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Influences of Phosphorus and Sulphur on Yield and Quality of Black Gram (*Physiolus mungo* L)

VPS NIRAJ* AND VED PRAKASH

Department of Soil Science, N. D. University of Agriculture & Technology, Kumarganj, Faizabad, UP, India

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ABSTRACT

Sixteen treatments were replicated thrice times in Randomized Block Design. Black gram variety Pant Urd-35 was taken as test crop. The data revealed that 45 kg/ha phosphorus and 30 kg/ha sulphur significantly increased growth parameters such as plant height, number of branches and dry matter accumulation. The same treatment combination proved most effective in improving the yield and yield attributing characters *viz.* number of pods, number of grains per pod, grains weight per plant, test weight, grain and straw yield. Application of 60 kg P and 45 kg S/ha produced highest grain and straw yield along with nutrients content and uptake of nitrogen, phosphorus, potassium and sulphur over rest of the treatments. However, this treatment was at par with the application of 45 kg P and 30 kg S/ha. A considerable buildup of soil fertility was also noted in this treatment. However, benefit: cost ratio was maximum with $P_{45}S_{30}$ treatments combination. Thus, recommendation of 45 kg P and 30 kg S/ha can be made to the farmer's of eastern Uttar Pradesh for obtaining good yield; net rerun and fertility build up of soil.

Keywords: Black gram, phosphorus, sulphur, yield and quality

INTRODUCTION

Being legume, black gram (*Physiolus mungo* L.) is a deep rooted drought hardy crop, source of fodder, green mannuring, pluses and lavish iron and zinc rich minerals (Singh *et al*., 2013). Madhya Pradesh the largest area under cultivation of this crop followed by Uttar Pradesh with average productivity of 460 kg/ha, production and area in 1.20 MT and 0.49 Mha respectively (Anonymous, 2006). Sulphur combination with phosphorus as phosphate ion is more strongly bound than sulphate (Singh *et al*., 2012 and Hedge and Murthy, 2005). Phosphorus fertilizer application result in increased of anion adsorption sites by phosphate, which releases sulphate ions into the soil solution (Tiwari and Gupta, 2006). Thus, it may be subjected to leaching if not taken up by plant roots. 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) for chickpea. Antagonistic relationship between P and S was observed in moong and wheat by Islam *et al.* (2006) and in lentil and chickpea by Hedge and Murthy (2005). Dynamic of P in soil is very complex and it has also got antagonistic relationship with zinc also (Singh *et al*., 2011). Performance of different in response to integrated nutrient management may be varied and its output is mainly depends nature of crops, soil status and agroclimatic condition too (Singh *et al*., 2014). The interaction of these nutrient elements may affect the critical levels of available phosphorus and sulphur below which response to their application could be observed. Information on effect of combined application of phosphorus and sulphur on yield, quality and content of each nutrient in black gram is rather limited. Therefore, the present investigation was undertaken to study the effects of phosphorus and sulphur application on yield and quality of black gram.

* Corresponding author email: vijaysoilsci@gmail.com

MATERIALS AND METHOD

A pot experiment was conducted at Department of Soil Science, College of Agriculture, and NDUA &T Kumarganj Faizabad (U.P.). The experimental soil had pH 8.2, EC 0.22 dS/m and OC (%), Available nitrogen, phosphorus, potassium and sulphur content in soil were, 0.36%, 181.0 kg, 13.0 kg, 222.0 kg and 11.6 kg ha^{-1} respectively. Soil was deficient in available sulphur and medium in available phosphorus. Sixteen treatments consisting of four levels of Phosphorus (0, 20, 40 and 60 kg P/ha) and four levels of Sulphur (0, 15, 30 and 45 kg S/ha) were laid in a Randomized Block Design with three replications. Phosphorus and sulphur were applied through di-ammonium phosphate and elemental sulphur, respectively. Seeds of black gram were sown in each field and plants were maintained after germination. Randomly selected plant from each treatment was harvested at the time of flowering and root nodules from each field were counted. At maturity remaining plants were harvest, seed and straw yields were recorded. Plant samples were collected for chemical analysis of phosphorus, potassium, sulphur and nitrogen in seed and straw samples. In grinding seed and straw samples, nitrogen was estimated by micro Kjeldahal method as described by Subbiah and Asija (1956). For Phosphorus and Sulphur plant samples were digested in di-acid mixture and phosphorus in the extract was determined by vanadomolybdate yellow colour method Jackson (1973). Sulphur content in the plant was determined according to method given by Williams and Steinberg's (1959). Soil samples from every pot were collected for chemical analysis after harvesting the crop. For available P, soil samples were extracted with 0.5M NaH_2CO_3 (pH=8.5) (Olsen *et al.,* 1954) and Phosphorus content in the extract was determined as described by Jackson (1973). Available Sulphur was determined by extracting soil samples with Williams and Steinberg's (1959) and sulphur in the extract was estimated by turbid metric method. Crude protein was computed by multiplying the nitrogen content with 6.25.The data were statistically analyzed as per the procedure outlined by Bharati and Singh (2014).

RESULTS AND DISCUSSION

Number of Nodules/Plant

Data presented in Table 2 showed that the application of 60 kg phosphorus/ ha increased the number of nodules plant by 33.92 and 22.06, control and statically at par with 40 kg phosphorus/ ha. Application of sulphur 45 k/ ha also increased number of nodules plant significantly over control and 15 kg/haand statically at par with 30 kg sulphur/ha. Similar results were also reported by Singh and Pareek (2003). The interaction effect of phosphorus and sulphur also non- significantly influenced number of nodules plant. The maximum number of nodules $plant^{-1}$ was reported at the highest level of phosphorus (60 kg phosphorus/ha) along with sulphur (45 kg sulphur kg/ ha).The increase in number of nodules plant 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. Beneficial effects of sulphur by decreasing soil pH and improving physical condition of the soil.

Grain and Straw Yield

With increasing level of both phosphorus and sulphur grain and straw yield of black gram were increased significantly (Table 2). The percent increase in grain yield due to phosphorus and sulphur varied from 65.19% and 60.06%, respectively, whereas the straw yield was increased from 36.10% and 32.82%. The magnitude of response was more in case of phosphorus as compared to sulphur. Synergistic effect of phosphorus and sulphur on grain and straw yield was highest at 60 kg phosphorus and 45 kg sulphur/ha. The magnitude of increase in grain yield was 58.25 and 52.61% due to application of phosphorus 40 kg and 30kg sulphur/ha over control, respectively. The synergistic effect of phosphorus and sulphur may be due to utilization of high quantities of nutrients through their well developed roots system and nodules which might have resulted in better growth and yield at medium. These results confirm the earlier findings of Islam *et al.* (2006) in rice. Kumar and Singh (1980) with soybean reported a suitable balance between

Table 1: Chemical properties of soil before the sowing the black gram.

Soil characters	pH	EC (dS/m)	Organic carbon (mg/kg)	Exchangeable sodium (me /100gm soil)	Available nitrogen (kg/ ha)	Available P_2O_5 (kg/ ha)	Available K_2O (kg/ ha)	Available S (kg/ ha)	Available Zn (ppm)
Value	8.2	0.37	2.90	16.50	145.72	17.50	215.20	14.09	0.45

phosphorus and sulphur for producing increased yield.

Table 2: Effect of phosphorus and sulphur on no. of nodules and yield of black gram

Treatments	No. of nodule (45 DAS)	No. of nodule (60 DAS)	Grain yield (q/ ha)	Straw yield (q/ha)
P levels				
0	29.18	14.19	6.78	21.19
20	36.41	16.76	7.85	23.20
40	37.60	18.84	10.73	27.80
60	39.08	19.95	11.20	28.84
SEm±	0.60	0.49	0.16	0.65
C.D. at5%	1.83	1.48	0.50	1.97
S levels				
0	31.63	15.34	6.88	21.54
15	35.18	17.26	8.13	24.11
30	36.85	18.53	10.50	26.65
45	38.61	19.31	11.05	28.61
SEm±	0.60	0.49	0.16	0.65
C.D. at5%	1.83	1.48	0.50	1.97
P X S	NS	NS	NS	NS

Nitrogen uptake and Protein Content

Nitrogen uptake (Table 3) was significantly increased with the increase in level of Phosphorus and Sulphur. That nitrogen content in black gram increased significantly by Phosphorus application up to 60 kg/ha. Application of phosphorus was at par with nitrogen uptake was recorded at 40 kg and 20 kg/ha. Protein content in black gram grain was increased significantly with application of Phosphorus and Sulphur individually (Table 3). The maximum increase in protein content (17.90 and 11.46) was obtained with 60 kg phosphorus kg and 45 kg sulphur/ha together. The response to applied Phosphorus with respect to protein content in black gram is attributed to more nitrogen fixation. Similar results were also reported by Pandey *et al.* (2003). Increasing doses of sulphur application resulted in a significant increase in protein content of black gram. The positive response to added sulphur is assigned to low status of available Sulphur of soil or due to stimulating effect of applied sulphur in the synthesis of protein resulting in greater photosynthetic efficiency which in turn translated in term of increased yield.

Phosphorus and Sulphur uptake:

With increasing in level of sulphur from 0 to 15 and 30 to 45 kg/ha, phosphorus and sulphur uptake in crop was increased significantly. Similarly phosphorus and sulphur uptake were increased significantly with increasing levels of phosphorus from 0 to 20 and 40 to 60 kg P/ha. Phosphorus uptake in black gram ranged from 9.5%, while sulphur uptake ranged from 5.83% increasing levels over control. Similar results were reported by Panday *et al.* (2003) and Islam *et al.* (2006) in moon bean.

Table 3: Effect of phosphorus and sulphur on protein content (%) and nutrients uptake of black gram

Treatments	Protein content (%)	N uptake	P uptake	S uptake
P levels				
0	21.89	71.73	11.63	13.87
20	23.60	77.78	11.90	15.30
40	24.90	82.82	12.30	16.48
60	25.81	84.63	12.74	17.05
SEm±	0.47	2.03	0.23	0.27
C.D. at5%	1.37	6.11	0.70	0.84
S levels				
0	22.50	73.98	11.66	13.76
15	23.30	78.40	12.05	15.46
30	24.50	81.55	12.15	16.59
45	25.08	83.00	12.34	16.92
SEm±	0.47	2.03	0.23	0.27
C.D. at5%	1.37	6.11	0.70	0.84
P X S	NS	NS	NS	NS

Available Phosphorus and Sulphur

The results presented in Table 4 showed that the available phosphorus was increased consistently with increasing in level of phosphorus; phosphorus content in soil increased from 27.27% with application of 60 kg phosphorus/ha. Similar results were also reported by Islam *et al.* (2006). Application of S was affect the available phosphorus significantly in the soil. It tends to increase with sulphur was increased with increasing levels of sulphur application. Phosphorus application had effect on sulphur content of the soil. The findings are similar to Panday *et al.* (2003) reported that application of 60 kg phosphorus/ha and sulphur 45 kg/ha, content of the soil.

CONCLUSION

Based on present investigation it was concluded that to improve its productivity of black gram and sustainability of mother soil, application of 45 kg P and 30 kg S/ha is economical in eastern Uttar Pradesh conditions.

Table 4: Effect of phosphorus and sulphur on available nutrients in soil of black gram.

Treatments	Available N	Available P	Available K	Available S
P levels				
0	184.42	14.09	223.00	14.13
20	189.30	15.15	223.25	15.05
40	194.36	16.70	224.18	16.65
60	197.70	17.93	224.98	16.87
SEm±	1.12	0.42	-	0.31
C.D. at5%	3.24	1.28	NS	0.94
S levels				
0	188.90	15.24	223.30	13.78
15	191.00	15.37	223.70	15.88
30	192.90	16.30	224.05	16.26
45	193.80	16.96	224.83	16.79
SEm±	1.12	0.42	-	0.31
C.D. at5%	3.24	1.28	NS	0.94
P X S	NS	NS	NS	NS

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