Original Research Article

Effect of Phosphorus and Sulphur on growth, protein content, yield and economics of Blackgram (*VignaMungo*L.)

ABSTRACT

To study the effect of phosphorus and sulphur levels on growth, protein content, yield and economics of blackgram, an field experiment was conducted during the *kharif*season of 2018-19 at the Research Farm, School of Agriculture, ITM University, Gwalior, (M.P.). The experiment was conducted in factorial randomized block design with four phosphorus levels *viz*., 0 kg/ha (P_0), 20 kg/ha (P_1), 40 kg/ha (P_2) and 60 kg/ha (P_3) along with three Sulphur levels *viz.*, 10 kg/ha (S_1), 20 kg/ha (S_2) and 30 kg/ha (S_3) which were replicated thrice. The blackgramvariety "Awasthi" was uniformly fertilized by 20 kg N, 20 kg K_2O /ha through Urea and muriate of potash. However, phosphorus and Sulphur was applied through Single Super Phosphate and Cossavet as per the requirement of the treatments. The experimental results revealed that among the phosphorus levels, the application of phosphorus @ 60 kg/ha recorded significantly highest plant height (37.12 cm) at 60 DAS, maximum number of branches per plant (6.33), maximum number of leaves per plant (10.62) at 60 DAS, seed yield (14.12 q/ha), Stover yield (35.42 q/ha). While among the sulphur levels, application of Sulphur @ 30 kg/ha recorded significantly highest plant height (36.19 cm), maximum number of branches per plant (6.06), Maximum number of leaves per plant (10.01) at 60 DAS, higherseed yield (12.55 q/ha) and Stover yield (31.85 q/ha). Among the economics, combined application of phosphorus @ 60 kg with application of Sulphur @ 30 kg/ ha produced significantly highest net returns and Benefit Cost. Thus, application of phosphorus @ 60 kg along with application of Sulphur @ 30 kg/ ha was found to be most promising treatment in enhancing the growth and yield in blackgram.

Keywords: Sulphur, Black gram, Protein content, Yield and Phosphorus

1. Introduction:

India holds the title of the world's largest producer and consumer of pulse crop, making it a vital legume crop in South and Southeast Asia. It contributes a significant 25% to the world's total pulse production, with one-third of the world's total acreage under pulses cultivated in India. The productivity of pulses mainly depends on proper nutrient management practices particularly phosphorus and sulphur. However, the production of pulses in the country is far below the requirement to meet even the minimum level per capita consumption which is causing malnutrition among the population. To meet this malnutrition, there is need to increase pulse production in India.

Black gram (*Vignamungo*L.) is one of the important kharif pulse crop. It is commonly grown in summer and rainy seasons in northern India. It is a protein rich (25 per cent) staple food containing almost three times that of cereals. It supplies protein requirement of vegetarian population. Black gram accounts for 10 per cent of total pulse production in India. It belongs to Leguminosae, sub family papilionaceae,and 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 improved the soil fertility. But there exists a vast gap between potential productivity and actual productivity of black gram. So to meet it, proper fertilization is essential. Although, the crop can meet its nitrogen requirements by symbiotic fixation of atmospheric nitrogen. The nutrients which need attention are phosphorus and sulphur (Thakur and Negi, 1985; Nandal, *et al*., 1987). Black gram being a leguminous crop, requires adequate amount of phosphorus and sulphur as well as apart from other nutrients these are directly involved in growth and development of plant.

Phosphorus is among the essential macro-nutrients required for plant growth and development. It plays a key role in photosynthesis, metabolism of sugars, energy storage and transfer, cell division, cell enlargement, transfer of genetic information, root growth, nodulation and nitrogen fixation in plants. It promotes the development of roots, seed formation, and gives strength to straw, hastens maturity of crops, and increases ratio of grain to straw. 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 high yield of crops

Sulphur is another essential nutrient which is usually required by leguminous crops in amounts comparable to phosphorus. Sulphur is a part of amino acids cysteine and methionine, hence essential for protein production. It helps in chlorophyll formation, stimulating growth, seed formation and N fixation by enhancing nodule formation. Wide spread S deficiency have been observed on larger areas due to use of high analysis 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 synergistic or antagonistic effect on the availability of other nutrients. Generally, P and S interaction was 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 and Islam *et al.*, 2006). Further, Jaggi (1998) observed synergistic interaction between phosphorus andSulphur at all levels of applied P (0 to 60 kg P2O5 /ha) and S (0 to 90 kg S/ha) on seedand 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 ongrowth, protein content, yield and economics ofblackgram.

2. Materials and Method

The experiment was carried out during *kharif*season year 2018-19 at the Research Farm, School of Agriculture, ITM University, Gwalior, (M.P.). 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 (4.0 g/kg) and available nitrogen(183.50 kg/ha) and medium in phosphorus(14.40 kg/ ha) and potassium(243.00 kg/ ha)with electrical conductivity (0.41 dS /m)in the safer range.

The experiment was conducted in Factorial randomized block design with four levels of phosphorus as P_0- 0 kg/ha, P_1- 20 kg/ha, P_2- 40 kg/ha and P_3- 60 kg/ha, while three levels of Sulphur were tested are S_1- 10 kg/ha, S_2- 20 kg/ha and S_3- 30 kg/ha which were replicated thrice. Blackgramvariety "Awasthi" was sown at a spacing of 40cm x 10 cm and it was uniformly fertilized by 20 kg N, 20 kg K_2O /ha through Urea and muriate of potash. However, phosphorus and Sulphur was applied through Single Super Phosphate and Cossavet as per the requirement of the treatments. The crop was managed as per regional recommendations of the crop.

Data pertaining to the growth attributes were taken during different growth periods. For plant height, data was recorded with the help of measuring scale and numbers of branches per plant, number of leaves per plant and number of root nodules per plant were counted virtually. For data related to yield was obtained at harvest. For grain and stover yield, from the individual plot, net plot was harvested and subsequently, the grain and stover yield thus obtained were weighed and expressed in q/ ha. For protein content in seedcan be calculated by the formula,

Protein (%) = N (%) x 6.25.

Among economic parameters, net return per ha was calculated by deducting cultivation cost from gross returns. Benefit cost (B:C) ratio was calculated by dividing net returns with total cost of cultivation to evaluate the economic viability of treatments. The analysis of variance was conducted using OP-Stat developed by CCSHAU, Hisar for all observations.

3. Results and discussion

3.1 Growth attributes:

The data related to growth attributes like plant height at 60 DAS, number of branches per plant at 60 DAS, number of leaves per plant at 60 DAS were significantly influenced due to different phosphorus and sulphur levels.

Effect of phosphorus

Data presented in Table 1 revealed that highest plant height of 37.12 cm at 60 DAS, maximum number of branches per plant (6.33), maximum number of leaves per plant (10.62) at 60 DAS was recorded with the application of phosphorus @ 60 kg/ha. Whereas lowest plant height, number of branches per plant and number of leaves per plant was noted with without application of phosphorus applied @ 0 kg ha-1 (Control, P0) at 60 DAS. This might be due to higher availability of N & P and their uptake that progressively enhanced the vegetative growth of the plant. This result is similar with the findings of Sharma and Singh (1997). The fast increase in growth attributes in the early stage of plant growth may be attributed to the higher number of leaves producing higher food material for growth of the plant. In fact, more and large sized leaves were responsible for preparing more food photosynthates which increased cell division and resulted in rapid growth of the plants (Karache*et al*., 2008). The similar results have also been reported by Reddy *et al.*, (2003), Ghosh *et al.*, (2006), Gajera*et al.*, (2014).

Effect of Sulphur

The Sulphur also significantly influenced to the plant height at 60 DAS. Highest plant height (36.19 cm), maximum number of branches per plant (6.06), Maximum number of leaves per plant (10.01) was found under application of Sulphur @ 30 kg/ha followed by Sulphur @ 20 kg/ha. This is probably due to the fact that increase in growth might be due to the better nutrition and their utilization under well fertilized plots as compared to lower levels which could not meet out the nutrition requirement of the crop. The results were also found in conformity with those reported by Chaubey*et al*. (2000); Jat*et al*. (2012) and Akter*et al*. (2013) that application of S significantly increased the growth attributes.Increasing in growth might be due to favourable function of Sulphur being a major structural constituent of cell helps in stimulating the cell division and cell enlargement, which increased growth and inturn yield of blackgram.

Table 1: Influence of phosphorus and Sulphur on growth attributes of black gram at 60 DAS

Treatments	Plant height (cm)	Number of branches per plant	Number of leaves per plant
Phosphorus levels			
P_0: 0 kg/ha	33.75	4.99	8.46
P_1: 20 kg/ha	34.63	5.72	9.33
P_2: 40 kg/ha	35.15	5.98	9.67
P_3: 60 kg/ha	37.12	6.33	10.62
S.Em±	0.28	0.05	0.04
CD	0.81	0.15	0.11
Sulphur levels			
S_1: 10 kg/ha	5.39	27.34	9.07
S_2: 20 kg/ha	5.82	29.19	9.47
S_3: 30 kg/ha	6.06	31.85	10.01
S.Em±	0.24	0.04	0.03
CD	0.70	0.13	0.09

3.2 Protein content

Data on quality characters of black gram is presented in Table 2 revealed that quality characters are significantly affected by phosphorus and sulphur levels

Effect of Phosphorus

The result revealed that protein content was significantly influenced due to different levels of phosphorus. Protein content ranged from 21.05 to 24.71%. The highest protein content of 24.71 % was observed with the application of phosphorus @ 60 kg/ha. This is due to fact that application of adequate amount of phosphorus influenced the vigour of plants which has possibly accelerated the sulphur fixing power of plants by increasing the activity of nodule bacteria, proliferation of root growth resulting in more build up to Sulphur content in seed and straw ultimately produce higher concentration of protein. Similar results were found by Dhage*et al*. (2014) andChesti*et al*. (2012).

Effect of Sulphur

The different Sulphurlevels also significantly influenced the Protein content (Table 3).it was observed that the highest protein content of 23.14 % was recorded with the application of Sulphur @ 30 kg/ha followed by Sulphur @ 20 kg/ha There was a significant increase in protein content, recorded with higher dose of Sulphur at this growth stage. This is due to fact that protein molecules are built up through systematically controlled condensation of amino acid molecules, formed by combining reduced Sulphur with derivatives of carbohydrates obtained within the plant system as a produce of photosynthesis. Accumulation of protein in grain and straw under adequate Sulphur supply might be accounted to continuous availability of sulphur and enhance in its absorption through increased root cation exchange capacity which results more protein synthesis. Contrary to this, limited amount of available sulphur conspicuously associated with lower rate of Sulphur could not meet the sulphur requirement for protein synthesis, resulting into low protein percentage. As sulphur is the major constituent of protein, therefore, increasing levels of N increased the protein content and yield. Similar results were reported Yadav*etal*. (2017) and Bhat*et al*. (2009).

Table 2. Effect of phosphorus and sulphur on protein content of blackgram

Treatments	**Protein content (%)**
Phosphorus levels	
P_0: 0 kg/ha	21.05
P_1: 20 kg/ha	21.51
P_2: 40 kg/ha	22.59
P_3: 60 kg/ha	24.71
S.Em±	0.19
CD	0.56
Sulphur levels	
S_1: 10 kg/ha	21.99
S_2: 20 kg/ha	22.27
S_3: 30 kg/ha	23.14
S.Em±	0.17
CD	0.49

3.3 Yield andEconomics

Effect of Phosphorus

The data related to yield is presented in Table 3 revealed that the seed yield per hectare (14.12 q/ha), stover yield per hectare (35.42 q/ha), net returns (Rs.48221.00/ha) and B: C ratio (2.29:1)were recorded with the application of phosphorus @ 60 kg/ha Whereas lowest yield per plant and economics was noted with without application of phosphorus applied @ 0 kg/ha (Control). This might be due to the fact that plant treated with optimum phosphorus doses, resulted in higher yield due better root development and nodulation which will helps in higher nutrient availability leading to higher flowering, fruiting and grain and stover yield per hectare. Similar findings were reported by Abraham and Lal (2003), Sharma et al. (2021), Yadav*et al.* (2016). Further higher economics is possibly due to proportionately highest net return as compared to the cost involved which contributed to B: C ratio.

Effect of Sulphur

The data presented in Table 3 revealed that seed yield per hectare, Stover yield per hectare net returns and B:C ratio was significantly influenced due to different levels of sulphur. It was observed that highest seed yield per hectare (12.55 q/ha), stover yield per hectare (31.85 q/ha), net returns (Rs.48221.00/ha) and B: C ratio (2.29:1)were recorded with the application of Sulphur @ 30 kg/ha followed by Sulphur @ 20 kg/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 Sulphur increased the seed yield. Similar finding were reported by Bagayoko*et al*. (2000), Beg and Singh (2009), Singh *et al.* (2018).

Table 3. Effect of phosphorus and sulphur on grainyield, stover yield and economics of blackgram

Treatments	**Grain yield per hectare (q/ha)**	**Stover yield per hectare (q/ha)**	**Net return (Rs/ha)**	**B:C ratio**
Phosphorus levels				
P_0: 0 kg/ha	9.76	24.87	34971.67	1.86
P_1: 20 kg/ha	10.88	27.79	40265.00	2.04
P_2: 40 kg/ha	11.69	29.75	43801.33	2.12
P_3: 60 kg/ha	14.12	35.42	56162.67	2.61
S.Em±	0.09	0.24	-	-
CD	0.27	0.71	-	-
Sulphur levels				
S_1: 10 kg/ha	10.75	27.34	39804.50	2.04
S_2: 20 kg/ha	11.54	29.19	43375.00	2.14
S_3: 30 kg/ha	12.55	31.85	48221.00	2.29

S.Em±	0.08	0.21	-	-
CD	0.23	0.61	-	-

4. Conclusion

It can be concluded that the among the phosphorus levels, application of phosphorus @ 60 kg/ha recorded significantly highergrowth attributes, protein content, grain yield and Stover yield. Among the sulphur levels, application of Sulphur @ 30 kg/ha recorded higher growth attributes and yield of blackgram. Thus, application of phosphorus @ 60 kg with application of Sulphur @ 30 kg/ ha was found to be most promising treatment in enhancing the growth, protein content and yield in blackgram for resource poor farmers.

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