Impingement of NPK and Rhizobium on Physico-chemical Properties of Soil under Cluster bean (*Cyamopsis tetragonoloba* L.)

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ABSTRACT

The study pertaining to the present topic under field investigation entitled "effect of different levels of NPK and *Rhizobium* on Physico-chemical properties of soil, growth and yield attributes of cluster bean" beginning from *kharif* seasons of the years 2023 at Research Farm, Department of Soil Science and Agricultural Chemistry. The excavated soil sample from experimental site before conducting research operation, mentioned that, the land topography range was nearly levelled with 1-3% slope, soil is of sandy loam texture with neutral to alkaline in reaction (7.140), electrical conductivity was non-saline (0.346 dS m^{-1}) in nature, low organic carbon content (0.38%), low to medium available N (261.39 kg ha^{-1}), available P (14.60 kg ha^{-1}) and available K (193.99 kg ha^{-1}). Among nine treatments, during field experimentation, the conjunctive use of NPK and different *Rhizobium* levels, together come with best results significantly. However, the physical and chemical soil parameters, cumulative mean value for Bulk density (1.42 Mg m^{-3} and 1.45Mg m^{-3}), Particle density (2.64 Mg m^{-3} and 2.66 Mg m^{-3}) and Soil pH (7.140 and 7.370) was found optimum in T_1 (Absolute control) at 0-15 cm depth and 15-30 cm depth, respectively. Percentage pore space (45.17% and 43.17%), Water holding capacity (42.32% and 39.70%), Electrical conductivity (0.323 dS m^{-1} and 0.300 dS m^{-1}), Percentage organic carbon (0.49% and 0.46%), Available N (284.41 kg ha^{-1} and 281.48 kg ha^{-1}), Available P (22.54 kg ha^{-1} and 21.29 kg ha^{-1}), Available K (210.52 kg ha^{-1} and 203.98 kg ha^{-1}) were found optimum in T_9 consisting of (@ 100% NPK + @ 100% *Rhizobium*) in comparison to other NPK and *Rhizobium* levels application.

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Key word: Rhizobium, cluster bean, NPK, kharif season

1. INTRODUTION

Soil is a medium for plant growth. Crop production is based largely on soils. Some of the soil properties affecting plant growth include: soil texture (coarse fine), aggregate size, porosity, aeration (permeability), ~~, and~~ water holding capacity, pH, bulk density, and particle density. The rate of water movement into the soil (infiltration) is influenced by its texture, physical condition (soil structure and tilth), and the amount of vegetative cover on the soil

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surface. Organic matter tends to increase the ability of all soils to retain water, and also increases infiltration rates of fine textured soils. Bulk density reflects the soil's ability to function for structural support, water and solute movement, and soil aeration. [1]

Nutrient balance is the key component to increase crop yields. Excess and imbalanced use of nutrients has caused nutrient mining from the soil, deteriorated crop productivity and ultimately soil health. Replenishment of these nutrients through organic and combination with organic and inorganic? has a direct impact on soil health and crop productivity. By keeping in view all the factors related to soil fertility and productivity fertilizers are applied to soil to maintain soil status and crop productivity green gram highly responsive to fertilizer application. ~~The~~ D~~d~~ose of fertilizerapplication depends on the initial soil fertility status and moisture availability conditions. Application of N, P and K to pulses and oilseeds showed greater response than to cereals. Sulphur not only improved grain yield but also improved the quality of crops. [3]

The use of biofertilizers is more eco-friendly in nature. They can play a significant role in fixing atmospheric nitrogen biofertilizers enrich soil fertility and improves soil fertility. Of these biofertilizers, *Rhizobium* inoculants specific for different leguminous crop is the most important in India. The largest contribution of biological nitrogen fixation to agriculture is derived from the symbiosis between legumes and *Rhizobium* species.

Cluster bean (*Cyamopsis tetragonoloba* L.) is an important kharif crop that belongs to leguminaceae family. It has been emerged in North western India through trans-domestication of Cyamopsis senegalensis and was separated into three species, *viz.* C. *tetragonoloba*, C. senegalensis and C. serrata. Among these three species, *Cyamopsis tetragonoloba* is widely grown. It is a self- pollinated, diploid plant with 14 number of chromosomes (2n = 14). Cluster bean is also being widely known as guar, guwar, gavar or guvar bean and is the source of guar gum having a wide range of industrial applications. [4].

No research problemor gap is identified

Noaim or any objective is mentioned for theresearch work

2. MATERIAL AND METHODS

2.1 Experimental Site and Location

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The investigation site of the crop research farm is situated 5 kilometres distant on the right bank of the Yamuna River and is located at 250 58' N latitude and 810 52' E longitude. It has an elevation of 98 metres abovee ~~e mean~~ sea level. Representative of the Agro-Climatic Zone (Upper Gangetic Plain Region) and the Agro-Ecological Subregion (North Alluvial Plain Zone, 0–1% slope).

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2.2 Climate Condition

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The area of Prayagraj district comes under subtropical belt in the South east of Uttar Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 46^0C – 48^0C and seldom falls as low as 4^0C – 5^0C. The relative humidity ranged between 20 to 94 percent. The average rainfall in this area is around 1100 mm annually.

2.3 Treatment Combination

Table 1: Symbolic presentation of treatment combination

Treatment	Treatment Combination	Symbol
T_1	Absolute Control	$R_0 R_0$
T_2	@ 0% NPK + @ 50% *Rhizobium*	$R_0 R_1$
T_3	@ 0% NPK + @ 100% *Rhizobium*	$R_0 R_2$
T_4	@ 50% NPK + @ 0% *Rhizobium*	$R_1 R_0$
T_5	@ 50% NPK + @ 50% *Rhizobium*	$R_1 R_1$
T_6	@ 50% NPK + @ 100% *Rhizobium*	$R_1 R_2$
T_7	@ 100% NPK + @ 0% *Rhizobium*	$R_2 R_0$
T_8	@ 100% NPK + @ 50% *Rhizobium*	$R_2 R_1$
T_9	@ 100% NPK + @ 100% *Rhizobium*	$R_2 R_2$

Note: RDF:- 20:40:40 NPK, Rhizobium:- 3.0 kg ha^{-1}

2.4 Experimental Details

The current study was set up using a randomised block design (RBD), which consists of nine treatment combinations that are replicated three times with different treatment allocations in each replication. This creates twenty-seven plots at the research site. In this study, organic manure such as Vermicompost and FYM was applied in three different doses along with inorganic fertilisers such as Nitrogen, Phosphorous and Potassium as RDF. The cluster bean crop was manually sown on August 2nd, 2023, as appropriate. At a pace of 15 kg per hectare, with a row-to-row distance of 30 cm and a plant-to-plant distance of 15 cm, the seed variety Harit Shobha was planted.

2.5 Fertilizer Application

The recommended doses of NPK 20:40:40 (100%) were applied to the spinach: N (44 kg ha^{-1}), P_2O_5 (250 kg ha^{-1}), and K_2O (67 kg ha^{-1}). The 100 percent application of N, P, and K was used as the basal dose at the time of sowing. In addition to these applications vermicompost 4 t ha^{-1} and FYM was used as a basal dose at 10 t ha^{-1} for the treatment. The sources of NPK fertilisers were nitrogen through urea (46% N_2O). Phosphorus through single superphosphate (16% P_2O_5) and potassium through muriate of potassium (60% K_2O) were applied earlier to sowing in regards to treatments just before the seed sowing. Nitrogen and urea (46% N) were applied in two different doses.

2.6 Soil Analysis

For laboratory examination, the soils from each plot were taken apart, air dried, powdered, and put through a 2-mm-size sieve. Soil samples were analysed for Bulk density, Particle density, Percentage pore space and Water holding capacity (WHC) using a 100-ml measuring cylinder (Muthuvel *et al.*, 1992) [8], pH [6], EC (Wilcox, 1950) [17], Percentage OC (Walkley and Black, 1934) [16], Available Nitrogen (Subbiah and Asiija, 1956) [13], Available Phosphorus (Olsen *et al.*, 1954) [10] and Available Potassium (Toth and Prince, 1949) [14] before sowing the experimental crop and after harvest of the crop.

2.7 Statistical Analysis

The statistical analysis of the data was carried out using STATISTICA software [2].

3. RESULTS AND DISCUSSION

3.1 Effect of Nutrient Management on Physical Properties of Soil after Harvest of Cluster bean

The data showed that the treatment T_1 (Absolute control) non-significantly influenced the Bulk density of soil (1.42 and 1.45 Mg m^{-3}), Particle density of soil (2.64 and 2.66 Mg m^{-3}) at 0-15 cm and 15-30 cm depth and significantly influenced Percentage pore space (45.17 and 43.17%), Water holding capacity (42.32 and 39.70%) of soil were found optimum in treatment T_9 (@ 100% NPK + @ 100% *Rhizobium*) over T1 (Absolute control) treatment at

0-15 cm and 15-30 cm depth, respectively (Table 2 and fig. 1). This corroborates with the findings of [1,5,9,11,15].

3.2 Effect of Nutrient Management on Chemical Properties of Soil after Harvest of Cluster bean

The data showed that the treatment T_1 (Absolute control) non-significantly influenced the soil pH is maximum (7.140 and 7.370) at 0-15 cm and 15- 30 cm depth, respectively (Table 2 and fig.1). There was significantly influenced maximum build-up of Electrical Conductivity (0.323 and 0.300 dS m^{-1}), Percentage Organic Carbon (0.49% and 0.46%), Available N (284.41 and 281.48 kg ha^{-1}), Available P (22.54 kg ha-1 and 21.9 kg ha^{-1}) and Available K (210.52 and 203.98 kg ha^{-1}) were observed under the treatment T_9 (@ 100% NPK + @ 100% *Rhizobium*)content in soil, however minimum values were detected in the treatments T1 (absolute control) at 0-15 cm depth and at 15- 30 cm depth, respectively (Table 3 and fig.2, 3). This corroborates with the findings of [1,5,9,11,15].

4. CONCLUSION

Conclusion Based on the results, the application of organic manure and inorganic fertilizer was found to improve the soil's health in references to cluster bean. Application of T_9 (@ 100% NPK + @ 100% *Rhizobium*)was found optimal for improving Soil Properties like Pore space, Water holding capacity, Electrical conductivity, Organic Carbon and Available Nitrogen, Phosphorus, Potassium.

Table 2. Effect of Different Levels of NPK and Rhizobium on Bulk Density Particle Density, Pore space, Water holding capacity and pH.

Treatments		Bulk Density ($Mg\ m^{-3}$)		Particle Density ($Mg\ m^{-3}$)		Pore space (%)		Water holding capacity (%)		pH	
T_1	Absolute Control	1.42	1.45	2.64	2.66	39.65	37.26	36.68	34.51	7.140	7.370
T_2	@ 0% NPK + @ 50% *Rhizobium*	1.38	1.41	2.59	2.61	41.48	39.48	38.35	36.38	7.107	7.337
T_3	@ 0% NPK + @ 100% *Rhizobium*	1.32	1.35	2.52	2.54	42.65	40.65	39.37	37.37	7.080	7.310
T_4	@ 50% NPK + @ 0% *Rhizobium*	1.37	1.40	2.57	2.59	40.36	38.36	37.26	35.26	7.093	7.323
T_5	@ 50% NPK + @ 50% *Rhizobium*	1.31	1.34	2.52	2.54	42.02	40.02	38.87	36.87	7.067	7.297
T_6	@ 50% NPK + @ 100% *Rhizobium*	1.27	1.30	2.47	2.49	43.75	41.75	40.64	38.64	7.033	7.263
T_7	@ 100% NPK + @ 0% *Rhizobium*	1.33	1.36	2.54	2.56	40.82	38.82	38.19	36.19	7.053	7.283
T_8	@ 100% NPK + @ 50% *Rhizobium*	1.28	1.32	2.48	2.50	43.14	41.14	41.31	39.31	7.013	7.243
T_9	@ 100% NPK + @ 100% *Rhizobium*	1.23	1.26	2.45	2.47	45.17	43.17	42.32	39.70	6.860	7.090
F- test		NS	NS	NS	NS	S	S	S	S		
S.Em. (±)		-	-	-	-	1.8304	1.7869	1.351	1.3333		
C.D (P=0.05)		-	-	-	-	5.4875	5.3570	4.052	3.9973		

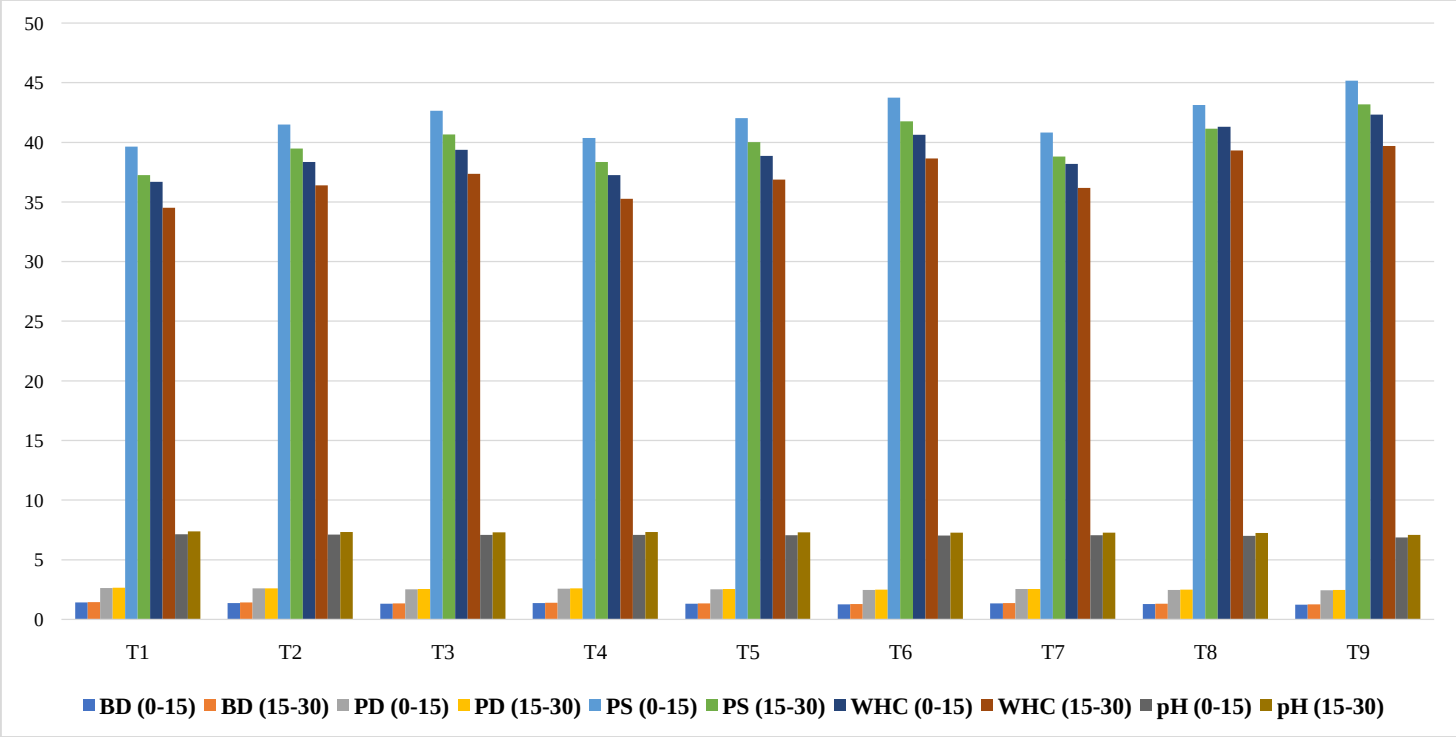

Fig. 1. Effect of Different Levels of NPK and Rhizobium on Bulk Density Particle Density, Pore space and Water holding capacity and pH.

Table 3. Effect of Different Levels of NPK and Rhizobium on Electrical conductivity, Organic carbon, Available Nitrogen, Available Phosphorus and Available Potassium.

Treatments		Electrical conductivity (dS m^{-3})		Organic carbon (%)		Available Nitrogen (kg ha^{-1})		Available Phosphorus (kg ha^{-1})		Available Potassium (kg ha^{-1})	
T_1	Absolute Control	0.323	0.300	0.38	0.34	261.39	252.30	14.60	13.25	193.99	187.45
T_2	@ 0% NPK + @ 50% *Rhizobium*	0.347	0.324	0.39	0.35	265.67	258.72	15.67	14.32	195.16	188.62
T_3	@ 0% NPK + @ 100% *Rhizobium*	0.380	0.357	0.41	0.38	270.54	264.62	17.60	16.25	199.49	192.95
T_4	@ 50% NPK + @ 0% *Rhizobium*	0.373	0.350	0.40	0.37	268.34	260.50	16.48	15.13	197.18	190.64
T_5	@ 50% NPK + @ 50% *Rhizobium*	0.397	0.374	0.42	0.39	275.37	266.26	18.57	17.22	201.38	194.84
T_6	@ 50% NPK + @ 100% *Rhizobium*	0.390	0.367	0.45	0.42	279.43	272.53	20.48	19.13	204.40	197.86
T_7	@ 100% NPK + @ 0% *Rhizobium*	0.370	0.347	0.44	0.41	277.34	268.35	18.07	16.72	202.03	195.49
T_8	@ 100% NPK + @ 50% *Rhizobium*	0.410	0.387	0.47	0.44	281.49	276.50	21.69	20.34	206.50	199.96
T_9	@ 100% NPK + @ 100% *Rhizobium*	0.400	0.377	0.49	0.46	284.41	281.48	22.54	21.29	210.52	203.98
F- test		S	S	S	S	S	S	S	S	S	S
S.Em. (±)		0.012	0.012	0.01	0.008	6.09	3.87	1.18	1.07	1.15	1.01
C.D (P=0.05)		0.037	0.036	0.03	0.026	18.27	11.61	3.55	3.21	3.46	3.05

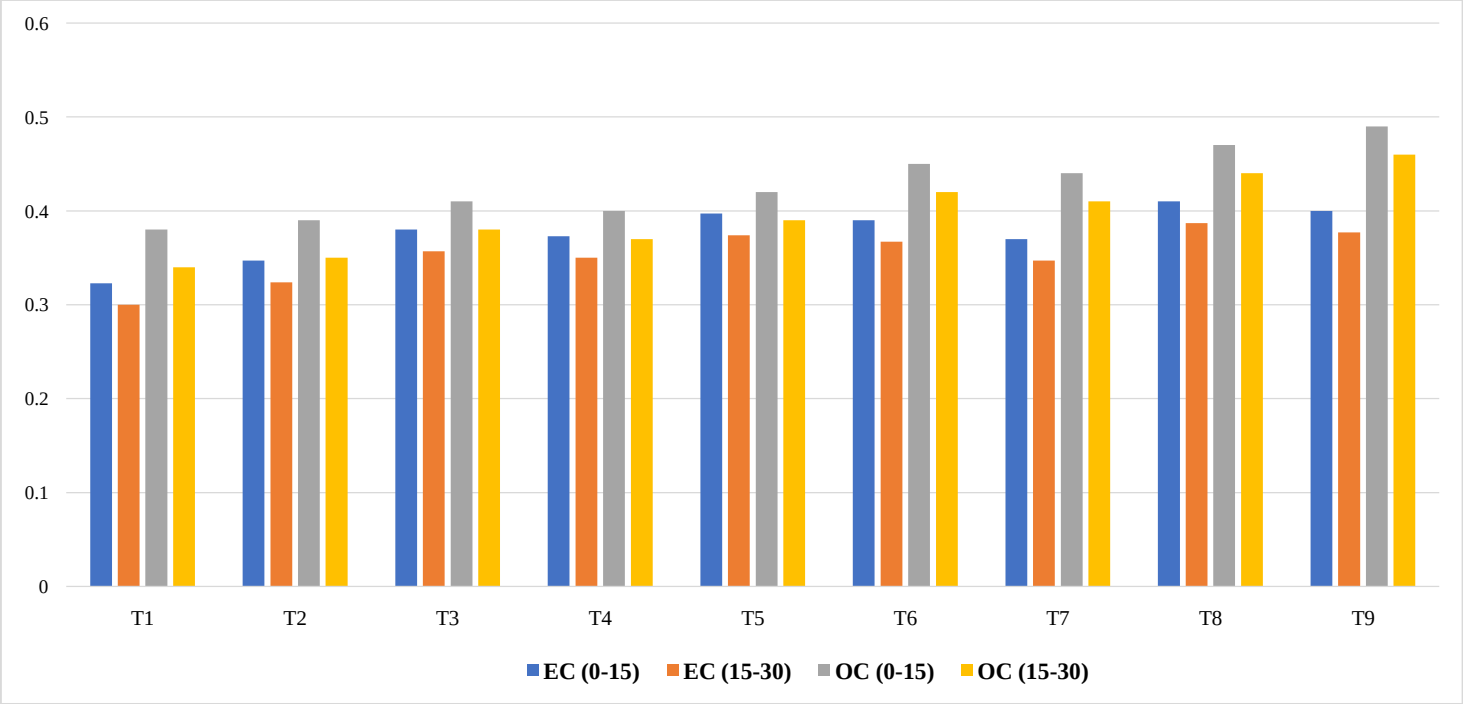

Fig. 2. Effect of Different Levels of NPK and Rhizobium on Electrical conductivity and Organic carbon.

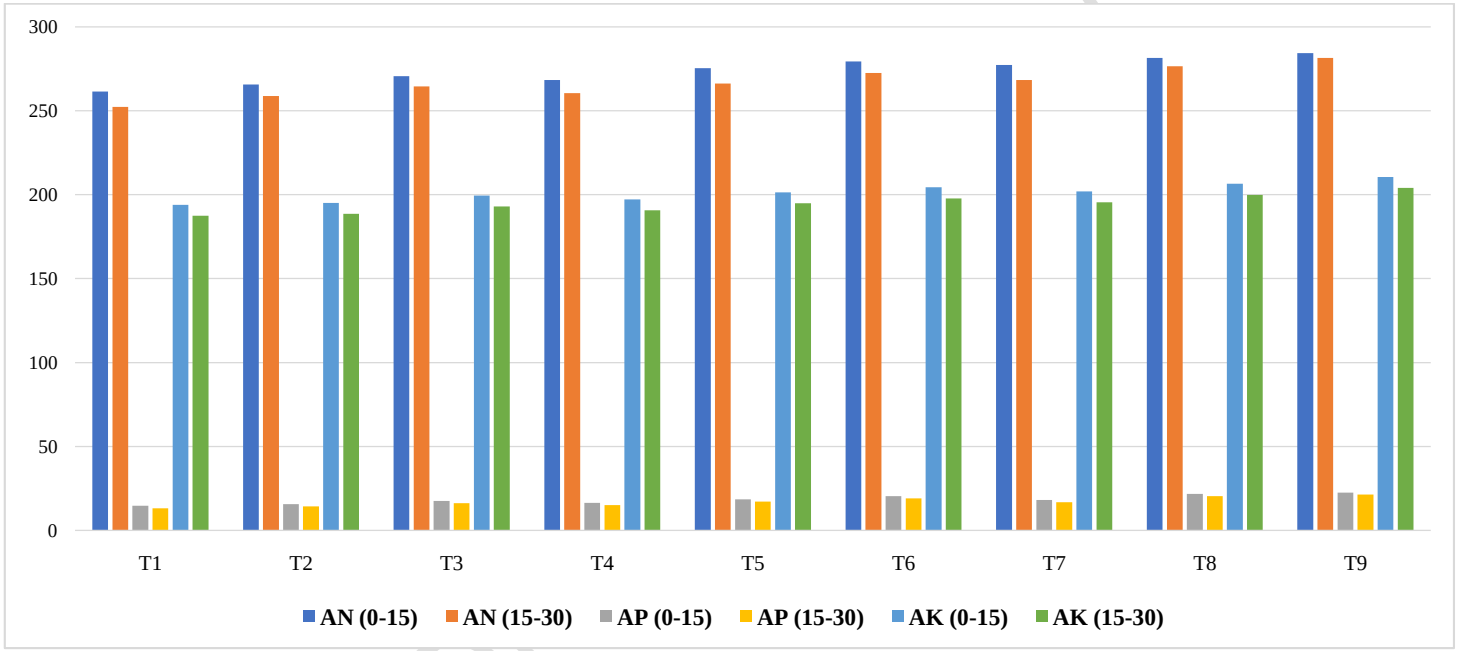

Fig. 3. Effect of Different Levels of NPK and Rhizobium on Available Nitrogen, Available Phosphorus and Available Potassium.

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