Original Research Article

Response of Phosphorous and Gibberellic acid on growth and yield of Black gram(*Vigna mungo* L.)

Abstract:

A field experiment was conducted during Zaid (summer) season of 2023 to study the "Response of Phosphorous and Gibberellic acid on growth and yield of Black gram (*Vigna mungo* L.)" at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (Uttar Pradesh). The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), medium in organic carbon (0.53 %), low in available N (171.48 kg/ha), medium in available P (33.6 kg/ha) and high in available K (244.5 kg/ha). The experiment was laid out in Randomized Block Design with Ten treatments each replicated thrice based on one year of experimentation. The treatments consisted of 3 levels of Phosphorous [30 kg/ha, 40 kg/ha and 50 kg/ha] and three levels of Gibberellic acid [100 ppm, 125 ppm and 150 ppm] and Control (RDF) 20- 40- 20 kg NPK/ha are used. The results showed that application of Phosphorous at 50 kg/ha and Gibberellic acid at 150 ppm, recorded significant growth parameters viz., Plant height (35.84 cm), nodules per plant (25.57) Plant dry weight (10.41 g/plant), yield attributes like pods/plant (24.53), Seeds/pod (8.00), test weight (33.56 g), Seed yield (1441.23 kg/ha), stover yield (3191.10 kg/ha) and harvest index (31.10 %). Highest net economic returns (Rs.46,984.20 /ha) and benefit-cost ratio (1.50) were also recorded in the same treatment concludes that application of 50 kg/ha of phosphorous along with foliar spray of 150 ppm gibberellic acid at 15 and 30 DAS performed better and is economically profitable.

Keywords:*Black gram, Economics, Gibberellic acid, Phosphorous.*

Introduction:

Black gram (*Vigna mungo* L.), also known as urd bean or urad dal, is a crucial pulse crop in tropical and sub-tropical countries like India, Bangladesh, Pakistan, Burma, and Ceylon. It is the cheapest source of protein for the poor and is called poor men's meat(Main, 1976).It contains about 26 percent protein, which is almost three times that of cereals. India is the world's largest producer and consumer of black gram, producing about 28.4 lakh tonnes annually from 47.6 lakh hectares.The highest yield was recorded in Bihar (898 kg/ha), followed by Sikkim (895 kg/ha) and Jharkhand (890 kg/ha), while the lowest yield was recorded in Chattisgarh (309 kg/ha). India accounts for about 29% of India's total pulse acreage and 10.25% of total pulse production.The area under black gram in Uttar Pradesh was 385 thousand hectares with production 163 thousand tonnes and 423 Kg/ha of productivity(Directorate of Economics and Statistics 2022). In addition, being an important source of human food and animal feed, it plays an important role in sustaining soil fertility by improving soil physical properties and fixing atmospheric nitrogen. Being a drought resistant crop, it is suitable for dryland farming and predominantly used as an intercrop with other crops.

Phosphorus is crucial nutrient for pulse growth and metabolism, but is often a limiting nutrient in Indian soils. Deficiency in phosphorus affects seed yield in pulse crops. Out of 135 districts, 68 have low Phosphorous status, while 62 have medium phsophorous status. Applying Phosphorous to pulse crops is essential for increasing productivity in India. Phosphorous uptake of urdbean is around 10 kg. Applying Phosphorous based on soil test information can significantly increase pulse yield. Management, including timely sowing, optimal plant population maintenance, proper moisture, and effective pest and weed management, can further improve response to Phosphorous.Phosphorus is crucial for photosynthesis, sugar metabolism, energy storage, cell division, genetic information transfer, root growth, nodulation, and nitrogen fixation in plants. Due to its widespread deficiency in India's soils, phosphorous application is economically viable. Approximately 80% of soils require phosphorous application at recommended rates, and phosphorous fertilizers are essential to prevent P mining and sustain crop yield (Singh et al. 2016).A wide variation in available P among different soils types as well as with in a given soil type could be attributed to parent material organic matter content and management practices such as addition of containing fertilizers. Thus one can expect that application of phosphorous to pulse crops, must be one of the most important strategy to increase a productivity of pulses in India (Ganeshamurthy *et al*. 2003).

Gibberellic acid is an plant growth regulator which are essential hormones found in plants and fungi that regulate plant development by regulating physiological mechanisms (Mukhtar *et al*. 2006). GAs can stimulate stem and root elongation, leaf expansion, flowering, fruit senescence, seed germination, or dormancy. They induce transcription of genes involved in cell elongation and division during growth and stimulate the expression of hydrolytic enzymes involved in starch conversion to sugar. By controlling starch accumulation and use, GAs can influence overall plant growth. (Parmar *et al*. 2011) When commercially available, GAs have shown to increase plant productivity in various physiological activities, including vegetative growth, flowering, fruit set, ion transport, osmoregulation, leaf area expansion, and biomass productionby the foliar application (Manjari 2018).

Material and Methods:

The experiment conducted to know the **Response of Phosphorous and Gibberellic acid on the growth and yield of Black gram (*Vigna mungo* L.)** was carried out at Crop Research Farm of Sam Higginbottom University, Prayagraj, Uttar Pradesh in 2023. The experiment was laid out in an RBD (Randomized Block Design) consisting of Ten treatments including Control with 3 replications, with the treatment combinations (T_1) P at 30 kg/ha + GA3 at 100 ppm, (T_2) P at 30 kg/ha + GA3 at 125 ppm, (T_3) P at 30 kg/ha + GA3 at 150 ppm, (T_4) P at 40 kg/ha + GA3 at 100 ppm, (T_5) P at 40 kg/ha + GA3 at 125 ppm, (T_6) P at 40 kg/ha + GA3 at 150 ppm, (T_7) P at 50 kg/ha + GA3 at 100 ppm, (T_8) P at 50 kg/ha + GA3 at 125 ppm, (T_9) P at 50 kg/ha + GA3 at 150 ppm, (T_{10}) Control (RDF) 20-40-20 kg N:P:K/ha.Black gram seeds (Shekhar -2) were sown on 31-01-2023 with a spacing of 30 cm x 10 cm. Fertilizers were applied as band placement, for which 4-5 cm deep furrows were made along the seed rows with a hand hoe. The nutrient sources were urea, single super phosphate (SSP) and Murate of potash (MOP), applied as per the recommended dose of 20-40-20 kg N:P:K/ha. As per the treatment, varying levels of Phosphorous is taken in the form of SSP (Single Super Phosphate) and for the varying levels of Gibberellic acid (100 ppm, 125 ppm, 150 ppm.) 0.4 ml, 0.5 ml,0.6 ml of Gibberellic acid is dissolved in 4 litres of water respectively according to the treatments and it is foliar sprayed at 15 and 30 Days After Sowing.The crop was harvested on 18 June 2023. Plant growth parameters *viz.*, plant height (cm), dry weight (g) were measured at a regular interval from germination till harvest and yield metrics *viz.*, pods/plant, seeds/pod, test weight (g), seed yield (kg/ha), stover yield (kg/ha) and harvest index (%) were measured at harvest. The observed data was statistically analyzed using analysis of variance (ANOVA) as applicable to randomized block design (Gomez and Gomez, 1984).

Results and Discussion:

Growth parameter

The data of growth parameter are presented in Table 1. Significantly highest plant height (35.84 cm), number of nodules (30.33), dry weight (10.41 g/plant) were recorded with theapplication of Phosphorous at 50 kg/ha and Gibberellic acid at 150 ppm(T9), However plant height was found statistically at par in treatment 5 (34.28 cm) Phosphorous at 40 kg/ha

+Gibberellic acid at 125 ppm and treatment 8 (34.89cm) Phosphorous at 50 kg/ha + Gibberellic acid at 125 ppm with the highest. While number of nodules were found statistically at par with treatment 8 (29.77) Phosphorous at 50 kg/ha + Gibberellic acid at 125 ppm. Although, dry weight was found statistically at par with treatment 8 (10.14 g/plant) Phosphorous at 50 kg/ha + Gibberellic acid at 125 ppm with the highest. These results might be due to the influence of increasing levels of phosphorous, which helps in the new cell formation and root development, leading to availability of all nutrients. Not only that phosphorous, gibberellic acid also increases the plant height by cell division and stem elongation thereby promoted the vegetative growth. Similar findings were reported by Singh *et al.*(2016) and Khan *et al*. (2017). The significant number of root nodule was reported due to the effect of phosphorous by the better root development Masih *et al.* (2020) & Siddharth (2020). Higher plant dry weight was due to the cumulative effect of increase in plant height, number of nodules and other vegetative matter by the application of phosphorous and gibberellic acid these findings were found relevant to Masih *et al.* (2020) and Manjari *et al.* (2018).

Yield attributes

The data of yield attributes are presented in Table no 2.Significantly higher Number of Pods/plant (24.53),was recorded with the treatment 9 application of Phosphorous at 50 kg/ha + Gibberellic acid at 150 ppm which was found statistically at par with treatment 8 (23.73)Phosphorous at 50 kg/ha + Gibberellic acid at 125 ppm. Significantly higher Number of seeds/pods (8.07) was recorded with the treatment 9, the application of Phosphorous at 50 kg/ha + Gibberellic acid at 150 ppm, whereas the treatment 8 (7.73) Phosphorous at 50 kg/ha + Gibberellic acid at 125 ppm was found to be statistically at par with the treatment 9. Significantly higher test weight (33.56 g) was recorded with the treatment 9 the application of Phosphorous at 50 kg/ha + Gibberellic acid at 150 ppm and T7 Phosphorous at 50 kg/ha + Gibberellic acid at 100 ppm (32.56 g), and T8 Phosphorous at 50 kg/ha + Gibberellic acid at 125 (33.10 g) ppm which were found to be statistically at par with T9. With increased phosphorous levels resulted in higher number of branches having more number of pods, weight of thousand grains which has more due to maximization of photosynthesis, respiration, energy storage, transfer, cell division and cell elongation which came out in enhancement in seed production these findings were in line with those findings by Parashar *et al.* (2020) and Yadav (2017).

Seed yield

The data in Table no 2. Shows that significantly higher seed yield (1441.23 kg/ha) was recorded with the treatment of application of phosphorous at 50 kg/ha and gibberellic acid at 150 ppm (T9). However, the treatments T7- phosphorous at 50 kg/ha and gibberellic acid at 100 ppm (1374.10 kg/ha) and T8–phosphorous at 50 kg/ha and gibberelic acid at 125 ppm (1432.10 kg/ha) which were found to be statistically at par with the highest T_9.The seed yield of black gram crop was increased due to cumulative effect of yield attributing characters, enhance photosynthetic efficiency and improvement in the capacity of the reproductive sinks to utilize the incoming assimilates due to the foliar application of gibberellic acid (Manjari 2018).

Stover yield

The data presented in Table no. 2 shows thatsignificantly higher stover yield (3191.10 kg/ha) was recorded with the treatment 9application of phosphorous at 50 kg/ha and gibberellic acid at 150 ppm. However, the treatment T5 - phosphorous at 40 kg/ha and gibberellic acid at 125 ppm (3094.70 kg/ha), T6 – Phosphorous at 40 kg/ha and gibberellic acid at 150 ppm (3105.43 kg/ha), T7– phosphorous at 50 kg/ha and gibberellic acid at 100 ppm (3124.00 kg/ha), T8– phosphorous at 50 kg/ha and gibberellic acid at 125 ppm (3191.10 kg/ha) which were found to be statistically at par with the highest T9. The results might due to the increase in the vegetative matter of the plants which was influenced by the varying levels of phosphorous and foliar application of gibberellic acid by cell division, stem elongation, profuse flowering, more number of pods, etc.

Harvest Index

Significantly higher harvest index (31.10 %) was recorded with the treatment T9 – phosphorous at 50 kg/ha and gibberellic acid at 150 ppm. However, the treatment T4 phosphorous at 40 kg/ha and gibberellic acid at 100 ppm (29.95 %),Phosphorous 40 kg/ha + Gibberellic acid at 125 ppm (30.29), Phosphorous 40 kg/ha + Gibberellic acid at 150 ppm (30.38), Phosphorous 50 kg/ha + Gibberellic acid at 100 ppm (30.55), Phosphorous 50 kg/ha + Gibberellic acid at 125 ppm (31.05 %) which were found to be statistically at par with the highest T9.

Economics

The data on the economics of different treatments presented in Table 3. showed that the maximum gross return (₹ 78,443.70/ha), net return (₹ 46,984.20/ha) and benefit-cost ratio (1.50) was recorded with application of Phosphorus 50 kg/ha and Gibberellic acid at 150 ppmand the minimum gross return (₹ 58,834.40/ha) and net return (₹ 33,062.40/ha)and lowest benefit-cost ratio (1.28) were observed in the control. These results might be due to an increase in grain and stover yields in the same treatment as a result of enhanced availability of nutrients by the gibberellic acid and phosphorus Dawar *et al.* (2018), Jadhav *et al.* (2020)&Guggulla *et al.* (2022).

Conclusion:

From the field experiment it is concluded that T9, the application of Phosphorous at 50 kg/ha along withGibberellic acid at 150 ppm during 15 & 30 Days After Sowing performed better in obtaining higher growth, yield and economic returns of Black gram.

Table 1. Response of Phosphorus and Gibberellic acid on growth attributes of Black gram.

S. No.	Treatments	Plant height (cm)	Dry weight (g)	No of Nodules
		60 DAS	60 DAS	45 DAS
1	Phosphorus 30 kg/ha + Gibberellic acid 100 ppm	25.33	7.02	24.97
2	Phosphorus 30 kg/ha + Gibberellic acid 125 ppm	26.25	7.06	25.27
3	Phosphorus 30 kg/ha + Gibberellic acid 150ppm	27.31	7.56	25.87
4	Phosphorus 40 kg/ha + Gibberellic acid 100 ppm	28.09	8.14	26.60
5	Phosphorus 40 kg/ha + Gibberellic acid 125 ppm	34.28	8.84	26.73
6	Phosphorus 40 kg/ha + Gibberellic acid 150ppm	29.99	9.09	27.92
7	Phosphorus 50 kg/ha + Gibberellic acid 100 ppm	31.01	9.48	28.95
8	Phosphorus 50 kg/ha + Gibberellic acid 125 ppm	34.89	10.14	29.77
9	Phosphorus 50 kg/ha + Gibberellic acid 150ppm	35.84	10.41	30.33
10.	Control (20-40-20 kg NPK /ha)	24.44	6.46	23.87
SEm(±)		0.62	0.15	0.37
CD (P= 0.05)		1.85	0.44	1.09

Table 2. Response of Phosphorus and Gibberellic acid on yield attributes and yield of Black gram.

S. No.	Treatments	No. of Pods/plant	No. of Seeds/pod	Test weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)
1	Phosphorus 30 kg/ha + Gibberellic acid 100 ppm	17.60	6.00	29.09	1245.30	2995.20	29.38
2	Phosphorus 30 kg/ha + Gibberellic acid 125 ppm	18.87	6.13	29.37	1263.80	3013.67	28.66
3	Phosphorus 30 kg/ha + Gibberellic acid 150 ppm	19.20	6.33	31.09	1282.40	3032.30	29.38
4	Phosphorus 40 kg/ha + Gibberellic acid 100 ppm	19.53	6.67	31.25	1307.50	3057.40	29.95
5	Phosphorus 40 kg/ha + Gibberellic acid 125 ppm	19.20	7.00	31.33	1344.80	3094.70	30.29
6	Phosphorus 40 kg/ha + Gibberellic acid 150 ppm	21.53	7.00	31.76	1355.50	3105.43	30.38
7	Phosphorus 50 kg/ha +Gibberellic acid 100 ppm	21.87	7.13	32.56	1374.10	3124.00	30.55
8	Phosphorus 50 kg/ha + Gibberellic acid 125 ppm	23.73	7.73	33.10	1432.10	3182.00	31.05
9	Phosphorus 50 kg/ha + Gibberellic acid 150 ppm	24.53	8.07	33.56	1441.23	3191.10	31.10
10.	Control (20-40-20 kg NPK /ha)	15.20	5.93	28.82	1064.13	2813.97	27.45
SEm(±)		0.34	0.13	0.42	28.81	41.50	0.57
CD (P= 0.05)		1.00	0.39	1.25	85.60	123.29	1.69

Table 3. Effect of Phosphorus and Gibberellic acid on economics of Black gram.

S. No.	Treatments	Cost of cultivation (₹ /ha)	Gross returns (₹ /ha)	Net returns (₹ /ha)	Benefit-cost ratio (B:C)
1	Phosphorus 30 kg/ha + Gibberellic acid 100 ppm	29,584.50	68,255.40	38,670.90	1.30
2	Phosphorus 30 kg/ha + Gibberellic acid 125 ppm	29,584.50	69,217.34	39,632.80	1.34
3	Phosphorus 30 kg/ha + Gibberellic acid 150 ppm	29,584.50	70,184.60	40,600.10	1.37
4	Phosphorus 40 kg/ha + Gibberellic acid 100 ppm	30,522.00	71,489.80	40,967.80	1.34
5	Phosphorus 40 kg/ha + Gibberellic acid 125 ppm	30,522.00	73,429.40	42,907.40	1.40
6	Phosphorus 40 kg/ha + Gibberellic acid 150 ppm	30,522.00	73,985.80	43,463.80	1.42
7	Phosphorus 50 kg/ha + Gibberellic acid 100 ppm	31,459.50	74,953.00	43,493.50	1.38
8	Phosphorus 50 kg/ha + Gibberellic acid 125 ppm	31,459.50	77,969.00	46,509.50	1.47
9	Phosphorus 50 kg/ha + Gibberellic acid 150 ppm	31,459.50	78,443.70	46,984.20	1.50
10	Control (20-40-20 kg NPK /ha)	25,772.00	58,834.40	33,062.40	1.28

Note : Price of grain yield - ₹ 5000/q (MSP) and price of stover yield - ₹ 200/q

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