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Effect of phosphorus and zinc on growth and yield of black gram (*Vigna mungo* L.)

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Abstract

A field experiment was conducted during *Kharif* season of 2025 at Crop Research Farm Department of Agronomy. The treatments consisted of 2 levels of phosphorus (20,40kg P/ha) and Zinc (10, 15,20 and 0.5% at 15 DAS and 30DAS) along with recommended doses of nitrogen and potash and a control (20-40-20 kg N-P-K/ha). The experiment was laid out in a Randomized Block Design with 9 treatments and replication thrice. Application of Phosphorus 40kg/ha + zinc 20kg/ha recorded in (treatment 7) higher Plant height (60.66), Number of nodules per plant (40.93), pods/plant (22.03), higher seed yield (1683 kg/ha), was recorded.

Higher gross returns (Rs. 1,65,346.36 kg/ha), net return (Rs.1,18,006.36 kg/ha) and benefit cost ratio (2.49) was recorded in the same treatment.

Keywords: Phosphorus, zinc, blackgram, growth, yield, economics

Introduction

Black gram (*Vigna mungo*) has significant effects on agriculture, soil health, and human nutrition. As a leguminous crop, it plays an important role in improving soil fertility by fixing atmospheric nitrogen through symbiotic association with *Rhizobium* bacteria, thereby enriching the soil and reducing the dependence on chemical fertilizers.

Its cultivation enhances soil structure and organic matter content, which benefits subsequent crops in rotation. Black gram is also valued nutritionally, as its seeds are rich in protein, carbohydrates, and essential minerals, making it an important component of a balanced diet, especially in vegetarian populations. Additionally, the crop supports sustainable agriculture due to its low water requirement, short growth duration, and adaptability to various Agro-climatic conditions, contributing to food security and environmental sustainability.

Black gram, being a pulse crop requires high amount of phosphorus (P). The adequate supply of phosphorus to legume is more important than that of nitrogen because it has beneficial effect on nodulation and nitrogen fixation, root development, growth and yield (Kumar, 2008) ^[12].

The most deficient micronutrient in Indian soils is zinc, in fact, zinc is regarded as the third most important limiting nutrient in crop production after nitrogen and phosphorus (Takkar and Randhawa, 1980) ^[39]. Zinc is involved in the channelization of photosynthesis during reproductive stage by way of its involvement in electron transfer (Baker *et al.*, 1982) ^[1].

Among the interactions involving macro and micro-nutrients the interaction between phosphorus and zinc is of greatest potential significance. This interaction is often antagonistic especially when soil is deficient in both the nutrients and only one of them is applied through fertilizers.

Phosphorus is second most critical plant nutrient, but for pulses, it assumes primary importance, owing to its important role in root proliferation and thereby atmospheric nitrogen fixation. The yield and nutritional quality of pulses is greatly influenced by application of phosphorus. It plays a key role in various physiological processes like root growth and dry matter production, nodulation and nitrogen fixation and in metabolic activities especially in protein synthesis. It also helps in establishing seedling quickly and hastens maturity as well as improves the quality of crop produce. (J M Kokani *et al.* 2014) ^[8].

Materials and Methods

This experiment was carried out during kharif 2025 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, UP, which is located at 25.28°N latitude, 81.54°E longitude and 98 m altitude above the mean sea level. This area situated on the right side of the river Yamuna by the side of Prayagraj Rewa Road about 5 km away from Prayagraj, city. The climate of this region is typically sub-tropical and semi-arid with monsoon commencing by the third week of June and with drawing by end of September. The temperature reached up to 48°C and in winter it goes down to as low as 2-3°C. During the summer hot scorching winds known as “Loo” and frost during winter months are common features. Experimental mechanical analysis of the soil was sand 59.50 (%), silt 24.10 (%), clay 16.40 (%) and textural class silt loam, while chemical analysis of soil was available nitrogen (242 kg/ha), available phosphorus (24.50 kg/ha), available potassium (95.00 kg/ha), organic carbon (0.40%), pH (7.50) and EC (0.19 DS/m). The experiment was laid out in a randomized complete block design with three replications. The treatments consisted of 2 levels of phosphorus (20, 40 kg P/ha) and Zinc (10, 15, 20 and 0.5% at 15 DAS and 30 DAS) along with recommended doses of nitrogen and potash and a control (20-40-20 kg N-P-K/ha).

Results and Discussion

Table 1 and 2 present the results of the yield attributes and economic performance of Black gram. Significantly Maximum number of pods per plant (22.03) was recorded with the treatment with application of Phosphorus 40 kg/ha + Zinc 0.5% (30DAS) and minimum was recorded in Phosphorus 40 kg/ha + Zinc 15 kg/ha (18.3), where was statistically at par with T8 Phosphorus 40 kg/ha + Zinc 40 kg/ha. The application of Zn, B and S in all combination increased the number of pods per plant. Kumar *et al.* (2009) and Kaisher *et al.* (2010) reported similar findings by Dinesh *et al.* (2020) [14, 7, 6]. Significantly Maximum number of seeds per pod (7.20) was recorded with the treatment in application of Phosphorus 40 kg/ha + Zinc 0.5% (30DAS) and minimum was recorded in control (20:40:20) (6.20), whereas T₆ and T₃ was statistically at par with T₇. Higher

yield attributes and yield were noticed with the combined foliar spray of secondary nutrients and zinc which might be attributed due to added advantage of zinc to secondary nutrients leading to optimum availability of nutrients for luxurious crop growth and efficient partitioning of assimilates from source to sink (Prasanna *et al.*, 2013) [7]. Choudhary *et al.* (2014) [1] found higher seed yield with foliar spray of S and Zn. B. significantly Maximum seed yield (1683 kg/ha) was recorded with the treatment in application of Phosphorus 40 kg/ha + Zinc 20 kg/ha and minimum was recorded in Treatment1 (835 kg/ha). Higher yield attributes and yield were noticed with the combined foliar spray of secondary nutrients and zinc which might be attributed due to added advantage of zinc to secondary nutrients leading to optimum availability of nutrients for luxurious crop growth and efficient partitioning of assimilates from source to sink (Prasanna *et al.*, 2013) [7]. Choudhary *et al.* (2014) [1] found higher seed yield with foliar spray of S and Zn. significantly increase in grain and straw yield could be attributes to the fact that nutrients uptake by the crop plant and ultimately photosynthesis activities, resulting laid down the foundation of higher yield. The results in respect of grain and straw yields are in agreement with the results advocated by Mishra and Tiwari (2002), Sahu and Singh (2009) and Ram and Katiyar (2013) [28, 41, 42]. Maximum harvest index (38.57%) was recorded with the treatment of Phosphorus 40 kg/ha + Zinc 10 kg/ha over all the treatments, minimum was recorded in treatment1 Phosphorus 20 kg/ha + Zinc 10 kg/ha whereas Phosphorus 40 kg/ha + Zinc 20 kg/ha at par with the treatment 5.

Economic analysis shows that Phosphorus 40 kg/ha + Zinc 20 kg/ha was the most intensive yet profitable treatment, recording the highest cost of cultivation (47,340 ₹/ha) alongside superior gross and net returns (118,006.36 ₹/ha). In contrast, the lowest phosphorus and zinc levels resulted in the minimum cost (41,240 ₹/ha) but significantly lower financial gains. Ultimately, the Phosphorus 40 kg/ha + Zinc 20 kg/ha application proved the most efficient, achieving the maximum benefit-cost ratio of 2.49 compared to the minimum of 1.0.

Table 1: Effect of Phosphorus and Zinc on yield attributes and yield of black gram (*Vigna mungo* L.)

S. No	Treatment	Number of pod per plant	Number of seeds per pod	Test Weight (g)	Seed yield (kg/ha)	Haulm yield	Harvest index
1.	Phosphorus 20kg/ha + Zinc 10kg/ha	21.07	6.93	51.9	835	2570.00	24.5
2.	Phosphorus 20kg/ha + Zinc 15kg/ha	20.30	6.73	53.78	1121	2820.00	28.44
3.	Phosphorus 20kg/ha + Zinc 20kg/ha	19.00	7.13	53.12	1225	2634.69	31.74
4.	Phosphorus 20kg/ha + Zinc 0.5% (15 DAS)	21.37	6.93	54.04	1282	2428.66	34.55
5.	Phosphorus 40kg/ha + Zinc 10kg/ha	18.73	7.20	59.55	1484	2363.32	38.57
6.	Phosphorus 40kg/ha + Zinc 15kg/ha	18.37	6.93	53.01	1386	2603.66	34.90
7.	Phosphorus 40kg/ha + Zinc 20kg/ha	22.03	7.13	56.09	1683	2730.68	38.13
8.	Phosphorus 40kg/ha + Zinc 0.5% (30DAS)	19.87	9.13	56.01	1144	3374.00	25.32
9.	N-P-K 20-40-20 kg/ha (control)	19.83	6.20	49.66	1095	2488.33	30.56
	F - Test	S	S	NS	S	S	S
	S Em±	0.23	0.16	1.65	0.46	121.9	2.06
	CD (p=0.05)	0.67	0.49	-	1.38	365.45	4.37

Table 2: Effect of Phosphorus and Zinc on Economics of Black gram

S. No	Treatment	Total Cost of cultivation	Gross Return	Net Return	B:C ratio
1	Phosphorus 20kg/ha + Zinc 10kg/ha	41,240	84,465.00	43,225.00	1.05
2	Phosphorus 20kg/ha + Zinc 15kg/ha	42,840	1,12,135.00	69,295.00	1.62
3	Phosphorus 20kg/ha + Zinc 20kg/ha	44,840	1,21,644.38	76,804.38	1.71
4	Phosphorus 20kg/ha + Zinc 0.5%(15 DAS)	37,840	1,26,647.20	89,167.50	2.38
5	Phosphorus 40kg/ha + Zinc 10kg/ha	43,740	1,45,706.64	1,01,966.64	2.33
6	Phosphorus 40kg/ha + Zinc 15kg/ha	45,340	1,36,877.32	91,537.32	2.02
7	Phosphorus 40kg/ha + Zinc 20kg/ha	47,340	1,65,346.36	1,18,006.36	2.42
8	Phosphorus 40kg/ha + Zinc 0.5%(30DAS)	39,980	1,15,428.00	75,448.00	1.89
9	N-P-K 20-40-20 kg/ha (control)	39,740	1,09,001.66	69,261.66	1.79

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