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Research paper

Effect of phosphorus and sulphur on productivity and profitability of blackgram (*Vigna mungo* L.)

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ABSTRACT

A field experiment was conducted during the *kharif* season of 2019 at the Research Farm, School of Agriculture, ITM University, Gwalior (Madhya Pradesh) to evaluate the effect of phosphorus and sulphur levels on productivity and profitability of blackgram. The experiment was conducted in a randomized block design with four phosphorus levels viz., 0, 20, 40 and 60 kg P/ha, along with three sulphur levels, *viz.*, 10, 20 and 30 kg S/ha, which were replicated thrice. Results revealed that among the P levels, the application of 60 kg P/ha recorded significantly higher number of pods/plant (25.9), number of seeds per pod (5.4), test weight (37.30 g), seed yield/plant (8.26 g), seed yield (1412 kg/ha), stover yield (3542 kg/ha), and biological yield (4954 kg/ha). While among the sulphur levels, application of 30 kg S/ha recorded significantly higher number of pods/plant (23.6), number of seeds/pod (5.1), test weight (36.33 g), seed yield/plant (7.84 g), seed yield (1255 kg/ha), Stover yield (3185 kg/ha), and biological yield (4441 kg/ha). Combined application of 60 kg P/ha and 30 kg S/ha produced significantly highest net returns and benefit-cost ratio. Thus, application of 60 kg P and 30 kg S/ha was found to be the more promising treatment for enhancing the yield in blackgram.

***Key words*:** Blackgram, Economics, Phosphorus, Sulphur, Yield

INTRODUCTION

India is the world's largest producer and consumer of pulse crops. It contributes about a quarter of the world's total pulse production. While one-third of the world's total acreage under pulses is in India, productivity of pulses mainly depends on proper nutrient management practices, particularly phosphorus (P) and sulphur (S). Low organic matter content in light-textured soils coupled with low and imbalanced application of nutrients to the crop limits the full potential of yield and is the main yield barrier for crops (Ghosh *et al*., 2003), which in turn results in deterioration of soil health and productivity (Kumpawat, 2010).

Blackgram (*Vigna mungo* L.), which accounts for 10 per cent of total pulse production in India, is one of the important *kharif* pulse crops. It is a protein rich (about 25%) staple food, containing almost three times that of cereals. It controls soil erosion and competes with weeds effectively due to its deep root system and foliage cover. It fixes atmospheric nitrogen into the soil and improves soil fertility. So, to bridge the gap, proper fertilization is essential. Although, the crop can meets its nitrogen requirement through symbiotic fixation of atmospheric nitrogen. The nutrients that need attention are phosphorus and sulphur (Kumawat *et al*., 2004; Yadav *et al*., 2017). Blackgram being a leguminous crop, it requires an adequate amount of phosphorus and sulphur, as well as other nutrients that are directly involved in the growth and development of the plant.

Phosphorus plays a vital role in photosynthesis, the metabolism of sugars, energy storage and transfer, cell division, cell enlargement, the transfer of genetic information, root growth, nodulation, and nitrogen fixation in plants. It was reported that 80 per cent of the Indian soils need P application (Motsara, 2002) at recommended rates, whereas the application of some quantity of P fertilizers would be essential to arrest P mining from the soils so as to sustain a high yield of crops. Sulphur is another essential nutrient element that is a part of the amino acids cysteine and methionine, hence essential for protein production. Sulphur is known to help in chlorophyll formation by stimulating growth, seed formation, and N fixation by enhancing nodule formation. Widespread S deficiency has been

observed on larger areas due to the use of sulphur-free fertilizers like urea and diammonium phosphate (DAP) in high-yielding varieties and intensive cropping and is more conspicuous in light-textured soils low in organic matter (Sinha *et al*., 1995).

The nutrient addition may have a synergistic or antagonistic effect on the availability of other nutrients. Generally, P and S interactions were found to be synergistic on dry matter yields of different crops at their lower levels of application, but at their higher levels of application, there was antagonistic interaction (Aulakh *et al*., 1990; Islam *et al*., 2006). Further, Jaggi (1998) observed the synergistic interaction between P and S at all levels of applied P (0 to 60 P_2O_5 kg/ha) and S (0 to 90 kg S/ha) on the seed and straw yield of Indian mustard. Thus, keeping the above fact in view, an experiment was conducted to assess the effect of phosphorus and sulphur levels on productivity and profitability in blackgram.

MATERIALS AND METHODS

The experiment was carried out during the *kharif* season of 2019 at the Research Farm, School of Agriculture, ITM University, Gwalior (Madhya Pradesh). The experimental site was located at 26.14°N latitude, 78.14°E longitude and an elevation of 206 m above mean sea level. The climate of this place is typically sub-tropical and semi-arid in nature. The soil of the experimental field was sandy clay loam in texture, low in organic carbon and available nitrogen, medium in phosphorus and potassium, and with electrical conductivity in the safer range (Table 1).

Table 1. Initial soil properties of the experimental site

Soil type	pH	EC (dS /m)	SOC (g/kg)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
Sandy clay loam	7.57	0.41	4.0	183.50	14.40	243.00

The experiment was conducted in a factorial randomized block design with four levels of phosphorus (0, 20, 40 and 60 kg P/ha) and three levels of sulphur (10, 20 and 30 kg S/ha) were replicated twice. Blackgram variety 'Awasthi' was sown at a spacing of 40 cm x 10 cm planting geometry, and it was fertilized uniformly with 20 kg N and 20 kg K_2O/ha through urea and muriate of potash. However, P and S were applied through single superphosphate and elemental sulphur as per the treatment. The other recommended package and practices were followed as per the region.

Data pertaining to yield attributes and yield were obtained at harvest. For grain and stover yield, from the individual plot, a net plot was harvested, and subsequently, the grain and stover yield obtained were weighed and expressed in kg/ha. Among economic parameters, the net return was calculated by deducting cultivation cost from gross returns. The benefit: cost (B: C) ratio was calculated by dividing the net returns by the total cost of cultivation to evaluate the economic viability of treatments. The data were analyzed following the method described by Gomez and Gomez (1984). A significant difference in sources of variation was tested at a probability level of 0.05. The standard error of the mean (SEm±) and the CD at 5% level of significance were indicated in the tables to compare the difference between the mean values.

RESULTS AND DISCUSSION

Yield attributes

Data pertaining to yield attributing characters of blackgram i.e., number of pods/plant, number of seeds/pod and test weight presented in Table 2 revealed that P and S significantly affect the yield attributes of blackgram. The result revealed that the number of pods per plant, number of seeds per pod, and test weight were significantly influenced by different levels of phosphorus. The significantly higher number of pods per plant (24.88), maximum number of seeds per pod (5.37), and highest test weight (37.30 g) were recorded with the application of P at 60 kg/ha. This might be due to the fact that plants treated with optimum P doses have increased root nodulation through better root development and more nutrient availability, resulting in vigorous plant growth and dry matter accumulation leading to flowering, fruiting, and pod formation. It also resulted in better nodulation and efficient functioning of nodule bacteria for the fixation of nitrogen to be utilized by plants during the grain development stage in the synthesis of protein, which in turn led to an increase in grain yield. Similar findings were reported by Chettri and Mondal (2004), Budhar and Tamilselvan (2001), Srinivasan *et al*. (2000) and Kachave (2001).

Sulphur levels also significantly influenced the number of pods per plant, the number of seeds per pod, and the test weight of a blackgram. The maximum number of pods/plant (23.62), maximum number of seeds/pod (5.07), and higher test weight (36.33 g) were recorded with the application of sulphur at 30 kg/ha. This is due to the fact that

Table 2. Effect of phosphorus and sulphur on yield attributes and yields of blackgram

Treatments	Number of pods per plant	Number of seeds per pod	Test weight (g)	Grain yield (kg/ha)	Stover yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)
Phosphorus level (kg/ha)							
0	19.41	4.37	33.39	976	2487	3463	28.18
20	22.18	4.56	35.01	1088	2779	3867	28.14
40	22.16	4.87	35.23	1169	2975	4145	28.22
60	24.88	5.37	37.30	1412	3542	4954	28.50
SEm±	0.19	0.07	0.12	9	24	33	0.04
CD (p=0.05)	0.56	0.21	0.36	27	71	97	0.11
Sulphur level (kg/ha)							
10	20.95	4.57	34.26	1075	2734	3809	28.21
20	22.13	4.74	35.11	1154	2919	4073	28.33
30	23.62	5.07	36.33	1255	3185	4441	28.24
SEm±	0.17	0.06	0.11	8	21	29	0.03
CD (p=0.05)	0.49	0.18	0.32	23	61	84	0.09

optimum sulphur restricted flower and pod dropping, which might have contributed to higher yield attributes. Similar results were reported by Bhat *et al*. (2009) in field beans and Singh *et al*. (2014).

Yield

The data related to yield is presented in Table 2 revealed that seed yield per plant, seed yield, stover yield and biological yield were significantly influenced due to different levels of phosphorus. The highest seed yield/plant (8.26 g), seed yield (1412 kg/ha), stover yield (3542 kg/ha), biological yield (4954 kg/ha) and harvest index (28.50%) were recorded with the application of 60 kg P/ha whereas lowest seed yield per plant, seed yield, stover yield and biological yield was recorded in control (0 kg P/ha). Similar findings were reported by Abraham and Lal (2003), Yadav *et al*. (2016). Kadam *et al*. (2014) found significant increase in seed and straw yield of mungbean with increase in P levels.

The data presented in Table 2 revealed that seed yield/plant, seed yield, stover yield and biological yield were significantly influenced due to different levels of sulphur. It was observed that highest seed yield/plant (7.84 g), seed yield (1255 kg/ha), stover yield (3185 kg/ha), biological yield (4441 kg/ha) were recorded with the application of 30 kg S/ha followed by 20 kg S/ha. This is due to fact that the highest yield is obtained due to maximum production of crop characters like plant height, branches/plant, leaves/plant, pods/plant and seeds/pod. This finding was partly supported by Singh *et al*. (1995) who stated that application of S increased the seed yield. Mir (2013) revealed that the application of S fertilizer significantly enhanced the grain and stover yield.

Economics

Relative economics of blackgram calculated on grain and stover basis presented in Table 3 revealed that the among the P levels, the highest gross return (INR. 77,684/ha), net return (INR. 56,162/ha) and B:C ratio (2.61) were obtained with the application of 60 kg P/ha which was followed by 40 kg P/ha. However, among the S levels, highest gross return (INR. 69,134/ha), net returns (INR. 48,221/ha) and B:C ratio (2.29) were found with the application of 30 kg S/ha followed by 20 kg S/ha. This was possibly due to proportionately highest net return as compared to the cost involved which contributed to B:C ratio. It was also reported that the application of 60 kg P/ha with application of 30 kg S/ha produced significantly highest net return (INR. 60,872/ha) due to fact that proportionately larger increase in seed and stover yield as compared to the cost involved which contributed to higher net returns and B:C ratio (2.73). Similar results were reported by Poonkodi and Deepa (2003), Bagayoko *et al*. (2000), Beg and Singh (2009) and Singh *et al*. (2018).

Table 3. Effect of phosphorus and sulphur on economics of blackgram

Treatments	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C ratio
Phosphorus level (kg/ha)				
0	18803	5377	34971	1.86
20	19709	59974	40265	2.04
40	20616	64417	43801	2.12
60	21522	77685	56163	2.61
Sulphur level (kg/ha)				
10	19413	59218	39805	2.04
20	20163	63538	43375	2.14
30	20913	69134	48221	2.29

CONCLUSION

The increase in grain yield and net returns were recorded with the increase in levels of phosphorus and sulfur. These elements (P and S) play critical role in growth and development of pulse crops. Thus, from present study, it can be concluded that application of phosphorus at 60 kg/ha and sulphur at 30 kg/ha may be recommended under Sandy clay loam soil of central India for higher yield and net returns of blackgram.

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