Response of NPK, Vermicompost and FYM on Physical and chemical Properties of Soil Under Cluster bean (*Cyamopsis tetragonoloba* L.)

ABSTRACT

The development and application of organic fertiliser is now regarded as an essential method in the field of soil science that is in the attention of investors worldwide due to the advancement of environmental contamination and health effects caused by the incorrect use of inorganic fertiliser. On the central research farm of the department of soil science and agricultural chemistry, (NAI) SHUATS, Prayagraj, research was carried out during the Kharif season of 2023. Field trial was designed on Randomized Block Design with three replications and nine treatments. It may be concluded from the trial that the different level of NPK, Vermicompost and FYM in the experiment gave the greatest value. The best results were resulted the greatest Pore Space, Water Holding Capacity, Electrical Conductivity, Available Nitrogen, Phosphorus and Potassium significantly in T_9 [@100% NPK + @ VC 4 t ha^{-1} + @FYM 10 t ha^{-1}]. In contrast, the control treatment T_1 [Absolute Control] had the least results in all categories.

Key word : vermicompost, cluster bean, FYM, NPK.

INTRODUCTION

Soil plays a crucial role in determining the sustainable productivity of agro-ecosystems by supplying essential nutrients to growing plants. The uptake of macronutrients by plants is influenced by various factors, including interactions between major nutrients, as noted by [3] However, soil degradation is becoming increasingly prevalent due to both natural processes and human activities, adversely impacting productivity. With the continuous growth of the human population, there is a greater demand on soil to provide essential nutrients for food and fiber production. Unfortunately, the soil's inherent ability to supply these nutrients has diminished, largely due to increased plant productivity associated with rising food demand [5]. Consequently, a significant challenge today is the development and implementation of soil, crop and nutrient management technologies that improve plant productivity while maintaining the quality of soil, water and air. Assessing soil fertility involves measuring available plant nutrients and estimating the soil's capacity to sustain a continuous supply of nutrients for crops [4]. Nutrient availability is influenced by factors such as soil type, irrigation methods, pH levels, and organic matter content. [19], the degradation of soil quality concerning productivity or fertility encompasses physical, chemical, and biological processes. Understanding and addressing these degradation processes are essential prerequisites for implementing appropriate conservation activities to monitor and safeguard our natural resource base [13,15,16].

After nitrogen and phosphate, Potassium is the most significant necessary nutrient. It is crucial for plant cell sap, enzymatic activity, photosynthesis, the transportation of sugar, and the synthesis of protein and starch. However, Potassium does not have any chemical bonds with carbon or oxygen. Additionally, it increases the ability of plants to hold off pest and disease attacks and builds tolerance to drought conditions [19]

The addition of vermicompost preserves and enhances the soil's fertility. Vermicompost gives the soil a deep colour and helps to keep it at a consistent temperature. One of the manures that farmers use to cultivate crops is vermicompost since it is readily available and contains nearly all of the nutrients that plants need. Vermicompost is composed of 0.13–0.22% P, 0.40-0.75 N, and 0.6–1.2% N. [17]

Farmyard manure refers to the decomposed mixture of dung and urine of farm animals along with litter and left-over material from roughages or fodder fed to the cattle. On an average well decomposed farmyard manure contains 0.5 percent N, 0.25 percent P_2O_5 and 0.5 percent K_2O [7].

The term "guar" derives from the sanskrit word "Gauahar," which means cow fodder or other livestock fodder. An annual legume plant known as the Cluster bean (*Cyamopsis tetragonoloba* L.) (2n=14) is cultivated for its edible, fodder, gum, and green fertilizer qualities. An important legume crop, the cluster bean, also known as "guar," is primarily grown under rainfed conditions in arid and semi-arid areas of India during the *Zaid* season. It is a product that tolerates drought very well. Its deeply penetrating roots give the plant the ability to use the rainfall it has access to more effectively, improving the potential for rainfed cropping. The legume can also withstand mild alkalinity and salinity conditions. There is no other legume product that is as resilient and drought-tolerant as the cluster bean [8,9,28].

2. MATERIALS AND METHODS

2.1 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.

2.2 Treatment Combination

Table 1.: Treatment combination

Treatment	Treatment Combination	Symbol
T_1	[Absolute Control]	**$R_0V_0F_0$**
T_2	@0% NPK + @VC 2 t ha^{-1} + @FYM 5 t ha^{-1}	**$R_0V_1F_1$**
T_3	@0% NPK + @VC 4 t ha^{-1} + @FYM 10 t ha^{-1}	**$R_0V_2F_2$**
T_4	@50% NPK + @VC 0 t ha^{-1} + @FYM 0 t ha^{-1}	**$R_1V_0F_0$**
T_5	@50% NPK + @VC 2 t ha^{-1} + @FYM 5 t ha^{-1}	**$R_1V_1F_1$**
T_6	@50% NPK + @ VC 4 t ha^{-1} + @FYM 10 t ha^{-1}	**$R_1V_2F_2$**
T_7	@100% NPK + @VC 0 t ha^{-1} +@FYM 0 t ha^{-1}	**$R_2V_0F_0$**
T_8	@100% NPK + @VC 2 t ha^{-1} + @FYM 5 t ha^{-1}	**$R_2V_1F_1$**
T_9	@100% NPK + @ VC 4 t ha^{-1} + @FYM 10 t ha^{-1}	**$R_2V_2F_2$**

Note: NPK:- 20:40:40, vermicompost:- 4 t ha^{-1}, FYM:- 10 t ha^{-1}

2.3 Soil Analysis

Physical and Chemical analysis

The soil samples were preserved in polythene bags for analysis of physical and chemical properties.

Physical Analysis

The physical analysis was done with the help of Bouyoucous Hydrometer method [2] for texture class and copper cylinder method for bulk and particle density also use of measuring cylinder method for pore space and water holding capacity [11].

Chemical Analysis

The chemical analysis of was done for pH [6], Electrical conductivity [25], Available Nitrogen [21], Available Phosphorus [26] and Available Potassium [23] also organic carbon (%) [24].

2.5 Statistical Analysis

The statistical analysis of the data was carried out using STATISTICA software [27].

3. RESULTS AND DISCUSSION

3.1 physical and chemical properties

In this finding research Bulk thickness, Particle Density, pH and EC was found non-significant. The critical varieties were seen in the event of pore space (%). The highest (%) pore space of soil was found in T_9 [@ 100% NPK + @ VC 4 t ha^{-1} + @ FYM 10 t ha^{-1}] and lowest was found in T_1 [Absolute Control] serially. The huge varieties were seen in the event of Water holding capacity (%). The most extreme water holding capacity limit of soil was found in T_9 [@ 100% NPK + @ VC 4 t ha^{-1} + @ FYM 10 t ha^{-1}] and lowest was found in T_1 [Absolute Control] serially. In the event of soil properties, we see that there was tremendous distinction between Organic carbon (%). The highest Organic carbon was kept in T_9 [@ 100% NPK + @ VC 4 t ha^{-1} + @ FYM 10 t ha^{-1}] and lowest was found in T_1 [Absolute Control] serially. In the event of soil properties, we see that there was critical difference between Nitrogen (kg ha^{-1}) and Phosphorus (kg ha^{-1}). The highest Nitrogen and Phosphorus was kept in T_9 [@ 100% NPK + @ VC 4 t ha^{-1} + @ FYM 10 t ha^{-1}] and lowest was found in T_1 [Absolute Control] serially in the event of soil properties, we see that there was massive contrast between Potassium (kg ha^{-1}). The highest Potassium was kept in T_9 [@ 100% NPK + @ VC 4 t ha^{-1} + @ FYM 10 t ha^{-1}] and least was found in T_1 [Absolute Control] serially [10,17,20,22].

4. CONCLUSION

Conclusion Based on the results, the application of NPK, Vermicompost and FYM was found to improve the soil's health in references to cluster bean. Application of T_9 [@ 100% NPK + @ VC 4 t ha^{-1} + @ FYM 10 t ha^{-1}] was found optimal for improving Soil Properties like Pore space, Water holding capacity, Electrical conductivity, Organic Carbon and Available Nitrogen, Phosphorus, Potassium.

5. ACKNOWLEDGEMENT

Success is the manifestation of diligence, perseverance, inspiration, motivations and innovations. It is my proud privilege to express a deep sense of gratitude of my Advisor Dr. Tarence Thomas, Professor and HoD, Department of Soil Science and Agricultural Chemistry, SHUATS, Prayagraj, whose generous help, untiring guidance, supervision, critical suggestions and his positive attitude towards my abilities enabled me to complete this work.

Table 2.: Influence of NPK, Vermicompost and FYM 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	1.43	1.46	2.64	2.69	42.15	40.27	40.18	38.03	6.902	7.08
T_2	@0% NPK + @VC 2 t ha^{-1} + @FYM 5 t ha^{-1}	1.39	1.43	2.63	2.68	43.98	41.98	41.88	39.73	6.842	7.02
T_3	@0% NPK + @VC 4 t ha^{-1} + @FYM 10 t ha^{-1}	1.33	1.45	2.61	2.66	45.64	43.64	44.14	41.99	6.796	6.974
T_4	@50% NPK + @VC 0 t ha^{-1} + @FYM 0 t ha^{-1}	1.38	1.43	2.62	2.68	42.86	40.86	40.76	38.61	6.869	7.047
T_5	@50% NPK + @VC 2 t ha^{-1} + @FYM 5 t ha^{-1}	1.32	1.42	2.61	2.67	44.52	42.52	42.37	40.22	6.829	7.007
T_6	@50% NPK + @ VC 4 t ha^{-1} + @FYM 10 t ha^{-1}	1.28	1.44	2.6	2.65	46.25	44.25	44.81	42.66	6.776	6.954
T_7	@100% NPK + @VC 0 t ha^{-1} +@FYM 0 t ha^{-1}	1.34	1.42	2.61	2.66	43.32	41.32	41.69	39.54	6.856	7.034
T_8	@100% NPK + @VC 2 t ha^{-1} + @FYM 5 t ha^{-1}	1.30	1.45	2.60	2.64	45.15	43.15	42.87	40.72	6.816	6.994
T_9	@100% NPK + @ VC 4 t ha^{-1} + @FYM 10 t ha^{-1}	1.24	1.41	2.59	2.61	47.36	45.67	45.54	43.39	6.671	6.849
F- test		NS	NS	NS	NS	S	S	S	S	NS	NS
S.Em. (±)		-	-	-	-	1.7985	0.6009	1.364	0.5163	-	-
C.D (P=0.05)		-	-	-	-	5.3919	1.8016	4.089	1.5479	-	-

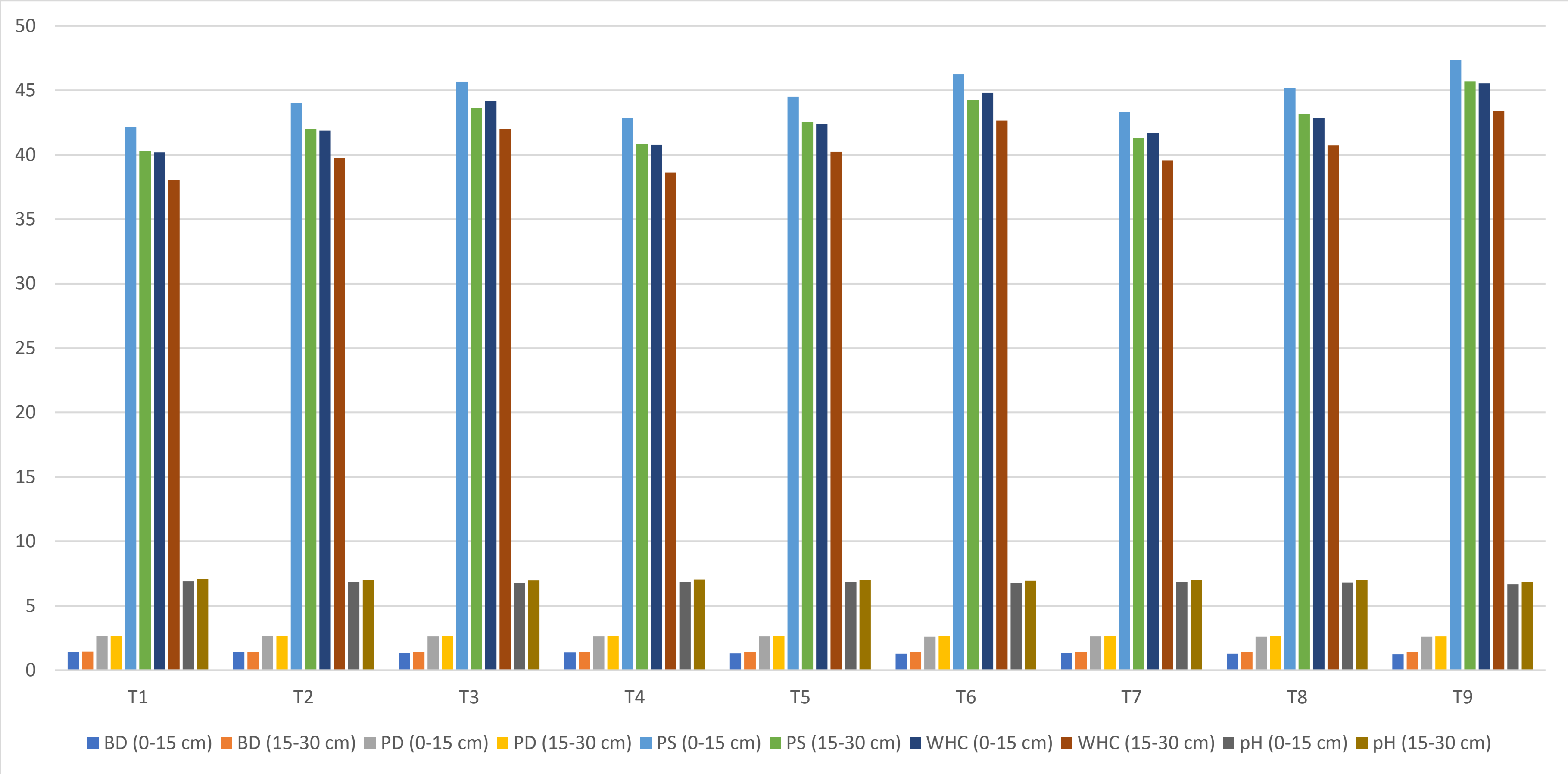

Fig 1.: Influence of NPK, Vermicompost and FYM on Bulk Density, Particle Density, Pore Space, Water Holding Capacity and pH.

Table 3.: Influence of NPK, Vermicompost and FYM on Electrical Conductivity, Organic Carbon, Available Nitrogen, Phosphorus and Potassium.

Treatments		EC ($dS\ m^{-3}$)		OC (%)		AN ($kg\ ha^{-1}$)		AP ($kg\ ha^{-1}$)		AK ($kg\ ha^{-1}$)	
T_1	Absolute Control	0.253	0.247	0.39	0.33	254.68	235.18	23.62	21.62	189.74	182.7
T_2	@0% NPK + @VC 2 t ha^{-1} + @FYM 5 t ha^{-1}	0.263	0.257	0.40	0.34	258.32	248.82	25.55	23.55	190.91	183.87
T_3	@0% NPK + @VC 4 t ha^{-1} + @FYM 10 t ha^{-1}	0.286	0.280	0.42	0.36	265.35	255.85	27.77	25.77	195.24	188.2
T_4	@50% NPK + @VC 0 t ha^{-1} + @FYM 0 t ha^{-1}	0.280	0.273	0.41	0.35	263.87	254.37	24.66	22.66	192.93	185.89
T_5	@50% NPK + @VC 2 t ha^{-1} + @FYM 5 t ha^{-1}	0.296	0.290	0.44	0.36	268.59	259.09	26.58	24.58	197.13	190.09
T_6	@50% NPK + @ VC 4 t ha^{-1} + @FYM 10 t ha^{-1}	0.303	0.297	0.43	0.34	275.64	266.14	28.75	26.75	200.15	193.11
T_7	@100% NPK + @VC 0 t ha^{-1} +@FYM 0 t ha^{-1}	0.276	0.270	0.41	0.36	273.87	264.37	26.52	24.24	197.78	190.74
T_8	@100% NPK + @VC 2 t ha^{-1} + @FYM 5 t ha^{-1}	0.306	0.300	0.44	0.35	278.65	269.15	29.64	27.64	202.25	195.21
T_9	@100% NPK + @ VC 4 t ha^{-1} + @FYM 10 t ha^{-1}	0.316	0.310	0.45	0.36	283.48	273.98	31.42	29.05	206.27	199.23
F- test		S	S	S	S	S	S	S	S	S	S
S.Em. (±)		0.007	0.008	0.008	0.011	6.19	5.70	1.20	0.97	0.52	0.54
C.D (P=0.05)		0.022	0.024	0.024	0.033	18.56	17.10	3.60	2.93	1.56	1.63

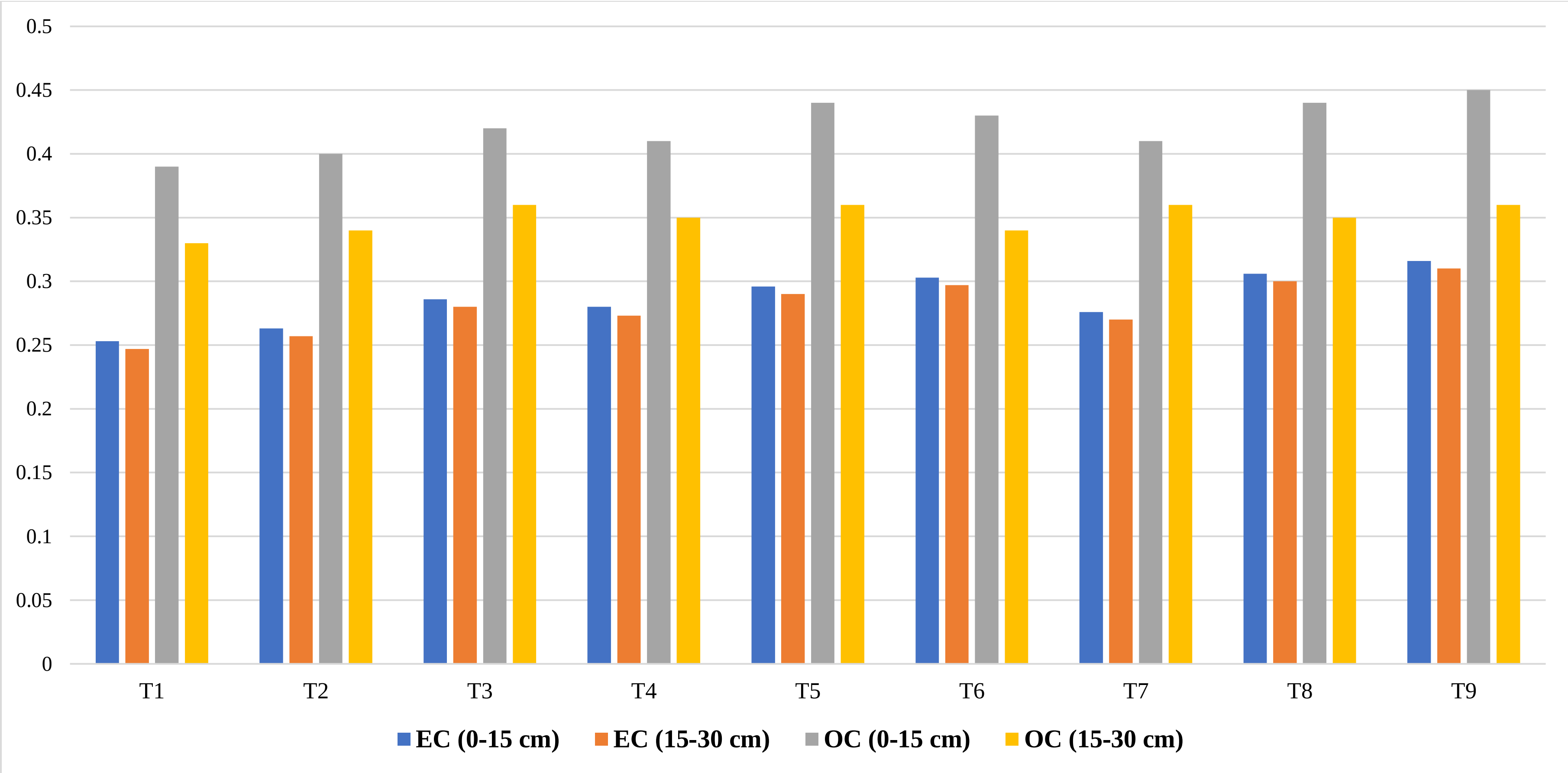

Fig 2.: Influence of NPK, Vermicompost and FYM on Electrical Conductivity and Organic Carbon.

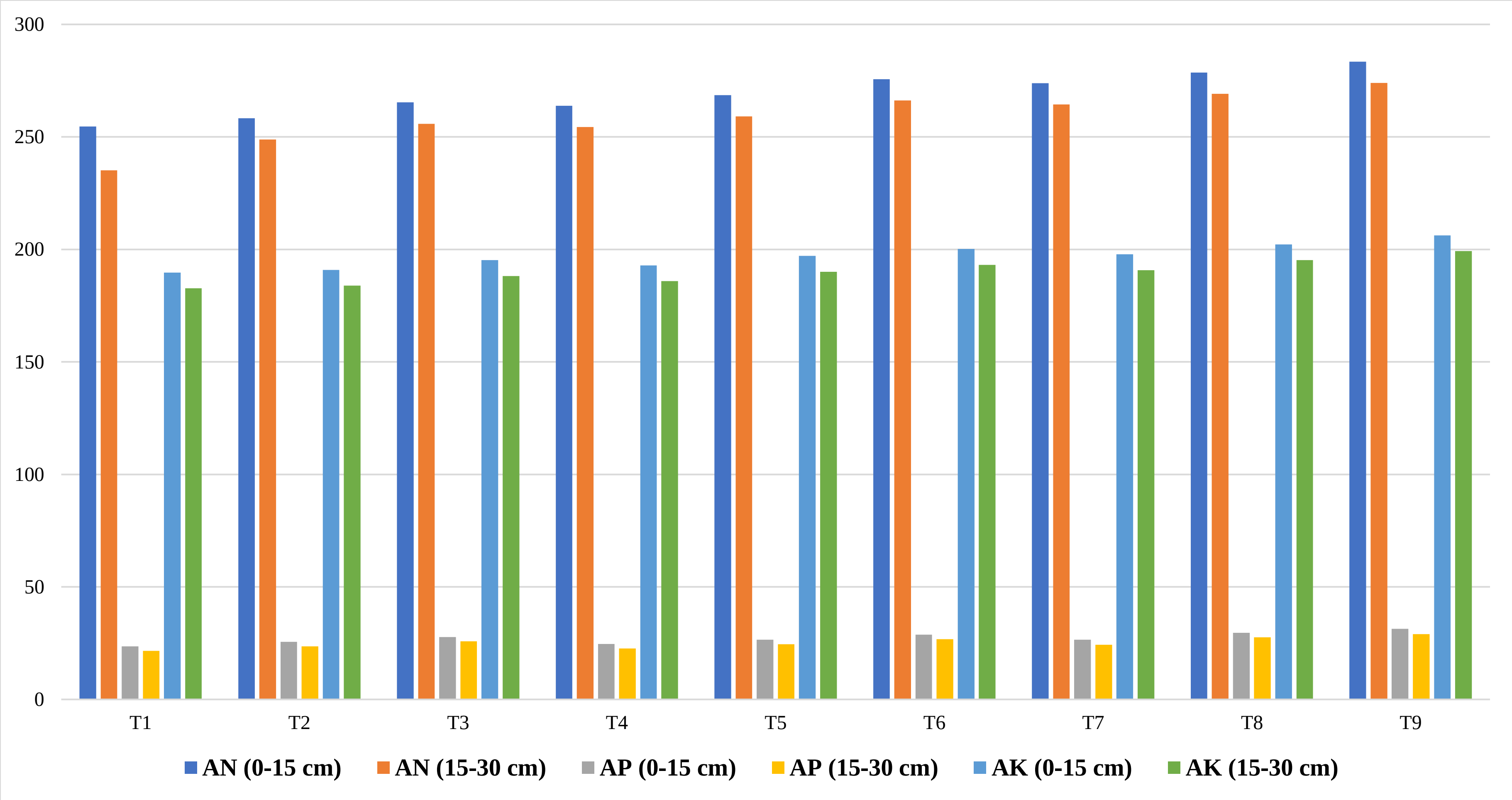

Fig. 3: Influence of NPK, Vermicompost and FYM on Available Nitrogen, Available Phosphorus and Available Potassium.

REFERENCES

1. Black, C.A. (1965) Methods of soil analysis 2, Am. Soc, Agron. madison, Wisconsin, U.S.A.
2. Bouyoucos, G. J. (1927) The hydrometer as a new method for the mechanical analysis of soils. *Soil Science,* 23(**6**): 343-353.
3. Fageria NK, Gheyi HR, Carvalho MC, Moreira A. Root growth, nutrient uptake and use efficiency by roots of tropical legume cover crops as influenced by phosphorus fertilization. Journal of Plant Nutrition. 2016 May 11;39(6):781-92.
4. FAO. Crop production manual A guide to fruit and vegetable production in the Federated States of Micronesia FAO Subregional Office for the Pacific Food and Agriculture Organization of the United Nations Apia, 2020.
5. Food and Agricultural Organisation. The State of Food Security and Nutrition in the World. Rome: FAO, IFAD, UNICEF, WEP AND WHO; 2017.
6. Jackson, M. L. (1958). Soil chemical analysis, Second edition Indian Reprint, prentice hall of India, New Delhi. Pp-498.
7. Jangir, R. P., Gurjar, R. K., Beniwal, R. L., and Kaswan, S. (2014). Effect of integrated nutrient management on yield and economics of cluster bean (*Cyamopsis tetragonoloba*) under arid conditions. *Indian Journal of Agricultural Sciences,* 84(**3**), 359-62.
8. Kherawat, B.S., Munna Lal, Agarwal, M., Yadav, H.K. And Kumar, S. (2013). Effect of applied potassium and manganese on yield and uptake of nutrients by cluster bean (*Cyamopsis tetragonoloba*). *J. Agric. Physics,* 13(**1**): 22-26.
9. Kumar, V. and Singh, A. (2002). Nutrient composition of cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] green pods. *Journal of Food Science and Technology*, 39(**5**), 526-528.
10. Kumar, J. (2008) Physio-chemical properties of the soil, under the two-forest plantation stands around Varanasi (U.P.), India. influenced by integrated nutrient management under alley cropping system. *Indian Journal of Agricultural Sciences*; 89 (**11**): 1876–80.
11. Munsell, A. H. (1971). A Color Notation. Baltimore, MD: Munsell Color Company. ed.; 1(2):65.
12. Muthuval, P., Udaysoorian, C., Natesan, R., Ramaswami, P. P. (1992) Introduction to Soil analysis, Tamil Nadu Agricultural University, Coimbatore,

641002.
13. Osman KT. Soils: Principles, properties and management. Springer Science & Business Media; 2012 Dec 4.
14. Page AL, Miller RH, Keeny DR. Methods of soil and plant analysis. American Society of Agronomy, Madison; 1982.
15. Panda SC. Soil management and organic farming. Agrobios;2006.
16. Piper CS. Soil and plant analysis. Scientific Publishers; 2019.
17. Rolaniya, M. K., Thomas, T. and Singh, A. K. (2023) Response of Different Levels of NPK and FYM on Growth and Yield of Cluster Bean (Cyamopsis tetragonoloba L.) *var*. Neelam-61, *International Journal of Environment and Climate Change*, 13(**8**), 487-491, 2023; ISSN: 2581-8627.
18. Singh YV, Singh SK, Sahi SK, Verma SK, Yadav RN, Singh PK. Evaluation of soil fertility status from Milkipur village, Arajiline block, Varanasi, district, Uttar Pradesh, in relation to soil characteristics. Journal of Pure and Applied Microbiology. 2016 Jun 1;10(2):1455-61.
19. Singh, Y. V., Singh, S. K., Sahi, S. K., Verma, S. K., Yadav, R. N. and Singh, P. K. (2016) Evaluation of soil fertility status from Milkipur village, Arajiline block, Varanasi, district, Uttar Pradesh, in relation to soil characteristics. *Journal of Pure and Applied Microbiology*;10(**2**):1455-61.
20. Sharma, D. K., Hasan, A., Thomas, T., David, A. A., Choudhary, A. and Sharma, A. (2022) Implication of integrated nutrient management on Soil properties of Cluster bean, *The Pharma Innovation Journal*, 11(**6**): 151-154.
21. Subbiah, B. V. and Asija, G. L. (1956) A rapid procedure for the estimate of *Available nitrogen in soil current sciences*, 2(5): 259-260.
22. Takase, M., Sam-Amoah, Owusu, L. K. and Sekyere, J. D. (2011) The Effects Of Four Sources Of Irrigation Water On Soil Chemical And Physical Properties. *Asian Journal of Plant Sciences* **10**(**1**): 92-96.
23. Toth, S. J., Prince, A. L. (1949) Estimation of Cation Exchange Capacity and exchangeable Ca, K and Na Content of Soil by Flame Photometer technique. *Soil Sci.,* 6 (7): 439- 445.
24. Walkley, A. and Black, I. A. (1947) Critical examination of rapid method for determining organic carbon in soils, effect of variance in digestion conditions and of inorganic soil

constituents. *Soil sci* pp. 632-251.

25. Wilcox, L. V. (1950) Electrical conductivity Am. water works Assoc. J 42, 775-776.
26. Olsen, S. R., Cole, C. V., Watanabe, F. S. and Dean, L. A. (1954) Estimation of available Phosphorus in soils by extraction with sodium bicarbonate ($NaHCO_3$), *U.S.D.A. Circular*. 939: 1-19.
27. Fisher, R. A. (1960) The underworld of probability, *The Indian journal of statistics*, **18** (3/4): 201- 210.
28. Bhadu A, David AA, Thomas T, Kumar A. Effect of Inorganic Fertilizers, FYM and Nano Urea on Soil Health, Growth and Yield of Cluster Bean (Cyamopsis tetragonoloba L.) cv. HGS 563. International Journal of Plant & Soil Science. 2023 Jun 28;35(16):404-10.