Effect of Integrated sources of nutrients on Growth, Yield and Economics of Cowpea (*Vigna unguculata* L.) *var* Ankur Gomati

ABSTRACT

A field experiment was conducted in randomized block design with 7 treatments and 3 replications to study the effect of fertilizers, organic manures, biochar and crop residues on growth. yield and economics of cowpea (*Vigna unguiculata* L.) in Inceptisols of Prayagraj, Uttar Pradesh, India in 2022. A research variety Ankur Gomati was taken for this research trial. Recommended doses of fertilizers (N, P_2O_5 and K_2O @ 25, 75 and 60 kg ha^{-1}) was applied with inorganic fertilizers (Zn and B), organic manures (FYM, vermicompost, neem cake and poultry manure), biochar and crop residues (rice straw and wheat straw). Growth parameters such as the maximum plant height 46.96 cm, 70.21 cm and 92.22 cm, maximum number of branch $plant^{-1}$ 5.82, 7.56 and 9.79, highest number of leaf $plant^{-1}$ 28.32, 30.56 and 35.22, highest length of leaf as 5.37, 7.31 and 9.18 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}]at 30 DAS, 55 DAS and 70 DAS respectively. And yield parameters such as high pod length as 21.72 and 20.01, highest number of pods $plant^{-1}$ 35.52 and 35.75, highest number of seed pod^{-1} 10.01 and 10.21 and highest test weight 27.12 and 26.23 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}]at 55 DAS and 70 DAS respectively. Highest yield 160.12 were obtained in treatment 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}]. Maximum gross return ₹ 2,72,204 was recorded in treatment 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}]. Maximum C:B ratio 1:4.31 was recorded in T_2 [RDF + Boron @2 kg ha^{-1} + Zinc @7 kg ha^{-1}]. But maximum net return ₹ 1,98,765.6 was recorded in treatment T_2 [RDF @100% + Boron @2 kg ha^{-1} + Zinc @7 kg ha^{-1}]. The yield and growth parameters also significantly increased with the application of the combination of organic and inorganic fertilizers.

Keywords: Fertilizes, organic manures, biochar, crop residues, micronutrients

INTRODUCTION

"Cowpea [*Vigna unguiculata* (L.) Walp] is one of the importantkharifpulsecropsgrownforvegetable,grain,forageandgreenmanuring belonging tofamilyLeguminaceae" (Ahmed *et al.,* 2012). "InIndiacowpeagrownstatesareUtter Pradesh,Punjab,Haryana,RajasthanandMadhya 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 contain24.8% 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).

"Cowpea is highly responsive to fertilizers.Thedoseoffertilizerdependsontheinitialsoilfertilitystatusandmoisture availability conditions. Although it gives good response to application of recommended dose of fertilizer" (Ahlawat and Shivakumar, 2005). "Nutrient management with recommended dose of NPK and micronutrients B and Zn can augment the economic yield of cowpea both in green pod and seed production" (Debnath *et al*., 2018)."Use of organic manure alone or in combination with chemical fertilizers, helps in improving physio-chemical properties of the soil, improves the efficient utilization of applied fertilizers resulted in higher seed yield and quality" (Salem, 2012). Organic manures viz., farm yard manure (FYM), vermicompost (VC), poultry manure (PM) and oilcakes help in the improvement of soil structure, aeration and water holding capacity of soil (Joshi *et al*., 2016). According to Behera *et al.*, (2007), it improves plant growth by improving the physical and chemical characteristics of the soil, i.e., cation

exchange capacity (CEC), bulk density, water holding capacity and permeability as well as biological properties, all contributing to an increased crop productivity. Crop residues are a potential source of organic matter in soils and Soil organic matter indirectly effects on the plant (Kumari *et al.,* 2019).

Previous researches on cowpea reveal growth and yield attributes enhancements through the use of inorganic nutrients sources (Debnath *et al*., 2018), organic nutrient sources (Joshi *et al.,* 2016; 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 the performance of cowpea. In this light, the present study aimed to evaluate the effect of integrated sources (inorganic and organic) of nutrients and carbon (biochar) on i) growth and yield, and ii) economics of cowpea crop grown in an Inceptisol of Indo-Gangetic plain.

METHOD AND MATERIALS

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– 48ºC and seldom falls as low as 4–5ºC. The average rainfall in this area is ~1100 mm most of which is received during July-September.

The 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 bulkdensity(Mgm^{-3}), particledensity(Mgm^{-3}), porespace percentage(%) and water holding capacity (%) all given by Muthuvel*etal.,*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 ($mg\ ha^{-1}$) given by Lindsay and Norvell, 1978 and available B ($mg\ ha^{-1}$) given by Berger and Truog, 1939. ThereadingsofZnweretaken in AtomicAbsorption 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 and zinc are 240.45 $kg\ ha^{-1}$, 20.21 $kg\ ha^{-1}$, 159.02 $kg\ ha^{-1}$, 0.73 $mg\ ha^{-1}$ and 0.60 $mg\ ha^{-1}$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 poultry manures were incorporated into soil before three weeks of sowing and other organic and 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 the method “Analysis of Variance (ANOVA) technique” as given by Fisher (1960). 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.

Growthparameters like plantheight(cm), numberofbranchesplant^{-1}, no of leaf plant^{-1},

leaflength(cm) and pod length taken at 30 DAS, 55 DAS and 70 DAS and yieldparameters like noofpodplant^{-1}, noofseedpod^{-1}, seed weight and podyield(kgha^{-1}) taken at 55 DAS and 70 DAS. Economics likenet profit, gross return, cost of cultivation and cost benefit ratio (C:B) / return per rupee invested also calculated.

RESULT AND DISCUSSIONS

Effect on growth parameters of Cowpea

The data presented in Table 1 shows that growth parameters significantly increased by using the combination of inorganic fertilizers, organic manures, biochar and crop residues. Maximum plant height 46.96 cm, 70.21 cm and 92.22 cm, maximum number of branch plant^{-1} 5.82, 7.56 and 9.79, highest number of leaf plant^{-1} 28.32, 30.56 and 35.22, highest length of leaf as 5.37, 7.31 and 9.18 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}]at 30 DAS, 55 DAS and 70 DAS respectively fallowed by T_4 [RDF + Vermicompost @ 2 t ha^{-1} + Rice Straw @ 6 t ha^{-1}] respectively and minimum result were found in T_1 [RDF]. Increase in plant height due to application of RDF combined with poultry manure, vermicompost, neem cake and biochar may be because of adequate supply of nutrients which helps in vigorous vegetative growth of plants and subsequently increase the plant height through cell elongation, cell division, photosynthesis and turbidity of plant cell. The increase in nodulation and nitrogen fixation leads to more plant height. Favorable soil physical environment stimulatedroot growth and thus increased the capacity of plants for efficient utilization of nutrients andwater resulted in better shoot growth andconsequently higher plant height. Similar findings were reported by Khandagle*etal.* (2019).RDF combined with poultry manure, vermicompost, neem cake and biochar increase number of branches may be due to adequate supply of macro and micronutrients which enhanced the vegetative growth of plant. Similar results were reported by Lateef *et al*.(2018).

Table 1.Effect of integrated sources of nutrients on growth parameters of Cowpea

Treatments	plant height (cm)			Noofbranchplant^{-1}			No of leaf plant^{-1}			Lengthofleaf(cm)		
	30 DAS	55 DAS	70 DAS	30 DAS	55 DAS	70 DAS	30 DAS	55 DAS	70 DAS	30 DAS	55 DAS	70 DAS
T_1	39.93	58.31	78.12	3.26	5.07	7.21	20.13	24.21	26.33	4.05	6.02	7.66
T_2	40.36	60.15	80.24	3.55	5.27	7.54	21.54	25.82	27.01	4.61	6.25	7.89
T_3	43.29	64.23	85.16	4.85	6.02	8.36	25.55	27.16	28.67	5.01	7.01	8.51
T_4	45.11	68.52	89.56	5.45	7.12	9.23	26.36	28.99	30.31	5.21	7.28	9.01
T_5	44.82	65.86	86.77	4.98	6.40	8.76	26.01	27.91	29.12	5.04	7.15	8.71
T_6	41.45	62.11	82.71	3.87	5.51	7.82	25.05	26.12	27.92	4.73	6.11	8.15
T_7	46.96	70.21	92.22	5.82	7.56	9.79	28.32	30.56	32.22	5.37	7.31	9.18
F-test	S	S	S	S	S	S	S	S	S	S	S	S
S.Em. (±)	0.72	1.18	1.32	0.04	0.01	0.11	0.31	0.31	0.38	0.07	0.08	0.13
C.D.	2.12	3.47	3.89	0.14	0.31	0.34	0.93	0.91	1.12	0.23	0.26	0.40

Effect on yield parameters of Cowpea

The data presented in Table 2 shows that yield parameters significantly increased by using the combination of inorganic fertilizers, organic manures, biochar and crop residues. Highest average pod yield 161.12 q ha^{-1} and yield parameters like high pod length 21.72 and 20.01, highest number of pods $plant^{-1}$ 35.52 and 35.75, highest number of seed pod^{-1} 10.01 and 10.21 and highest test weight 27.12 and 26.23 and 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}] at 55 DAS and 70 DASrespectively fallowed by T_4 [RDF + Vermicompost @ 2 t ha^{-1} + Rice Straw @ 6 t ha^{-1}] respectively and were found to be significant. Minimum yield parameters observed in T_1 [RDF]. Increased in yield parameters like Pod length (cm), No of pods $plant^{-1}$, No of seed pod^{-1}, Seed weight (g) and Pod Yield (qha^{-1})may be due to adequate availability of nutrients during reproductive stage of crop growth (El-Sharawy *et al.,* 2018).

Table 2.Effect of integrated sources of nutrients on yield parameters of Cowpea

Treatments	Pod length (cm)		No of pods $plant^{-1}$		No of seed pod^{-1}		Seed weight (g)		Pod Yield (qha^{-1})
	55 DAS	70 DAS	55 DAS	70 DAS	55 DAS	70 DAS	55 DAS	70 DAS	
T_1	14.12	15.01	19.21	20.12	6.99	7.45	20.55	19.79	19.79
T_2	15.63	14.92	21.98	22.11	7.45	8.14	21.21	20.13	20.13
T_3	17.16	15.55	25.24	26.01	8.21	8.95	23.85	23.21	23.21
T_4	19.36	19.12	28.74	28.89	9.74	9.86	26.01	25.13	25.13
T_5	17.75	16.21	26.07	26.52	8.82	9.05	24.31	23.43	23.43
T_6	16.55	15.16	23.54	23.03	8.12	8.56	22.45	21.54	21.54
T_7	21.72	20.01	35.52	35.75	10.01	10.21	27.12	26.23	26.23
F-test	S	S	S	S	S	S	S	S	S
S.Em. (±)	0.25	0.26	0.50	0.48	0.14	0.12	0.44	0.39	0.39
C.D.	0.75	0.77	1.47	1.43	0.42	0.35	1.29	1.16	1.16

Effect on economics

The data presented in Table 3 shows that maximum gross return (₹ 2,41,680) was recorded in treatment 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 gross return (₹ 1,51,020) recorded in treatment T_1[RDF]. Maximum B:C ratio (2.80) was recorded in T_4[RDF + Vermicompost @ 2 t ha^{-1} + Rice Straw @ 6 t ha^{-1}] treatment fallowed by T_3 [RDF + Farm Yard Manure @ 5 t ha-1] respectively and minimum B:C ratio (1.36) recorded in T_6 [RDF + Biochar @ 2.5 t ha^{-1}] treatment. But maximum net return (₹ 1,47,624.1) was recorded in treatment T_4 [RDF + Vermicompost @ 2 t ha^{-1} + Rice Straw @ 6 t ha^{-1}] fallowed by T_5 [RDF + Neem Cake @ 500 kg ha^{-1} + Wheat Straw @ 6 t ha^{-1}] respectively and the minimum net return (₹ 49,584.1) was recorded in T_6 [RDF + Biochar @ 2.5 t ha^{-1}].

Table 3. Economic of Cowpea of different treatment combination

Treatment	Yield(qha^{-1})	Yield(₹ha^{-1})	Grossreturn (₹ha^{-1})	Totalcostofcultivation (₹ha^{-1})	Netprofit (₹ha^{-1})	(C:B)
T1	100.68	1500	151020	56890.9	124129.1	1:2.65
T2	107.21	1500	160815	59991.4	100823.6	1:2.68
T3	128.51	1500	192765	69390.9	103874.1	1:2.77
T4	153.01	1500	229515	81890.9	147624.1	1:2.80
T5	141.56	1500	212340	78390.9	133949.1	1:2.70
T6	122.65	1500	183975	134390.9	49584.1	1:1.36
T7	161.12	1500	241680	175390.9	66289.1	1:1.37

CONCLUSION

Application of inorganic fertilizers, organic manures, biochar and crop residues gave the best economics like gross return, net return and cost benefit ratio (C:B) observed in T_4 [RDF + Vermicompost @ 2 t ha^{-1} + Rice Straw @ 6 t ha^{-1}] fallowed by T_3[RDF + Farm Yard Manure @ 5 t ha^{-1}] respectively and gave best significant results of growth and yield parameters 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 found at par than any other treatments.According to cost of cultivationbest three treatments are T_1[RDF @ 25:75:60 N:P:K] fallowed by T_2[RDF + B @ 2 kg ha^{-1} + Zn @ 7 kg ha^{-1}] and T_3[RDF + Farm Yard Manure @ 5 t ha^{-1}]. So, this is concluded that combination of inorganic, organic and carbon source increase growth and yield parameters of cowpea significantly.

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1.

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