Original Research Article

Response of Inorganic Fertilizers, Crop Residues, Organic Manure and Bio-fertilizer on Soil Health and Yield attributesof Cowpea (*Vigna unguiculata* L.)

Abstract

During Kharif season 2021-22 at the central research farm of the Department of Soil Science and Agricultural Chemistry in Naini Agriculture Institute research was carried out on response of cowpea by applying crop residues, organic manure, inorganic and Bio-fertilizers for effective crop growth. The experiment trial was conducted based on Randomize Block design with 9 treatments and 3 replications. The results revealed that the soil bulk density ranged from 1.15 to 1.45 Mg m^{-3}, particles density ranged from 2.04 to 2.44 Mg m^{-3}, and pore space ranged from 40.69% to 45.62%. The pH ranged from 6.63 to 7.27, E.C from 0.146 to 0.253 dS m^{-1}, Soil Organic carbon ranged from 0.344 to 0.627%, Available Nitrogen ranged from 142.38 to 248.39 kg ha^{-1}, Phosphorus ranged from 15.28 to 35.37 kg ha^{-1}, Potassium 179.63 to 240.67 kg ha^{-1} respectively. T_3 was shown the best yield compared to respective treatments which is 19.45 q ha^{-1}Thus, it indicates that the process of integrated nutrient management may be a better option for the physical and chemical condition of the soil to achieve better growth and yield attributes for Cowpea.

Keywords:*Cowpea, Crop residues,FYM, NPK, Rhizobium and SoilHealth*

Introduction:

In India consumption of pulses is highest in where majority of population is vegetarian. Pulses contain a high percentage of quality protein nearly three times as much as cereals **(Upadhyay *et al.*,2016).**The per capita availability of pulses in India is 45.5 g day^{-1} as against the minimum requirement of 70 g day $^{-1}$ as advocatedby Indian Council of Medical Research.Cowpea fixed atmospheric nitrogen resulting increase in soil fertility. Its quick growth and rapid ground cover checks soils erosion, and root decay in- situ produces nitrogen-rich residues that improve soil fertility and structure. It has the high vegetative growth and covers the ground surface resulting check the soil erosion in highly degradable areas.Cowpea leaves are known to be rich in proteins, vitamins such as provitamin A, folate, thiamine, riboflavin, and vitamin C, and minerals, such as calcium, phosphorus, and iron**(Xiong *et al.,* 2016).** Nitrogen is vitally important for plant nutrient. Nitrogen is essential constituent of protein and is present in many other compounds of great physiological importance in plant metabolism. Nitrogen is called a basic constituent of life**(Choudhary *et al.,* 2017).**Phosphorus is an essential constituent of majority of enzymes, which are of great importance in the transformation of energy, in carbohydrate metabolism, fat metabolism,in respiration, photosynthesis, energy storage, cell elongation and improves the quality of crops of plants.It enhances the activity of rhizobium and increased the formation of root nodules (**Sudharani *et al.,* 2020**)**.**Potassium also playsa vital role in carbon sequestration in soil. It helps in cell osmo-regulation, turgor maintenance and cell expansion.It imparts increased vigour and disease resistance to plant and function as an activator of numerous enzymes, regulates water conduction within the plant cell and water loss from the plant by maintaining the balance between anabolism,respiration and transpiration(**Salem *et al.*,2012**).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 physical properties of the soil through mineralization and gelation of soil particles.Crop straw can be incorporated into soil to provide readily available nutrients and to minimize the loss of crop straw(**Bhowate*et al.,* 2017**).FYM is important organic manures which supplies a suitable mineral balance and improve nutrient availability by enzymes.It is increasing cell permeability and hormonal growth and make availability of essential nutrients in available form to the plants through biological decomposition and improve physical-chemical properties of soil such as aggregation, aeration, permeability(**Singh *et al.*,2019**).The use of biofertilizers are more eco-friendly in nature. They can play a significant role in fixing atmospheric nitrogen;

biofertilizers enrich soil fertility and improves soil fertility of these biofertilizers. The seed of pulses is inoculated with Rhizobium with an objective of increasing their number in the rhizosphere, so that there is substantial increase in the microbiologically fixed nitrogen for the plant growth **(Meena *et al.*, 2016**).

Materials and Methods

A field experiment was conducted during *Kharif* in 2021-22. The trial was carried out in randomized block design with three levels of NPK, Rhizobium and FYM. The treatments were replicated three times and were allocated at random in each replication. The soil of experimental area falls in order of Inceptisol and in Experimental plot was alluvial soil. The soil samples were randomly collected from each plot in the experiment plot and analysed as standard method protocol given in Table.1. The treatment were fallowed during experiment trial T_1 [NPK @ 100% + Wheat straw @ 25% + FYM @ 25%], T_2[NPK @ 100% + Wheat straw @ 50% + FYM @ 50%], T_3 [NPK @ 100% + Wheat straw @ 100% + FYM @ 100%], T_4 [NPK @ 100% + Rice straw @ 25% + FYM @ 25%],T_5[NPK @ 100% + Rice straw @ 50% + FYM @ 50%],T_6 [NPK @ 100% + Rice straw @ 100% + FYM @ 100%],T_7 [NPK @ 100% + Mustard straw @ 25% + FYM @ 25%], T_8 [NPK @ 100% + Mustard straw @ 50% + FYM @ 50%] and T_9[NPK@ 100% + Mustard straw @ 100% + FYM @ 100%]. The seeds were inoculated with rhizobium @ 20 gm kg-1 seed at the time of sowing. The recommended dose of nitrogen (20 kg ha^{-1}) through urea, phosphorus (30 kg ha^{-1}) through DAP, potassium (10 kg ha^{-1}) through MOP and FYM through Cow dung were applied as basal as per treatments.Seed inoculated with Rhizobium at 10g kg^{-1}.

Results and Discussion

As found in respect to the response of inorganic fertilizer, crop residues, organic manure and bio-fertilizer on the physical properties of soil after harvesting of cowpea is given in table 2&3. The statistical data for bulk density is significant for Bulk density and Particle density of soil. The Physical properties observation of sample collected from 0-15cm and 15-30 cm shows Bulk density (Mg m^{-3}) and Particle density (Mg m^{-3}) increasing by soil depth whereas Percentage Pore space decreasing by soil depth, as 0-15 cm soil depth includes, Bulk density 1.23Mg m^{-3},Particle density 2.18 Mg m^{-3} and Pore space 45.62% whereas 15-30 cm soil depth includes Bulk density 1.45Mg m^{-3},Particle density 2.44 Mg m^{-3} and Pore space. Observation in respect to the Response of Inorganic fertilizer, Crop residues, Organic manure and Bio-fertilizer on the chemical properties of soil after harvesting of Cowpea is given in Table.2&3.The statistical data was significant for soil pH. The chemical properties observation of sample collected from 0-15 cm and 15-30cm shows pH and EC increasing by soil depth and Organic carbon, Available Nitrogen, Available Phosphorous, Available Potassium decreasing by soil depth as 0-15 cm soil depth includes pH 6.93,EC 0.173 dS m^{-1},Organic carbon 0.627%, Available Nitrogen,248.39 kg ha^{-1} Available Phosphorous35.37 kg ha^{-1}, Available Potassium 240.67 kg ha^{-1} whereas 15-30 cm soil depth includes pH 6.93, EC 0.173 dS m^{-1}, Organic carbon 0.627%, Available Nitrogen 199.15 kg ha^{-1} Available Phosphorous 30.73 kg ha^{-1}, Available Potassium 208.23 kg ha^{-1}.

Conclusion

Based on the result of research, it is conducted that the T_3 has shown the best result on effective of growth of plant and crop production which has applied 25 N Kg ha^{-1},50 P kg ha^{-1}, 50 K kg $ha^{-1}$with FYM 5t $ha^{-1}$and Wheat Straw 6t ha^{-1}which has shown highest yield @ 19.45 q ha^{-1} and using 100% FYM, Crop residue (wheat straw) which has shown shows pH and EC increasing by soil depth and Organic carbon, Available Nitrogen, Available Phosphorous, Available Potassium decreasing by soil depth as 0-15 cm soil depth includes pH Organic carbon 0.627%, Available Nitrogen,248.39 kg ha^{-1} Available Phosphorous35.37 kg ha^{-1}, Available Potassium 240.67 kg ha^{-1} whereas 15-30 cm soil depth includes pH 6.93, EC 0.173 dS m^{-1}, Organic carbon 0.627%, Available Nitrogen 199.15 kg ha^{-1} Available Phosphorous 30.73 kg ha^{-1}, Available Potassium 208.23 kg $ha^{-1}$and has shown significant treatment for crop growth.

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Table 1: Standard protocol followed to analysed the Physio-chemical parameters of soil

S.No.	**Particulars**	**Protocols**
1.	Bulk density (Mg m^{-3})	Muthuval *et al*.,1992
2.	Particles density (Mg m^{-3})	Muthuval *et al.*, 1992
3.	Texture (Sand, Silt Clay %)	Bouyoucous,1927
4.	Water holding capacity (%)	Muthuval *et al.*, 1992
5.	Soil pH (w/v)	Jackson,1958
6.	Electrical Conductivity (dS m^{-1})	Wilcox, 1950
7.	Organic Carbon (Kg ha^{-1})	Walkley and Black,1947
8.	Available Nitrogen (Kg ha^{-1})	Subbiah and Asija,1956
9.	Available Phosphorous (Kg ha^{-1})	Olsen *et al.*,1954
10.	Available Potassium (Kg ha^{-1})	Toth and Prince,1949

Table 2: Response of Inorganic fertilizer, Crop residues, Organic manure and Bio-fertilizer onBulk density, Particle density and Pore space.

Treatment	D_B (Mg m^{-3})		D_P (Mg m^{-3})		Pore space (%)	
	0-15 cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm
T_1 [RDF@100%+Wheat straw@25%+FYM@25%]	1.18	1.41	2.14	2.41	44.94	41.52
T_2**[**RDF@100%+Wheat straw@50%+FYM@50%]	1.16	1.40	2.09	2.39	44.23	41.52
T_3[RDF@100%+Wheat straw@100%+FYM@100%]	1.15	1.38	2.04	2.38	43.55	41.73
T_4 [RDF@100%+Rice straw@25%+FYM@25%]	1.18	1.42	2.17	2.43	45.62	41.62
T_5[RDF@100%+Rice straw@50%+FYM@50%]	1.17	1.40	2.10	2.40	44.22	41.374
T_6 [RDF@100%+Rice straw@100%+FYM@100%]	1.16	1.40	2.06	2.39	43.57	41.35
T_7[RDF@100%+Mustard straw@25%+FYM@25%]	1.23	1.45	2.18	2.44	43.78	40.69
T_8 [RDF@100%+Mustard straw@50%+FYM@50%]	1.18	1.41	2.12	2.43	44.40	41.95
T_9[RDF@100%+Mustard straw@100%+FYM@100%]	1.17	1.41	2.08	2.40	43.62	41.34

Table3: Response of Inorganic fertilizer,Crop residues,Organic manure and Bio-fertilizer of pH, EC, Organic carbon, Available N,P, and K

Treatment	**pH**		**EC (dS m^{-1})**		**OC(%)**		**N (kg ha^{-1})**		**P(kg ha^{-1})**		**K(kg ha^{-1})**	
	0-15	**15-30**	**0-15**	**15-30**	**0- 15**	**15-30**	**0-15**	**15-30**	**0-15**	**15-30**	**0-15**	**15-30**
T_1	6.87	7.17	0.153	0.232	0.565	0.395	198.58	149.13	27.01	22.93	230.9	197.74
T_2	6.71	7.05	0.159	0.239	0.617	0.466	244.58	197.74	34.82	30.73	239.67	206.62
T_3	6.63	6.82	0.173	0.253	0.627	0.476	248.39	199.15	35.37	30.52	240.67	208.23
T_4	6.93	7.24	0.146	0.225	0.51	0.361	193.25	151.29	23.4	18.92	216.5	180.68
T_5	6.83	7.14	0.153	0.232	0.585	0.415	204.92	154.95	28.52	24.74	231.62	198.24
T_6	6.76	7.02	0.159	0.239	0.613	0.463	241.19	196.37	33.72	29.02	238.12	204.88
T_7	7.03	7.27	0.146	0.225	0.493	0.344	177.46	142.38	20.16	15.28	210.69	180.38
T_8	6.92	7.21	0.149	0.229	0.514	0.364	193.92	151.63	23.48	21.34	214.53	179.63
T_9	6.84	7.15	0.156	0.236	0.575	0.405	202.25	151.54	28.6	24.51	229.77	195.84

OC = Organic carbon, N = Available Nitrogen, P = Available Phosphorous,K = Available Potassium