil 7.40 and 7.52 at 0-15 cm and 15-30 cm was recorded in treatment T_1 (absolute control) followed by 7.36 and 7.49 at 0-15 cm and 15-30 cm in treatment T_2 (@

0% NPK + @ 0% Poultry Manure + @ 100% PSB) and minimum pH of soil 6.35 and 6.52 at 0-15 cm and 15-30 cm was recorded in treatment T_{18} (@ 100% NPK + @ 100% Poultry Manure + @ 100% PSB) respectively (Hussein *et al.*, 2014 and Nkaa *et al.*, 2014) [7, 16].

The maximum EC of soil 0.59 dSm^{-1} and 0.64 dSm^{-1} at 0-15 cm and 15-30 cm was recorded in treatment T_{18} (@ 100% NPK + @ 100% Poultry Manure + @ 100% PSB) followed by 0.55 dSm^{-1} and 0.62 dSm^{-1} at 0-15 cm and 15-30 cm in treatment T_{16} (@ 100% NPK + @ 50% Poultry Manure + @ 100% PSB) and minimum EC of soil 0.36 dSm^{-1} and 0.38 dSm^{-1} at 0-15 cm and 15-30 cm was recorded in treatment T_1 (absolute control) respectively (Hussein *et al.*, 2014 and Nkaa *et al.*, 2014) [7, 16].

The maximum organic carbon of soil 0.60% and 0.57% at 0-15 cm and 15-30 cm was recorded in treatment T_{18} (@ 100% NPK + @ 100% Poultry Manure + @ 100% PSB) followed by 0.57% and 0.54% at 0-15 cm and 15-30 cm in treatment T_{17} (@ 100% NPK + @ 50% Poultry Manure + @ 0% PSB) and minimum organic carbon of soil 0.39% and 0.35% at 0-15 cm and 15-30 cm was recorded in treatment T_1 (absolute control) respectively (Verma *et al.*, 2015 and Joshi *et al.*, 2016) [28, 10].

The maximum available nitrogen of soil 281.52 kg ha^{-1} and 276.30 kg ha^{-1} at 0-15 cm and 15-30 cm was recorded in treatment T_{18} (@ 100% NPK + @ 100% Poultry Manure + @ 100% PSB) followed by 278.34 kg ha^{-1} and 274.43 kg ha^{-1} at 0-15 cm and 15-30 cm in treatment T_{17} (@ 100% NPK + @ 50% Poultry Manure + @ 0% PSB) and minimum available nitrogen of soil 249.45 kg ha^{-1} and 245.83 kg ha^{-1} at 0-15 cm and 15-30 cm was recorded in treatment T_1 (absolute control) respectively (Choudhary, G. L. and Yadav L. R. 2017 and Sudharani *et al.*, 2020) [4, 24].

The maximum available phosphorus of soil 37.02 kg ha^{-1} and 32.78 kg ha^{-1} at 0-15 cm and 15-30 cm was recorded in treatment T_{18} (@ 100% NPK + @ 100% Poultry Manure + @ 100% PSB) followed by 34.70 kg ha^{-1} and 30.55 kg ha^{-1} at 0-15 cm and 15-30 cm in treatment T_{17} (@ 100% NPK + @ 50% Poultry Manure + @ 0% PSB) and minimum available phosphorus of soil 17.40 kg ha^{-1} and 14.36 kg ha^{-1} at 0-15 cm and 15-30 cm was recorded in treatment T_1 (absolute control) respectively (Choudhary, G. L. and Yadav L. R. 2017 and Sudharani *et al.*, 2020) [4, 24].

The maximum available potassium of soil 200.28 kg ha^{-1} and 196.52 kg ha^{-1} at 0-15 cm and 15-30 cm was recorded in treatment T_{18} (@ 100% NPK + @ 100% Poultry Manure + @ 100% PSB) followed by 197.52 kg ha^{-1} and 193.78 kg ha^{-1} at 0-15 cm and 15-30 cm in treatment T_{17} (@ 100% NPK + @ 50% Poultry Manure + @ 0% PSB) and minimum available potassium of soil 169.36 kg ha^{-1} and 165.54 kg ha^{-1} at 0-15 cm and 15-30 cm was recorded in treatment T_1 (absolute control) respectively (Choudhary, G. L. and Yadav L. R. 2017 and Sudharani *et al.*, 2020) [4, 24].

Table 3: Influence of NPK and poultry manure on bulk density (Mg m^{-3}), particle density (Mg m^{-3}), pore space (%) and Water holding capacity (%) of soil inoculated with PSB

Treatments	Bulk density (Mg m^{-3})		Particle density (Mg m^{-3})		% pore space		Water holding capacity (%)	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1	1.275	1.279	2.434	2.437	41.16	37.54	32.65	31.28
T_2	1.278	1.282	2.440	2.443	42.87	38.78	32.97	31.53
T_3	1.280	1.283	2.436	2.438	43.04	39.01	33.12	31.90
T_4	1.281	1.285	2.439	2.442	43.72	39.45	33.73	32.12
T_5	1.284	1.288	2.443	2.446	44.17	39.83	34.06	32.55
T_6	1.285	1.290	2.447	2.450	44.59	40.97	34.68	32.98
T_7	1.287	1.291	2.452	2.455	45.01	41.14	35.14	33.32
T_8	1.290	1.294	2.458	2.461	45.62	41.58	35.82	33.73
T_9	1.292	1.296	2.455	2.459	46.14	42.07	36.19	34.05
T_{10}	1.296	1.299	2.460	2.464	46.42	42.48	37.53	34.40
T_{11}	1.298	1.301	2.463	2.468	46.81	43.95	37.92	34.87
T_{12}	1.302	1.305	2.469	2.473	47.05	44.21	38.08	35.10
T_{13}	1.306	1.307	2.466	2.469	47.23	44.64	38.45	35.62
T_{14}	1.308	1.310	2.471	2.475	48.59	45.06	39.27	35.94
T_{15}	1.311	1.314	2.477	2.480	48.87	45.49	39.74	36.37
T_{16}	1.316	1.318	2.482	2.485	49.17	45.92	40.26	36.85
T_{17}	1.320	1.323	2.480	2.483	49.46	46.11	40.82	37.50
T_{18}	1.322	1.326	2.484	2.488	50.88	46.65	41.30	38.07
F-Test	NS	NS	NS	NS	S	S	S	S
S.Ed. (±)	-	-	-	-	0.85	0.96	0.78	0.86
C.D. at 0.5%	-	-	-	-	1.78	1.97	1.60	1.82

Table 4: Influence of NPK and poultry manure on pH, EC (dSm^{-1}), organic carbon (%), available nitrogen (kg ha^{-1}), available phosphorus (kg ha^{-1}) and available potassium (kg ha^{-1}) of soil inoculated with PSB.

Treatments	pH		EC (dSm^{-1})		Organic carbon (%)		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	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1	7.40	7.52	0.36	0.38	0.39	0.35	249.45	245.83	17.40	14.36	169.36	165.54
T_2	7.36	7.49	0.39	0.42	0.42	0.37	251.72	247.56	18.63	14.85	173.65	168.32
T_3	7.30	7.44	0.37	0.39	0.44	0.38	252.06	248.50	20.07	16.05	175.82	171.37
T_4	7.27	7.37	0.40	0.43	0.45	0.40	252.35	249.78	20.48	16.62	177.62	174.82
T_5	7.22	7.31	0.42	0.47	0.43	0.39	253.18	250.08	21.74	17.27	176.78	170.15
T_6	7.17	7.26	0.38	0.42	0.46	0.42	254.34	251.60	23.86	18.58	176.08	172.78
T_7	7.11	7.22	0.41	0.45	0.47	0.45	256.08	253.16	25.05	18.22	178.37	175.42
T_8	7.08	7.16	0.44	0.49	0.49	0.44	257.50	254.45	26.70	20.55	178.55	176.08
T_9	7.02	7.10	0.45	0.51	0.48	0.46	260.55	256.50	28.02	19.78	183.45	179.62
T_{10}	6.97	7.03	0.42	0.47	0.50	0.43	262.08	258.18	27.40	21.36	185.18	178.78
T_{11}	6.90	6.98	0.46	0.50	0.51	0.47	265.88	261.36	29.63	22.85	182.19	180.18
T_{12}	6.84	6.92	0.49	0.54	0.49	0.45	268.76	264.76	30.07	24.05	186.34	183.45
T_{13}	6.72	6.89	0.51	0.59	0.52	0.48	270.08	267.18	31.48	25.62	189.18	185.78
T_{14}	6.65	6.80	0.48	0.55	0.55	0.50	273.36	269.52	30.74	27.27	188.67	182.38
T_{15}	6.57	6.73	0.52	0.58	0.53	0.49	275.62	270.76	31.86	26.58	191.76	187.50
T_{16}	6.49	6.68	0.55	0.62	0.56	0.53	276.95	272.16	33.05	28.22	195.82	190.96
T_{17}	6.42	6.60	0.54	0.59	0.57	0.54	278.34	274.43	34.70	30.55	197.52	193.78
T_{18}	6.35	6.52	0.59	0.64	0.60	0.57	281.52	276.30	37.02	32.78	200.28	196.52
F-Test	NS	NS	NS	NS	S	S	S	S	S	S	S	S
S.Ed. (±)	-	-	-	-	0.08	0.05	2.17	2.76	1.45	1.15	2.31	2.68
C.D. at 0.5%	-	-	-	-	0.20	0.13	4.42	5.65	2.96	2.38	4.70	5.41

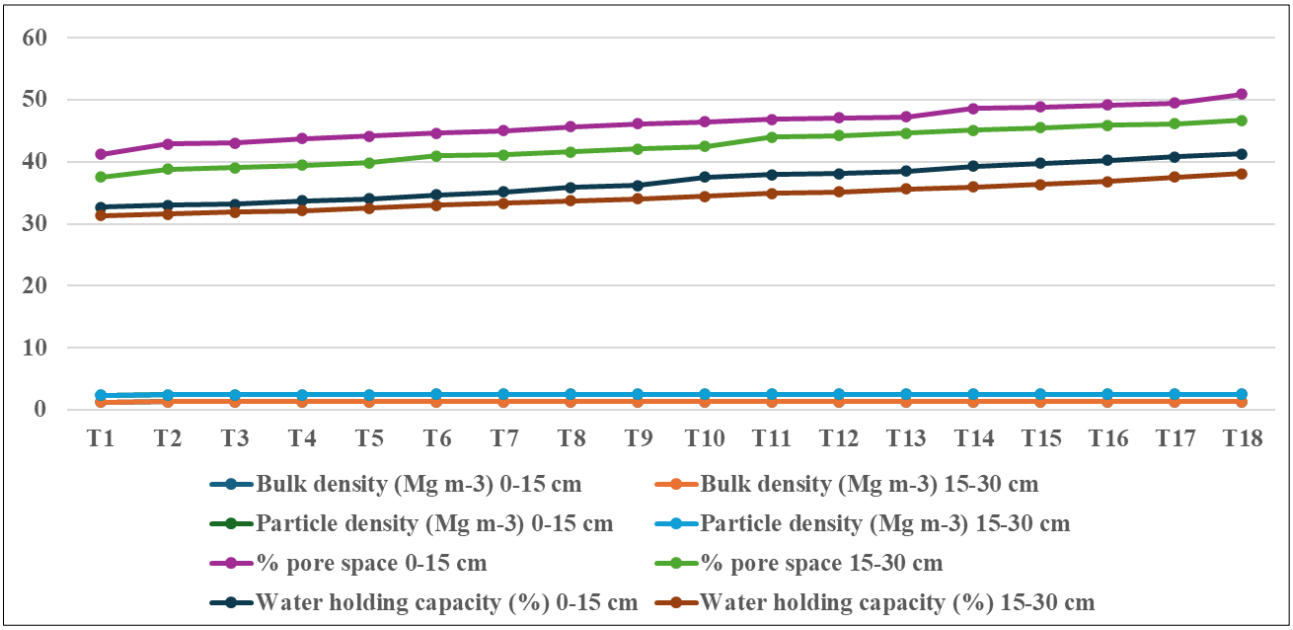

Fig 1: Influence of NPK and poultry manure on bulk density (Mg m^{-3}), particle density (Mg m^{-3}), pore space (%) and Water holding capacity (%) of soil inoculated with PSB

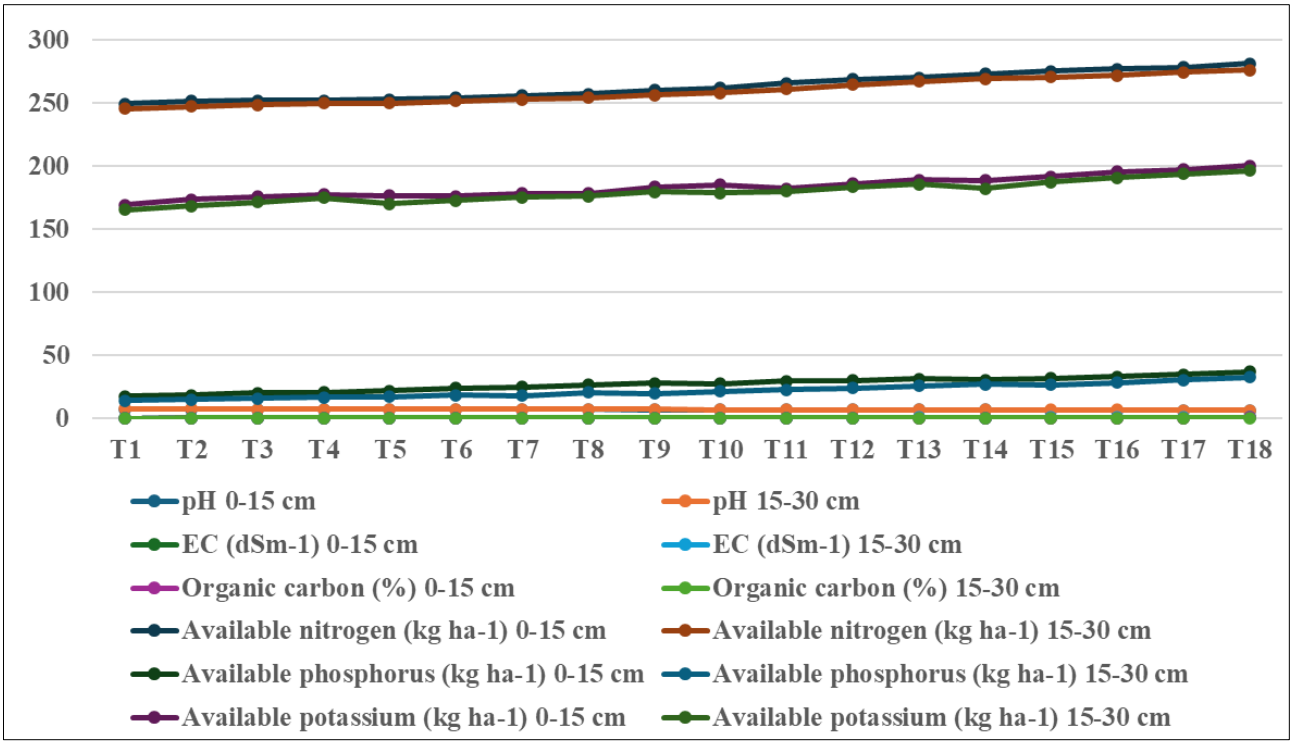

Fig 2: Influence of NPK and poultry manure on pH, EC (dSm^{-1}), organic carbon (%), available nitrogen (kg ha^{-1}), available phosphorus (kg ha^{-1}) and available potassium (kg ha^{-1}) of soil inoculated with PSB

Conclusion

According to the results revealed the treatment T_{18} (@ 100% NPK + @ 100% Poultry Manure + @ 100% PSB) was seen to be best for all the physico-chemical parameters which is followed by treatment T_{17} (@ 100% NPK + @ 50% Poultry Manure + @ 0% PSB) and the lowest treatment was T_1 [Absolute control]. Which proved that full dose of NPK, poultry manure, FYM and PSB are recommendable to the farmers.

Acknowledgements

The authors are grateful to the Hon'ble Vice chancellor SHUATS, Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, for taking their keen interest and encouragement to carry out the research work.

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