International Journal of Plant & Soil Science

Volume 35, Issue 17, Page 109-116, 2023; Article no.IJPSS.101132
ISSN: 2320-7035

Effect of Different Levels of Organic Manures on Physico-Chemical Properties of Soil under Cowpea Crop in an Inceptisol of Prayagraj, Uttar Pradesh, India

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Authors' contributions

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

Article Information

DOI: 10.9734/IJPSS/2023/v35i173189

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/101132

Original Research Article

Received: 05/05/2023
Accepted: 26/06/2023
Published: 03/07/2023

ABSTRACT

An experiment was conducted on "Effect of different levels of organic manures on physico-chemical properties of soil under cowpea crop in an inceptisol of Prayagraj, Uttar Pradesh, India" to observe the combined effect of farmyard manure, Vermi Compost and Neem Cake on soil health and yield. The result showed that the application of FYM, Vermi Compost and Neem Cake had a significant

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and non-significant effect on soil Physico-chemical properties, respectively. The maximum bulk density (1.32 Mg m^{-3} and 1.35 Mg m^{-3}), particle density (2.46 Mg m^{-3} and 2.48 Mg m^{-3}), pH (7.47 and 7.49) and EC (0.251 dS m^{-1} and 0.248 dS m^{-1}) were recorded in T_1(absolute control) at 0-15 cm and 15-30 cm depth. Similarly, the maximum percentage pore space (48.92 % and 45.47 %), water holding capacity (43.96 % and 40.38 %), organic Carbon (0.49 % and 0.47 %), Available Nitrogen (301.14 kg ha^{-1} and 294.97 kg ha^{-1}), Available Phosphorus (30.96 kg ha^{-1} and 27.50 kg ha^{-1}), Available Potassium (196.58 kg $ha^{-1}$and 188.41 kg ha^{-1}) were recorded in T_9 treatment.

Keywords: Soil nutrients; FYM; vermicompost; neem cake and cowpea.

1. INTRODUCTION

"Cowpea is one of the important legume vegetable crops grown in India. It 1s also known as black eye pea, southern pea and Crowder pea, well adapted to many areas of the humid tropics and sub-tropical zones. It is grown throughout India for its long, green vegetable pods, seeds and foliage for fodder. There is a world-wide consensus that sole dependence on chemical input-based agriculture is not suitable in the long run and only integrated plant nutrient systems (IPNS) involving a combination of fertilizer, organic manures and bio-fertilizers are essential to sustain crop production and preserve soil heat and biodiversity. In addition to this, the organic manures help in improving the use efficiency of inorganic fertilizers" [1].

"Crop residues are a potential source of organic matter in soils. Essentially, the presence of organic matter in soils is responsible for improved chemical and integrated use of vermicompost and biofertilizers ncreases the nutrient status of soil at the harvest stage. Available P and micronutrient level increases with the combine use of biofertilizers and vermicompost Organic compost is a very important method of providing x plants with their nutritional requirements without having an undesirable impact on the environment" [2].

"Organic manures viz., FYM, vermicompost, poultry manure and oilcake help in the improvement of soil structure, aeration and water-holding capacity of the soil. Further, it stimulates the activity of microorganisms that makes the plant x get the macro and micro-nutrients through enhanced biological processes, increase nutrient solubility, alter soil salinity, solubility and pH" [3].

"Incorporation of FYM or organic manure alone or integration with chemical fertilizers improves not only the nutrient use efficiency, but also increases the available nutrient status of soil with enhanced soil biological activity which in turn provides a congenial physical condition and improved availability of nutrients in the rhizosphere" [4].

"Neem Cakes are more cost-efficient because the fertilizer in them lasts longer. The Neem Cake remains effective until the next crop is planted because of its long-sustaining organic fertilizer compounds too. This, in turn, cuts the cost of having to add extra nutrients; always a bonus. This soil amendment is twofold. It will provide a better crop yield because it will provide the nutrients that crops need. And secondly, it helps to cure diseases and will control the growth of nematodes and harmful plant pathogens. Plus, the crop yield is15-25% higher when used. Neem Cakes than with any other fertilizer. Neem Cakes can also improve the organic content of the soil by providing lots of micro and macronutrients. This also improves the fertility of the soil in which your plants or crops are planted. The use of Neem Cakes too will increase the water-holding capability of the soil and improve soil structure. With the soil improvement here will be an increase in beneficial organisms like earthworms also Additionally, Neem Cake will help improve x the texture of your soil, the organic content and water-holding capacity as stated as well as help to keep the soil aerated for root development"[5].

2. MATERIALS AND METHODS

2.1 Experimental Site and Location

The experiment was conducted at the Research Farm of Soil Science at Sam Higginbottom University of Agriculture, Technology Sciences, Prayagraj which is located at $25^0$24'30" N latitude, 81^0 51'10" E longitude and 98 m above the mean sea level and is situated 6 km away on the right bank of Yamuna river. Representing the Agro-Ecological Sub Region [North Alluvium plain zone (0-1 % slope)] and Agro-Climatic Zone (Upper Gangetic Plain Region).

Table 1. Details of treatment combination

S. No.	Treatment combination	Symbol
T_1	Absolute Control,	
T_2	Vermicompost @ 50% and Neem cake @ 50%	V_1N_1
T_3	Vermicompost @ 50% and Neem cake @ 100%	V_1N_2
T_4	Vermicompost @50% and FYM @ 50%	V_1F_1
T_5	Vermicompost @50% and FYM @ 100%	V_1F_2
T_6	Vermicompost @ 100% and Neem cake @ 50%	V_2N_1
T_7	Vermicompost @ 100% and Neem cake @ 100%	V_2N_2
T_8	Vermicompost @ 100% and FYM @ 50%	V_2F_1
T_9	Vermicompost @ 100% and FYM @ 100%	V_2F_2

Note: Recommended dose of fertilizer was applied at the time of sowing (P = @ 20 Kg ha^{-1}, K= @ 20 Kg ha^{-1}) (N was applied in two different doses @ 40 kg ha^{-1}), FYM@ 5 t ha^{-1}, Vermicompost @ 2 t ha^{-1} and Neem cake @ 2.64 t ha^{-1}

2.2 Climate Condition

The area of Prayagraj district comes under a subtropical belt in the Southeast of Uttar Pradesh, which experiences extremely hot summer and cold winter. The maximum temperature of the location reaches up to 46^{0}C – 48^{0}C and seldom falls as low as 4^{0}C – 5^{0}C. The relative humidity ranged between 20 to 94 percent. The average rainfall in this area is around 1100 mm annually. Prayagraj has a sub-tropical and semi-arid climate with rain mostly during July- September.

2.3 Experimental Design

The experiment was conducted in a randomized complete block design (RCBD) having nine treatment combinations which is replicated thrice, randomly allocated in each replication, dividing into 27 plots. In the study, Organic manures like FYM, Vermicompost and Neem Cake were applied in two different doses. Sowing of the cowpea crop was carried out on the 15th of March, 2022 respectively, by hand. The seed variety kashi Nidhi was sown at a rate of 25 kgha^{-1} and a row –to – row spacing of 30 cm and plant-to-plant spacing of 15 cm.

2.4 Soil Analysis

The soils from each plot were separately collected, air-dried, ground, and passed through a 2-mm-size sieve for laboratory analysis. Soil samples were analyzed for bulk density, particle density, Percentage pore space, and water holding capacity [6], pH [7], EC [8], Percentage Organic Carbon [9], Available Nitrogen [10], Available Phosphorus [11] and Available Potassium [12] before sowing and after harvest of the crop.

2.5 Statistical Analysis

The statistical analysis of the data was carried out using STATISTICA (7.0) software.

3. RESULTS AND DISCUSSION

3.1 Effect of Different Levels of Organic Manures on Physical Properties of Soil after Harvest of Cowpea

The result observed in treatment T_1 non-significantly higher bulk density (1.32 Mg m^{-3} and 1.35 Mg m^{-3}), particle density (2.46 Mg m^{-3} and 2.48 Mg m^{-3}) and significantly higher percentage pore space (48.92% and 45.47%) and Water holding capacity (43.96% and 40.38%) were recorded in T_9 at 0-15 cm and 15-30 cm depth. This corroborates with the findings of [13,7,5,14,4,15,6,11, 16,17].

3.2 Effect of Different Levels of Organic Manures on Soil on Chemical Properties of Soil after Harvest of Cowpea

The result observed in treatment T_1 non significantly higher soil pH (7.47 and 7.49) and significantly higher Electrical conductivity (0.251 dS m^{-1} and 0.248 dS m^{-1}) at 0-15 cm and 15-30 cm. There was a significantly higher percentage of organic Carbon (0.49 % and 0.47 %), Available Nitrogen (301.14 kg ha^{-1}and 294.97 kg ha^{-1}), Available Phosphorus (30.96 kg ha^{-1} and 27.50 kg ha^{-1}), Available Potassium (196.58 kg ha^{-1} and 188.41 kg ha^{-1}) were recorded in T_9 at 0-15 cm and 15-30 cm depth [2,3,13,7,5,14,4, 15,6,11,16].

Table 2. Effect of different levels of organic manures on bulk density, particle density, pore space, water holding capacity and pH

S. No.	Treatment combination	Bulk Density (Mg m^{-3})		Particle Density (Mg m^{-3})		Pore space (%)		Water holding Capacity (%)		pH	
		0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1	Absolute Control	1.32	1.35	2.46	2.48	42.22	39.12	38.21	33.37	7.47	7.49
T_2	Vermicompost 50 % and Neem cake 50 %	1.29	1.32	2.44	2.47	43.38	41.25	39.32	33.67	7.45	7.48
T_3	Vermicompost 50% and Neem cake 100%	1.25	1.27	2.41	2.43	44.53	41.34	40.38	37.94	7.36	7.39
T_4	Vermicompost 50% and FYM 50 %	1.27	1.30	2.43	2.45	43.98	40.31	39.98	35.44	7.43	7.46
T_5	Vermicompost 50 % and FYM 100 %	1.22	1.24	2.38	2.39	46.32	43.16	41.37	38.31	7.31	7.33
T_6	Vermicompost 100 % and Neem cake 50 %	1.24	1.26	2.40	2.42	45.84	41.37	40.91	36.26	7.34	7.38
T_7	Vermicompost 100 % and Neem cake 100 %	1.19	1.20	2.30	2.35	48.36	43.33	43.28	39.87	7.23	7.24
T_8	Vermicompost 100 % and FYM 50 %	1.20	1.23	2.36	2.39	47.64	43.28	42.84	36.35	7.27	7.26
T_9	Vermicompost 100 % and FYM 100%	1.17	1.19	2.27	2.29	48.92	45.47	43.96	40.38	7.20	7.22
F(test)		NS	NS	NS	NS	S	S	S	S	NS	NS
S.Em. ±						0.82	0.44	0.66	0.62		
C.D. at 5%						2.48	1.32	1.99	1.88		

Table 3. Effect of different levels of organic manure on electrical conductivity, organic carbon, available nitrogen, available phosphorus and available potassium

S. No.	Treatment combination	EC (dS m^{-1})		Organic Carbon (%)		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	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1	Absolute Control	0.251	0.248	0.35	0.31	245.88	236.80	16.38	14.35	138.25	130.32
T_2	Vermicompost 50 % and Neem cake 50 %	0.248	0.244	0.38	0.35	253.73	248.34	17.47	15.64	140.59	132.77
T_3	Vermicompost 50% and Neem cake 100%	0.242	0.239	0.42	0.41	273.80	265.66	22.34	20.79	148.88	137.87
T_4	Vermicompost 50% and FYM 50 %	0.244	0.242	0.40	0.38	265.52	257.91	20.37	17.92	146.59	139.05
T_5	Vermicompost 50 % and FYM 100 %	0.231	0.227	0.44	0.42	285.45	276.94	23.47	22.55	166.72	156.11
T_6	Vermicompost 100 % and Neem cake 50 %	0.237	0.232	0.42	0.40	278.99	270.40	23.52	21.43	158.33	138.62
T_7	Vermicompost 100 % and Neem cake 100 %	0.220	0.218	0.47	0.45	298.95	283.48	28.12	24.68	187.17	171.95
T_8	Vermicompost 100 % and FYM 50 %	0.229	0.225	0.46	0.43	294.28	286.50	25.08	23.75	176.32	162.02
T_9	Vermicompost 100 % and FYM 100%	0.216	0.213	0.49	0.47	301.14	294.97	30.96	27.50	196.58	188.41
F(test)		S	S	S	S	S	S	S	S	S	S
S.Em. ±		0.004	0.004	0.006	0.006	3.17	3.80	0.33	0.33	2.79	2.03
C.D. at 5%		0.011	0.011	0.019	0.02	9.54	11.45	1.01	0.99	8.42	6.13

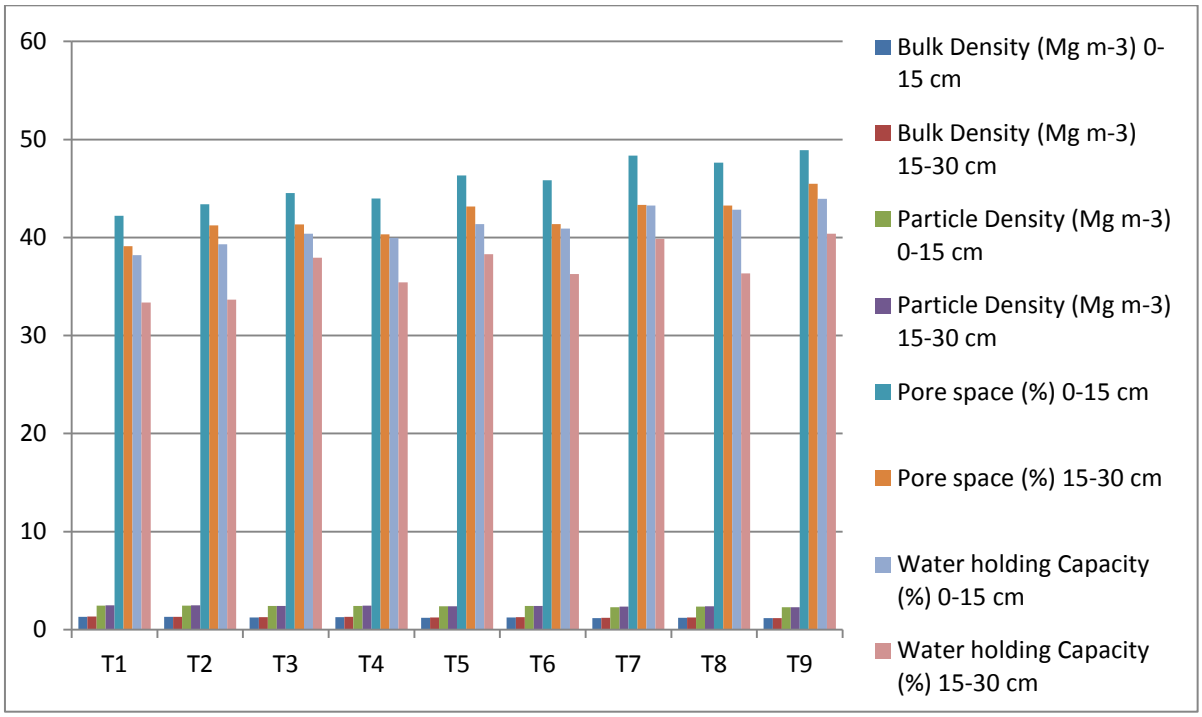

Fig. 1. Effect of different levels of organic manures on bulk density, particle density, pore space and water holding capacity

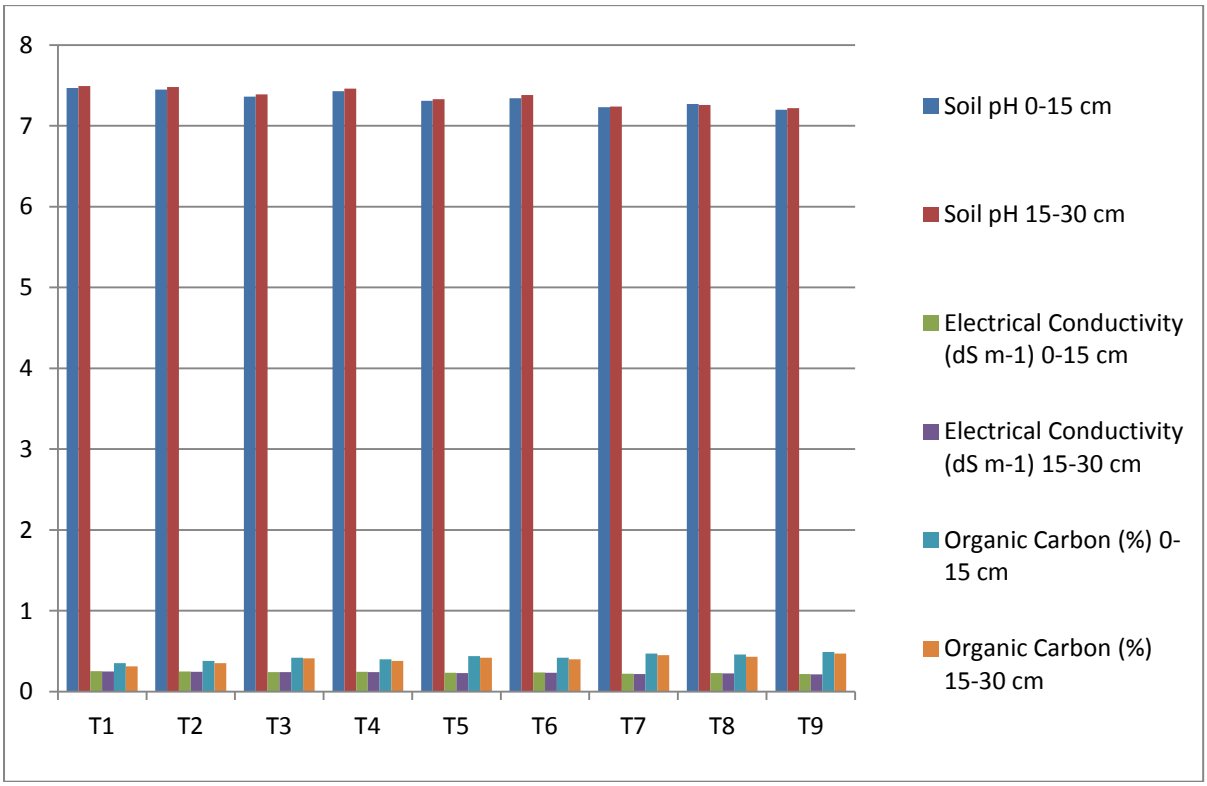

Fig. 2. Effect of different levels of organic manures on soil pH and Electrical conductivity and Organic Carbon

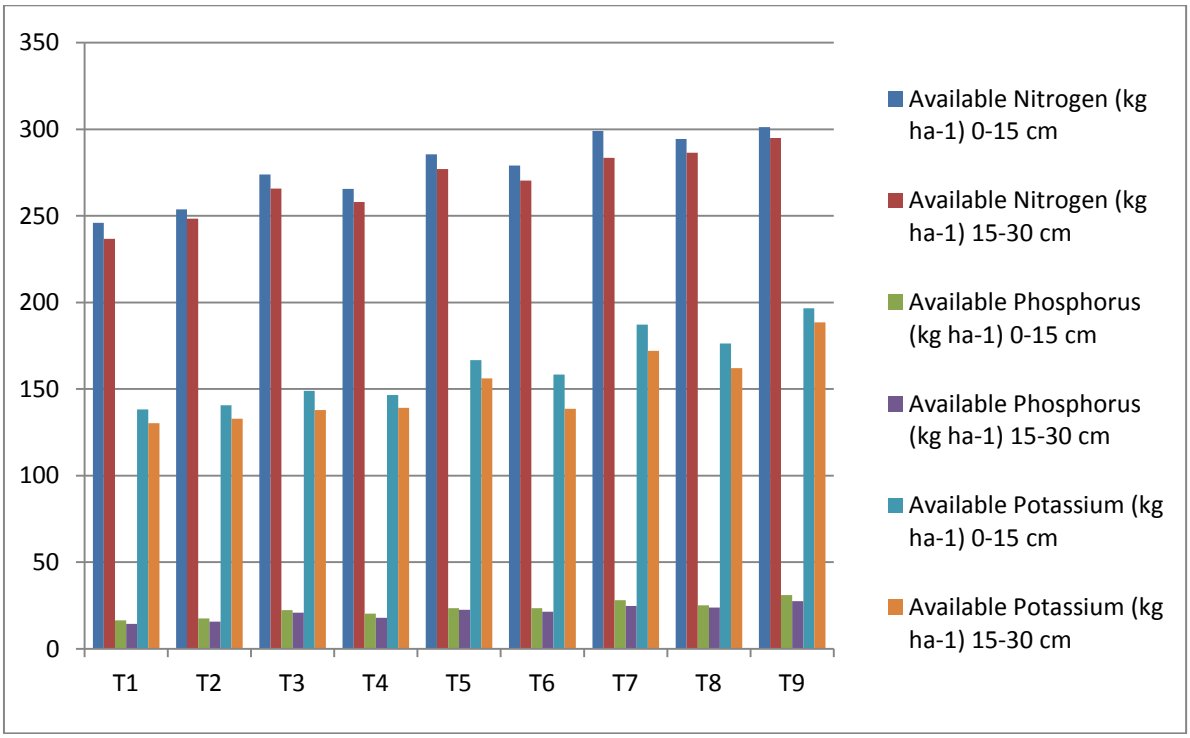

Fig. 3. Effect of different levels of organic manures on available nitrogen, available phosphorus and available potassium

4. CONCLUSION

Conclusion based on the results; the application of organic manures was found to improve the soil health about cowpea. Application of T_9 (Vermicompost @ 2 t ha^{-1} and FYM @ 5 t ha^{-1}] was found optimal for improving soil properties like pore space, water holding capacity, Available Nitrogen, Available phosphorus and Available potassium.

ACKNOWLEDGEMENTS

Authors are highly acknowledged to the Department of Soil science and agricultural chemistry, Sam Higginbottom university of agriculture, technology and sciences, Prayagraj, U.P. due to available the facilities of soil science farm and the laboratory to conduct the research work.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/101132