Influence of Phosphorus, Sulphur and Zinc levels on growth and yield of Blackgram (*Vigna mungo* L.)

ABSTRACT

A field trial was undertaken on the crop black gram in the Zaid season of 2021–2022, at the Crop Research Farm (CRF), in the department of agronomy, SHUATS, Prayagraj, (U.P). The trail was carried out to research "the influence of different levels of phosphorus, sulphur, and zinc on black gram crop". The soil of the exploratory plot had a sandy loam texture, a naturally occurring pH of 7.1, a low level of organic carbon (0.36%), and readily available amounts of N (171.48 kg/ha), P (15.2 kg/ha), and K (232.5 kg/ha). The treatment included two amounts of phosphorus (40 and 50 kg/ha), sulphur (15 and 20 kg/ha), zinc (10 and 15 kg/ha) and a control. The experiment was designed in RBD, duplicated three times, and included nine treatments. The experiment's findings indicated that applying 50 kg of phosphorus and 15 kg of zinc to the soil (Treatment 8) resulted in the highest plant height (28.50 cm), number of nodules per plant counted (25.77), maximum plant dry weight (4.19 g/plant), higher number of pods per plant (30.67), a greater number of seeds per pod (12.00), test weight (36.30 g), seed yield (0.85 t/ha), straw yield (1.99 t/ha), and harvest index, were found to be non-significant. The same treatment (T8) also produced the maximum gross return (73720 INR/ha), net return (47732 INR/ha), and benefit: cost ratio (1.83).

Key words: phosphorus, sulphur, zinc, growth, yield.

INTRODUCTION

"Pulses play a special role in cropping systems as a primary crop, catch crop, cover crop, green manure, and intercrop. It is frequently produced in soils with low fertility levels or with sparing application of organic and inorganic plant nutrients, both of which have a negative impact on the health and productivityof the soil" (Kumpawat, 2010). "The extensively cultivated grain legume known as black gram (*Vigna mungo* L.) is a member of the Fabaceae family. On a dry weight basis, it has a protein content of 25–28%, ash contentof 4.5–5.5%, oil content of 0.5–1.5%, fibre content of 3.5–4.5%, and carbohydrate content of 62–65%" (Kaul,1982). "It is one of the significant pulse crops growing all over India. The productivity of this crop must be increased through proper fertilization. It can symbiotically repair atmospheric nitrogen to suit its nitrogen needs. Phosphorus and Sulphur are the nutrients that require care" (Thakur and Negi, 1985; Nandal, *et al*., 1987).

Phosphorus enhances the symbiotic nitrogen fixation process, because the presence of phosphorus causes bacterial cells to become mobile which is essential for their migration to root hair for nodulation (Charel 2006). Phosphorus aids in healthy root growth, which enhances the quantity of root nodules and, as a result, the rate of nitrogen fixation also raises. The quality and quantity both can be upgraded by phosphorus and sulphur. According to (Renthunglo *et al*., 2018) substantial superior growth characteristics and yield attributable with 100% prescribed fertilizer dose.

One of the sixteen nutrients necessary for a plant's healthy growth and development is sulphur. Plants without an important nutrient develop slowly, yield poorly, and produce of worse quality. The application of sulphur to increase crop yields.

Micronutrients are necessary for the production of crops, and zinc deficiency in plants and soil has been documented globally (Alloway, 2008). Zinc participates in the electron transfer process, which channels photosynthesis during the reproductive stage (Baker *et al*., 1982). "Zinc is required for the activity of several antioxidant enzymes that maintain the membrane lipids, proteins, and nucleic acids in plant cells" (Cakmak, 2008). After nitrogen and phosphorus, zinc is regarded as the third most crucial yield-limiting nutrient in India. ~~In India, zinc is considered as the 3rd important yield limiting nutrient after the nitrogen and phosphorus.~~

MATERIALS AND METHODS

During the Zaid season of 2021-2022, a field trial was conducted on the crop black gram. The trial was set up using a Randomized Block Design with nine treatment combinations and three replications, with different treatments assigned randomly in each replication. The treatment details are T_1- 40 kg/ha P + 15 kg/ha S, T_2-40 kg/ha P + 20 kg/ha S, T_3- 40 kg/ha P + 10 kg/ha Zn, T_4- 40 kg/ha P + 15 kg/ha Zn, T_5- 50 kg/ha P + 15 kg/ha S, T_6- 50 kg/ha P + 20 kg/ha S, T_7- 50 kg/ha P + 10 kg/ha Zn 50 kg/ha, T_8- P + 15 kg/ha Zn, T_9-Control R. D. F (25:50:25 kg/ha). The results were documented for a several growth characteristics, including plant height (cm), nodule count per plant, dry weight, and yield attributes like number of pods per plant, number of seeds per pod, test weight, seed yield, straw yield and harvest index.

RESULTS AND DISCUSSION

Growth Attributes:

Plant height increased progressively with crop age and was significantly affected by different treatments (Table 1). Treatment 8 (50 kg/ha P + 15 kg/ha Zn) recorded the maximum plant height at 30, 45, and 60 DAS, measuring 19.43, 28.50, and 31.00 cm, respectively. This treatment outperformed the other treatments, while T9 had the least plant height (control). Similar findings were reported by Niraj *et. al* (2014) which shows significantly increased growth parameters such as plant height, due application of phosphorus. Khan *et. al*. (2013) revealed that application of Zn significantly increased the growth attributes, i.e., plant height of urdbean over control. The increase in plant height under zinc growth characters might be due to its effect in the metabolism of growing plants, which may effectively explain the response of zinc application

The number of nodules per plant with crop age was significantly affected by different treatments (Table 1). Treatment 8 (50 kg/ha P + 15 kg/ha Zn) recorded the maximum number of nodules per plant at 30, 45 and 60 DAS measuring 19.20, 25.77 and 17.33, respectively. This treatment outperformed the other treatments, while T9 had the least number of nodules per plant (control). Similar results were also reported by Kumar *et. al.* (2018) which indicates positive effect of application of nutrients (phosphorus) on Growth attributing characters i.e., Root length, number and dry weight of root nodules. Meena *et al.* (2017) found that foliar application of Zn recorded maximum number of nodules per plant over rest of the treatments of black

gram. A better root development brought on by higher levels of these nutrients may be the cause of the increase in nodules in plant-1. Due to the fact that phosphorus is a component of nucleic acid and various types of proteins, it is possible that it stimulated plant cell division, leading to greater growth. ~~The increase in number of nodules plant-1 might be due to better root development with increasing levels of these nutrients. Phosphorus, being the constituent of nucleic acid and different forms of proteins, might have stimulated cell division resulting in increased growth of plants.~~

The plant dry weight with crop age was significantly affected by different treatments (Table 1). Treatment 8 (50 kg/ha P + 15 kg/ha Zn) recorded the maximum plant dry weight at 30, 45 and 60 DAS, measuring 2.53, 4.19, and 6.60, respectively. This treatment outperformed the other treatments, while T9 had the least plant dry weight (control). Similar findings were reported by Tanwar *et al*. (2002) on black gram crop and found that application of P increased the dry matter production plant. Singh and Singh (2004) also reported that "application of P increased the total dry matter yield of black gram. Zinc helps in chlorophyll formation which might have resulted in better interception and utilization of radiant energy leading to higher photosynthetic rate and finally increased dry matter production".

Yield Attributes:

Pods per plant with crop age was significantly affected by different treatments (Table 2). Treatment 8 (50 kg/ha P + 15 kg/ha Zn) noted greater number of pods per plant (30.67) which was remarkably better over all other treatments and treatment 7 with application of P 50 kg/ha + Zn 10 kg/ha (29.90) was statistically at par with treatment 8.

Seeds per pods with crop age was significantly affected by different treatments (Table 2). Treatment 8 (50 kg/ha P + 15 kg/ha Zn) noted greater number of seeds per pod (12.00) which was remarkably better over all others and treatment 7 with application of P 50 kg/ha + Zn 10 kg/ha (11.20) was statistically at par with treatment 8.

Test weight with crop age was significantly affected by different treatments (Table 2). Treatment 8 (P 50 kg/ha + Zn 15 kg/ha) noted greater test weight 36.30 g which was remarkably better over all others & treatment 7 with application of P 50 kg/ha + Zn 10 kg/ha (35.77 g) was statistically at par with treatment 8.

Seed yield with crop age was significantly affected by different treatments (Table 2). Treatment (P 50 kg/ha + Zn 15 kg/ha) noted maximum seed yield (0.85 t/ha) which was remarkably better over all others & treatment 7 with application of P 50 kg/ha + Zn 10 kg/ha (0.74 t/ha) was statistically at par with treatment 8.

Straw yield with crop age was significantly affected by different treatments (Table 2). Treatment (P 50

kg/ha + Zn 15 kg/ha) noted maximum straw yield (1.99 t/ha) which was remarkably better over all others &

treatment 7 with application of P 50 kg/ha + Zn 10 kg/ha (1.93 t/ha) was statistically at par with treatment 8. Harvest Index with crop age was found to be non-significantly influence by any treatment (Table 2).

Similar findings were reported by Patel and Thakur (2003) that application of Phosphorus significantly increased the number of pods per plant, seeds per pods, 100 seed weight and seed yield of black gram. Phosphorus is a constituent of phytin and phospholipids, which might have accumulated in seed and helped in seed formation and its development. Gupta *et al.*, (2006) also observed the significant response on black gram seed yields with higher doses of P. and Mishra *et. al*. (2018) evaluates the effect of zinc (Zn) on black gram crop. Results showed that the application of zinc resulted in highest yield and yield attributes *viz.*, seeds/pod, Pods /plant, Test weight, Seed yield, Straw yield etc.

Yield attributes *viz.*, seeds/pod, Pods /plant, Test weight, Seed yield, Straw yield and Harvest Index of black gram increased significantly with each increment in the dose of phosphorus along with zinc. The improvement in yield characteristics may be attributable to zinc, in particular because of its part in the initiation of primordia for reproductive parts and the partitioning of photosynthates towards them, which led to better flowering and fruiting. ~~The increasein the yield attributes might be due to role zinc especially due to its role in initiation of primordia for reproductive parts and partitioning of photosynthates towards them, which resulted in better flowering and fruiting.~~

CONCLUSION

It can be concluded that the application of phosphorous 50 kg/ha and Phosphorus along with 15 Zinc kg/ha was found to be more productive (0.85 t/ha) and commercially viable (1.83).

The conclusion drawn based on one season data only which requires further confirmation for recommendation.

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Table 1: Impact of various levels of Phosphorus, Sulphur and Zinc on growth attributes of Blackgram

Treatments	Plant Height (cm)			No. of nodules/Plant			Dry weight (g/plant)		
	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS
* 1. 40 kg/ha P + 15 kg/ha S	15.68	23.60	25.56	16.47	21.20	14.80	1.54	2.86	4.40
2. 40 kg/ha P + 20 kg/ha S	17.38	24.43	27.27	16.57	22.40	14.90	1.64	2.99	4.71
3. 40 kg/ha P + 10 kg/ha Zn	15.53	23.57	25.48	17.07	21.80	15.24	1.63	2.80	4.86
4. 40 kg/ha P + 15 kg/ha Zn	18.01	24.30	26.80	16.87	22.91	14.97	2.13	3.40	5.85
5. 50 kg/ha P + 15 kg/ha S	17.52	25.77	28.30	17.41	23.47	15.61	1.95	2.92	4.99
6. 50 kg/ha P + 20 kg/ha S	17.57	25.80	28.48	17.02	24.03	15.62	1.93	3.03	5.13
7. 50 kg/ha P + 10 kg/ha Zn	18.42	27.07	30.04	18.43	24.93	16.09	2.15	3.76	5.84
8. 50 kg/ha P + 15 kg/ha Zn	19.43	28.50	31.00	19.20	25.77	17.33	2.53	4.19	6.60
9. N.P.K 25-50-25 kg/ha (Control)	13.03	22.20	24.80	15.87	20.87	13.87	1.08	2.10	3.65
F test	S	S	S	S	S	S	S	S	S
S Ed (±)	0.62	0.49	0.67	0.54	0.61	0.77	0.18	0.36	0.36
CD (P=0.05)	1.33	1.05	1.43	1.15	1.31	1.64	0.39	0.76	0.78

N & K was applied as 25:25 kg/ha as basal.

Table 2: Impact of various levels of Phosphorus, Sulphur and Zinc on Yield attributes of Black gram:

Treatments	No of Pods/plant	No of Seeds/pod	Test weight(g)	Seed yield (t/ha)	Straw yield(t/ha)	Harvest Index (%)
* 1. 40 kg/ha P + 15 kg/ha S	25.20	9.53	31.74	0.56	1.73	24.45
2. 40 kg/ha P + 20 kg/ha S	26.03	10.14	32.54	0.57	1.77	24.35
3. 40 kg/ha P + 10 kg/ha Zn	27.07	10.37	35.40	0.60	1.86	24.39
4. 40 kg/ha P + 15 kg/ha Zn	28.27	10.58	33.75	0.61	1.85	24.79
5. 50 kg/ha P + 15 kg/ha S	27.91	10.77	34.80	0.58	1.77	24.68
6. 50 kg/ha P + 20 kg/ha S	28.23	10.88	34.77	0.57	1.78	24.25
7. 50 kg/ha P + 10 kg/ha Zn	29.90	11.20	35.77	0.74	1.93	27.71
8. 50 kg/ha P + 15 kg/ha Zn	30.67	12.00	36.30	0.85	1.99	29.98
9. N.P.K 25-50-25 kg/ha (Control)	20.80	7.07	30.00	0.50	1.57	24.15
F test	S	S	S	S	S	NS
S Ed (±)	0.61	0.39	0.43	0.11	0.05	---
CD (P=0.05)	1.30	0.84	0.93	0.23	0.11	---

N & K was applied as 25:25 kg/ha as basal.