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Effect of integrated nutrient management on soil properties, growth and yield of cowpea (*Vigna unguiculata* L.)

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Abstract
A field experiment conducted during summer seasons of 2021-22 at Agricultural Research Farm of Sam Higginbottom University of Agriculture Technology and Science Prayagraj, UP. Effect of integrated nutrient management on soil properties, growth and yield of cowpea (*Vigna unguiculata* L.) Keeping in this view experiment was conducted in Factorial RBD with three replications Treatments are T_1-control, T_2 @ 50% (NPK) + @ 50% FYM, T_3 @ 100% (NPK) + @ 50% FYM, T_4 @ 50% (NPK) + @ 100% FYM, T_5 @ 100% (NPK) + @ 100% FYM, T_6 @ 50% (NPK) + @ 50% PSB, T_7 @ 100% (NPK) + @ 50% PSB, T_8 @ 50% (NPK) + @ 100% PSB, T_9 @ 100% (NPK) + @ 100% PSB Results showed that T_5 is superior in bulk density, particle density, pore space and water holding capacity with 1.281 Mg m^{-3}, 2.445 Mg m^{-3}, 45.19% and 46.93%, respectively and T_5 is superior in soil pH, Electric Conductivity, Organic Carbon and available Nitrogen, Phosphorus and Potassium with 7.46, 0.46 dSm^{-1}, 0.36%, 289.46 kg h^{-1}, 15.23 kg h^{-1} and 175.29 kg h^{-1}, respectively. And T_1 is inferior in Bulk density, Particle density, Pore space and Water holding capacity with 1.201 Mg m^{-3}, 2.421 Mg m^{-3}, 42.08%, and 41.15%, respectively and T_1 is inferior in soil pH, Electric Conductivity, Organic Carbon and available Nitrogen, Phosphorus and Potassium with 6.89, 0.303 dS m^{-1}, 0.26, 263 kg h^{-1}, 10.12 kg h^{-1}, and 163.60 kg ha^{-1}, respectively.

Keywords: Soil physical properties and soil chemical properties, bulk density, particle density, pore space and water holding capacity

Introduction
With the growing population of the world in general and the developing countries in particular, demands are overwhelmed for enhanced food production. Various pulses play an important role to satisfy the growing human food demands and nutritional security. India is the largest producer of pulses, accounts for about 25 percent of the global share. Being an inseparable ingredient in the diet of the vast majority of vegetarian population and mainstay of sustainable crop production, pulses continue to be an important component of the rainfed agriculture, since time immemorial. Pulses are second most important group of crops after cereals. Among the pulse crops, cowpea is more cosmopolite and grown in most of the regions of India which showed very encouraging results and promises to have a far-reaching significant in achieving a breakthrough in the pulse production (Chandramohan and Chandragiri, 2007) [8].
It is grown for its long green pods as vegetables, seeds as pulses, and leaf and plant residues as green manure, as well as green fodder. The cultivars grown for their immature pods are variously known as 'Asparagus bean', 'Snake bean' and 'Yard long bean'. Cowpea seeds contain 54.5% carbohydrates, 24.1% protein and 0.1% fat. Moreover, it is a rich source of Phosphorus, calcium and iron. The protein in cowpea seed is rich in amino acids, *viz*, lycine and tryptophan as compared to cereal grains. However it is deficient in methionine and cysteine as compared to cereals (Maheshbabu *et al*, 2008) [29].

Material and Methods
This experiment was conducted during kharif season 2021 on crop research farm of the department of Soil Science and Agricultural Chemistry. The right bank of the river Yamuna and about 6 km away from Prayagraj station. It is positioned at 25.570 N Latitude and 81.50 E latitude and about 98 meter above sea level
The details of the materials used and technologies adopted during the courses for present investigations entitled "Effect of Integrated Nutrient Management on soil properties, growth

and yield of cowpea (*Vigna unguiculata* L.)" This chapter provides complete description of soil, planting materials used and climatic conditions prevalent in the locality during the experimental period.

The experiment is conducted in a randomized block design (RBD) with two levels of Inorganic fertilizers NPK (50, 100% dosage), PSB and FYM respectively, the treatments are replicated into three time dividing the experimental area into twenty seven plots.

Details of treatments

Details of layout

Season	:	*Kharif*
Crop name	:	Cowpea
Variety name	:	Gomati
Design of experiment	:	RBD
No. of treatments	:	9
No. of replications	:	3
Total no. of plots	:	27
Size of each plot	:	4m2 (2x2)
Width of main irrigation channel	:	1.0 m
Width of sub irrigation channel	:	0.5 m
Width of bunds	:	0.3 m
Planting distance	:	40 cm x 20 cm
Total length of experimental plot	:	22.3 m
Total Width of experimental plot	:	7 m
Gross cultivated area	:	156.1 m2
Net cultivated area	:	108 m2

Table 1: Treatment combination

	Treatment combination
T1	Control
T2	@ 50% (NPK) + @ 50% FYM
T3	@ 100% (NPK) + @ 50% FYM
T4	@ 50% (NPK) + @ 100% FYM
T5	@ 100% (NPK) + @ 100% FYM
T6	@ 50% (NPK) + @ 50% PSB
T7	@ 100% (NPK) + @ 50% PSB
T8	@ 50% (NPK) + @ 100% PSB
T9	@ 100% (NPK) + @ 100% PSB

1. Soil physical analysis

- Bulk density (Mg m^{-3})
- Particle density (Mg m^{-3})
- Pore space (%)
- Water holding capacity (%)

2. Soil chemical analysis

- Soil pH (1:2.5)
- EC (dS m^{-1})
- Organic Carbon (%)
- Available Nitrogen (kg ha^{-1})
- Available Phosphorus (kg ha^{-1})
- Available Potassium (kg ha^{-1})

Results and Discussion

Physical analysis

Bulk density (Mg m^{-3}): Data shows significant Effect of different treatment on Bulk density of soil. The maximum Bulk density of soil at depth 0-15 cm (1.281 Mg m^{-3}) and 15-30 cm (1.284 Mg m^{-3}) was recorded at T_5 @ 100% (NPK) + @ 100% FYM and minimum Bulk density of soil at depth 0-15 cm (1.201 Mg m^{-3}) and 15-30 cm (1.206 Mg m^{-3}) was found in T_1 (control). These results were in close conformity with the findings of Dekhane *et al.* (2011) [12], Das *et al.* (2013) [10], Singh *et al.* (2013) [33] and Nadeem *et al.* (2017) [34].

Particle density (Mg m^{-3}): Data shows significant Effect of different treatment on Particle density (Mg m^{-3}) of soil. The maximum Particle density of soil at depth 0-15 cm (2.456 Mg m^{-3}) and 15-30 cm (2.448 Mg m^{-3}) was recorded at T_5 @100% (NPK) + @100% FYM. Followed by T_9 @100% (NPK) + @100% PSB whereas the minimum

Particle density at depth 0-15 cm (2.421 Mg m^{-3}) and 15-30 cm (2.425 Mg m^{-3}) was found in T_1 control. These results were in close conformity with the findings of Dekhane *et al.* (2011) [12], Das *et al.* (2013) [10], Singh *et al.* (2013) [33] and Nadeem *et al.* (2017) [34].

Pore space (%): The data shows significant Effect of different treatment on pore space (%) of soil. The maximum pore space of soil at depth 0-15 cm (45.19%) and 15-30 cm (44.24%) was recorded at T_5 @ 100% (NPK) + @ 100% FYM. followed by T_3 @ 100% (NPK) + @ 50% FYM. Where as the minimum pore space at depth 0-15 cm (42.08%) and 15-30 cm (41.97%) was found in T_1 (control). These results were in close conformity with the findings of Dekhane *et al.* (2011) [12], Das *et al.* (2013) [10], Singh *et al.* (2013) [33] and Nadeem *et al.* (2017) [34].

Water holding capacity (%)

The data shows significant Effect of different treatment on water holding capacity of soil. The maximum water holding capacity of soil at depth 0-15 cm (46.93%) and 15-30 cm (45.03%) was recorded at T_5 @ 100% (NPK) + @100% FYM. followed by T_4 @ 50% (NPK) + @100% FYM. whereas the minimum water holding capacity at depth 0-15 cm (41.15%) and 15-30 cm (39.25%) was found in T_1 (control). These results were in close conformity with the findings of Dekhane *et al.* (2011) [12].

Chemical analysis

pH of soil: The data shows significant effect of different level of Integrated nutrient management (INM) on pH of soil. The maximum pH of soil at depth 0-15 cm (7.46) and 15-30 cm (7.53) was recorded at T_5 @100% (NPK) + @100% FYM. followed by T_3 @100% (NPK) + @50% FYM. Whereas the minimum pH at depth 0-15 cm (6.89) and 15-30 cm (6.96) was found in T_1 control. These results were in close conformity with the findings of Dekhane *et al.* (2011) [12], Das *et al.* (2013) [10], Singh *et al.* (2013) [33] and Nadeem *et al.* (2017) [34].

Electrical Conductivity (dS m^{-1})

The data shows significant Effect of different treatment on Electrical Conductivity of soil (dS m^{-1}) of soil. The maximum Electrical Conductivity (dS m^{-1}) of soil at depth 0-15 cm (0.464) and 1530 cm (0.403) was recorded at T_5 @100% (NPK) + @ 100% FYM. Followed by T_3 @100% (NPK) + @ 50% FYM. Whereas the minimum Electrical Conductivity of soil (dS m^{-1}) at depth 0-15 cm (0.303) and 15-30 cm (0.242) was found in T_1 control. These results were in close conformity with the findings of Dekhane *et al.* (2011) [12], Das *et al.* (2013) [10], Singh *et al.* (2013) [33] and Nadeem *et al.* (2017) [34].

Organic Carbon (%)

Data shows significant effect of different level of NPK, PSB and FYM on Organic Carbon of soil. The maximum Organic Carbon of soil at depth 0-15 cm (0.36) and 15-30 cm (0.32) was recorded at T_5 @100% (NPK) + @100% FYM. Followed by T3 @100% (NPK) + @50% FYM, where as the minimum Organic Carbon at depth 0-15 cm (0.23) and 15-30 cm (0.21) was found in T_1 control. These results were in close conformity with the findings of Dekhane *et al*. (2011) [12].

Available Nitrogen (kg ha^{-1})

The data shows significant effect of different level of NPK, PSB and FYM on Available Nitrogen of soil. The maximum Available Nitrogen of soil at depth 0-15 cm (289.46kg ha^{-1}) and 15-30 cm (299.33kg ha^{-1}) was recorded at T_5 @100% (NPK) + @100% FYM. followed by T_3 @100% (NPK) + @50% FYM, where as the minimum Available Nitrogen at depth 0-15 cm (263.02 kg ha^{-1}) and 1530 cm (272.89 kg ha^{-1}) was found in T_1 control. These results were in close conformity with the findings of Dekhane *et al*. (2011) [12]

Available Phosphorus (kg ha^{-1}): The data shows significant Effect of different treatment on Available Phosphorus of soil. The maximum Available Phosphorus of soil at depth 0-15 cm (19.89 kg ha^{-1}) and 15-30 cm (18.61 kg ha^{-1}) was recorded at T_9 @100% (NPK) + @100% PSB. followed by T_9 @100% (NPK) + @100% PSB, where as the minimum Available Phosphorus at depth 0-15 cm (10.12 kg ha^{-1}) and 15-30 cm (10.92 kg ha^{-1}) was found in T_1 control. These results were in close conformity with the findings of Dekhane *et al.* (2011) [12],

Available Potassium (kg ha^{-1})

The data shows significant Effect of different treatment on Available Potassium of soil. The maximum Available Potassium of soil at depth 0-15 cm (175.29 kg ha^{-1}) and 15-30 cm (172.10 kg ha^{-1}) was recorded at T_5 @100% (NPK) + @100% FYM. Followed by T_9 @100% (NPK) + @100% PSB, where as the minimum Available Potassium at depth 0-15 cm (163.60 kg ha^{-1}) and 15-30 cm (161.41 kg ha^{-1}) was found in T_1 control. These results were in close conformity with the findings of Dekhane *et al*. (2011) [12],

Table 2: Physical analysis of soil

Treatment	BD (Mg m^{-3})		PD (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	1.201	1.206	2.421	2.425	42.08	41.97	41.15	39.25
T_2	1.209	1.210	2.425	2.428	44.85	42.26	41.76	39.82
T_3	1.261	1.263	2.438	2.442	42.60	41.53	42.34	40.08
T_4	1.263	1.267	2.427	2.430	42.10	41.86	46.73	44.52
T_5	1.281	1.284	2.445	2.448	45.19	44.24	46.93	45.68
T_6	1.272	1.276	2.437	2.446	43.28	42.56	44.82	43.61
T_7	1.252	1.258	2.439	2.440	43.89	42.20	46.24	44.37
T_8	1.278	1.280	2.440	2.442	44.65	42.85	42.73	43.71
T_9	1.268	1.271	2.441	2.445	43.95	41.24	43.93	41.62
F- test	NS	NS	NS	NS	S	S	S	S
S.Em.(±)	-	-	-	-	13.329	14.187	0.116	0.132
C.D.	-	-	-	-	6.288	7.223	0.055	0.051

Table 3: Chemical analysis of soil

Treatment	pH		EC (dS m^{-1})		Organic Carbon (%)		Nitrogen (Kg ha^{-1})		Phosphorus (Kg ha^{-1})		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	0-15 cm	15-30 cm
T_1	6.89	6.96	0.303	0.242	0.26	0.24	263.02	272.89	10.12	10.92	163.60	161.41
T_2	7.43	7.51	0.392	0.334	0.25	0.22	283.36	293.23	13.84	12.14	164.34	162.15
T_3	7.45	7.52	0.451	0.395	0.28	0.25	287.13	297.54	15.52	16.82	165.02	163.83
T_4	7.43	7.52	0.402	0.342	0.31	0.28	286.92	296.79	14.83	15.93	167.02	166.83
T_5	7.46	7.53	0.464	0.403	0.36	0.32	289.46	299.33	15.23	15.61	175.29	172.10
T_6	6.91	6.98	0.325	0.261	0.23	0.21	265.84	275.71	15.85	12.98	169.63	167.44
T_7	7.34	7.41	0.384	0.325	0.24	0.20	278.05	287.92	16.09	15.89	165.38	163.19
T_8	6.98	7.05	0.342	0.284	0.29	0.27	273.52	283.39	18.38	16.88	165.04	162.85
T_9	7.43	7.47	0.391	0.331	0.30	0.27	279.78	289.65	19.89	18.61	169.02	167.83
F- test	NS	NS	NS	NS	S	S	S	S	S	S	S	S
S.Em. (±)	-	-	-	-	0.020	0.024	12.03	10.53	6.993	5.254	0.063	0.079
C.D.	-	-	-	-	0.009	0.007	5.67	4.13	3.299	2.154	0.030	0.037

Conclusion

It was concluded from the trial that in treatment combination T_5 @ 100% (NPK) + @ 100% FYM found to be appropriate for Maize (*Zea mays* L.) var. Gomtai on Prayagraj. It was also found significant for getting maximum growth, yield, CBR of the crop and Physico-chemical properties of soil. Therefore, here it's a need for further investigation to confirm the results at various locations in Prayagraj.

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