Effect of Vermicompost and Inorganic Fertilizer on Physico-Chemical Properties of Soil on Cowpea *(Vigna unguiculata)*

ABSTRACT

An experiment was conducted during *Kharif* (July to October) season 2022-23 on central research farm department of Soil Science and Agricultural Chemistry, SHUATS, Prayagraj. The soil of experimental area falls in order *Inceptisol* and soil texture was sandy loam (sand % 62.65, silt % 21.09 and clay % 16.26). The design applied for statistical analysis was carried out with randomized block design having two factors with three levels of @NPK 0, 50, and 100% ha^{-1} and three levels of @Vermicopost 0, 50 and 100% ha^{-1} respectively. The best treatment was effect on physical and chemical property of soil T_9 (@100%NPK+ 100% Vermicompost) and yield Attributes T_9 (@100%NPK+ 100% Vermicompost) of cowpea. A variety of cowpea, Maruti -52 was taken for a research trial. Bulk density (mg m^{-3}) and Particle density (mg m^{-3}) was recorded maximum in T1 (Absolute Control) and minimum in T9 (NPK @ 100% + Vermicompost @ 100%). pH (1:2.5) w/v was recorded maximum in T1 (Absolute Control) and minimum in T9 (NPK @ 100% + Vermicompost @ 100%). Pore space (%), Water holding capacity (%), EC (dS m^{-1}), Organic carbon (%), Nitrogen (kg ha^{-1}), Phosphorus (kg ha^{-1}) and Potassium (kg ha^{-1}) was measured maximum in T9 (NPK @ 100% + Vermicompost @ 100%) and minimum in T1 (Absolute Control).

Keywords: *Soil nutrients, Vermicompost ,Nitrogen , Phosphorus , Potassium and Cowpea.*

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, 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 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 dose of fertilizer depends on the initial soil fertility status and moisture availability conditions. [5]

Vermicompost treatment promotes germination and seedling growth improves crop yield and quality and enhances soil physiological, chemical and biological properties, reduces pathogenic infections . Besides, Vermicompost has also many direct and indirect effects on plants and soil such as improving soil structure, increasing organic matter and carbon content, porosity and water retention reducing bulk density, promoting microbial biomass and activity, suppressing plant diseases, and inducing various enzymatic activities, i.e., dehydrogenase, nitrogenase, phosphatase. [3]

The cowpea (*Vigna unguiculata*) is an annual herbaceous legume from the genus Vigna. Its tolerance for sandy soil and low rainfall have made it an important crop in the semiarid regions across Africa and Asia. It requires very few inputs, as the plant's root nodules are able to fix atmospheric nitrogen, making it a valuable crop for resource-poor farmers and well-suited to intercropping with other crops. The whole plant is used as forage for animals, with its use as cattle feed likely responsible for its name. Four subspecies of cowpeas are recognized, of which three are cultivated. Cowpeas can be erect, semi erect (trailing), or climbing. The crop is mainly grown for its seeds, which are high in protein, although the leaves and immature seed pods can also be consumed. Cowpeas were domesticated in Africa and are one of the oldest crops to be farmed. The optimum temperature for cowpea growth is 30 °C (86 °F), making it only available as a summer crop for most of the world. The seeds can be harvested after about 100 days or the whole plant used as forage after about 120 days. [2]

2. MATERIAL AND METHODS

2.1 Experimental Site and Location

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 above 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).

2.2 Climate Condition

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
T1	Absolute control	**R0V0**
T2	@[50% NPK + 0% Vermicompost]	**R1V0**
T3	@[100% NPK + 0% Vermicompost]	**R2V0**
T4	@[0% NPK + 50% Vermicompost]	**R0V1**
T5	@[50% NPK + 50% Vermicompost]	**R1V1**
T6	@[100% NPK + 50% Vermicompost]	**R2V1**
T7	@[0% NPK + 100% Vermicompost]	**R0V2**
T8	@[50% NPK + 100% Vermicompost]	**R1V2**
T9	@[100% NPK + 100% Vermicompost]	**R2V2**

Note: RDF:- 20:60:40 NPK, Vermicompost 4 t 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 was applied in three different doses along with inorganic fertilisers such as Nitrogen, Phosphorous and Potassium as RDF. The cowpea crop was manually sown on August 8th, 2023, as appropriate. At a pace of 25 kg per hectare, with a row-to-row distance of 30 cm and a plant-to-plant distance of 10 cm, the seed variety Maruti - 52 was planted.

2.5 Fertilizer Application

The recommended doses of NPK 20:60:40 (100%) were applied to the crop: N (44 kg ha^{-1}), P_2O_5 (375 kg ha^{-1}), and K_2O (66.67 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 4t ha^{-1} was used as a basal dose 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.

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[8], Particle density[8], Percentage pore space[8] and Water holding capacity (WHC)[8] using a 100-ml measuring cylinder (Muthuvel *et al.,* 1992) [8], pH [6], EC (Wilcox, 1950) [16], Percentage OC (Walkley and Black, 1934) [15], Available Nitrogen (Subbiah and Asiija, 1956) [13], Available Phosphorus (Olsen *et al.*, 1954) [11] 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 [4].

3. RESULTS AND DISCUSSION

3.1 Effect of Nutrient Management on Physical Properties of Soil after Harvest of Cowpea

The data showed that the treatment T_1 (Absolute control) non-significantly influenced the Bulk density of soil (1.40 and 1.41 Mg m^{-3}), Particle density of soil (2.45 and 2.47 Mg m^{-3}) at 0-15 cm and 15-30 cm depth and significantly influenced Percentage pore space (42.85 and 42.49 %), Water holding capacity (39.60 and 40.12%) of soil were found optimum in treatment T_9 (@ 100% NPK + @ 100% Vermicompost) over T1 (Absolute control) treatment at 0-15 cm and 15-30 cm depth, respectively. (Table 2 and fig. 1 and fig. 2). Similar findings were also observed [9],[10].

Table 2. . Effect of Different Levels of N, P, K and Vermicompost on physical properties of post-harvest soil sample of cowpea.

Treatments	Bulk Density (Mg m^{-3})		Particle Density (Mg m^{-3})		Pore space (%)		Water holding capacity (%)	
	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm
T_1	1.40	1.41	2.45	2.45	42.85	42.49	39.60	40.12
T_2	1.38	1.39	2.44	2.45	43.44	42.03	39.96	40.78
T_3	1.39	1.40	2.45	2.46	43.26	42.85	38.05	39.57
T_4	1.37	1.38	2.44	2.45	44.85	42.93	38.20	40.83
T_5	1.36	1.37	2.43	2.45	45.03	43.98	40.11	41.32
T_6	1.35	1.37	2.44	2.45	45.67	44.85	40.87	41.91
T_7	1.34	1.36	2.43	2.44	45.85	45.03	41.17	42.47
T_8	1.33	1.35	2.42	2.43	46.01	45.21	41.84	42.87
T_9	1.32	1.34	2.41	2.42	46.22	45.39	42.28	43.34
F- test	NS	NS	NS	NS	S	S	S	S
S.Em. (±)	-	-	-	-	0.66	0.66	0.55	0.61
C.D (P=0.05)	-	-	-	-	1.99	1.98	1.66	1.85

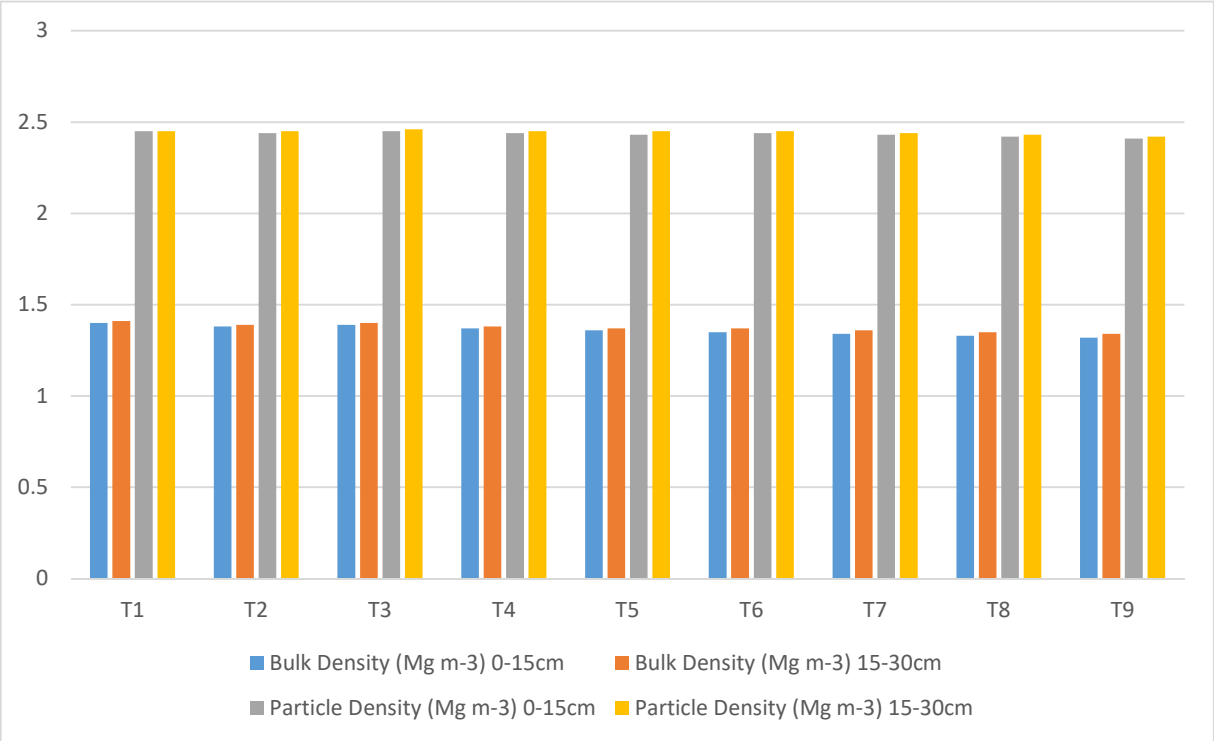

Fig. 1. Effect of Different Levels of N, P, K and Vermicompost on Bulk density and Particle density of the post-harvest soil sample

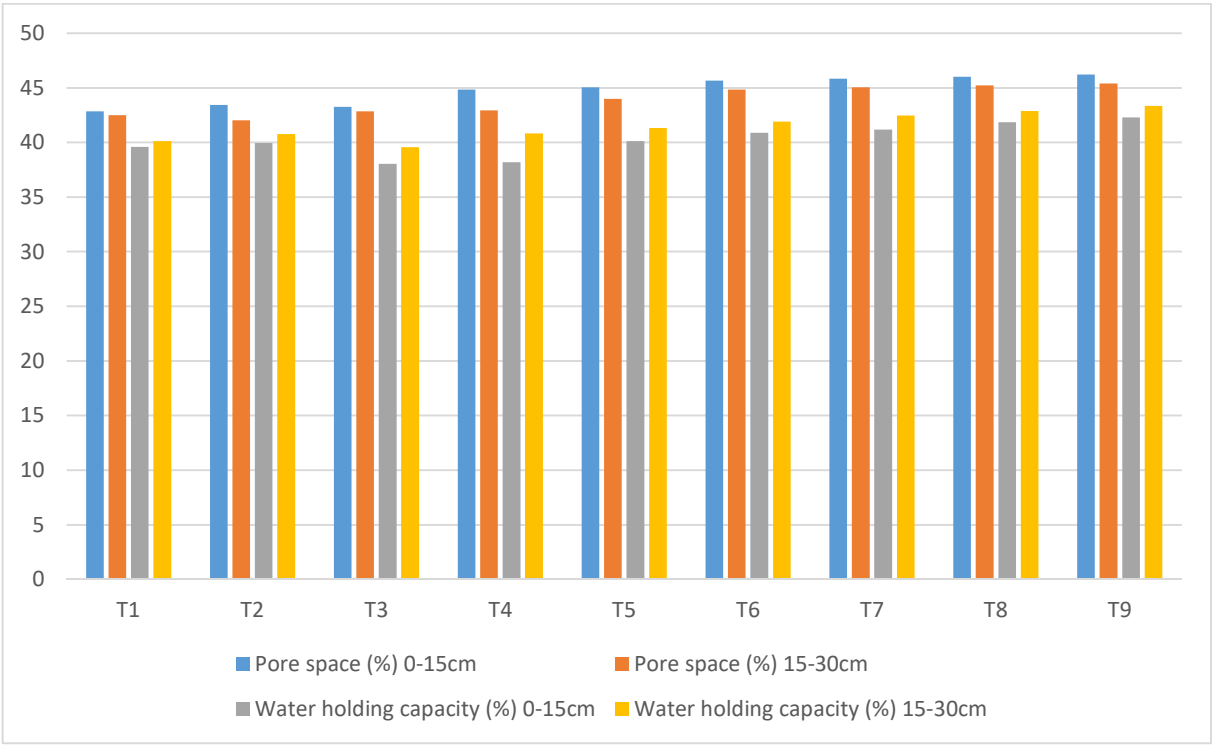

Fig. 2. Effect of Different Levels of N, P, K and Vermicompost on Pore space and Water holding capacity of the post-harvest soil sample.

3.2 Effect of Nutrient Management on Chemical Properties of Soil after Harvest of Cowpea

The data showed that the treatment T_1 (Absolute control) non-significantly influenced the soil pH is maximum (6.89 and 6.91) at 0-15 cm and 15- 30 cm depth, respectively and Electrical Conductivity (0.42 and 0.44 dS m^{-1}), There was significantly influenced maximum build-up of Percentage Organic Carbon (0.40% and 0.38%),(Table 3 and fig.3) Available N (299.43and 293.36 kg ha^{-1}), Available P (22.34 kg ha-1 and 21.67 kg ha^{-1}) and Available K (179.84 and 176.63 kg ha^{-1}) were observed under the treatment T_9 (@ 100% NPK + @ 100% Vermicompost) 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 4 and fig.3,4). Similar findings were also observed [9], [10].

Table 3. Effect of Different Levels of N, P, K and Vermicompost on pH, EC and Organic carbon of the post-harvest soil sample

Treatments	pH		Electrical conductivity (dS m^{-1})		Organic carbon (%)	
	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm
T_1	6.89	6.91	0.42	0.44	0.33	0.31
T_2	6.87	6.90	0.42	0.45	0.34	0.32
T_3	6.85	6.87	0.43	0.46	0.33	0.33
T_4	6.86	6.89	0.43	0.43	0.35	0.34
T_5	6.84	6.88	0.44	0.46	0.36	0.35
T_6	6.83	6.86	0.44	0.47	0.37	0.35
T_7	6.82	6.85	0.44	0.48	0.38	0.36
T_8	6.81	6.84	0.45	0.49	0.39	0.37
T_9	6.80	6.83	0.46	0.50	0.40	0.38
F- test	NS	NS	NS	NS	S	S
S.Em. (±)	-	-	-	-	0	0.01
C.D (P=0.05)	-	-	-	-	0.01	0.02

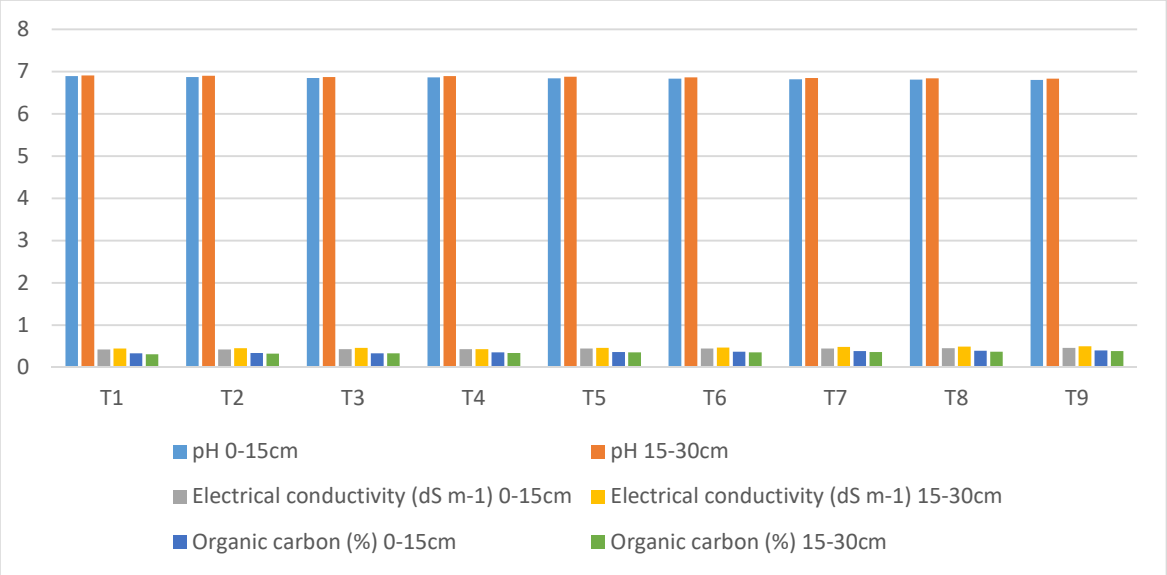

Fig. 3. Effect of Different Levels of N, P, K and Vermicompost on pH, EC and Organic carbon of the post-harvest soil sample

Table 4. Effect of Different Levels of N, P, K and Vermicompost on Available Nitrogen, Available Phosphorus and Available Potassium of the post-harvest soil sample

Treatments	Available Nitrogen (kg ha^{-1})		Available Phosphorus (kg ha^{-1})		Available Potassium (kg ha^{-1})	
	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm
T_1	280.04	273.04	17.45	15.33	168.38	165.56
T_2	283.87	275.17	17.67	16.65	169.49	166.43
T_3	285.28	276.28	18.09	17.89	171.17	168.76
T_4	286.48	287.98	17.76	16.87	170.67	169.97
T_5	288.14	288.64	18.45	18.00	173.15	171.17
T_6	290.87	290.87	19.07	18.87	175.39	172.37
T_7	294.56	292.16	19.17	17.97	177.95	174.54
T_8	296.76	290.76	20.21	19.23	178.47	175.76
T_9	299.43	293.36	22.34	21.67	179.84	176.43
F- test	S	S	S	S	S	S
S.Em. (±)	3.85	3.69	0.14	0.25	2.26	1.92
C.D (P=0.05)	11.54	11.06	0.42	0.77	6.78	5.77

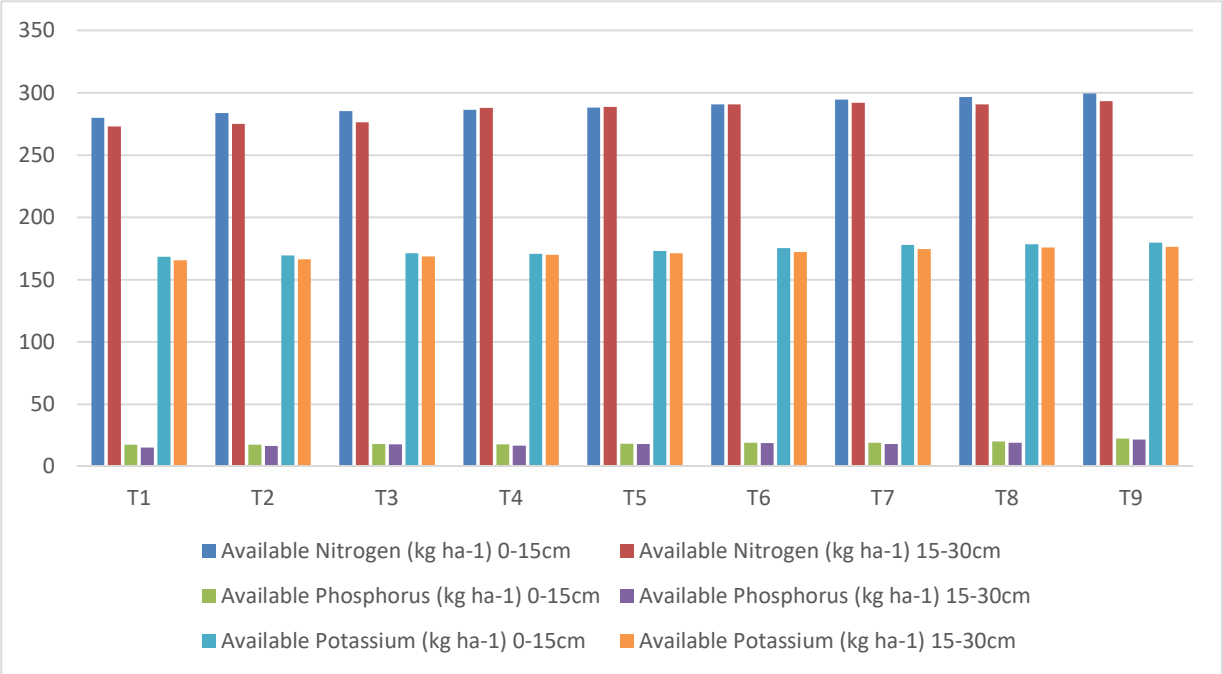

Fig. 4. Effect of Different Levels of N, P, K and Vermicompost on Available Nitrogen, Available Phosphorus and Available Potassium of the post-harvest soil sample

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 cowpea. Application of T_9(@ 100% NPK + @ 100% Vermicompost) was found optimal for improving Soil Properties like Pore space, Water holding capacity, Organic Carbon and Available Nitrogen, Phosphorus, Potassium.

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