

Original Research Article

Effect of phosphorus and boron on growth, yield and economics of green gram

(Vigna radiata L.)

ABSTRACT

A field experiment was conducted during *Kharif*, 2022 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj (U.P) to determine the “Effect of Phosphorus and Boron on growth, yield and economics of summer green gram (*Vigna radiata L.*)”. The result showed that treatment 9 [Phosphorus (50kg/ha) + Boron (1.0kg/ha)] recorded significantly higher plant height (42.57 cm), higher number of branches/plant (6.73), higher number of nodules/plant (24.13), higher dry weight (16.88g). Significant and maximum number of pods/plant (32.47), maximum number of seed/pod (8.40), higher test weight (37.0 g), higher seed yield (12.43q/ha), higher stover yield (22.83 q/ha) and higher harvest index (35.28%) was recorded in treatment in treatment 9 [Phosphorus (50kg/ha) + Boron (1.0kg/ha)]. Maximum gross return (1,16,278 INR/ha), net return (82,434 INR/ha) and highest benefit cost ratio (2.43) was recorded in treatment 9 [phosphorus (50 kg/ha) + Boron (1.0kg/ha)] as compared to other treatments.

Keywords: Greengram, phosphorus, boron, growth, yield and economics.

Introduction:

Green gram is one of the important kharif pulse crops of India which can be grown as catch crop between rabi and kharif seasons. India is its primary origin and is mainly cultivated in East Asia, Southeast Asia and the Indian subcontinent. India is the largest pulses producer globally, accounting for 24% of the world total production. It is an important pulse crop having high nutritive value. It is also considered as a cheap source of protein and other minerals. Due to short duration nature, it is an excellent crop to fit in intercropping system with different major crops. It is an important conventional pulse crop of India. The calorific value of green gram is 334 calories per 100 g. it is known for high nutritional content crude protein 24.0%, fat 1.3%, carbohydrate 56.6%, minerals 3.5%, lysine 0.43%, methionine 0.10% and tryptophan 0.04%. The Indian Council of Medical Research (ICMR) has recommended a minimum consumption of 40 gram/day. Green gram popularly known as mungbean. It was extensively cultivated under varying agro-climatic conditions. India is the major producer of green gram in the world and grown in almost all the states. In India during 2020-21, green gram is grown in about 30.37 lakh/ ha with the total production of 2.64 million tonnes with a productivity of 888 kg/ha and contributing 10% to the total pulse production. Some of the states like Rajasthan (19.23 lakh/ ha), Karnataka (4.23 lakh/ ha), Maharashtra (4.03 lakh/ ha) Madhya Pradesh (2.10 lakh/ ha), Odisha (1.69 lakh/ ha), Telangana (0.73 lakh/ ha) and Uttar Pradesh (0.30 lakh/ ha) are the major producers of green gram in India (GOI, 2021).

Phosphorus is most critical nutrient in pulse crop. It stimulates the symbiotic nitrogen fixation of bacterial cell to root hair for nodulation. Indian soils are poor to medium in available phosphorus. Only about 30 % of the applied phosphorus is available for crops and remaining part converted into insoluble phosphorus. As the concentration of available Phosphorus in the soil solution is normally insufficient to support the plant growth, continual replacement of soluble Phosphorus from inorganic and organic sources is necessary to meet the Phosphorus requirements of crop. Phosphorus is added extra dose in recommended dose of phosphorus which increase nitrogen fixation and finally improve productivity of green gram. It plays an important role in virtually all main metabolic processes in plant including photosynthesis, energy transfer, signal transduction, macromolecular biosynthesis and respiration (Singh *et al.*, 2021).

Phosphorus is needed in large quantities during the early stages of cell division, the initial overall symptom is slow, weak, and stunted growth. Phosphorus is relatively mobile in

plants and can be transferred to sites of new growth, causing symptoms of dark to blue-green coloration to appear on older leaves of some plants. Under severe deficiency, purpling of leaves and stems may appear. Phosphorus deficiency cause delayed maturity and poor seed and fruit development which lead to yield reduction by limiting the plant growth (Choudhary *et al.*, 2017).

Boron is very important in plant metabolism through acting activity of certain enzyme, cell division, carbohydrate transport, and calcium and potassium uptake and protein synthesis, ultimately it may enhance in pod and seed formation. It is an essential micronutrient required for crop growth and yield due to its major role in formation and maintenance of cell wall and cell membrane integrity (Janaki *et al.*, 2017).

Micronutrients like boron is one of the mineral nutrients required for normal plant growth. The most important functions of boron in plants are thought to be its structural role in cell wall development, cell division, seed development and stimulation or inhibition of specific metabolic pathways for sugar transport and hormone development (Ahmed *et al.*, 2009). Boron deficiency causes decrease in pollen grain count, pollen germination etc. It also influences growth parameters and filling up of seeds. It is usually accepted that boron availability is decreased under dry soil conditions. Thus, boron deficiency is often associated with dry weather and low soil moisture conditions. This behaviour may related to restricted release of boron from organic complexes which ultimately impaired ability of plants to extract boron from soil due to lack of moisture in the rhizosphere. Even of boron levels in soil is high, then also low soil moisture impairs transport of boron to absorbing root surfaces (Praveena *et al.*, 2018). Keeping the above aspect in view, the present investigation entitled “Effect of phosphorus and boron application on growth, yield and economics of green gram (*Vigna radiata* L.)”.

MATERIALS AND METHODS:

The field experiment was conducted during *kharif* 2022 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj, and Uttar Pradesh. The soil of the experimental field was sandy loam in texture, nearly neutral in soil reaction (pH 8), low level organic carbon (0.62%), medium available N (225 Kg/ha), high in available P (38.2 kg/ha) and low available K (240.7 kg/ha). The treatment consists of 3 levels of Phosphorus

viz. Phosphorus (30 kg/ha), Phosphorus (40 kg/ha) and Phosphorus (50 kg/ha) with combination of different levels of Boron viz. B (0.6 kg/ha), B (0.8 kg/ha) and B (1.0 kg/ha). The experiment was laid out in RBD with 10 treatments each replicated thrice. The treatment combinations are T₁ Phosphorus (30 kg/ha) + Boron (0.6 kg/ha), T₂ Phosphorus (30 kg/ha) + Boron (0.8 kg/ha), T₃ Phosphorus (30 kg/ha) + Boron (1.0 kg/ha), T₄ Phosphorus (40 kg/ha) + Boron (0.6 kg/ha), T₅ Phosphorus (40 kg/ha) + Boron (0.8 kg/ha), T₆ Phosphorus (40 kg/ha) + Boron (1.0 kg/ha), T₇ Phosphorus (50 kg/ha) + Boron (0.6 kg/ha), T₈ Phosphorus (50 kg/ha) + Boron (0.8 kg/ha), T₉ Phosphorus (50 kg/ha) + Boron (1.0 kg/ha), T₁₀ (control) N:P:K 25:50:25 Kg/ha. Data recorded on different aspect of crop, viz., growth, yield attributes were subjected to statistically analysis by analysis of variance method (**Gomez and Gomez, 1976**).

RESULT AND DISSCUSSION:

Growth parameters

Plant height (cm)

The data (Table1) revealed that significant and higher plant height (42.57cm) was recorded in treatment 9 [Phosphorus(50kg/ha) +Boron(1.0kg/ha)]. However, treatment 8 [Phosphorus (50kg/ha) + Boron (0.8kg/ha)] and treatment 7 [Phosphorus (50kg/ha+ Boron(0.6kg/ha)] were found to be statistically at par with treatment 9 [Phosphorus (50kg/ha + Boron (1.0kg/ha)]. The significant and higher plant height was observed with the application of phosphorus(50kg/ha) might be due to the adequate availability of plant nutrient through appropriate nutrient supply and sunlight to each plant. An appropriate phosphorus supply indirectly helps in providing nitrogen supply and its availability helped the plants to attain more vigour in term of plant height (**khan et al.,2017**). Further, the application of boron (1kg/ha) encourage growth promoting hormones and protein synthesis means more chlorophyll content leading to higher photosynthesis. These results were in conformity with those of **Yadav et al. (2020)**.

Number of Branches/plants

The data (Table1) revealed that significant and maximum number of branches/plant (6.13) was recorded in treatment 9 [Phosphorus (50 kg/ha) + (Boron1.0kg/ha)]. However, the treatments 8 [Phosphorus (50 kg/ha) + Boron (0.8 kg/ha)], treatment 7 [Phosphorus (50 kg/ha) + (Boron 0.6 kg/ha)], treatment 6 [Phosphorus (40kg/ha+ Boron (1.0kg/ha)], treatment 5 [phosphorus (40kg/ha) + Boron (0.8 kg/ha)] were found to be statistically at

par with treatment 9 [Phosphorus (50 kg/ha) + (Boron (1.0kg/ha)]. The significant and maximum number of branches/plant was observed with the application of boron (1.0kg/ha) might be due to quick availability of boron to show crucial role in tissue differentiation, carbohydrate metabolism and necessary for sugar translocation in plant and development of new cell in meristematic tissue. Similar results were reported was by **Janaki et al. (2018)**.

Number of Nodules/plants

The data (Table 1) revealed that significant and higher number of nodules/plant (24.13) was recorded in treatment 9 [Phosphorus (50 kg/ha) + (Boron1.0kg/ha)] which was significantly superior over rest of the treatments. However, the treatments 8 [Phosphorus (50 kg/ha) + Boron (0.8 kg/ha)], treatment 7 [Phosphorus (50 kg/ha) +(Boron 0.6 kg/ha)], treatment 6 [Phosphorus (40kg/ha+ Boron (1.0kg/ha)] were found to be statistically at par with treatment 9 [Phosphorus (50 kg/ha) + (Boron (1.0kg/ha)]. The significant and higher number of nodule/plant was observed with the application of Phosphorus (50kg/ha) might be due to better proliferation of roots and increased nodulation due to higher phosphorus availability which leads to higher plant growth (**Patel et al., 2020**). Further, the application of boron (1kg/ha) promoted the nodule due to direct involvement of boron in nodulation, symbiotic nitrogen fixation and help in retaining cell wall and membrane integrity of nodules. These results were in conformity with those of **Sharmila et al. (2020)**.

Plant dry Weight (g/plant)

The result (Table 1) revealed that plant dry weight was recorded significantly higher (16.88g) in treatment 9 [Phosphorus (50kg/ha) +(Boron 1kg/ha)]. However, treatment 8[Phosphorus (50kg/ha) +(Boron 0.8kg/ha)], treatment 7 [Phosphorus (50kg/ha) + (Boron 0.6kg/ha)], treatment 6 [Phosphorus (40kg/ha) +(Boron 1kg/ha)], treatment 5 [Phosphorus(40kg/ha) +(Boron 0.8kg/ha)] was found statistically at par with treatment 9 [Phosphorus (50kg/ha) +(Boron 1kg/ha)]. Higher Plant dry weight (g) was significantly influenced by application of Phosphorus (50kg/ha), might be due to adequate supply and availability of Phosphorus increased dry weight of the plant and better photosynthetic activity due to greater exposure to light and increased the availability of nutrients to the plants which resulted in higher plant dry weight. Similar result was reported by **Swami et al. (2020)**.

Yield parameters:

Number of pods/plants

The data (Table 2) revealed that significant and higher number of pods/plant (32.47) was recorded in Treatment 9 [Phosphorus (50kg/ha) + (Boron 1kg/ha)] which was significantly superior over rest of the treatments. However, treatment 8 [Phosphorus (50kg/ha) + (Boron 0.8kg/ha)], treatment 7 [Phosphorus (50kg/ha) + (Boron 0.6kg/ha)] were statically at par with the treatment 9 [Phosphorus (50kg/ha) + (Boron 1kg/ha)]. significant and maximum number of pods/plant with the application of Phosphorus (50kg/ha) might be due to better photosynthetic activities with sufficient availability of light and supply of nutrients in balance quantity at growing stage. (**Khan et al., 2017**). Further, the increase in number of pods/plant with the application of Boron (1kg/ha) might be due to it plays an important role in tissue difference, carbohydrate metabolism and sugar translocation **Satya et al. (2020)**.

Number of Seeds/pods

The data (Table 2) revealed that significant and higher number of seeds/pod was recorded in Treatment 9 [Phosphorus (50kg/ha) + (Boron 1kg/ha)], which was significantly superior over rest of the treatment. However, treatment 8 [Phosphorus (50kg/ha) + (Boron 0.8 kg/ha)], treatment 7 [Phosphorus (50kg/ha) + (Boron 0.6 kg/ha)] was statically at par with the treatment 9 [Phosphorus (50kg/ha) + (Boron 1kg/ha)]. Significant and maximum number of seeds/pods with the application of Phosphorus (50kg/ha) might be due to the increase in vegetative development and reproductive attributes under proper availability of phosphorus and better physical condition of soil resulted higher number of seeds per pods. Similar result was reported by (**Mashi et al., 2020**). Further, the increase in seeds/pods with the application of Boron (1kg/ha) might be due to translocation of photosynthates, pollen viability, pollen tube growth. These results are in similar findings with those of **Ram et al. (2017)**.

Test weight (g)

The data (Table 2) recorded that highest test weight (37.70g) was observed in treatment 8 [Phosphorus 50kg/ha) + Boron (0.8kg/ha) and though there was no significant difference among other treatments.

Seed yield (q/ ha)

The data (Table 2) revealed that significant and higher seed yield (12.43 q/ha) was

observed in Treatment 9 [Phosphorus (50kg/ha) + (Boron 1.0kg/ha), which was significant superior over rest of the treatments. However, treatment 8 [Phosphorus (50kg/ha) + (Boron 0.8kg/ha)] were statistically at par with the treatment 9 [Phosphorus (50kg/ha) + (Boron 1kg/ha)]. The higher and significant seed yield obtained with application of Phosphorus (50 kg/ha) might be due to well-developed root system, greater translocation of photosynthates from source to sink (**Balai *et al.*, 2017**). Further, increase in seed yield with the application of Boron (1kg/ha) might be due to enhancement of cell wall, tissue difference, sugar transport, maintenance of conducting tissue with regulatory effect on another element and metabolism of nucleic acids, carbohydrate, auxins and phenols. Similar results were reported by **Praveena *et al.* (2018)**.

Stover yield (q/ ha)

The data (Table 2) revealed that significant and higher stover yield (22.83 q/ha) was observed in Treatment 9 [Phosphorus (50kg/ha) + (1.0 kg/ha)] which was significant superior over rest of treatments. However, treatment 8 [Phosphorus (50kg/ha) + (Boron 0.8 kg/ha)]. Were statistically at par with the treatment 9 [Phosphorus (50kg/ha) + (1.0 kg/ha)]. maximum stover yield was obtained with the application of phosphorus (50kg/ha) might be due to increase in photosynthetic activities of plant and root system enabled the plant to extract more water and nutrient from soil depth (**Rekha *et al.*, 2018**). Further, increased in Stover yield with the application of Boron (0.8 kg/ha) might be due to vegetative development create too many sites for photosynthetic, translocation. Similar result was reported by **Karthik *et al.* (2021)**.

Harvest index (%)

The data (Table 2) recorded that Highest harvest index (35.38%) was observed in treatment 9 [phosphorus 50kg/ha) + Boron (1kg/ha)] and though there was no significant difference among other treatments.

Economics:

The result showed (Table 3) that maximum gross return (1,16,278 INR/ha), net return (82,434 INR/ha) and Benefit cost ratio (2.43) was recorded in treatment 9 [Phosphorus (50kg/ha) + (Boron 1kg/ha) as compared to other treatments. Higher gross return, Net return and Benefit cost ratio was recorded with application of Phosphorus (50kh/ha) might be due to higher growth and yield attributes resulting in more seed and stover yield. These results are in conformity with those observed by **Singh *et al.* (2020)**.

CONCLUSION:

Based on the above findings It can be concluded that in greengram with the application of Phosphorus 50 kg/ha along with the application of Boron 1.0 kg/ha (Treatment 9) was observed highest seed yield and benefit cost ratio.

UNDER PEER REVIEW

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Table 1. effect of phosphorus and boron on growth parameter of green gram.

S. No.	Treatment combination	At 60 DAS			
		Plant height	No of branches/	No of nodules/	Plant dry weight
		(cm)	Plant	Plant	(g)
1.	Phosphorus 30 kg/ha + Boron 0.6 kg/ha	33.30	4.33	11.40	12.19
2.	Phosphorus 30 kg/ha + Boron 0.8 kg/ha	34.40	4.73	12.67	13.04
3.	Phosphorus 30 kg/ha + Boron 1.0 kg/ha	35.37	5.00	13.93	14.01
4.	Phosphorus 40 kg/ha + Boron 0.6 kg/ha	36.17	5.40	15.47	14.60
5.	Phosphorus 40 kg/ha + Boron 0.8 kg/ha	37.17	5.60	17.07	15.01
6.	Phosphorus 40 kg/ha + Boron 1.0 kg/ha	38.60	5.87	19.00	15.58
7.	Phosphorus 50 kg/ha + Boron 0.6 kg/ha	40.17	6.27	21.07	16.12
8.	Phosphorus 50 kg/ha + Boron 0.8 kg/ha	41.77	6.53	22.73	16.45
9.	Phosphorus 50 kg/ha + Boron 1.0 kg/ha	42.57	6.73	24.13	16.88
10	Control + RDF (NPK-25:50:25 kg/ha)	32.53	3.87	10.73	11.07
	F-test	S	S	S	S
	SEm (\pm)	1.42	0.52	0.87	0.86
	CD (p=0.05)	4.22	1.56	2.60	2.56

Table 2. Effect of phosphorus and boron on yield attribute and yield of green gram.

S. No.	Treatment combination	Yield attributes and yield					
		No. of pods/plant	No. of seeds/pod	Test weight (g)	Seed yield (q/ha)	Stover yield (q/ha)	Harvest index (%)
1.	Phosphorus 30 kg/ha + Boron 0.6 kg/ha	22.73	5.20	33.76	7.49	14.27	34.45
2.	Phosphorus 30 kg/ha + Boron 0.8 kg/ha	23.73	5.60	33.31	8.77	15.29	36.40
3.	Phosphorus 30 kg/ha + Boron 1.0 kg/ha	24.20	6.00	33.95	8.72	16.56	34.52
4.	Phosphorus 40 kg/ha + Boron 0.6 kg/ha	25.00	6.20	34.75	9.83	18.13	35.15
5.	Phosphorus 40 kg/ha + Boron 0.8 kg/ha	26.93	6.60	34.61	10.54	19.34	35.29
6.	Phosphorus 40 kg/ha + Boron 1.0 kg/ha	27.93	7.00	36.03	10.90	20.27	34.97
7.	Phosphorus 50 kg/ha + Boron 0.6 kg/ha	29.27	7.60	36.11	11.34	20.84	35.23
8.	Phosphorus 50 kg/ha + Boron 0.8 kg/ha	30.80	7.80	37.70	11.83	22.03	34.95
9.	Phosphorus 50 kg/ha + Boron 1.0 kg/ha	32.47	8.40	37.00	12.43	22.83	35.38
10.	Control + RDF (NPK-25:50:25 kg/ha)	21.60	4.60	33.01	6.51	13.58	32.64
	F-test	S	S	NS	S	S	NS
	SEm (\pm)	1.16	0.37	1.01	0.19	0.58	1.09
	CD (p=0.05)	3.45	1.11	-	0.58	1.74	-

Table 3. Effect of phosphorus and boron on economics of greengram.

S. No.	Treatment combination	Economics			
		Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C ratio
1.	Phosphorus 30 kg/ha + Boron 0.6 kg/ha	31794	70839	39045	1.22
2.	Phosphorus 30 kg/ha + Boron 0.8 kg/ha	32194	80817	48623	1.51
3.	Phosphorus 30 kg/ha + Boron 1.0 kg/ha	32594	82392	49798	1.52
4.	Phosphorus 40 kg/ha + Boron 0.6 kg/ha	32419	92073	59654	1.84
5.	Phosphorus 40 kg/ha + Boron 0.8 kg/ha	32819	98547	65755	2.00
6.	Phosphorus 40 kg/ha + Boron 1.0 kg/ha	33219	102354	68026	2.04
7.	Phosphorus 50 kg/ha + Boron 0.6 kg/ha	33044	106104	73060	2.21
8.	Phosphorus 50 kg/ha + Boron 0.8 kg/ha	33444	111123	77679	2.32
9.	Phosphorus 50 kg/ha + Boron 1.0 kg/ha	33844	116278	82434	2.43
10.	Control (NPK-25:50:25 kg/ha)	28719	63336	34617	1.20