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Analysis the Effect of Different Levels of Inorganic and Bio Fertilizers on Physico - Chemical Properties of Soil in Mung Bean

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The research conducted at the Soil Science Research Farm of Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U. P. during the *Summer* season (May to July 2022). The experiment was laid out in randomized block design with nine treatment and three replications with three levels of inorganic fertilizer (0, 50 and 100% NPK), and three level of biofertilizer (0, 50 and 100% Rhizobium and Azotobacter) that leads to the non-significant findings *i. e.* bulk density, particle density, pH and EC and remaining% pore space, WHC, OC, and NPK were found significantly low to medium range, which comprises yellowish brown colour, sandy loam

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textured soil and neutral to alkaline soil that is non- saline in nature among all the nine treatments combination applied in treatment T_9 [NPK @ 100% + Rhizobium @ 100% + Azotobacter @ 100%] has shown the best results in improving the soil nutritional status that leads to increased crop yield and also increased morphological parameters as compare with in treatment T_1 [NPK @ 0% + Rhizobium @ 0% + Azotobacter @ 0%] Application of inorganic and biofertilizer increased improved physical and chemical properties of soil.

Keywords: Mung bean; NPK; rhizobium; azotobacter; physio-chemical properties of soil etc.

1. INTRODUCTION

"Soils supply the essential nutrients, water, oxygen and root support that our food- producing plants need to grow and flourish. They also serve as a buffer to protect delicate plant roots from drastic fluctuations in temperature. A healthy soil is a living, dynamic ecosystem, teeming with microscopic and larger organisms that perform many vital functions including converting dead and decaying matter as well as minerals to plant nutrients (nutrient cycling); controlling plant disease, insect and weed pests; improving soil structure with positive effects for soil water and nutrient holding capacity, and ultimately improving crop production. A healthy soil also contributes to mitigating climate change by maintaining or increasing its carbon content". [1]

Green gram (*Vigna radiata* L.) is one of the important pulse crops in India. Green gram commonly known as "mung bean" has been cultivated in India since ancient times. "It belongs to *Fabaceae* family [2,3]. Green gram is originated from India and central Asia. It is the third most popular pulse crop cultivated throughout in India" [4]. "Green gram is a protein rich staple food. It has enormous potential for the future needs to be capitalized. It has an edge over other pulses because of its high nutritive value, digestibility and non-flatulent behavior. It is grown principally for protein rich edible seeds which contain 24% crude protein, 56.7% carbohydrates, 1.3% fats, 3.5% minerals, 0.43% lysine, 0.1% methionine and 0.04% tryptophan" [4,5].

Green gram also known as moong or mung, is the third most important pulse crop in India after gram and red gram [4]. It belongs to the "Leguminosae" family and sub family "Papillionaceae". Green gram is thought to have originated in India and Central Asia. It extends from India to China, Iraq, Japan, Africa, and other countries. Green gram is primarily growing Rajasthan, Maharashtra, Andhra Pradesh, Orissa, Gujarat, Madhya Pradesh, Punjab, and Utter Pradesh in India.

The inorganic fertilizers, no doubt, are the important source of nutrients in crops which can meet the nutrient requirement but their imbalance and continuous use causes environmental pollution and deterioration of soil health [1]. Another issue for the farmer is the availability of fertilizer at reasonable rates. Under these circumstances, farmers should not depend on single source of plant nutrients like inorganic fertilizers. A balanced use of inorganic fertilizers, organic manures and bio-fertilizers are required to develop an integrated plant nutrition supply system [6].

"Increasing the application of N fertilizer during the early growth period promotes vegetative growth and creates conditions favoring high yield. P fertilizer promotes root growth, disease resistance, drought tolerance, and enhances nutrient and water absorption in the seedlings after they have depleted their endosperm reserves. K fertilizer improves sugar metabolism, enhances osmotic cell concentration, maintains stomatal guard cell turgor, helps regulate stomatal opening, participates in photosynthesis, enhances drought resistance, and increases yield". [7].

Rhizobium are known to form colonies on the root surface stimulating biological nitrogen fixation and providing nitrogen to the leguminous crops and hence considered as a significant process for improving yield and soil fertility. Azotobacter spp. is sensitive to acidic pH, high salt concentration and temperature. They pose advantageous impacts on the crop growth and yield through the biosynthesis of biologically active substances, instigation of rhizospheric microbes, production of phytopathogenic inhibitors, alteration of nutrient uptake and eventually magnifying the biological nitrogen fixation. The objective of this study is to analysis the Effect of Different Levels of Inorganic and Bio Fertilizers on Physico - Chemical Properties of Soil in Mung Bean.

2. MATERIALS AND METHODS

A field experiment conducted at the Soil Science Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, during *summer* season May to July 2022 growing mung bean *Var*. RMG-975 applied 3 levels of NPK and Rhizobium + Azotobacter respectively 0%, 50% and 100% including RDF for mung bean = 20:60:40 kg ha^{-1} experiment is lead to observe the physical and chemical parameters. In physical parameters like that bulk density, particle density, pore space and water holding capacity through method by 100 ml graduated measuring cylinder and process by Muthuvel et al. [8].

In chemical parameters through method by-

a. Soil pH – method given by Jackson, M. L. [9] through using digital pH meter.
b. Soil EC (dSm^{-1}) - method given by Wilcox, [10] through using digital EC meter.
c. Organic Carbon (%) - Wet oxidation method given by Walkley and Black, [6]
d. Available Nitrogen (kg ha^{-1}) - Kjeldhal Method [11]
e. Available Phosphorus (kg ha^{-1}) - Colorimetric method by using Jasper single beam U.V. Spectrophotometer at 660 nm wavelength given by Olsen *et al.* [12]
f. Available Potassium (kg ha^{-1}) - Flame photometric method by using Metzer Flame Photometer given by Toth and Prince [13].

3. RESULTS AND DISCUSSION

Physical Properties of Soil Bulk Density (Mg m^{-3})

The data presented in Table 1 and Fig. 1 show the influence on bulk density (Mg m^{-3}) of soil after crop harvest due to application of inorganic and bio fertilizers. The response in bulk density of soil was found non-significant due to level of inorganic and bio fertilizers. The maximum bulk density of soil 1.38 and 1.45 Mg m^{-3} at 0-15 and 15-30 cm was recorded in treatment T1 (NPK @ 0% + Rhizobium @ 0% + Azotobacter @ 0%) and minimum 1.26 and 1.30 Mg m^{-3} at 0- 15 and 15-30 cm was recorded in treatment T9 (NPK @ 100% + Rhizobium @ 100% + Azotobacter @ 100%) respectively. Similar result has been recorded by Venkatarao et al. [14].

Particle Density (Mg m^{-3})

The data presented in Table 1 and Fig. 1 shows the influence on particle density (Mg m^{-3}) of soil after crop harvest due to application of inorganic and bio fertilizers. The response in particle density of soil was found non-significant due to level of inorganic and bio fertilizers. The maximum particle density of soil 2.50 and 2.62 Mg m^{-3} at 0-15 and 15-30 cm was recorded in treatment T1 (NPK @ 0% + Rhizobium @ 0% + Azotobacter @ 0%) and minimum 2.32 and 2.37 Mg m^{-3} at 0-15 and 15-30 cm was recorded in treatment T9 (NPK @ 100% + Rhizobium @ 100% + Azotobacter @ 100%) respectively. Similar result has been recorded by Chaudhari et al. [15] and Venkatarao et al. [14].

Percent Pore Space

The data presented in Table 1 and Fig. 1 depicted the influence in percent pore space of soil after crop harvest due to application of inorganic and bio fertilizers. The response in percent pore space of soil was found significant due to level of inorganic and bio fertilizers. The maximum percent pore space of soil 44.86 and 42.18% at 0-15 and 15-30 cm was recorded in treatment T9 (NPK @ 100% + Rhizobium @ 100% + Azotobacter @ 100%) and minimum 38.28 and 35.62% at 0-15 and 15-30 cm was recorded in treatment T1 (NPK @ 0% + Rhizobium @ 0% + Azotobacter @ 0%) respectively. Similar result has been recorded by Bhavya et al. [16].

Water Holding Capacity (%)

The data presented in Table 1 and Fig. 1 depicted the influence in water holding capacity (%) of soil after crop harvest due to application of inorganic and bio fertilizers. The response in water holding capacity (%) of soil was found significant due to level of inorganic and bio fertilizers. The maximum water holding capacity of soil 38.65 and 35.80% at 0-15 and 15-30 cm was recorded in treatment T9 (NPK @ 100% + Rhizobium @ 100% + Azotobacter @ 100%) and minimum 32.63 and 29.26% at 0-15 and 15-30 cm was recorded in treatment T1 (NPK @ 0% + Rhizobium @ 0% + Azotobacter @ 0%) respectively. Similar result has been recorded by Bhavya et al. [16].

Table 1. Influence in bulk density (Mg m^{-3}), particle density (Mg m^{-3}), pore space (%) and water holding capacity (%) of soil after crop harvest due to application of inorganic and bio fertilizers

Treatment		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
T1	NPK @ 0% + Rhizobium @ 0% + Azotobacter @ 0%	1.38	1.45	2.50	2.62	38.28	35.62	32.63	29.26
T2	NPK @ 0% + Rhizobium @ 50% + Azotobacter @ 50%	1.36	1.44	2.46	2.58	39.35	35.92	33.02	29.85
T3	NPK @ 0% + Rhizobium @ 100% + Azotobacter @ 100%	1.35	1.40	2.43	2.54	40.62	36.29	33.78	30.12
T4	NPK @ 50% + Rhizobium @ 0% + Azotobacter @ 0%	1.37	1.42	2.42	2.52	40.92	37.06	34.15	30.72
T5	NPK @ 50% + Rhizobium @ 50% + Azotobacter @ 50%	1.33	1.39	2.40	2.49	41.22	37.82	34.78	31.82
T6	NPK @ 50% + Rhizobium @ 100% + Azotobacter @ 100%	1.30	1.36	2.37	2.45	42.71	39.20	35.60	32.48
T7	NPK @ 100% + Rhizobium @ 0% + Azotobacter @ 0%	1.32	1.38	2.35	2.42	43.08	40.36	36.06	33.24
T8	NPK @ 100% + Rhizobium @ 50% + Azotobacter @ 50%	1.30	1.35	2.33	2.38	44.12	41.32	36.82	34.26
T9	NPK @ 100% + Rhizobium @ 100% + Azotobacter @ 100%	1.26	1.30	2.32	2.37	44.86	42.18	38.65	35.80
	F-Test	NS	NS	NS	NS	S	S	S	S
	S.Ed. (±)	-	-	-	-	0.65	0.48	0.42	0.35
	C.D. at 0.5%	-	-	-	-	1.32	0.98	0.87	0.73

Table 2. Influence in pH (1:2.5) w/v, electrical conductivity (dSm^{-1}) and organic carbon (%) of soil after crop harvest due to application of inorganic and bio fertilizers

Treatment		Soil pH (1:2.5) w/v		Electrical Conductivity (dSm^{-1})		Organic carbon (%)	
		0 – 15 cm	15 – 30 cm	0 – 15 cm	15 – 30 cm	0 – 15 cm	15 – 30 cm
T1	NPK @ 0% + Rhizobium @ 0% + Azotobacter @ 0%	7.56	7.62	0.38	0.41	0.41	0.37
T2	NPK @ 0% + Rhizobium @ 50% + Azotobacter @ 50%	7.42	7.58	0.40	0.43	0.42	0.38
T3	NPK @ 0% + Rhizobium @ 100% + Azotobacter @ 100%	7.40	7.52	0.44	0.46	0.43	0.40
T4	NPK @ 50% + Rhizobium @ 0% + Azotobacter @ 0%	7.34	7.46	0.39	0.42	0.42	0.39
T5	NPK @ 50% + Rhizobium @ 50% + Azotobacter @ 50%	7.27	7.38	0.41	0.45	0.44	0.41
T6	NPK @ 50% + Rhizobium @ 100% + Azotobacter @ 100%	7.18	7.26	0.42	0.49	0.47	0.44
T7	NPK @ 100% + Rhizobium @ 0% + Azotobacter @ 0%	7.01	7.15	0.45	0.51	0.48	0.45
T8	NPK @ 100% + Rhizobium @ 50% + Azotobacter @ 50%	6.88	6.97	0.49	0.53	0.51	0.47
T9	NPK @ 100% + Rhizobium @ 100% + Azotobacter @ 100%	6.80	6.92	0.51	0.55	0.54	0.50
	F-Test	NS	NS	NS	NS	S	S
	S.Ed. (±)	-	-	-	-	0.08	0.05
	C.D. at 0.5%	-	-	-	-	0.20	0.12

Table 3. Influence in available nitrogen (kg ha^{-1}), available phosphorus (kg ha^{-1}) and available potassium (kg ha^{-1}) of soil after crop harvest due to application of inorganic and bio fertilizers

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**	**0 – 15 cm**	**15 – 30 cm**
T1	NPK @ 0% + Rhizobium @ 0% + Azotobacter @ 0%	242.15	245.32	16.42	14.26	182.32	178.25
T2	NPK @ 0% + Rhizobium @ 50% + Azotobacter @ 50%	244.68	246.54	17.36	14.68	183.54	179.42
T3	NPK @ 0% + Rhizobium @ 100% + Azotobacter @ 100%	245.42	248.35	19.27	15.65	186.05	181.46
T4	NPK @ 50% + Rhizobium @ 0% + Azotobacter @ 0%	246.72	249.28	20.52	17.02	188.38	184.02
T5	NPK @ 50% + Rhizobium @ 50% + Azotobacter @ 50%	248.46	251.60	22.48	17.80	192.65	187.80
T6	NPK @ 50% + Rhizobium @ 100% + Azotobacter @ 100%	252.08	254.32	23.96	19.18	197.82	191.56
T7	NPK @ 100% + Rhizobium @ 0% + Azotobacter @ 0%	253.36	255.45	24.05	20.32	201.25	196.25
T8	NPK @ 100% + Rhizobium @ 50% + Azotobacter @ 50%	256.17	259.62	26.82	22.65	206.38	202.74
T9	NPK @ 100% + Rhizobium @ 100% + Azotobacter @ 100%	260.45	264.18	29.14	25.82	211.29	207.62
	F-Test	S	S	S	S	S	S
	S.Ed. (±)	2.30	1.95	0.75	0.60	1.40	1.15
	C.D. at 0.5%	4.63	3.98	1.52	1.24	2.82	2.34

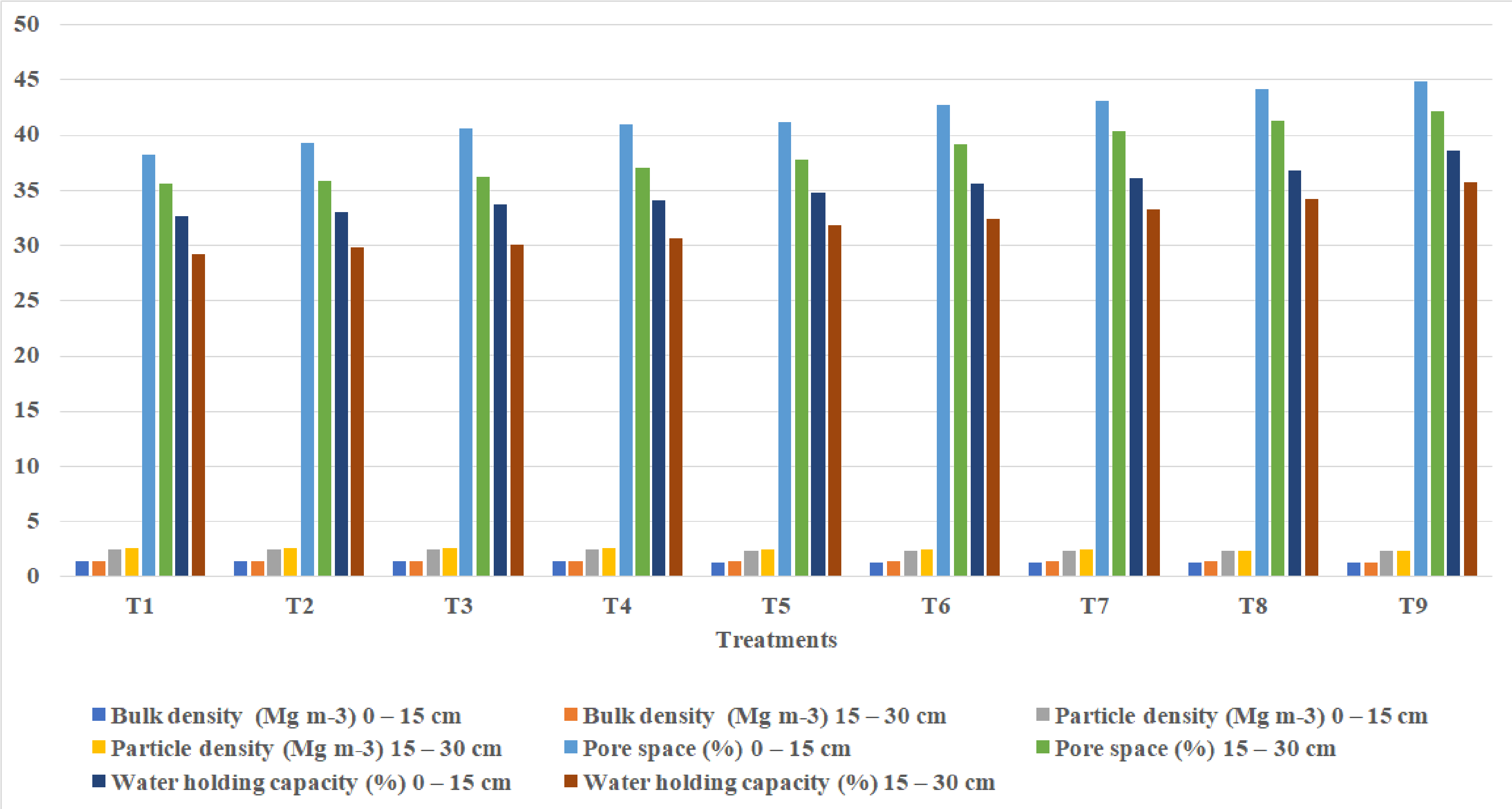

Fig. 1. Influence in bulk density (Mg m^{-3}), particle density (Mg m^{-3}), pore space (%) and water holding capacity (%) of soil after crop harvest due to application of inorganic and bio fertilizers

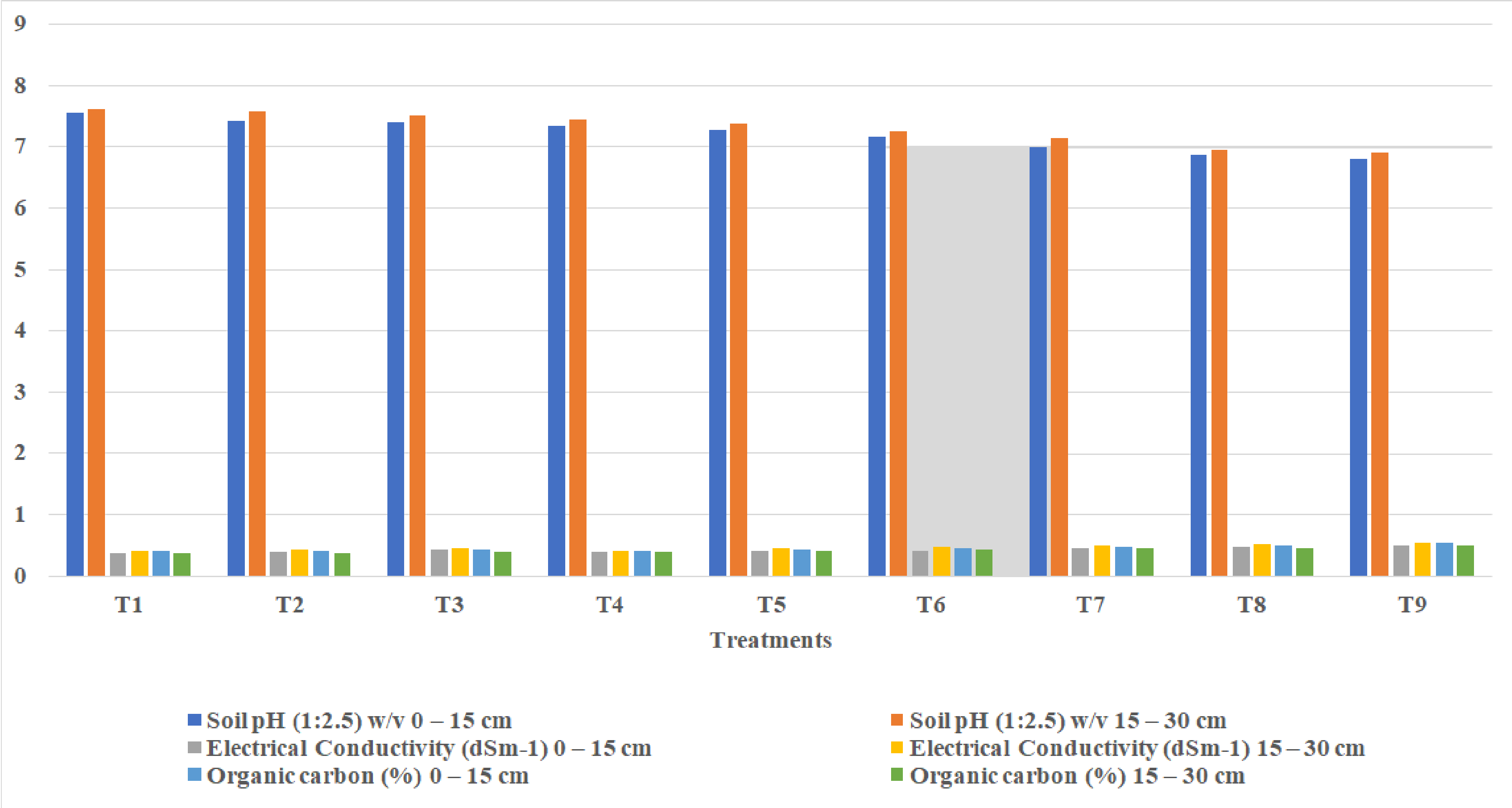

Fig. 2. Influence in pH (1:2.5) w/v, electrical conductivity (dSm^{-1}) and organic carbon (%) of soil after crop harvest due to application of inorganic and bio fertilizers

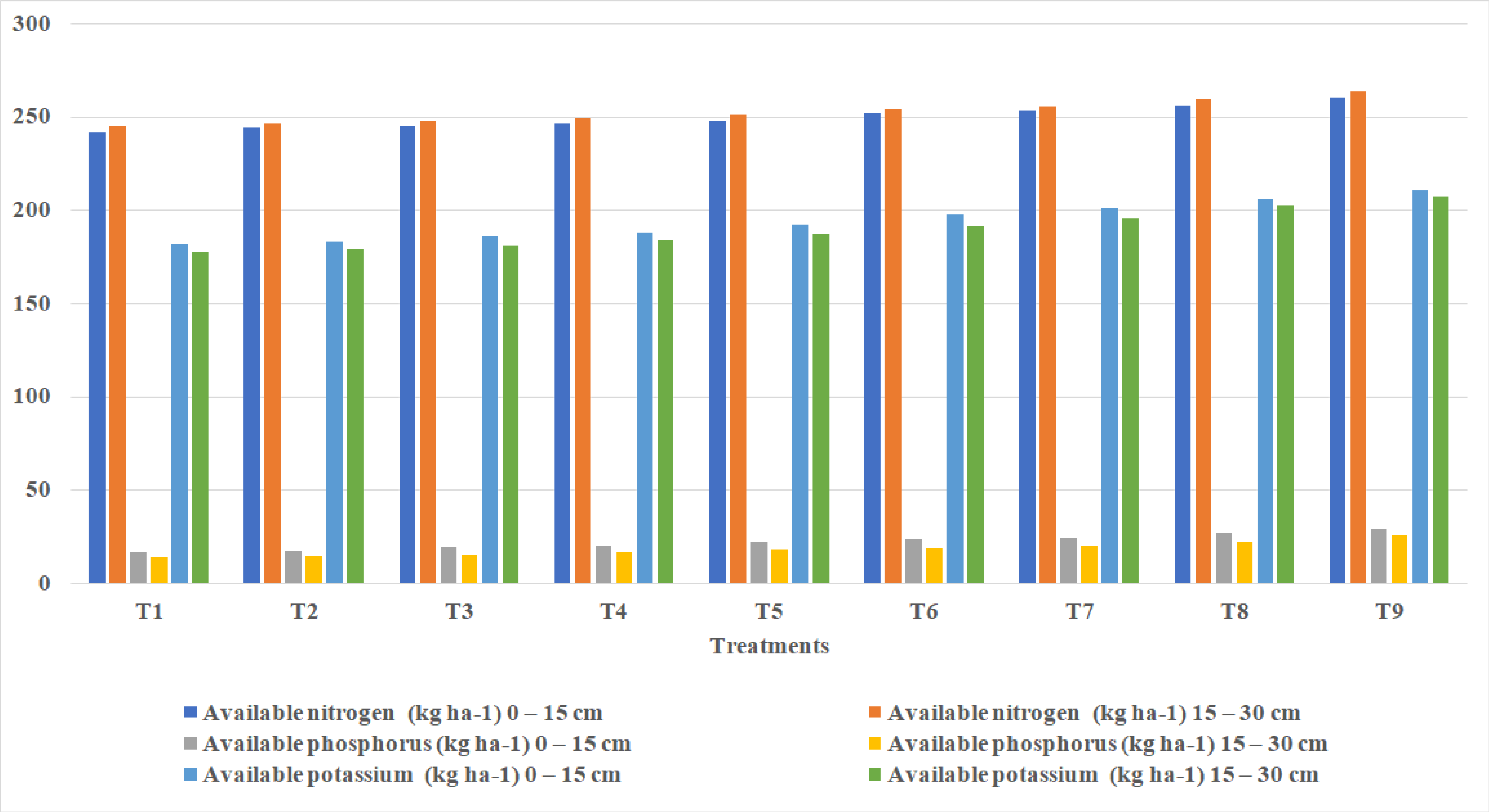

Fig. 3. Influence in available nitrogen (kg ha^{-1}), available phosphorus (kg ha^{-1}) and available potassium (kg ha^{-1}) of soil after crop harvest due to application of inorganic and bio fertilizers

Chemical Properties of Soil Soil pH (1:2.5) w/v

The data presented in Table 2 and Fig. 2 depicted the influence in pH of soil after crop harvest due to application of inorganic and bio fertilizers. The response in pH of soil was found non- significant due to level of inorganic and bio fertilizers. The maximum pH of soil 7.56 and 7.62 at 0-15 and 15-30 cm was recorded in treatment T1 (NPK @ 0% + Rhizobium @ 0% + Azotobacter @ 0%) and minimum 6.80 and 6.92 at 0-15 and 15-30 cm was recorded in treatment T9 (NPK @ 100% + Rhizobium @ 100% + Azotobacter @ 100%) respectively. Similar result has been recorded by Ghanshyam *et at*., 2010 Rathour et al. 2015; Bhavya et al. [16]; and Rekha et al. [17].

Soil Electrical Conductivity (dSm^{-1})

The data presented in Table 2 and Fig. 2 show the influence in electrical conductivity (dSm^{-1}) of soil after crop harvest due to application of inorganic and bio fertilizers. The response in electrical conductivity of soil was found non-significant due to level of inorganic and bio fertilizers. The maximum electrical conductivity of soil 0.51 and 0.55 dSm^{-1} at 0-15 and 15-30 cm was recorded in treatment T9 (NPK @ 100% + Rhizobium @ 100% + Azotobacter @ 100%) and minimum 0.38 and 0.41 dSm^{-1} at 0-15 and 15-30 cm was recorded in treatment T1 (NPK @ 0% + Rhizobium @ 0% + Azotobacter @ 0%) respectively. Similar result has been recorded by Bhavya et al., [16]; and Rekha et al. [17].

Organic Carbon (%)

The data presented in Table 2 and Fig. 2 depicted the influence in organic carbon (%) of soil after crop harvest due to application of inorganic and bio fertilizers. The response in organic carbon (%) of soil was found significant due to level of inorganic and bio fertilizers. The maximum organic carbon of soil 0.54 and 0.51% at 0-15 and 15-30 cm was recorded in treatment T9 (NPK @ 100% + Rhizobium @ 100% + Azotobacter @ 100%) and minimum 0.41 and 0.37% at 0-15 and 15-30 cm was recorded in treatment T1 (NPK @ 0% + Rhizobium @ 0% + Azotobacter @ 0%) respectively. Similar result has been recorded by Rekha et al. [17].

Available Nitrogen (kg ha^{-1})

The data presented in Table 3 and Fig. 3 depicted the influence in available nitrogen (kg ha^{-1}) of soil after crop harvest due to application of inorganic and bio fertilizers. The response in available nitrogen (kg ha^{-1}) of soil was found significant due to level of inorganic and bio fertilizers. The maximum available nitrogen of soil 260.45 and 264.18 at 0-15 and 15-30 cm was recorded in treatment T9 (NPK @ 100% + Rhizobium @ 100% + Azotobacter @ 100%) and minimum 242.15 and 245.32 kg ha^{-1} at 0-15 and 15-30 cm was recorded in treatment T1 (NPK @ 0% + Rhizobium @ 0% + Azotobacter @ 0%) respectively. Similar result has been recorded by Chaudhari et al. [15] and Venkatarao et al. [14].

Available Phosphorus (kg ha^{-1})

The data presented in Table 3 and Fig. 3 depicted the influence in available phosphorus (kg ha^{-1}) of soil after crop harvest due to application of inorganic and bio fertilizers. The response in available phosphorus (kg ha^{-1}) of soil was found significant due to levels of inorganic and bio fertilizers. The maximum available phosphorus of soil 29.14 and 25.82 kg ha^{-1} at 0-15 and 15- 30 cm was recorded in treatment T9 (NPK @ 100% + Rhizobium @ 100% + Azotobacter @ 100%) and minimum 16.42 and 14.26 kg ha^{-1} at 0-15 and 15-30 cm was recorded in treatment T1 (NPK @ 0% + Rhizobium @ 0% + Azotobacter @ 0%) respectively. Similar result has been recorded by Chaudhari et al. [15] and Venkatarao et al. [14].

Available Potassium (kg ha^{-1})

The data presented in Table 3 and Fig. 3 depicted the influence in available potassium (kg ha^{-1}) of soil after crop harvest due to application of inorganic and bio fertilizers. The response in available potassium (kg ha^{-1}) of soil was found significant due to levels of inorganic and bio fertilizers. The maximum available potassium of soil 211.29 and 207.62 kg ha^{-1} at 0-15 and 15-30 cm was recorded in treatment T9 (NPK @ 100% + Rhizobium @ 100% + Azotobacter @ 100%) and minimum 182.32 and 178.25 kg ha^{-1} at 0-15 and 15-30 cm was recorded in treatment T1 (NPK @ 0% + Rhizobium @ 0% + Azotobacter @ 0%) respectively. Similar result has been recorded by Chaudhari et al. [15]; Venkatarao et al. [14].

4. CONCLUSION

The results of the experiment were concluded as the effect of inorganic and bio fertilizes on Nitrogen, Phosphorus and Potassium (kg ha^{-1}),% 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, EC (dSm^{-1}) and organic carbon (%) of soil after harvest. The treatment T9 (NPK @ 100% + Rhizobium @ 100% + Azotobacter @ 100%) was recorded as best treatment for major soil parameters. The treatment T9 (NPK @ 100% + Rhizobium @ 100% + Azotobacter @ 100%) also shows the significantly.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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