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Effect of Phosphorus and Organic Manures on Growth, Yield and Economics of Cowpea [*Vigna unguiculata* (L.)Walp.]

Nisha[1*], O. P. Sharma[1], Ajeet Singh Shekhawat[2], R. S. Sain[2], Devi Lal Dhaker[1], Raj Singh Choudhary[3]

[1]Department of Agronomy, School of Agriculture, Suresh Gyan Vihar University, Jaipur-302017 Rajasthan, India

[2]Department of Genetics and Plant Breeding, School of Agriculture, Suresh Gyan Vihar University, Jaipur-302017 Rajasthan, India

[3]Department of Soil Science, School of Agriculture, Suresh Gyan Vihar University, Jaipur-302017 Rajasthan, India

*Correspondence author: nisha210599@gmail.com

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Abstract: Cowpea [*Vigna unguiculata* (L.)Walp.]is more cosmopolite and grown in most of the regions of India which showed very encouraging results and promises to have a far-reaching significance in achieving a breakthrough in the pulse production. Phosphorusis an essential nutrient required for plant growth. It helps in root development, plant maturation, and seed development. Vermicompost contains biologically active substance such as plant growth regulators. Poultry manure contains all the essential nutrients required for crop production, and its value as an organic fertilizer and a source of plant nutrients has been recognized for centuries. Farm yard manure improves physical and chemical properties and health of soil such as aggregation, aeration, permeability, water holding capacity, slow release of nutrients, increase in cation exchange capacity, stimulation of soil flora and fauna *etc.*Keeping in view the importance of organic manures and phosphorus for cowpea, the present investigation was conducted.In the present work, experiment was laid out in factorial randomized block design *i.e.* with sixteen treatments combinations four levels of phosphorus (Control, 20, 40 and 60 kg P_2O_5 ha^{-1}) and four source of organic manure and their replications (Control, vermicompost @ 2 t ha^{-1}, poultry manure @ 3 t $ha^{-1}$and FYM @ 6 t ha^{-1}) on cowpea variety CPD-119 at Research farm of Suresh Gyan Vihar University, Jaipur.The independent application of 40 kg P_2O_5 ha^{-1} and vermicompost @ 2 t ha^{-1}produced significantly higher plant height and dry matter accumulation at 50 DAS and at harvest, number of total and effective nodules $plant^{-1}$ at 40 DAS, number of pods $plant^{-1}$, number of seeds pod^{-1}, seed yield, straw yield and biological yield, net return and B:C ratio as compared to rest of the treatments of phosphorus and organic manures.

Keywords: Cowpea, Phosphorus, Organic manures, Economic and Yield.

1. INTRODUCTION

Cowpea [*Vigna unguiculata* (L.) Walp.] is an important grain legume crop and belongs to family fabaceae. India is the largest producer of pulses and accounts for about 25 per cent of the global share. In India, pulse crops are grown over an area of 31 million ha with an annual production of 28 million tonnes and productivity of 892 kg ha^{-1}. (Anonymous, 2022-23) Pulse crops play an important role in Indian agriculture and India is the largest producer and consumer of pulses in the world. Pulses contain a high percentage of quality protein nearly three times as much as cereals (Upadhayay *et al*., 1999). The first pair of leaves is basic and opposite while the rest are arranged in an alternate pattern and are trifoliate. The leaves are usually dark green in colour. Among the pulse crops, cowpea is more cosmopolite and grown in most of the regions of India showed very encouraging results and promises to have a far-reaching significance in achieving a breakthrough in the pulse production. Cowpea is cultivated throughout India for its long green pods as vegetable, pulse, green manure, as well as green fodder. The mature cowpea seeds contain around 25% protein, 63.6% carbohydrates, 1.9% fat, 6.3% fibre, 0.00074% thiamine, 0.00042% riboflavin and 0.0028% niacin.

Phosphorusis an essential nutrient required for plant growth. It helps in root development, plant maturation, and seed development. Along with nitrogen and potassium, phosphorus is one of the most important elements for plant life. In terms of significance, phosphorus is most indispensable mineral nutrient for pulse crops as it helps in better root growth and development and thereby making them more efficient in biological nitrogen fixation. Phosphorus is an essential constituent of nucleic acids such as ribonucleic acid (RNA) and deoxyribonucleic acid (DNA), adenosine diphosphate (ADP) and adenosine tri-phosphate (ATP), nucleoproteins, amino acids, proteins, phosphatides, phytin, several co-enzymes viz., thiamine, pyrophosphate and pyridoxal phosphate.

Organic manures *viz*., FYM, vermicompost and poultry manure help in the improvement of soil structure, aeration and water holding capacity of soil. Farm yard manure supplies nitrogen, phosphorus, potassium and micronutrients like Fe, Mo and Zn *etc*.Farm yard manure is a bulky organic substance releases soil nutrients and increases the aeration. It supplies plant nutrients and enhances soil texture by binding the aggregate of the soil increasing the productivity of fertilizer usage and microbial soil population. It increases cation exchange ability, waterholding capacity, soil phosphate availability and reducing nitrogen loss due to slow discharge of nutrients.

Vermicompost is ecofriendly low cost and an effective way to recycle agricultural and kitchen waste. It is a recent innovation in composting technology. It is a mixture of earthworm's castings, organic materials, humus and other organisms. Use of vermicompost as an organic fertilizer and substitute for chemical fertilizer is advised by pioneers of organic farming. Earthworm processed organic waste, often referred to as vermicompost are finely divided peat like materials with high porosity, aeration, drain ability and water holding capacity.It is a good source of micronutrients besides N, P and K. It also increases the amount of organic carbon in the soil and aids in the gradual release of nutrients in addition to having a healthy proportion of exchangeable Ca, Mg, Na, *etc*. It enhances the soil's physical, chemical, and biological qualities. Additionally, it has a lot of growth hormones and vitamins and works well as a biocide against nematodes and illness. Castings from earthworms, humus, and other organic components are all mixed together.

Poultry manure contains all the essential nutrients required for crop production, and its value as an organic fertilizer and a source of plant nutrients has been recognized for centuries. It is cheap, readily available at all times, environmentally friendly, and also has a residual effect and ability to improve soil structure compared with chemical fertilizers.It contains N, Pand K and other important elements (Farhad*et al*., 2009).

2. MATERIALS AND METHODS

The experiment was conducted during *kharif* 2023 at Research Farm, School of Agriculture, Suresh Gyan Vihar University, Jaipur (Rajasthan). Geographically, this region falls under agro-climatic zone III A of Rajasthan (Semi-arid Eastern Plain Zone) and this area is located at 75° 51’44” E longitude and 26°48’35’’ N latitude and altitude of 432 m above mean sea level. The experiment was laid out in factorial randomized block design with three replications. The treatments consisting four levels of phosphorus (control, 20, 40 and 60 kg ha^{-1}) and four source of organic manures (control, vermicompost @ 2 t ha^{-1}, poultry manure @3 t $ha^{-1}$and FYM @ 6 t ha^{-1}). The seeds of cowpeavariety CPD – 119were sown on 24thJuly, 2023. The sowing was done at row spacing of 30 x 10cm using a seed rate of 20 kg ha^{-1} by “Kera” method with the help of *desi* plough. The seeds were dropped manually in furrow opened by plough at a depth of 20 cm. The soil samples were collected from 0-15 cm depth of soil profile with the help of screw auger before sowing. It was air dried in shade, grounded and analyzed for determination of physical and chemical properties of soil. Soils are loamy sand with 0.22% organic carbon, 136.74 kg ha^{-1} N, 20.09 kg ha^{-1} P_2O_5 and 237.34 kg ha^{-1} K_2O. The total rainfall received during the crop season was 449.5 mm. On the basis of gross plot size, the quantity of fertilizer required as per treatment was calculated and weighed for different plots. The recommended dose of N and P_2O_5 was applied in the form of DAP and urea to all plots as basal. Full dose of phosphorus and organic manures was applied at the time of sowing as per treatment. One hoeing and weeding was done manually at 30 DAS to facilitate aeration and removing the weeds. All the plant protection measures were adopted to take healthy crop at maturity stage, after leaving two rows on each side as well as 50 cm along the width of each side, a net plot area was harvested separately for recording the yield. Data on growth, yield and yield attributesand economics of cowpea were statistically analyzed as per guidelines of Panse and Sukhatme (1985).

3. RESULTS AND DISCUSSION

3.1 Effect of phosphorus

The application of phosphorus has a considerable impact on the growth parameters of cowpea, as demonstrated by clear data. The application of 40 kgP_2O_5 ha^{-1} significantly increased the plant height at 50 DAS and at harvest, and dry matter accumulation at 50 DAS and at harvest, number of total and effective nodules plant at 40 DASover control and 20 kgP_2O_5 ha^{-1}, and remained at par with 60 kg P_2O_5 ha^{-1}(Table 1).

It is probable to correlate the overall increase in crop growth caused by phosphorus application to improved root development and proliferation as well as higher nitrogenfixation in the soil, which raises the soil's nitrogen status. As the primary component of the co-enzymes ATP and ADP, it serves as the "energy currency" for plants.

The experimental data demonstrated that phosphorus levels had a substantial influence on cowpea production characteristics and yield when compared to the control. The treatment40 kg P_2O_5 ha^{-1}resulted in a considerably larger number of pods plant^{-1}, number of seeds pod^{-1}, seed yield, straw yield, and biological yield of cowpea (Table 2) over control and 20 kg P_2O_5 ha^{-1}, and remained at par with 60 kg P_2O_5 ha$^{-1.}$

The treatment of 40 kg P_2O_5 ha^{-1}resulted in a significant increase in seed,straw and biological yield as compared to lesser levels (Table 2). This could be attributed to the simultaneous rise in the quantity of pod plant^{-1} and seeds pod^{-1}under this treatment. This could be because surplus assimilates were retained in the leaves and then translocated into seeds during senescence, resulting in a larger seed production. This could be attributed to increased plant height, branches, and dry matter as a result of a more favorable nutritional environment in the rhizosphere and plant system. These findings support the conclusions of Choudhary et al. (2023).
The analysis of cowpea economic data (Table 3) revealed that the use of all phosphorus levels had a substantial impact. The application of 40 kg P_2O_5 ha^{-1}resulted in significantly greater net returns and a B:C ratio over control and 20 kg P_2O_5 ha^{-1}, and remained at par with 60 kg P_2O_5 ha^{-1}. This could be related to an increase in seed output that decreases when phosphorus levels rise. Jat *et al*. (2013) and Serawat*et al.* (2020) have also reported an increase in net returns and B:C ratios as a result of increased phosphorus treatment.

3.2 Effect of organic manures

The data revealed that growth parameters such as plant height, dry matter accumulation, number of branches, and total and effective nodules (Table 1) of cowpea enhanced significantly after applying organic manures. The application of vermicompost @ 2 t ha^{-1} produced significantly higher values of the aforesaid parameters than the control and FYM @ 6 t ha^{-1}, and remained at par with the application of poultry manure @ 3 t ha^{-1}.

Table 1. Effect of phosphorus and organic manures on growth attributes of cowpea.

Treatments	**Plant height (cm)**		**Dry matter accumulation per metre row length (g)**		**Total and effective nodules plant**	
	50 DAS	**At Harvest**	**50 DAS**	**At Harvest**	**Total**	**Effective**
Phosphorus (kg ha^{-1})						
0	30.4	51.0	76.56	99.50	33.85	29.34
20	34.3	56.9	83.81	116.70	38.37	33.96
40	38.0	60.8	89.51	129.28	42.25	38.02
60	39.8	61.9	90.96	132.07	43.53	39.40
SEm ±	0.8	2.0	1.97	3.68	1.06	1.04
CD (p=0.05)	2.2	5.7	5.70	10.61	3.07	3.02
Organic Manures						

Control	33.2	45.9	74.79	98.60	33.63	29.43
Vermicompost: 2 t ha^{-1}	38.1	65.7	91.43	134.27	43.43	38.56
Poultry Manure: 3 t ha^{-1}	36.9	64.2	90.78	129.42	42.60	38.18
Farm yard manure: 6 t ha^{-1}	34.3	54.7	83.84	115.24	38.36	34.56
SEm ±	0.8	2.0	1.97	3.68	1.06	1.04
CD (p=0.05)	2.2	5.7	5.70	10.61	3.07	3.02

The significant increase in seed yield with the addition of FYM, poultry manure, and vermicompost could be attributed to their positive influence on maintaining a balanced source-sink relationship, as demonstrated by significant increases in dry matter production and yield attributes such as number of pods plant^{-1} and seeds pod^{-1}, which ultimately resulted in increased seed yield. The increase in straw yield caused by the application of organic manures might be attributed in part to its direct influence on dry matter production in each vegetative portion, as well as indirectly to higher morphological growth parameters.

Table 2. Effect of phosphorus and organic manures on yield attributes and yield of cowpea.

Treatments	**Yield Attributes**			**Yield (kg ha^{-1})**			
	No. of pods plant^{-1}	**No. of Seeds pod^{-1}**	**Test weight (g)**	**Seed**	**Straw**	**Biological**	**Harvest Index %**
Phosphorus (kg ha^{-1})							
0	7.65	5.54	83.80	731	1313	2044	35.81
20	8.96	6.42	84.23	910	1655	2565	35.50
40	10.17	7.16	86.85	1080	1993	3073	35.10
60	10.52	7.34	86.91	1134	2088	3222	35.14
SEm ±	0.31	0.21	1.54	33	59	68	1.14
CD (p=0.05)	0.90	0.61	NS	94	171	196	NS
Organic Manures							
Control	7.76	5.22	83.61	679	1316	1995	34.34
Vermicompost: 2 t ha^{-1}	10.38	7.34	87.42	1129	2059	3188	35.51
Poultry Manure: 3 t ha^{-1}	9.99	7.21	86.03	1095	1984	3080	35.66
Farm yard manure: t ha^{-1}	9.17	6.69	84.71	950	1691	2641	36.04
SEm ±	0.31	0.21	1.54	33	59	68	1.14
CD (p=0.05)	0.90	0.61	NS	94	171	196	NS

Biological yield is the result of seed and straw yield, which indicate crop vegetative and reproductive growth. FYM, poultry manure, and vermicompost manuring had a significant

impact on both of these crop growth components, resulting in increased biological output. Meena *et al.* (2014).
The existence of a positive and significant association between yield qualities and yield lends credence to the preceding conclusions.
An evaluation of data associated with cowpea economics (Table 3) showed that application of vermicompost @ 2 t ha^{-1} given the significantly higher net returns and B: C ratio over control and farm yard manure @ 6 t ha^{-1}, whereas poultry manure @ 3 t ha^{-1} remained at par. This could be attributed to the higher seed and straw yields obtained through these treatments. Jat *et al.* (2012) and Verma *et al.* (2018) showed a similar increase in net returns and the B: C ratio.

Treatments	**Economics**	
	Net Return	B:C Ratio
Phosphorus (kg ha^{-1})		
0	14773	1.47
20	26212	1.80
40	37079	2.13
60	40375	2.23
SEm ±	1811	0.06
CD (p=0.05)	5231	0.16
Organic Manures		
Control	18620	1.73
Vermicompost: 2 t ha^{-1}	36074	1.99
Poultry Manure: 3 t ha^{-1}	34343	1.96
Farm yard manure: 6 t ha^{-1}	29403	1.94
SEm ±	1811	0.06
CD (p=0.05)	5231	0.16

Table 3. Effect of phosphorus and organic manures on economics of cowpea.

4. CONCLUSION

Based on results of one year experiment, it may be concluded that application of phosphorus @40 kg ha^{-1} produced significantly higher seed, straw and biological yield and net returns. Further, application of vermicompost @ 2 t ha^{-1} bought about significantly higher seed, straw and biological yield, of cowpea as compared to other treatments except poultry manure.Therefore, application of phosphorus @40 kg ha^{-1} and vermicompost @ 2 t ha^{-1} may be recommended for higher production and profitability of cowpea under semi- arid condition of Rajasthan.

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