Evaluation of various levels of phosphorus and sulphur on yield and economics of blackgram (*Phaseolus mungo* L) in Vylogam soil series of Madurai district

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ABSTRACT

A field experiment was conducted to study the interaction effect of phosphorus and sulphur on improvement of productivity of blackgram (VBN 4) in Vylogam soil series of Madurai district, Tamil Nadu during kharif season 2017. The experiment was laid out in a factorial randomized block design with three replications having 25 treatment combinations viz five levels of phosphorus (0, 20, 40, 60 and 80 kg P_2O_5/ha) applied through diammonium phosphate as factor A and five levels of sulphur (0, 20, 40, 60 and 80 kg S/ha) applied through elemental sulphur as factor B. The results revealed that application of P up to 60 kg/ha and increasing levels of sulphur up to 40 kg/ha proved to be the best treatments in improving the grain and haulm yield. Higher doses of phosphorus and sulphur did not increase the parameters further. Thus interaction of phosphorus and sulphur exhibited a strong synergistic relationship at $P_{60}S_{40}$ kg/ha on yield of blackgram with grain yield (1103 kg/ha) and haulm yield (1683 kg/ha) in Vylogam soil series of the district.

Keywords: Phosphorus; sulphur; interaction; blackgram; Vyglogam

INTRODUCTION

Pulses are the cheapest source of dietary proteins. Blackgram is one among the important pulse crops in India both in terms of total area and production. Currently blackgram area in the country stands at 3.47 Mha with a production of 1.43 MT. In Tamil Nadu blackgram is a popular pulse crop occupying an area of 4.56 lakh hectare with a production of 2.36 lakh tonne (Kannaiyan 2001). The 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 limit the full potential of yield and is the main yield barrier for crops. To solve this problem synthetic fertilizers were always thought to be a better way to improve the soil fertility and crop productivity but unfortunately the excessive use of these creates a number of serious environmental and health risks.

Phosphorus and sulphur play a vital role in the nutrition of plants. Phosphorus is an essential macronutrient 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. Sulphur is the second most important plant nutrient after phosphorus for pulses. Sulphur has a profound influence on protein synthesis for pulses and is a part of amino acids such as cystein, cystine and methionine. In fact these are the nutrients which lack mostly in the soils. Analysis of Indian soils has indicated that soils are medium to low in the phosphorus and deficient in sulphur. Out of 135 districts of Tamil Nadu under pulses soils in 68 districts are low and 62 districts are medium in available P status (Shweta and Malik 2014). Next most important emerging nutrient that is showing widespread deficiency is sulphur. Sulphur deficiencies have been reported from 72 countries in the world. Over 27000 soil samples from twelve states of India were analysed of which 40 per cent were found deficient and another 35 per cent were potentially deficient in available sulphur (Biswas et al 2004).

Phosphatic fertilizer application results in increased anion adsorption sites by phosphate which releases sulphate ions into the soil solution (Tiwari and Gupta 2006). Studies have indicated both synergistic and antagonistic relationship between sulphur and phosphorus but their relationship depends on their rate of application and crop species (Sinha et al 1995). Synergistic effect of applied phosphorus and sulphur was observed by Pandey et al (2003) in chickpea. Antagonistic relationship between P and S was observed in moong and wheat by Islam et al (2006). Performance of different levels of P and S may be varied and its output mainly depends on nature of crops, soil status and agroclimatic conditions too (Singh et al 2014). Information on combined application of P and S on yield of black gram is limited in Tamil Nadu. It was therefore necessary to develop a strong workable and compatible package of phosphorus and sulphur management for blackgram based on scientific facts and local conditions. Thus the present study was undertaken to investigate the effect of phosphorus and sulphur on yield and economics of blackgram in Madurai district of Tamil Nadu.

MATERIAL and METHODS

A field experiment was conducted in farmers' fields at Allangampatti village, Melur block, Madurai district, Tamil Nadu with test crop blackgram (VBN 4) during the year 2017 to evaluate the effect of phosphorus and sulphur and to find out the optimum levels of P and S for maximum productivity of blackgram. The soil of the experimental site belonged to Vylogam series and according to USDA soil taxonomy it was classified as Typic Rhodustalf. The soil was sandy loam in texture with pH 7.1 having an organic carbon content of 2.4 g/kg, 236 kg/kg of available nitrogen, 10.2 kg/ha of available P_2O_5, 248 kg/ha of available K_2O and 5.2 mg/kg of $CaCl_2$ extractable S. The experiment was laid out in factorial randomized block design with three replications having twenty five treatment combinations viz five levels of phosphorus (0, 20, 40, 60 and 80 kg/ha) as factor A and five levels of sulphur (0, 20, 40, 60 and 80 kg/ha) as factor B. Nitrogen was applied at the rate of 25 kg/ha and potassium at the rate of 25 kg/ha in all the treatments. Nitrogen was applied through urea, phosphorus through diammonium phosphate, potassium through muriate of potash and S through elemental sulphur (field grade 90% pure) and was applied as basal. The experimental plot size was 5 x 4 m. The crop was sown in middle of August. The blackgram variety used was Vamban 4 (CO 4 x PDU 102) sown at the rate 30 kg/ha with a spacing of 30 x 10 cm. Hand weeding was done twice at 20 and 40 days after sowing.

Five plants from each plot were selected at random, tagged and yield parameters were recorded. Harvesting of blackgram was done from net plot area leaving two border rows all around. Well-matured blackgram plants were pulled out and sun-dried for two days. Threshing was done by beating with sticks. Grain yield was recorded plot-wise at 14 per cent moisture level. The dry weight of haulm yield from each plot was also recorded.

The data collected were statistically analyzed as suggested by Gomez and Gomez (1984).

RESULTS and DISCUSSION

Effect of phosphorus and sulphur on grain and haulm yield of blackgram

The effect of different levels of P and S application on grain and haulm yield of blackgram is presented in Table 1. It is apparent from the data that the application of P significantly and markedly increased the grain and haulm yield up to P 60 kg/ha and thereafter showed a declining trend with higher doses. The highest grain and haulm yield of 962 and 1414 kg/ha respectively was recorded in P 60 kg/ha. The increase in grain and haulm yield with 60 kg/ha of phosphorus application over control was 31 and 34 per cent respectively which might be due to increased supply of phosphorus to plants. The supply of phosphorus to soil might have accelerated cell division and enlargement, favoured carbohydrate and fat metabolism and respiration in plants leading to increased growth and yield (Dhage et al 2014).

The sulphur application also significantly increased the grain and haulm yield up to S 40 kg/ha. The magnitude of increase in grain and haulm yield was 20.2 and 23.1 per cent respectively due to application of S 40 kg/ha over control. The magnitude of response was found more in case of phosphorus as compared to sulphur. The application of sulphur might have increased the availability of nutrient to plants due to improved nutritional environment which in turn favourably influenced the energy transformation activation of enzymes, chlorophyll synthesis as well as increased carbohydrate metabolism. These results corroborate the findings of Dhage et al (2014).

Table 1. Effect of different levels of phosphorus and sulphur on yield of blackgram in Vylogam soil series (mean of three replications)

P level (kg/ha)	Grain yield (kg/ha) at S level (kg/ha)						Haulm yield (kg/ha) at S level (kg/ha)					
	0	20	40	60	80	Mean	0	20	40	60	80	Mean
0	651	709	721	753	820	731	963	1031	1067	1161	1072	1059
20	679	720	769	808	838	763	1029	1097	1161	1226	1098	1122
40	692	756	866	834	842	798	1092	1156	1219	1252	1187	1181
60	821	993	1103	974	921	962	1156	1459	1683	1414	1356	1414
80	843	911	1058	936	915	933	1223	1288	1589	1350	1283	1347
Mean	737	818	903	861	867	-	1093	1206	1344	1281	1199	-

	Grain yield			Haulm yield		
	P	S	P x S	P	S	P x S
SEd	11.39	11.39	25.47	15.52	15.52	30.15
$CD_{0.05}$	22.90	22.90	51.21	30.63	30.63	62.45

A strong synergistic effect on grain and haulm yield was registered by combined application of P 60 kg/ha + S 40 kg/ha and the highest grain and haulm yield was 1103 and 1683 kg/ha respectively. This might be due to greater release and uptake of nutrients causing a favourable environment for better growth and development of plants. These results are in conformity with the findings of Niraj and Prakash (2014) in blackgram. The P and S both being anions might have complemented each other for the absorption sites in order to strike a proper balance between cation and anion in producing synergistic effect (Aulakh and Pasricha 1977). Singh et al (1995) reported that nature of P and S interaction depends on their rate of action.

Effect of phosphorus and sulphur on economics of blackgram

The economics of blackgram production was considerably influenced by interaction of various levels of phosphorus and sulphur (Table 2). The cost of cultivation was maximum (Rs 34968) under the treatment $P_{80}S_{80}$ and minimum (Rs 22808) under treatment P_0S_0. The maximum net profit was recorded under the treatment $P_{60}S_{40}$ (Rs 33020) and the lowest under P_0S_0 (Rs 13960). The magnitude of benefit-cost ratio varied from 1.39 to 2.13. The highest B-C ratio of 2.13 was registered in case of $P_{60}S_{40}$. Findings of this study provided a sound base to believe that combined application of phosphorus and sulphur increased the grain and haulm yield of blackgram crop over control and was proved to be the most economical treatment for increasing net profit. Similar findings were made by Das (2017).

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Table 2. Effect of different levels of phosphorus and sulphur on economics and benefit-cost ratio of blackgram in Vylogam soil series

P level (kg/ha)	S level (kg/ha)				
	0	20	40	60	80
Total cost of cultivation (Rs)					
0	22808	25408	28008	30608	33208
20	23248	25848	28448	31048	33648
40	23688	26288	28888	31488	34088
60	24128	26728	29328	31928	34528
80	24568	27168	29768	32368	34968
Gross return (Rs)					
0	36768	40026	40722	42576	46172
20	38374	40697	43456	45666	47188
40	39152	42736	48849	47122	47497
60	46311	56074	62348	54984	52011
80	47588	51393	59174	52830	51608
Net return (Rs)					
0	13960	14618	12714	11968	12964
20	15126	14849	15008	14618	13540
40	15464	16448	19961	15634	13409
60	22183	29346	33020	23056	17483
80	23020	24225	30011	20462	16640
Benefit-cost ratio					
0	1.61	1.58	1.45	1.39	1.39
20	1.65	1.57	1.53	1.47	1.40
40	1.65	1.63	1.69	1.50	1.39
60	1.92	2.10	2.13	1.72	1.51
80	1.94	1.89	2.01	1.63	1.48

Value of blackgram seed produced= Rs 55/kg, Value of haulm= Re 1/kg

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