Plant Archives Vol. 25, Supplement 2, 2025 pp.373-377 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-2.047

EFFECT OF PHOSPHORUS AND MICRONUTRIENTS ON GROWTH AND YIELD OF GREENGRAM (*VIGNA RADIATA* L.)

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(Date of Receiving : 06-03-2025; Date of Acceptance : 09-05-2025)

ABSTRACT

A field experiment was conducted on Greengram during *Zaid* season 2024 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Faculty of Agriculture, Sam Higginbottom University of Agriculture, Technology and Sciences. The experiment was laid out in a Randomized Block Design with 10 treatments and replicated thrice. The treatment consisted of 3 levels of Phosphorus (30, 40 and 50 kg/ha) and Micronutrients Zinc (0.05%), Boron (0.1%) and their combination *i.e.* Zinc + Boron (0.05% + 0.1%) along with recommended doses of Nitrogen, Phosphorus and Potassium (20:40:20 N:P:K kg/ha). The experimental field soil was sandy loam in texture, neutral in reaction (pH 7.2), available medium organic carbon (0.597%), low in available nitrogen (171.48 kg/ha), high in available phosphorus (37.8 kg/ha), medium in available potassium (247.1 kg/ha) and medium electrical conductivity (0.542 ds m^{-1}). The result showed that higher growth attributes *viz.* plant height (25.41 cm), number of branches/plant (4.67), number of nodules/plant (30.50) and dry weight/plant (39.00 g) were observed with application of Phosphorus (40kg/ha) along with a foliar spray of Zinc (0.05%) *i.e.* Treatment 4, and higher yield attributes *viz.* number of pods/plant (13.33), number of seeds/pod (7.93), seed yield (585.96kg/ha), were observed with application of Phosphorus (40kg/ha) along with a foliar spray of Zinc (0.05%) + Boron (0.1%) *i.e.* Treatment 6 whereas stover yield (1343.27 kg/ha) were observed with application of Phosphorus (50 kg/ha) along with a foliar spray of Zinc (0.05%) *i.e.* Treatment 7.The aforesaid treatment also recorded maximum gross return (58194.85 INR/ha), net return (36220.30 INR/ha) and B:C ratio (1.65) was observed with the application of Phosphorus (40 kg/ha) along with a foliar spray of Zinc (0.05%) + Boron (0.1%) *i.e.* Treatment 6. It is concluded that application of Phosphorus (40 kg/ha) along with a foliar spray of Zinc (0.05%) + Boron (0.1%) *i.e.* Treatment 6 recorded highest yield and economics in greengram crop.
Keywords: Economics, Growth, Micronutrients, Phosphorus, Yield.

Introduction

Greengram (*Vigna radiata* L.), also known as mung bean, is an important legume crop in India and part of the pulse family. It is mainly grown as a short-season crop between the *Zaid* and *Kharif* seasons. Green gram is one of the oldest and most commonly grown legumes in the country. It covers around 3.4 to 4 million hectares and produces about 3.15 million tonnes of pulses (Dhadge *et al.* 2024) Uttar Pradesh is a major contributor, with 0.97 million hectares and 0.83 million tonnes. After a past decline, India's daily pulse consumption increased to 56 grams per person in 2018. (Directorate of Economics and Statistics, 2023). Mungbean is highly regarded for its nutritional content, containing approximately 25% protein, which is almost three times greater than that of grains, making it a key food source for India's vegetarian population.

Phosphorus is a key nutrient that supports plant growth by improving root development and helping nitrogen-fixing bacteria work better (Singh *et al.* 2018). This results in stronger plants and greater yields. It also helps plants absorb more nutrients and water from deeper soil layers (Kanwar *et al.* 2013). Micronutrients are important for increasing the yield of pulse crops by helping plants grow well and fix nitrogen (Movalia *et al.* 2020). Zinc supports the creation of growth hormones and helps in plant reproduction (Masih *et al.* 2020). It also encourages root and shoot growth, leading to better seed production (Rengel, 2001). Boron is another key nutrient that helps build strong cell walls, supports seed development, and controls sugar transport and hormone activity (Krishna *et al.* 2022). Using foliar nutrition along with basal fertilizer can lower farming costs by reducing the amount of fertilizer needed and minimizing waste. Improving the yield and nutritional value of green gram by using the right balance of fertilizers, especially phosphorus and micronutrients, is important for boosting crop performance and supporting India's food security.

Materials and Methods

Experiment Site and Soil analysis

A field experiment was conducted at the Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, Uttar Pradesh during *Zaid* 2024. Located at 98 metres above mean sea level having 25°57'N latitude and 81°54'E longitude. About 5 km from Prayagraj city, this area is located on the Yamuna River's right bank by the Allahabad Rewa Road. The department supplied all the facilities needed for crop production. The experimental plot's soil was sandy loam in texture and had a nearly neutral pH of 7.2. The soil analysis showed organic carbon content (0.597%), available nitrogen (N) 171.48 kg/ha, available phosphorus (P) 37.8 kg/ha, available potassium (K) 247.1 kg/ha, and an electrical conductivity was 0.542 dS/m.

Treatment and Crop management

The experiment followed a Randomized Block Design (RBD) with three replications and included 10 different treatment combinations. These included three levels of phosphorus (30, 40, and 50 kg/ha) and micronutrients (Zinc 0.05%, Boron 0.1%, and their combination) applied at 15, 30, and 45 days after sowing (DAS). Recommended doses of nitrogen, phosphorus, and potassium (20:40:20 N:P:K kg/ha) were also applied. The size of each plot was (3m x 1.9m). Gap filling and thinning were performed to maintain proper plant spacing, while intercultural operations were carried out at 15 and 30 DAS to reduce weed competition.

Ten treatments were evaluated

T_1 (Phosphorus 30 kg/ha + Zinc 0.05%), T_2 (Phosphorus 30 kg/ha + Boron 0.1%), T_3 (Phosphorus 30 kg/ha + Zinc 0.05 + Boron 0.1%), T_4 (Phosphorus 40 kg/ha + Zinc 0.05%), T_5 (Phosphorus 40 kg/ha + Boron 0.1%), T_6 (Phosphorus 40 kg/ha + Zinc 0.05 + Boron 0.1%), T_7 (Phosphorus 50 kg/ha + Zinc 0.05%), T_8 (Phosphorus 50 kg/ha + Boron 0.1%), T_9 (Phosphorus 50 kg/ha + Zinc 0.05 + Boron 0.1%) and T_{10} (Control).

Details of the Variety Under Study

The Greengram (mungbean) variety Virat (IPM 205-7), developed by ICAR-IIPR, is a high-yielding, early-maturing crop with a duration of just 55–60 days. Known for its tolerance to Yellow Mosaic Virus (YMV) and its large, attractive, shiny green seeds, this variety can produce yields of up to 12–14 quintals per hectare. On 28th February 2024, seeds of Virat (IPM 205-7) were sown with a spacing of 25 cm between rows and 10 cm between plants.

Spraying and Fertilizer Application

The spraying of micronutrients like Zinc and Boron, individually and in combination, were sprayed at three key growth stages: 15 DAS (vegetative stage), 30 DAS (vegetative to reproductive transition stage), and 45 DAS (flowering and pod formation). Phosphorus was incorporated as a basal application prior to sowing to stimulate early root establishment and improve nutrient accessibility during the initial growth stages. The fertilizers were placed in 4–5 cm deep furrows at the time of sowing, facilitating efficient nutrient absorption and encouraging robust seedling development.

Data Collection and Statistical analysis

Plant growth attributes such as plant height (cm), dry weight (g/plant), number of branches/plants, and number of root nodules were assessed from 15 DAS to 60 DAS at 15-day intervals. At harvest, yield attributes like the number of pods/plants, number of seeds/pods, test weight (g), seed yield (kg/ha), stover yield (kg/ha), and harvest index (%) were recorded. All data were statistically analyzed using the analysis of variance (ANOVA) for the randomized block design, as outlined by Gomez and Gomez (1984). The F-value was computed at a 5% level of probability, and the critical difference was calculated for comparing treatment means.

Results and Discussion

Growth Attribute

The data on growth-attributing traits are summarized in Table 1. showed a steady increase in plant height, peaking at 60 DAS, while root nodule numbers peaked at 45 DAS before declining, likely due to senescence after flowering. This decline coincides with nutrient remobilization during the reproductive phase. The highest values for plant height (25.41 cm), nodules (30.50), branches (4.67), and dry weight (39.00 g) were recorded in Treatment 4, which involved phosphorus (40 kg/ha) along with foliar spray of zinc (0.05%). These values were statistically at par with other treatments. The positive response to phosphorus is attributed to improved availability of phosphate ions in the rhizosphere, enhancing nutrient uptake. Zinc contributed to better water and nutrient absorption and supported reproductive development, especially under zinc-deficient conditions, aligning with findings by Singh and Rathore (2004), Jat *et al.* (2013), and Doddamani *et al.* (2020).

Yield Attributes

The data on yield-attributing traits are summarized in Table 2. revealed that Treatment 6, which involved phosphorus (40 kg/ha) with foliar sprays of zinc (0.05%) and boron (0.1%), produced the highest number of pods per plant (13.33) and seeds per pod (7.93). However, Treatment 3 and Treatments 2, 4, 7, 8, 9 and 10 were statistically at par with it respectively. Test weight was highest (55.60 g) in Treatment 7, though not statistically significant. The combined application of phosphorus, zinc, and boron positively influenced yield parameters, likely due to enhanced root growth, energy transfer, and metabolic activity. These factors support efficient translocation of assimilates to developing pods. Similar findings were reported by Desai *et al.* (2001), Jat *et al.* (2013), and Hussain *et al.* (2022), indicating improved enzyme activity, nutrient uptake, and reproductive success with integrated nutrient management.

Seed Yield (kg/ha)

The data on grain yield is summarized in Table 2. showed that significantly highest grain yield (585.96 kg/ha) was recorded under Treatment 6, which involved phosphorus (40 kg/ha) with foliar sprays of zinc (0.05%) and boron (0.1%). However, yields from Treatments 1, 3, 4, 5, and 7 were statistically at par. The increased yield in Treatment 6 can be attributed to better phosphorus availability, enhancing nodulation and nitrogen fixation, which boosted photosynthesis and plant productivity. Zinc contributed by improving chlorophyll synthesis, enzyme activity, and flower retention, while boron enhanced pollen viability, pod setting, and carbohydrate translocation. These results align with findings from Rekha *et al.* (2018), Doddamani *et al.* (2020), and Krishna *et al.* (2022).

Stover Yield (kg/ha)

The data on stover yield is summarized in Table 2. showed significantly highest stover yield (1343.27 kg/ha) was recorded with Treatment 7, which involved phosphorus (50 kg/ha) along with foliar spray of zinc (0.05%). However, Treatments 1, 3, 4, 6, 9, and 10 were statistically at par with it. The increase in stover yield is attributed to greater plant height, improved branching, and higher dry matter accumulation, resulting from enhanced photosynthate production. Zinc further supported growth by boosting enzyme activity, nutrient uptake, and pollen viability. These observations align with findings by Bairwa *et al.* (2012), Kumawat *et al.* (2014), Sahu *et al.* (2021), and Hussain *et al.* (2022).

Harvest Index (%)

The data on harvest index is summarized in Table 2. showed that the highest harvest index (32.10 %) was recorded with Treatment 8, which involved Phosphorus (50 kg/ha) along with foliar spray of (Boron 0.1%) and statistically found to be non-significant.

Economics

The data on the economics of different treatments summarized in Table 2. showed that Treatment 6, involved phosphorus (40 kg/ha) along with foliar spray of zinc (0.05%) and boron (0.1%), resulted in the highest net return (Rs. 36,220.30/ha) and benefit-cost ratio (1.65). In contrast, the lowest net return (Rs. 24,048.38/ha) and B:C ratio (1.06) were recorded in Treatment 8. The higher profitability in Treatment 6 is attributed to increased grain and stover yields due to improved phosphorus availability, enhanced nodulation, and better photosynthesis. Zinc contributed by improving chlorophyll synthesis and flower retention, while boron enhanced reproductive success and carbohydrate translocation. These results align with those reported by Rekha *et al.* (2018), Doddamani *et al.* (2020), and Krishna *et al.* (2022)

Conclusion

Based on one year of experimentation, the combined application of Phosphorus (40 kg/ha) along with a foliar spray of Zinc (0.05%) and Boron (0.1%) as applied in Treatment 6 proved most effective in maximizing both yield and economic returns from greengram cultivation.

Acknowledgement

I would like to express my heartfelt gratitude to my esteemed advisor, whose unwavering guidance, expertise, and insightful feedback were invaluable throughout this experimental research study. Their mentorship provided me with the clarity and direction needed to navigate complex challenges. I also extend my sincere appreciation to the faculty members of the

Department of Agronomy, whose support and encouragement fostered an environment of growth and collaboration. Their collective knowledge and dedication to advancing agricultural research significantly enriched this study, and for that, I am deeply thankful.

Table 1. Effect of Phosphorus and Micronutrients on Growth attributes of Greengram.

Treatment Combinations	Plant height (cm)	Number of nodules/plant	Number of branches/plant	Dry weight (g)
	60 DAS	60 DAS	60 DAS	60 DAS
1. Phosphorus 30 kg/ha + Zinc 0.05%	23.41	27.67	4.47	34.54
2. Phosphorus 30 kg/ha + Boron 0.1%	23.69	30.00	4.27	37.67
3. Phosphorus 30 kg/ha + Zinc 0.05 + Boron 0.1%	23.84	27.67	4.27	36.33
4. Phosphorus 40 kg/ha + Zinc 0.05%	25.41	30.50	4.67	38.00
5. Phosphorus 40 kg/ha + Boron 0.1%	24.47	28.83	4.33	38.33
6. Phosphorus 40 kg/ha + Zinc 0.05 + Boron 0.1%	25.01	28.83	4.40	37.83
7. Phosphorus 50 kg/ha + Zinc 0.05%	25.41	28.33	4.47	35.17
8. Phosphorus 50 kg/ha + Boron 0.1%	23.89	27.50	4.47	35.00
9. Phosphorus 50 kg/ha + Zinc 0.05 + Boron 0.1%	24.69	29.17	4.33	35.17
10. N:P:K-20:40:20 kg/ha (Control)	24.64	29.67	4.53	39.00
SEm(±)	1.01	1.61	0.26	1.44
CD (p=0.05)	-	-	-	-

Table 2 : Effect of Phosphorus and Micronutrients on Yield and Economics of Greengram.

Treatment Combinations	No. of pods /plant	No. of seeds /pod	Test weight (g)	Seed yield kg/ha)	Stover yield (kg/ha)	Harvest index (%)	Net Return (INR/ha)	B:C ratio
1. Phosphorus 30 kg/ha + Zinc 0.05%	10.73	6.00	53.15	524.56	1145.61	31.21	30950.01	1.46
2. Phosphorus 30 kg/ha + Boron 0.1%	10.93	7.27	55.19	454.89	1050.29	30.72	24158.83	1.14
3. Phosphorus 30 kg/ha + Zinc 0.05 + Boron 0.1%	12.30	6.67	55.25	516.37	1227.49	29.05	30285.98	1.43
4. Phosphorus 40 kg/ha + Zinc 0.05%	11.47	7.20	53.43	568.42	1263.16	30.36	34601.77	1.58
5. Phosphorus 40 kg/ha + Boron 0.1%	11.33	5.60	52.58	554.39	1090.64	31.40	32942.03	1.50
6. Phosphorus 40 kg/ha + Zinc 0.05 + Boron 0.1%	13.33	7.93	52.07	585.96	1264.33	28.20	36220.30	1.65
7. Phosphorus 50 kg/ha + Zinc 0.05%	11.53	6.80	55.60	544.44	1343.27	28.98	31734.22	1.40
8. Phosphorus 50 kg/ha + Boron 0.1%	12.20	7.00	50.64	471.93	935.67	32.10	24048.38	1.06
9. Phosphorus 50 kg/ha + Zinc 0.05 + Boron 0.1%	11.80	6.80	55.04	488.59	1324.56	30.56	26340.62	1.16
10. N:P:K-20:40:20 kg/ha (Control)	10.53	7.13	53.10	477.19	1166.67	31.05	26720.65	1.28
SEm(±)	0.36	0.38	2.49	32.63	71.71	1.87	-	-
CD (p=0.05)	1.10	1.15	-	96.95	213.07	-	-	-

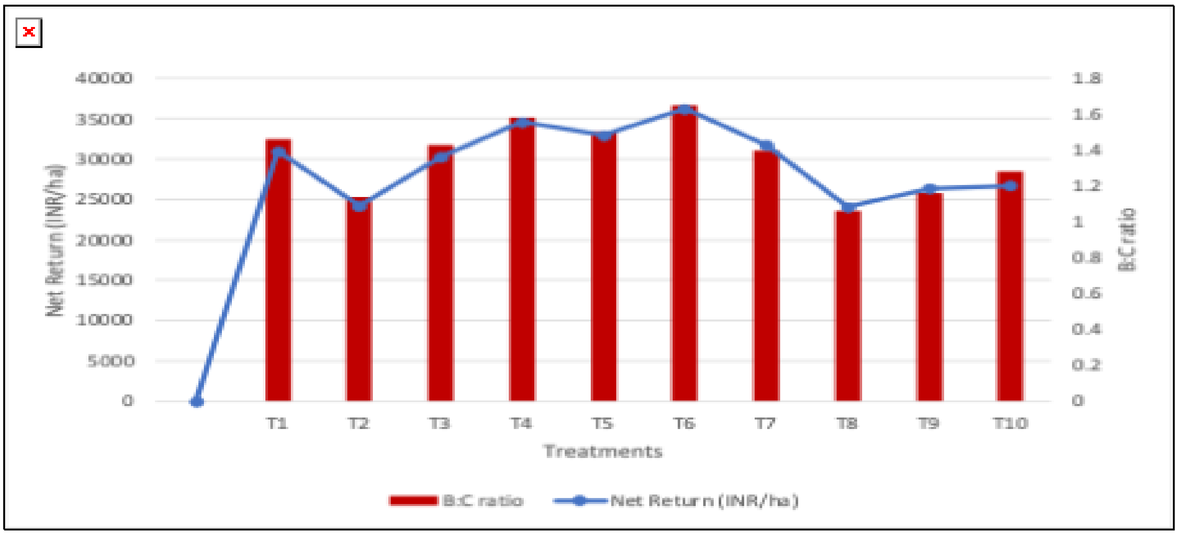

Fig. 1. Influence of phosphorus and micronutrient treatments on the economic returns of greengram (*Vigna radiata* L.) cultivation.

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