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

ABSTRACT

Keeping this in view on experiment entitled **"Effect of Vermicompost and Inorganic Fertilizer on Physico-Chemical Properties of Soil on Cowpea (*Vigna unguiculata*) VAR. MARUTI-52"**is present with the following objective:

To evaluate the effect of different doses of vermicompost with NPK on physico-chemical properties of soil.

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 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. The largest percentages of pore space (%) with depths of 0–15 cm and 15–30 cm, 46.22% and 45.39%, water holding capacity (%) of 42.28% and 43.34%, and organic carbon (%) of 0.40% and 0.38% were found in the post-harvest soil and pre-harvest plant. There were 299.43 kg ha^{-1} and 293.36 kg ha^{-1} of available nitrogen, 22.34 kg ha^{-1} and 21.67 kg ha^{-1} of available phosphorus, and 179.84 kg ha^{-1} and 176.43 kg ha^{-1} of available potassium. The combination of T9-(@100%NPK+100% Vermicompost) demonstrated non-significant differences in particle density (Mg m^{-3}) of 2.45 and 2.47 Mg m^{-3}, pH of 6.89 and 6.91, and EC(dS m^{-1}) in bulk density (Mg m^{-3}) with depth 0-15 cm and 15-30 cm, which was 1.40 and 1.41 Mg $m^{-3,}$ particle density (Mg m^{-3}) was 2.45 and 2.47 Mg m^{-3} pH was 6.89 and 6.91 and EC(dS m^{-1}) 0.46 dS m^{-1} and 0.50 dS m^{-1}

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

1. INTRODUTION

Soil serves as a medium for plant growth. Soils are paramount to crop productivity. The coarseness and fineness of the soil, aggregate size, porosity, aeration (permeability), water-holding capacity, pH, bulk density, and particle density constitute a few of the soil characteristics that influence plant growth. The texture, physical state (soil structure and

tilth), and amount of vegetation cover on the soil surface significantly affect the pace at which water moves into the soil (infiltration). All soils' capacity to hold water is generally increased by organic matter, which also speeds up fine-textured soil infiltration. Bulk density shows the soil's ability to provide structural support, water and solute movement, and aeration. [1]

Nutrient balance is the key component to increase crop yields. Excess and imbalanceduse 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. Fertilizers are applied to the soil to preserve soil health and crop output. Green gram is extremely responsive to fertilizer treatment. The fertilizer dose is determined by the soil's initial fertility level with moisture availability. [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]

Cowpea (Vigna unguiculata) is an annual herbaceous legume belonging to the Vigna genus. Due to its ability to endure sandy soil and little rainfall, it is a significant crop in semiarid parts of Asia and Africa. Since the plant's root nodules can fix atmospheric nitrogen, it requires relatively little in the way of inputs, which makes it an excellent crop for resource-constrained farmers and a good fit for intercropping with other crops. The entire plant is fed to animals as fodder; in fact, its name probably originated from the fact that it was fed to cattle. There have been four identified subspecies of cowpeas, three of which are farmed. Cowpeas can ascend, be semierect (trailing), or stand erect. The crop is predominantly raised for its protein-rich seeds, though it is additionally grown for its leaves and immature seed pods can also be consumed. One of the earliest crops to be farmed, cowpeas were first domesticated in Africa. The majority of the world can only cultivate cowpeas as a summer crop because the ideal temperature for their growth is 30 °C (86 °F). It takes roughly 100 days to harvest the seeds, and 120 days to use the entire plant for fodder. [2]

2. MATERIAL AND METHODS

2.1 Experimental Site and Location

Situated on the Yamuna River's right bank, five kilometers away, the crop research farm's inquiry site is located at 250 58' N latitude and 810 52' E longitude. At 98 meters above mean sea level, it is elevated. Symbolic of the Agro-Ecological Subregion (North Alluvial Plain Zone, 0-1% slope) and the Agro-Climatic Zone (Upper Gangetic Plain Region).

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.

Table 1: Symbolic presentation of treatment combination

Treatment	Treatment Combination
T1	@[0%NPK + 0% Vermicompost]
T2	@[50% NPK + 0% Vermicompost]
T3	@[100% NPK + 0% Vermicompost]
T4	@[0% NPK + 50% Vermicompost]
T5	@[50% NPK + 50% Vermicompost]
T6	@[100% NPK + 50% Vermicompost]
T7	@[0% NPK + 100% Vermicompost]
T8	@[50% NPK + 100% Vermicompost]
T9	@[100% NPK + 100% Vermicompost]

Note: Recommended Dose of Fertilisers :- 20:60:40 NPK, Vermicompost 4 t ha^{-1}

2.3 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 8^{th}, 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.

2.4 Fertilizer Application

The crop received the following required dosages of NPK 20:60:40 (100%): N (44 kg ha-1), P2O5 (375 kg ha-1), and K2O (66.67 kg ha-1). The basal dose at the time of sowing was the administration of N, P, and K at 100%. Vermicompost 4 t ha-1 was also utilized as the treatment's basal dose in addition to these uses. NPK fertilizers derived their nitrogen from urea, which contains 46% N2O. In terms of treatments immediately prior to seed planting, phosphorus was administered through single superphosphate (16% P2O5) and potassium with muriate of potassium (60% K2O) earlier in the process.

2.5 Soil Analysis

The soils from each plot were separated, allowed to air dry, ground into a powder, and then passed through a screen with a mesh size of two millimeters for laboratory analysis. Using a 100-ml measuring cylinder, soil samples were analyzed for bulk density[8], particle density[8], percentage pore space[8], and water holding capacity (WHC)[8] (Muthuvel et al., 1992) before sowing the experimental crop and after crop harvest. These variables include 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].

2.6 Statistical Analysis

The statistical analysis of the data was carried out using STATISTICA software [4].

3. RESULTS AND DISCUSSION

The results indicated that treatment T1 (absolute control) had a non-significant impact on the bulk and particle densities of the soil at 0–15 and 15–30 cm depth, respectively, and a significant impact on the percentage of pore space with minimum in T1 (42.85 and 42.49 %) and water holding capacity (39.60 and 40.12%). The treatment T9 (@ 100% NPK + @ 100% Vermicompost) was found to be optimal over treatment T1 (abssolute control) at 0–15 cm and 15–30 cm depth, respectively. (Table 2).

Table 2. Effect of Different Levels of NPK and Vermicompost on physical properties of 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	@[0%NPK + 0% Vermicompost]	1.40	1.41	2.45	2.45	42.85	42.49	39.60	40.12
T_2	@[50% NPK + 0% Vermicompost]	1.38	1.39	2.44	2.45	43.44	42.03	39.96	40.78
T_3	@[100% NPK + 0% Vermicompost]	1.39	1.40	2.45	2.46	43.26	42.85	38.05	39.57
T_4	@[0% NPK + 50% Vermicompost]	1.37	1.38	2.44	2.45	44.85	42.93	38.20	40.83
T_5	@[50% NPK + 50% Vermicompost]	1.36	1.37	2.43	2.45	45.03	43.98	40.11	41.32
T_6	@[100% NPK + 50% Vermicompost]	1.35	1.37	2.44	2.45	45.67	44.85	40.87	41.91
T_7	@[0% NPK + 100% Vermicompost]	1.34	1.36	2.43	2.44	45.85	45.03	41.17	42.47
T_8	@[50% NPK + 100% Vermicompost]	1.33	1.35	2.42	2.43	46.01	45.21	41.84	42.87
T_9	@[100% NPK + 100% Vermicompost]	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

3.1 Effect of Different Levels of NPK and Vermicompost on Chemical Properties of Soil after Harvest of Cowpea

The data showed that the treatment T1 (absolute control) had a non-significant effect on soil pH, which reached maximum values of 6.89 and 6.91 at 0-15 cm and 15-30 cm depths, respectively. The Electrical Conductivity (EC) under T1 was measured at 0.42 and 0.44 dS m-1 for these depths. (Table 3 and 4).In contrast, treatment T9 (100% NPK + 100% Vermicompost) significantly enhanced several soil fertility parameters. The maximum values observed under T9 were:

- Percentage Organic Carbon: 0.40% at 0-15 cm and 0.38% at 15-30 cm (Table 3 and Fig. 3)
- Available Nitrogen (N): 299.43 kg ha-1 at 0-15 cm and 293.36 kg ha-1 at 15-30 cm
- Available Phosphorus (P): 22.34 kg ha-1 at 0-15 cm and 21.67 kg ha-1 at 15-30 cm
- Available Potassium (K): 179.84 kg ha-1 at 0-15 cm and 176.63 kg ha-1 at 15-30 cm

Table 3. Effect of Different Levels of NPK and Vermicompost on pH, EC and Organic carbon of the 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	@[0%NPK + 0% Vermicompost]	6.89	6.91	0.42	0.44	0.33	0.31
T_2	@[50% NPK + 0% Vermicompost]	6.87	6.90	0.42	0.45	0.34	0.32
T_3	@[100% NPK + 0% Vermicompost]	6.85	6.87	0.43	0.46	0.33	0.33
T_4	@[0% NPK + 50% Vermicompost]	6.86	6.89	0.43	0.43	0.35	0.34
T_5	@[50% NPK + 50% Vermicompost]	6.84	6.88	0.44	0.46	0.36	0.35
T_6	@[100% NPK + 50% Vermicompost]	6.83	6.86	0.44	0.47	0.37	0.35
T_7	@[0% NPK + 100% Vermicompost]	6.82	6.85	0.44	0.48	0.38	0.36
T_8	@[50% NPK + 100% Vermicompost]	6.81	6.84	0.45	0.49	0.39	0.37
T_9	@[100% NPK + 100% Vermicompost]	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

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

Treatments		Available Nitrogen (kgha^{-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	@[0%NPK + 0% Vermicompost]	280.04	273.04	17.45	15.33	168.38	165.56
T_2	@[50% NPK + 0% Vermicompost]	283.87	275.17	17.67	16.65	169.49	166.43
T_3	@[100% NPK + 0% Vermicompost]	285.28	276.28	18.09	17.89	171.17	168.76
T_4	@[0% NPK + 50% Vermicompost]	286.48	287.98	17.76	16.87	170.67	169.97
T_5	@[50% NPK + 50% Vermicompost]	288.14	288.64	18.45	18.00	173.15	171.17
T_6	@[100% NPK + 50% Vermicompost]	290.87	290.87	19.07	18.87	175.39	172.37
T_7	@[0% NPK + 100% Vermicompost]	294.56	292.16	19.17	17.97	177.95	174.54
T_8	@[50% NPK + 100% Vermicompost]	296.76	290.76	20.21	19.23	178.47	175.76
T_9	@[100% NPK + 100% Vermicompost]	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

4. CONCLUSION

According to the findings, combining inorganic fertilizer and organic manure significantly enhanced soil health for cowpea cultivation. The study specifically highlighted that the best approach to improving various soil properties was the application of T9, which consists of 100% NPK (nitrogen, phosphorus, and potassium) along with 100% vermicompost. This combination proved to be the most effective in enhancing soil characteristics such as pore space, water holding capacity, organic carbon content, and the availability of key nutrients like nitrogen, phosphorus, and potassium. The results indicate that using T9 not only promotes better soil health but also supports more robust cowpea growth.

5. ACKNOWLEDGEMENTS

I would like to express my gratitude to my advisor, Dr. Narendra Swaroop of the Department of Soil Science and Agricultural Chemistry at Sam Higginbottom University of Agriculture, Technology, and Sciences in Prayagraj, for his unwavering support, inspiration, keen interest, comments, and helpful suggestions during my studies and investigation. Sam Higginbottom also provided the soil science farm and laboratory needed to conduct the research.

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