



# Response of Phosphorus and Gibberellic Acid on Growth and Yield of Black Gram (*Vigna mungo* L.)

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## Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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## ABSTRACT

A field experiment was conducted during the Zaid (summer) season of 2023 to study the "Response of Phosphorus 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 the application of Phosphorus 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), Plant dry weight (10.41 g/plant), yield attributes like pods/plant (24.53/plant),

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Seeds/pod (8.00/pod), test weight (33.56 g), Seed yield (1441.23 kg/ha), stover yield (3191.10 kg/ha) and harvest index (31.10%). The highest net economic returns (Rs.46,984.20 /ha) and benefit-cost ratio (1:1.5) 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 days after sowing performed better and is economically profitable.

**Keywords:** Black gram; economics; gibberellic acid; phosphorus.

## 1. INTRODUCTION

Black gram (*Vigna mungo* L.), also known as urad 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 [1]. It contains about 26 per cent 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 of 163 thousand tonnes and 423 Kg/ha of productivity [2]. 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 dry land farming and predominantly used as an intercrop with other crops.

Phosphorus is a 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 phosphorus status. Applying phosphorus to pulse crops is essential for increasing productivity in India. The phosphorus uptake of urd bean is around 10 kg. Applying Phosphorus 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 phosphorus. 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 phosphorus fertilizers are essential to prevent P mining and sustain crop yield [3]. A wide variation in available P among different soil types as well as within a given soil type could be attributed to parent material organic matter content and management practices such as the addition of containing fertilizers. Thus, one can expect that application of phosphorous to pulse crops, must be one of the most important strategies to increase a productivity of pulses in India [4].

Gibberellic acid is a plant growth regulator which are essential hormone found in plants and fungi that regulates plant development by regulating physiological mechanisms [5]. 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 [6] By controlling starch accumulation and use, GAs can influence overall plant growth. Parmar *et al.* [7] reported increased productivity when commercial, GAs have been used in various physiological activities, including vegetative growth, flowering, fruit set, ion transport, osmoregulation, leaf area expansion, and biomass production by the foliar application.

## 2. MATERIALS 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<sub>1</sub>) P at 30 kg/ha + GA3 at 100 ppm, (T<sub>2</sub>) P at 30 kg/ha + GA3 at 125 ppm, (T<sub>3</sub>)

P at 30 kg/ha + GA3 at 150 ppm, (T<sub>4</sub>) P at 40 kg/ha + GA3 at 100 ppm, (T<sub>5</sub>) P at 40 kg/ha + GA3 at 125 ppm, (T<sub>6</sub>) P at 40 kg/ha + GA3 at 150 ppm, (T<sub>7</sub>) P at 50 kg/ha + GA3 at 100 ppm, (T<sub>8</sub>) P at 50 kg/ha + GA3 at 125 ppm, (T<sub>9</sub>) P at 50 kg/ha + GA3 at 150 ppm, (T<sub>10</sub>) Control (Recommended Dose of Fertilizers) 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 18th June 2023. Plant growth parameters viz., plant height (cm), dry weight (g) was 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).

### 3. RESULTS AND DISCUSSION

#### 3.1 Growth Parameter

Plant height and dry weight was measured at 15,30,45 and 60 DAS, but maximum plant height and dry weight was recorded at 60 DAS Table 1. Significantly highest plant height (35.84 cm) and dry weight (10.41 g/plant) were recorded with the application of Phosphorous at 50 kg/ha and Gibberellic acid at 150 ppm (T<sub>9</sub>), 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.

Similarly nodules per plant was measured at 15,30,45 and 60 DAS but maximum number of nodules per plant was recorded at 45 DAS (30.33) application of Phosphorous at 50 kg/ha

and Gibberellic acid at 150 ppm (T<sub>9</sub>) while number of nodules were found statistically at par with treatment 8 (29.77/plant) 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 the availability of all nutrients. Not only that phosphorous, gibberellic acid also increases the plant height by cell division and stem elongation thereby promoting the vegetative growth. Similar findings were reported by Singh *et al.* [3] and Khan *et al.* [8]. The significant number of root nodules were reported due to the effect of phosphorous through root development [9,10]. The higher plant dry weight was due to the cumulative effect of increase in plant height, number of nodules and other vegetative matter as result of application of phosphorous and gibberellic acid as reported in previous findings [9,6].

#### 3.2 Yield Attributes

The data of yield attributes are presented in Table 2. Significantly higher Number of Pods/plant (24.53/plant), 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/plant) Phosphorous at 50 kg/ha + Gibberellic acid at 125 ppm. Significantly higher Number of seeds/pod (8.07/pod) 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/pod) 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 T<sub>7</sub> Phosphorous at 50 kg/ha + Gibberellic acid at 100 ppm (32.56 g), and T<sub>8</sub> Phosphorous at 50 kg/ha + Gibberellic acid at 125 (33.10 g) ppm which were found to be statistically at par with T<sub>9</sub>. 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, cell division and cell elongation which came out in enhancement in seed production these findings were in line with those findings in some researches [11,12].

### 3.3 Seed Yield

The data in Table 2. shows that significantly higher seed yield of (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 gibberellic acid at 125 ppm (1432.10 kg/ha) were found to be statistically at par with the highest T<sub>9</sub>. 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 [6].

**Table 1. Response of phosphorus and gibberellic acid on growth attributes of black gram**

S. No.	Treatments	Plant height	Dry weight	No of
		(cm)	(g)	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 150 ppm	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 150 ppm	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 150 ppm	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

### 3.4 Stover Yield

The data presented in Table 2 shows that significantly higher stover yield of (3191.10 kg/ha) was recorded with the treatment 9 which is application of phosphorous at 50 kg/ha and gibberellic acid at 150 ppm. Similarly, 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), as well as 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 be due to the increase in the vegetative matter of the plants which was influenced by varying levels of phosphorous and foliar application of gibberellic acid leading to enhancement of cell division, stem elongation, profuse flowering, a greater number of pods among other factors.

### 3.5 Harvest Index

Significantly higher harvest index (31.1%) was recorded with the treatment T9 –

phosphorous at 50 kg/ha and gibberellic acid at 150 ppm. Furthermore, 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.

### 3.6 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 (1:1.5) was recorded with application of Phosphorous 50 kg/ha and Gibberellic acid at 150 ppm and the minimum gross return (₹ 58,834.40/ha) and net return (₹33,062.40/ha) and lowest benefit-cost ratio (1:1.28) 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 [13,14,15].

#### 4. CONCLUSION

From the field experiment it is concluded that combination of phosphorous and gibberellic acid at varying concentration was successfully performed with T9 which involved the application of Phosphorous at 50 kg/ha along with Gibberellic acid at 150 ppm during 15 & 30 days after sowing performed appreciably in obtaining higher growth, yield and economic returns of Black gram.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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