Original Research Article

Influence of Phosphorus and Gibberelic acid on Growth and Yield of Cowpea (Vigna unguiculata L.)

ABSTRACT

A field experiment was conducted during *Kharif* season 2022 on Cowpea crop at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P). The experiment was laid out in Randomized Block Design with ten treatments each replicated thrice. Application of Phosphorus 60 kg/ha and Gibberelic acid 150 ppm (treatment 9) in cowpea recorded significantly highest plant height (82.77 cm), more number of nodules/plant (5.57 g), higher plant dry weight (24.90 g), maximum number of pods/plant (15.74), seeds/pod (13.98), highest test weight (20.93 g), higher seed yield (2.37 t/ha), higher stover yield (2.78 t/ha), higher harvest index (30.39%), maximum gross return (INR 63,000.00/ha), net return (INR 40,133.00/ha) and benefit cost ratio (1.76) was obtained in the same treatment 9.

Keywords: *Cowpea, Phosphorus, Gibberelic acid, Yield and Economic.*

1. INTRODUCTION

India has become self – sufficient with respect to the production of food grains but still lags behind in the production of pulses. Moreover, increasing population pressure and increasing degree of protein mal-nutrition aggravated the problem call for stepping up the pulses production. Pulses are the main source of Lysine, which is a rich quality protein, providing supplement to cereal-based diet.

Cowpea [Vigna unguiculata (L.)] belongs the family Leguminosae and commonly known as Lobia, Black Eye Pea, Southern Pea. Cowpea is a kharif pulse crop grown for vegetables, grain, forage and green manuring. This crop has drought hardy nature, its wide and droopy leaves keep soil and soil moisture conserved due to shading effect at favourable conditions. It also works as smother crop keeping weed infestation low.

In India, vegetable Cowpea is grown over an area of 23,012 ha with production of 1,33,58 of green pod and productivity of 5800 kg/ha. The leading states are UP, Bihar, Jharkhand, West Bengal, Odisha etc. Cowpea is called vegetable meat due to high amount of protein in grain with better biological value on dry weight basis. Beside its use as vegetable, pulse and fodder it can also be used as green manure, N fixer, cover crop , leafy vegetable. Apart from this, Cowpea forms excellent forage and it gives a heavy vegetative growth and covers the ground so well that it checks the soil erosion. As a leguminous crop, it fixes about 70-240 kg of Nitrogen per ha per year. In India, despite the fact that a large number of varieties/hybrids and agro-techniques have been developed, the productivity of cowpea has not still reached the desired level. Cowpea is the most versatile legume because of its drought resistance character, soil restoring properties and multi purpose use.

Phosphorus, is an important macronutrient, is among the most needed elements for crop production in most tropical soils. In plant tissues, it is present in much smaller amount than nitrogen and potassium although it is the key plant nutrient involved in energy transfer in the plant chemical reactions (Prasad, R 2007) [1] and in the biosynthesis of chlorophyll, where phosphorus as pyridoxol phosphate must be present for the biosynthesis of chlorophyll. Phosphorus helps in nodulation and other enzymatic activity and also act as yield limiting nutrient next to nitrogen. It has important role in photosynthesis, respiration and other physiological processes of plant. Phosphorus is known to promote the development of roots thereby flouring the nitrogen fixation in legumes. This increased amount of nitrogen fixed might be utilized by the host plant for its own growth (Rajasree and Pillai, 2001) [2]**.** Phosphorus plays key roles in many plant processes such as energy metabolism, nitrogen fixation, synthesis of nucleic acids and membranes, photosynthesis, respiration and enzyme regulation.

Phosphorus is essential nutrient to cowpea because of its multiple effect on plant nutrition. This nutrient makes the plant more tolerant to drought, cold, insect and disease and helps in hastening the crop maturity. Phosphorus is required in large quantities in young cells such as shoot and root tips where metabolism is high and cell division is rapid. It also aids in flower initiation, seed and fruit development (Ndakemi and Dakora, 2007) [3].

Plant growth regulators are known to regulate and modify various physiological processes within the plant. There by influence their effect on morphological characters and yield. The production and distribution of photosynthesis is related to various physiological and biological processes, which are influenced by the plant growth regulators. Growth regulators are effective in root initiation, flower setting, terminal flowering, pod settting and enhance rate of growth in plants which results in final productivity.

Soil application of plant growth regulators have the potential to influence crop growth and yield. Application of PGR's in the form of foliar spray at the flowering stage helps in improving physiological efficiency along with crop productivity. (Dashora and Jain 1994) [4]. The use of plant growth regulators activate growth along the longitudinal axis, increase number of leaves, leaf area which subsequently contributes towards higher plant production and productivity.

Gibberelic acid (GA3) is the most widely used plant growth regulator which increases stem elongation along with plant height, growth, dry matter accumulation as well as yield in various crops (Harrington et al, 1996, Akter et al, 2009) [5, 6].

Keeping in view of the importance of phosphorus and gibberelic acid in crop physiology, morphology and ultimately in the economics of cowpea, a field experiment entitled, " Influence of phosphorus and gibberelic acid on growth and yield of cowpea," was conducted at the Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P) during kharif season of 2022 with the following specific objectives.

2. MATERIALS AND METHODS

A field experiment was conducted during *Kharif* season 2022 on Cowpea crop at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in nature, nearly neutral in soil reaction (pH 7.3), low in organic carbon (0.48%), available nitrogen (230 kg/ha), available phosphorus (13.60 kg/ha) and available potassium (215.4 kg/ha). The treatments consisted of three levels soil application of Phosphorus (20, 40, 60) kg/ha and foliar application of Gibberelic acid (50, 100, 150) ppm along with control. The experiment was laid out in Randomized Block Design with ten treatments each replicated thrice and was laid out with different treatments allocated randomly in each replication. The treatment combinations are T_1- Phosphorus (20kg/ha) + GA_3 50ppm, T_2 - Phosphorus (20kg/ha) + GA_3 100ppm, T_3- Phosphorus (20kg/ha) + GA_3 150ppm, T_4- Phosphorus (40kg/ha) + GA_3 50ppm, T_5- Phosphorus (40 kg/ha) + GA_3 100ppm, T_6- Phosphorus (40 =kg/ha) + GA_3 150ppm, T_7- Phosphorus (60kg/ha) + GA_3 50ppm, T_8- Phosphorus (60kg/ha) + GA_3 100ppm, T_9- Phosphorus (60kg/ha) + GA_3 150ppm, T_{10}- Control N:P:K 25:50:25 kg/ha.

All agronomic practices are followed as per requirements during the crop period. During the course of the experiment, random sampling technique was adopted for recording the observations on various morphological characters of the plant. The parameters on which the observation were taken are divided into Pre – harvest observations (pertaining to growth attributes), Post – harvest observations (pertaining to yield attributes, quality parameter, soil parameter and economics) and was examined accordingly.

The observations were recorded for Plant height (cm), Plant dry weight (g), Crop growth rate (g/m2/day), Relative growth rate (g/g/day), Number of nodules, Number of pods/plant, Number of seeds/pod, Test weight (g), Seed yield (tonnes), Stover yield (tonnes), Harvest index (%). The collected data was subjected to statistical analysis of variance (ANOVA) as outlined by Gomez and Gomez [7]. Critical Difference (CD) values were calculated wherever the ‘F’ test was found significant at 5 per cent level.

3. RESULTS AND DISCUSSION

3.1 Growth attributes

Plant height : At 75 DAS, the data on plant height show significant difference among the treatments. Maximum plant height (82.77 cm) was recorded with treatment 60 kg P/ha + 150 ppm of GA3. Whereas, treatment with the application of 60 kg P/ha + 50 ppm GA3 (81.67 cm) was recorded to be statistically at par with treatment 60 kg P/ha + 150 ppm of GA3.
Similar findings was observed by Anil et al (2007) [8].

Akter et al (2007), Emongor 2007) [9,10] stated that Gibberelic acid is the most widely used plant growth regulator which increases stem elongation along with plant height, growth, dry matter accumulation as well as yield in various crops.

Plant dry weight : At 75 DAS, the data in the plant dry weight show there is significant difference among the treatments. The maximum plant dry weight (24.90 g) was recorded in 60 kg P/ha + 150 ppm GA3. Whereas, the treatment with the application of 60 kg P/ha + 100 ppm GA3 (23.55 g) was recorded to be statistically at par with 60 kg P/ha + 100 ppm GA3.

Similar findings was found in Bhilare and Patil (2002) [11].

3.2 Yield attributes

Number of pods / plant : The highest number of pods (15.74) was significantly recorded with the treatment of application 60 kg P/ha + 150 ppm GA3 and the treatment with the application of 40 kg P/ha + 150 ppm GA3 was found to be statistically at par with treatment 60 kg P/ha + 150 ppm GA3.

Similar observations were found by Gupta et al (2009) [12].

Number of seeds / pod : The maximum number of seeds (13.98) was significantly recorded with the treatment of application 60 kg P/ha + 150 ppm GA3. However, the treatments with the application of 40 kg P/ha + 150 ppm GA3 (12.34) and 60 kg P/ha + 100 ppm GA3 (12.91) were found to be statistically at par with treatment 60 kg P/ha + 150 ppm GA3.

Similar results were found by Ravindra Kumar Sharma et al. (2011) [13].

Test weight : The highest test weight (20.93 g) was significantly recorded in 60 kg P/ha + 150 ppm GA3. Whereas, the treatment with the application of 40 kg P/ha + 150 ppm GA3 (19.67 g) and 60 kg P/ha + 100 ppm P/ha (19.93 g) were found to be statistically at par with 60 kg P/ha + 150 ppm GA3.

Similar observations was found by Singh et al. (2011) [14].

Seed yield : The significantly higher seed yield (2.37 t/ha) was recorded with the application of 60 kg P/ha + 150 ppm GA3. Whereas, the tratments with the application of 40 kg P/ha + 100 ppm GA3 (1.92 t/ha), 40 kg P/ha + 150 ppm GA3 (2.13 t/ha), 60 kg P/ha + 100 ppm GA3 (2.10 t/ha) were found to be statistically at par with 60 kg P/ha + 150 ppm GA3.

Stover yield : The significantly higher stover yield (2.78 t/ha) was recoeded with the application of 40 kg P/ha + 150 ppm GA3. Whereas, the treatments with the application of 40 kg P/ha + 50 ppm GA3 (1.97 t/ha), 40 kg P/ha + 100 ppm GA3 (2.05 t/ha), 40 kg P/ha + 150 ppm GA3 (2.26 t/ha), 60 kg P/ha + 50 ppm GA3 (2.25 t/ha), 60 kg P/ha + 100 ppm GA3 (2.45 t/ha) were found to be statistically at par with 60 kg P/ha + 150 ppm GA3.

Harvest index : The significantly highest harvest index (30.39 %) was recorded with the application of 60 kg P/ha + 150 ppm GA3 whereas the lowest harvest index (22.55 %) was obtained in 20 kg P/ha + 50 ppm GA3.

Similar observations was found by Pamar et al (2007) and Ma et al (2001) [15,16].

3.3 Economics : The result on Table showed that maximum gross retuen (INR 63,000.00/ha), net return (INR 40,133.00/ha) and B:C ratio (1.76) was recorded in treatment 9 with the application of 60 kg Phosphorus and foliar application of 150 ppm Gibberelic acid.

Similar observations was found by Meena et al (2014) [17].

4. CONCLUSION

Based on the above results, it may be concluded that soil application of 60 kg/h of Phosphorus and foliar application of 150 ppm Gibberelic acid (treatment 9) gave the highest results in terms of growth and yield attributes. Maximum gross returns, net returns and benefit cost ratio were also observed in the same (treatment 9). These findings were based on one season. Therefore, further trials may be required for further confirmation.

REFERENCES

1. Prasad, R. Phosphorus management in the Rice – Wheat cropping system of Indo – Gangetic Plains. Better Crops India. 2007; 1(1) : 8 - 11.

2. Rajashree, G.; Pillai, G.R. Performance of fodder legumes under lime and phosphorus nutrition in summer rice fallows. Journal of Tropical Agriculture 2001; 39(1) : 67 - 70.

3. Dashora, L.D. and Jain, P.M. Effect of growth regulators and phosphorus levels on growth and yield of soybean. Madras Agri. Journal. 1994; 81: 235 – 237.

4. Ndakidemi, P.A. and Dakora, F.D. Yield Components of nodulated

Cowpea(Vigna unguiculata L.) and Maize (Zea mays.) plants grown with exogenous phosphorus in different cropping systems. Australian Journal of Experimental Agriculture, 47, 583 – 589.

5. Harrington, J.F., L. Rappaport and K.J. Hood. The influence of gibberellins on stem elongation and flowering on endive. Science. 1996; 125: 601 – 601.

6. Akter, A. Ali, E., Islam, M.M.Z., Karim, R. and Razzaque, A. H. M. Effect of GA3 on growth and yield of Mustard. Int. J. Sustain. Crop Prod. 2007; 2(2): 16 – 20.

7. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research. 2nd Edition, John Wiley and Sons, New York, 1984; 680p.

8. Anil Kumar, Reena, Brij Nanadan, Jai Kumar and Jamwal B. S. Effect of Phosphorus and seed rate on growth and productivity of large seede kabuli chickpea in sub - tropical kandi areas of Jammu and Kashmir. Journal of food legumes. 2008; 21 (4): 621 – 623.

9. Akter, A. Ali, E., Islam, M.M.Z., Karim, R. and Razzaque, A. H. M. Effect of GA3 on growth and yield of Mustard. Int. J. Sustain. Crop Prod. 2007; 2(2): 16 – 20.

10. Emongor , V. Gibberelic acid (GA3) influence on vegetative growth, nodulation and yield of Cowpea (Vigna unguiculata L. Walp. Journal of Agronomy, 2007; 6 (4).

11. Bhilare RiL, Patil V S. Response of forage cowpea varieties to phosphorus application. Forage Research. 2002; 28 (3):179-180.

12. Gupta, A., and Nagpur, P. Effect of bio fertilizers and phosphorus levels and yield attributes, yield and quality of urdbean (Vigna mungo L.). Indian Journal of agronomy. 2009; 51(2):142 – 144.

13. Ravindra Kumar Sharma. Effect of Phosphorus, Sulphur and Phosphate solubilizing bacteria on productivity and nutrient uptake of chickpea. Ann. Agri. Res. New series, 32 (3 & 4); 116 – 119.

14. Singh, A., Boule, A.L., Ahmed, H.G., Dikko, A.U., Aliyu, U., Sokoto, M.B.,Alhassan, J., Musa, M. and Haliru, B. Influence of Phosphorus on the performance of cowpea varieties in the Sudan Savanna of Nigeria. Agricultual Sciences. 2011; 2 : 313 – 317.

15. Pamar, P.P. and Thanki, J.D. Effect of iirigation, phosphorus and bio fertilizer on growth and yield of rabi green gram (Vigna radiata L.) under Gujarat condition. Crop Research Hisa.2007; 34 (1/3) : 100 – 102.

16. Ma , Q., Longnecker, N. and Atkins, C.,.Varying Phosphorus supplies and development, growth and seed yield in narrow leafed lupin. Plant and Soil. 2001; 239: 79 – 85.

17. Meena, L.R and Chand, R. Response of cowpea fodder to varying levels of Phosphorus and Nitrogen under rainfed conditions of Rajasthan,. The Indian Journal of Small Ruminants. 2014; 20: 121 – 123.

Table 1. Influence of phosphorus and gibberellic acid on growth parameters of cowpea.

	Treatment combinations	At 75 DAS	
		Plant height (cm)	Dry weight (g/plant)
1.	Phosphorus 20 kg/ha + Gibberelic acid 50ppm	63.57	18.57
2.	Phosphorus 20 kg/ha + Gibberelic acid 100ppm	70.18	19.73
3.	Phosphorus 20 kg/ha + Gibberelic acid 150ppm	71.25	20.00
4.	Phosphorus 40 kg/ha + Gibberelic acid 50ppm	72.54	20.70
5.	Phosphorus 40 kg/ha + Gibberelic acid 100ppm	73.22	22.73
6.	Phosphorus 40 kg/ha + Gibberelic acid 150ppm	74.43	21.47
7.	Phosphorus 60 kg/ha + Gibberelic acid 50ppm	81.76	21.67
8.	Phosphorus 60 kg/ha + Gibberelic acid 100ppm	77.29	23.55
9.	Phosphorus 60 kg/ha + Gibberelic acid 150ppm	82.77	24.90
10.	Control N:P:K 25 : 50 : 25 kg/ha	63.63	18.16
	F test	S	S
	SEm(±)	0.72	0.45
	CD (p = 0.05)	2.15	1.36

Table 2. Influence of phosphorus and gibberelic acid on pods/plant, seeds/pod and test weight

S. No.	Treatments	No. of pods/plant	Number of seeds/pod	Test weight (g)
1.	Phosphorus 20 kg/ha + Gibberelic acid 50 ppm	12.12	8.81	15.99
2.	Phosphorus 20 kg/ha + Gibberelic acid 100 ppm	12.63	9.12	16.48
3.	Phosphorus 20 kg/ha + Gibberelic acid 150 ppm	13.34	9.82	17.29
4.	Phosphorus 40 kg/ha + Gibberelic acid 50 ppm	13.69	9.89	17.84
5.	Phosphorus 40 kg/ha + Gibberelic acid 100 ppm	14.33	10.19	18.63
6.	Phosphorus 40 kg/ha + Gibberelic acid 150 ppm	15.22	12.34	19.67
7.	Phosphorus 60 kg/ha + Gibberelic acid 50 ppm	13.58	11.54	17.29
8.	Phosphorus 60 kg/ha + Gibberelic acid 100 ppm	14.45	12.91	19.93
9.	Phosphorus 60 kg/ha + Gibberelic acid 150 ppm	**15.74**	**13.98**	**20.93**
10.	Control : N : P : K = 25 : 50 : 25 (kg/ha)	11.32	8.30	15.77
	F test	S	S	S
	SEm(±)	0.35	0.39	0.44
	CD(p=0.05)	1.04	1.17	1.30

Table 3. Influence of phosphorus and gibberelic acid on seed yield, stover yield and harvest index

S. No.	Treatments	Seed yield (q/ha)	Stover yield (q/ha)	Harvest index (%)
1.	Phosphorus 20 kg/ha + Gibberelic acid 50 ppm	0.97	1.30	22.55
2.	Phosphorus 20 kg/ha + Gibberelic acid 100 ppm	1.20	1.42	23.78
3.	Phosphorus 20 kg/ha + Gibberelic acid 150 ppm	1.18	1.92	24.11
4.	Phosphorus 40 kg/ha + Gibberelic acid 50 ppm	1.10	1.97	28.42
5.	Phosphorus 40 kg/ha + Gibberelic acid 100 ppm	1.92	2.05	26.36
6.	Phosphorus 40 kg/ha + Gibberelic acid 150 ppm	2.13	2.26	27.35
7.	Phosphorus 60 kg/ha + Gibberelic acid 50 ppm	1.56	2.25	28.04
8.	Phosphorus 60 kg/ha + Gibberelic acid 100 ppm	2.10	2.45	28.55
9.	Phosphorus 60 kg/ha + Gibberelic acid 150 ppm	**2.37**	**2.78**	**30.39**
10.	Control : N : P : K = 25 : 50 : 25 (kg/ha)	0.89	1.23	25.07
	F test	S	S	S
	SEm(±)	0.21	0.28	0.29
	CD(p=0.05)	0.65	0.85	0.88

Table 4: Effect of phosphorus and gibberellic acid on economics of cowpea

S. No.	Treatments	Cost of cultivation (INR/ha)	Gross return (INRF/ha)	Net return (INR/ha)	B:C
1.	Phosphorus 20 kg/ha + Gibberelic acid 50 ppm	22585.00	51000.00	28415.00	1.26
2.	Phosphorus 20 kg/ha + Gibberelic acid 100 ppm	22636.00	53000.00	30364.00	1.34
3.	Phosphorus 20 kg/ha + Gibberelic acid 150 ppm	22687.00	57500.00	34813.00	1.53
4.	Phosphorus 40 kg/ha + Gibberelic acid 50 ppm	22675.00	54000.00	31325.00	1.38
5.	Phosphorus 40 kg/ha + Gibberelic acid 100 ppm	22726.00	56000.00	33274.00	1.46
6.	Phosphorus 40 kg/ha + Gibberelic acid 150 ppm	22777.00	58500.00	35723.00	1.57
7.	Phosphorus 60 kg/ha + Gibberelic acid 50 ppm	22765.00	55000.00	32235.00	1.42
8.	Phosphorus 60 kg/ha + Gibberelic acid 100 ppm	22816.00	61000.00	38184.00	1.67
9.	Phosphorus 60 kg/ha + Gibberelic acid 150 ppm	**22867.00**	**63000.00**	**40133.00**	**1.76**
10.	Control : N : P : K = 25 : 50 : 25 (kg/ha)	22432.00	46000.00	23568.00	1.05