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Effect of Integrated sources of nutrients on Soil properties of Cowpea (*Vigna unguculata* L.) var Ankur Gomati

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ABSTRACT

A field experiment was conducted in randomized block design with seven treatments to study the effect of fertilizers, organic manures, biochar and crop residues on soil properties and yield of cowpea (*Vigna unguiculata* L.) in an Inceptisols of Prayagraj, Uttar Pradesh, India in 2022. A research variety Ankur Gomati was taken for thisresearch trial. Recommended doses of fertilizers (N, P_2O_5 and K_2O @ 25, 75 and 60 kg ha^{-1}) was applied with inorganic fertilizers (Zinc and Boron), organic manures (Farm Yard Manure, vermicompost, neem cake and poultry manure), biochar and crop residues (rice straw and wheat straw) Better result of soil parameters like bulk density 1.31 Mg m^{-3}, particles density 2.49 Mg m^{-3} and soil pH 7.7 were recorded in T_1 [RDF] andthe maximum porosity 49.56 %, water holding capacity 47.55%, and electrical conductivity 0.29 dS m^{-1}, soil organic carbon 0.59%, available nitrogen, phosphorus, potassium, Fe, Mn, and Cu 325.39 Kg ha^{-1},33.78 Kg ha^{-1}, 208.68 Kg ha^{-1}, 2.88 mg kg^{-1}, 2.66 mg $kg^{-1}$and 1.34 mg kg^{-1}respectively were recorded in T_7[RDF + Poultry Manure @2 t ha^{-1} + Biochar @2.5 t ha^{-1}+ Vermicompost @2 t ha^{-1} + Neem Cake @500 kg ha^{-1}]. The maximum available Zn 0.90 mg kg^{-1} and available Boron 1.60 mg kg^{-1} were recorded in T_2 [RDF + Boron @2 kg ha^{-1} + Zinc @7 kg ha^{-1}]. All soil parameters significantly influenced after harvest of cowpea andwith applying the combination of organic and inorganic fertilizers.

Key words : *Biochar, Crop Residues, Organic Manures and Soil Properties.*

Introduction

Soil properties are the physical, chemical, and biological characteristics of soil that determine its suitability for different uses such as agriculture, construction, and environmental management (Brady *et al*., 2016). Pulses have long been recognized and valued as "Soil building" crops. Growing pulses improves soil quality through their beneficial effects on soil biological, chemical and physical conditions. When properly managed, pulses benefits soil quality in the form of increasing soil organic matter, improving soil porosity, recycling nutrients, improving soil structure, decreasing soil pH, diversifying the microscopic life in the soil and breaking disease build up and weed problems. It has unique ability of maintaining and restoring soil fertility through biological nitrogen fixation with the help of rhizobium bacteria (Kumari *et al.,* 2022).

Cowpea (*Vigna unguiculata* L.) is one of the important *kharif* pulse crops grown for vegetable, grain, for age and green manuring belonging to family Leguminaceae (Ahmed *et al.,* 2012). In India cow pea grown states are Utter Pradesh, Punjab,

Haryana, Rajasthan and Madhya Pradesh and cowpea cultivated in arid and semi-arid. Uttar Pradesh is the leading state among them (Meena *et al*., 2014). Green tender pods of cowpea are used as vegetable, the vegetable cowpea pods contain 24.8% protein, 63.6% carbohydrate, 1.9% fat, 6.3% fiber, 7.4 ppm thiamine, 4.2 ppm riboflavin and 28.1 ppm niacin (Ahlawat and Shivkumar, 2005).

Recommended dose of NPK and micronutrients like Boron (B) and Zinc (Zn) significantly improve nutrient availability in soil, improving the soil properties (Debnath *et al*., 2018). Organic fertilizers improve the physical properties of soil and add organic content to it which is chemical free, increase microbial activity in soil which is responsible for rapid decomposition of nutrients. Crop residue significantly increased soil moisture content (Kumari *et al.,* 2022). Biochar effects the physical and chemical characteristics of the soil such as improved pH; improved water holding capacity, which raises the available water to the plant, and improved nutritional contents (Yeboah *et al*., 2020). Soil properties improve the use of inorganic nutrients sources (Debnath *et al*., 2018), organic nutrient sources (Patel *et al*., 2018), crop residues (Ndiso *et al*., 2018), and even with biochar application (Phares *et al.,* 2020). However, there is no systematic study that involves the integrated use of these nutrient and carbon sources on soil properties. In this light, the present study aimed to evaluate the effect of integrated sources (inorganic and organic) of nutrients and carbon (biochar) on soil properties in an Inceptisol of Indo-Gangetic plain.

Materials and Methods

The field experiment was conducted at research farm located at Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh ($25^0$24′ Nlatitude, 81^0 51′ E longitude) during *Kharif* season of 2022. This area experiences sub-tropical to semi-arid climate with extremely hot summer and cold winter. The maximum temperature reaches up to 46– 48 ºC and seldom falls as low as 4–5 ºC. The average rainfall in this area is ~1100 mm most of which is received during July-September.

The pre soil samples and post soil samples from each plot were separately collected through soil auger for laboratory analysis. And sieving with 2 mm brass sieve. Soil samples were analysed for soil physical properties like bulk density (Mgm^{-3}), particle density (Mgm^{-3}), pore space percentage (%) and water holding capacity (%) all given by Muthuvel *et al.,* 1992, soil colour given by Munsell, 1971 in Munsell colour chart and soiltexture (sand, silt and clay %) given by Bouyoucos, 1952 and chemical properties like soil pH given by Wilcox, 1950, electrical conductivity (dS m^{-1}) given by Jackson, 1958, organic carbon (kg ha^{-1}) given by Walkley and Black, 1947, available nitrogen (kg ha^{-1}) given by Subbiah and Asija, 1956, available phosphorus (kg ha^{-1}) given by Olsen *et al.,* 1954, available potassium (kg ha^{-1}) given by Toth and Prince, 1949, available Zn, Fe, Mn and Cu (mg ha^{-1}) given by Lindsay and Norvell, 1978 and available B (mg ha^{-1}) given by Berger and Truog, 1939. The readings of Zn, Fe, Mn and Cuweretaken in Atomic Absorption Spectrophotometer The results pre soil sample analysis are texture sandy loam, and soil colour in dry condition is pale brown and in wet condition olive brown, bulk density 1.33 Mgm^{-3}, partial density 2.50 Mgm^{-3}, porosity 46.80 %, water holding capacity 44.01 %, pH 7.8, EC 0.20 dS m^{-1}, organic carbon 0.40 kg ha^{-1}, available nitrogen, phosphorus, potassium, boron, zinc, iron, manganese and copper are 240.45 kg ha^{-1}, 20.21 kg ha^{-1}, 159.02 kg ha^{-1}, 0.73 mg ha^{-1}, 0.60 mg ha^{-1}, 2.64 mg ha^{-1}, 2.42 mg ha^{-1} and 1.12 mg ha^{-1} respectively.

The experimental area was laid out in randomized block design with seven treatments and three replications. The treatments comprised of T_1- RDF @ 25:75:60 N:P:K, T_2- RDF + B @ 2 kg ha^{-1} + Zn @ 7 kg ha^{-1}, T_3- RDF + Farm Yard Manure@ 5 t ha^{-1}, T_4- RDF + Vermicompost @ 2 t ha^{-1} + Rice Straw @ 6 t ha^{-1}, T_5- RDF + Neem Cake @ 500 kg ha^{-1} + Wheat Straw @ 6 t ha^{-1}, T_6- RDF + Biochar @ 2.5 t ha^{-1} and T_7- RDF + Poultry Manure @ 2 t ha^{-1} + Vermicompost @ 2 t ha^{-1} + Biochar @ 2.5 t ha^{-1} + Neem Cake @ 2 t ha^{-1}. The organic manures were incorporated into soil before three weeks of sowing and the inorganic fertilizers were applied at the time of showing. The sources of N, P, K, Zn and B were urea, SSP, MOP, zinc sulphate and zorax respectively. Half dose of urea was applied at the time of showing and the other half were applied after 21 days of showing as split dose. First picking was held on 55 DAS and the final harvesting was held on 70 DAS. All cultural practices were adopted uniformly in each plot as and when required. In general, no incidence of disease and pest was recorded during both the season. The data recorded during the course of the investigation will be subjected to statistical analysis by 3X 3 RBD, as

per (ANOVA). Experiment will be laid out in RBD and the treatment will be replicated three times. The significant and non-significant effect was judged with the help of "F" (variance ratio) table. The significant difference between the means was tested against the critical difference of 5% level.

Results and Discussion

Effect on soil physical properties

Data presented in Table 1 shows that better result of soil parameters like bulk density 1.31 Mg m^{-3} and particles density 2.49 Mg m^{-3} were recorded in T_1 [RDF] fallowed by T_2 [RDF + Boron @2 kg ha^{-1} + Zinc @7 kg ha^{-1}] respectively and minimum bulk density and particle density recorded in T_7 [RDF + Poultry Manure @2 t ha^{-1} + Biochar @2.5 t ha^{-1}+ Vermicompost @2 t ha^{-1} + Neem Cake @500 kg ha^{-1}] and found to be significant. The maximum porosity 49.56 % and water holding capacity 47.55% were recorded in T_7 [RDF + Poultry Manure @ 2 t ha^{-1} + Biochar @ 2.5 t ha^{-1} + Vermicompost @ 2 t ha^{-1} + Neem Cake @ 500 kg ha^{-1}] followed by T_4 [RDF + Vermicompost @2 t ha^{-1} + Rice Straw @6 t ha^{-1}] respectively and minimum results were found in T_1 [RDF] and they increased significantly. The soil texture is sandy loam, and soil colour in dry condition is light yellowish brown and in wet condition olive brown. The results indicates that soil porosity and water holding capacity was improved due to the addition of organic matter to soil which improve soil aggregation and this is why the bulk density and particle density decreased.

Effect on soil chemical properties

The result shows in Table 2 revels that chemical parameters significantly influenced by the application of inorganic fertilizers, organic manures, biochar and crop residues. Maximum soil pH 7.7 was recorded in T_1 [RDF] fallowed by T_2 [RDF + Boron @2 kg ha^{-1} + Zinc @7 kg ha^{-1}] respectively and minimum pH was recorded in T_7 [RDF + Poultry Manure @2 t ha^{-1} + Biochar @2.5 t ha^{-1}+ Vermicompost @2 t ha^{-1} + Neem Cake @500 kg ha^{-1}]. The maximum electrical conductivity 0.29 dS m^{-1}, soil organic carbon 0.59%, available nitrogen, phosphorous, potassium, Fe, Mn and Cu 325.39 kg ha^{-1}, 33.78 kg ha^{-1}, 208.68 kg ha^{-1}, 2.88 mg kg^{-1}, 2.66 mg kg^{-1} and 1.34 mg kg^{-1} respectively were recorded in T_7 [RDF + Poultry Manure @2 t ha^{-1} + Biochar @2.5 t ha^{-1} + Vermicompost @2 t ha^{-1} + Neem Cake @ 500 kg ha^{-1}] fallowed by T_4 [RDF + Vermicompost @2 t ha^{-1} + Rice Straw @6 t ha^{-1}] respectively and minimum results were recorded in T_1 [RDF]. The maximum available Zn 0.90 mg kg^{-1} and available B 1.60 mg kg^{-1} were recorded in T_2 [RDF +

Table 1. Effect of Integrated sources of nutrients on soil physical properties

Treatment	T_1	T_2	T_3	T_4	T_5	T_6	T_7	F-test	S.Em. (±)	C.D.
BD(Mg m^{-3})	1.31	1.30	1.22	1.17	1.19	1.25	1.15	S	0.01	0.05
PD(Mg m^{-3})	2.49	2.48	2.35	2.30	2.31	2.40	2.28	S	0.02	0.08
Porosity (%)	47.38	47.58	48.08	49.13	48.48	47.91	49.56	S	0.75	2.21
WHC(%)	44.34	44.52	45.27	46.09	46.81	45.12	47.55	S	0.57	1.69

BD- Bulk density, PD-Particle density and WHC- Waterholdingcapacity

Table 2. Effect of Integrated sources of nutrients on soil chemical properties

Treatment	pH (1:2.5)	ECd S m^{-1}	OC%	N kg ha^{-1}	P kg ha^{-1}	K kg ha^{-1}	B mg kg^{-1}	Zn mg kg^{-1}	Fe mg kg^{-1}	Mn mg kg^{-1}	Cu mg kg^{-1}
T_1	7.7	0.21	0.40	268.56	22.98	167.42	0.73	0.60	2.64	2.42	1.12
T_2	7.6	0.22	0.41	271.36	23.64	168.16	1.60	0.90	2.64	2.42	1.12
T_3	7.4	0.25	0.44	290.43	24.55	172.45	0.80	0.64	2.70	2.48	1.18
T_4	7.2	0.27	0.47	302.26	28.05	189.72	0.90	0.68	2.76	2.54	1.24
T_5	7.3	0.26	0.46	312.28	27.01	178.84	0.86	0.66	2.74	2.52	1.22
T_6	7.5	0.23	0.43	282.74	25.72	182.12	0.76	0.62	2.66	2.44	1.14
T_7	7.0	0.29	0.49	325.39	33.78	208.68	1.12	0.72	2.88	2.66	1.34
F-test	S	S	S	S	S	S	S	S	S	S	S
S.Em. (±)	0.12	0.004	0.008	4.15	0.30	2.28	0.008	0.01	0.03	0.02	0.01
C.D.	0.37	0.01	0.02	12.19	0.89	6.70	0.02	0.03	0.09	0.07	0.05

Boron @2 kg ha^{-1} + Zinc @7 kg ha^{-1}] fallowed by T_7 [RDF + Poultry Manure @2 t ha^{-1} + Biochar @2.5 t ha^{-1} + Vermicompost @2 t ha^{-1} + Neem Cake @500 kg ha^{-1}] followed by T_4 [RDF + Vermicompost @2 t ha^{-1} + Rice Straw @6 t ha^{-1}] respectively and minimum available zinc and boron were recorded in T_1 [RDF]. The results indicates that pH decreased because the addition of acidity in soil by organic manures and EC increased due to the addition of salt by organic manures and organic carbon increased due the use of organic fertilizers (Singh *et al.*, 2017). Micronutrients like Fe, Mn and Cu increased because of the composition of organic manures (Madhu *et al*., 2017) and on the other hand available Zn and B increased due to the composition of organic manures and addition of zinc sulphate and borax (Debnath *et al*., 2018).

Conclusion

Application of inorganic fertilizers, organic manures, biochar and crop residues gave best significant results of yield and soil health parameters such as pore space, water holding capacity, EC, organic carbon, available nitrogen, phosphorus, potassium, Fe, Mn and Cu in T_7- [RDF + Poultry Manure @2 t ha^{-1} + Biochar @2.5 t ha^{-1} + Vermicompost @2 t ha^{-1} + Neem Cake @500 kg ha^{-1}] and pH, bulk density and particle density in T_1- [RDF] and available Zn and B in T_2- [RDF + Boron @ 2 kg ha^{-1} + Zinc @ 7 kg ha^{-1}] and found at par than any other treatments. So, this is concluded that combination of inorganic, organic and carbon source improve soil properties as well as yield of cowpea.

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