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Effect of sources and levels of sulphur on yield, quality and uptake of nutrients in green gram (*Vigna radiata*)

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ABSTRACT

A field experiment was conducted during Kharif seasons of 2011 and 2012 at S.V.B.P. University of Agriculture and technology, Meerut (U.P.) to study the effect of sources and levels of sulphur on yield, quality and nutrient uptake by green gram (Vigna radiata). The sources and levels of sulphur were evaluated in randomized block design with three replications. Results revealed that most of the growth and yield parameters were significantly influenced by different levels and sources of sulphur. The plant height, branches/plant, nodules/plant and test weight were found maximum with 40 kg S ha^{-1} as gypsum. The highest grain and straw yields were 10.90 and 28.78 q ha^{-1}, respectively in the treatment T_9 (40 kg S ha^{-1} as gypsum), resulting in 30.2 and 27.3% increase in the yield over that of the control. The mean protein content (20.62%) and protein yield (224.7 kg ha^{-1}) were highest in the treatment T_9 (40 kg S ha^{-1} as gypsum). The uptake of nutrients by green gram grain and straw increased significantly with increasing levels of S in the form of both sources. Soil pH decreased with levels of S but status of available N, P, K and S improved significantly with increasing levels of S in post harvest soil. Both the sources of S were statistical at par in respect of pH, available N, P and K buildup in soil. The status of available sulphur increased in post harvest soil with gypsum than that of elemental sulphur.

Keywords: Sulphur sources, levels, quality, nutrient uptake, yield, green gram

INTRODUCTION

Pulses are important sources of protein in the diets of a large section of vegetarian population in the developing countries in general and India in particular among the many cultivated legumes, green gram is the most important rainfed pulse crop grown on marginal lands. Optimum nutrition is required for getting maximum grain yield and good quality of the grain. Among the measures to increase pulse production, application of sulphur is one of the most important practice. Sulphur improves the quality of food crops, particularly of legumes. It plays an important role in the formation of S. containing amino acids like cystine (27% S), Cystein (26% S), methionine (21% S), which act as building blocks in the synthesis of proteins. It has a role to play in increasing chlorophyll formation and aiding photosynthesis (Marschner 1986). Sulphur also plays a role in the activation of enzymes, nucleic acids and forms a part of biotin and thiamine. Sulphur fertilizers are most commonly available as either soluble sulphate or relemental forms. Elemental sulphur is totally unavailable to plants. It must be oxidized by soil microbes to sulphate (SO_4-S) before it becomes available to crops. Thus, it takes considerably more time for sulphur to become available, compared to soluble sulphate forms of fertilizers. The positive response of sulphur to cowpea and lentil has been reported by earlier authors (Jat *et al.* 2013, Upadhyay, 2013). Gypsum has been found either superior or equal to other S containing fertilizers in pulse crops (Kumar *et al.* 2014). Keeping these in view, the present investigation was undertaken to study the effect of sources and levels of sulphur on yield, quality and uptake of nutrients in green gram.

MATERIALS AND METHODS

Field experiment was conducted at the crop research centre, S.V.B.P. University of Agriculture & Technology, Meerut (28° 04' N latitude, 77° 42' E longitude, 237 meter above mean sea level), Uttar Pradesh during the Kharif season 2011 and 2012 with green gram (CV K 851) in an alluvial soil. The chemical properties of the experimental soil were pH 8.2, organic carbon 4.5 g kg^{-1}, available N 150 kg ha^{-1}, available P 11.3 kg ha^{-1}, available K 170 kg ha^{-1}

and available sulphur 17.0 kg ha^{-1}. The treatment comprised of control (T_1), elemental S 10 kg S ha^{-1} (T_2), 20 kg S ha^{-1} (T_3), 30 kg S ha^{-1} (T_4), 40 kg S ha^{-1} (T_5) sulphur as gypsum 10 kg S ha^{-1} (T_6), 20 kg S ha^{-1} (T_7), 30 kg S ha-1 (T_8) and 40 kg S ha^{-1} (T_9). The experiment was laid out in randomized block design with three replications. A basal dose of 20 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1} was applied at the time of sowing through diammonium phosphate and muriate of potash, respectively. Sulphur as elemental sulphur and gypsum was broadcasted before sowing of the crop. Green gram was sown on June 6 in both the years. The crop was grown by adopting standard agronomic practices. The crop was harvested in the last week of October in both the years and grain and straw yields were recorded at harvest. The grain and straw samples were digested with di acid mixture (HNO_3 : $HClO_4$, 9 : 4) and sulphur was determined turbidimetrically (Chesnin and Yien 1951). Phosphorus and potassium in di acid digest were determined by adopting standard procedures (Jackson 1973). Nitrogen in grain and straw was determined by modified Kjeldahl method. The protein content was obtained by multiphying N content with a constant factor of 6.25. The post harvest soil samples were collected and analysed for pH, available N (Subbiah and Asija 1956), P (Olsen *et al.* 1954), available K by extracting with 1 N NH_4 OAc (pH7) and S by extracting with 0.15%. $CaCl_2$ solution (Chesnin and Yien 1951).

RESULTS AND DISCUSSION

Application of both the sources of sulphur improved the growth and yield attributes of green gram significantly over control (Table 1). Gypsum proved superior to elemental S in respect of these attributes. The maximum values of plant height (57.5 cm), branches/plant (30.0), nodules/plant (22.6) at 30 days and test weight (40.7 g) were recorded with 40 kg S ha^{-1} as gypsum. Increasing levels of sulphur applied through both sources of S significantly increased these parameters over control. All the higher levels of S proved significantly superior to control in respect of these parameters. It may be due to the fact that sulphur enhanced the metabolic activity and promoted chlorophyll, amino acid and protein synthesis. It also enhances the photosynthetic activity finally resulting in to higher number of pods and grains/pod of higher size. Similar results have been reported by Chaurasia and Chaurasia (2010) in soybean and Himanshu *et al.* (2008) in green gram.

Table 1: Effect of levels and sources of sulphur on growth and yield attributes and yield of green gram (mean of 2 years)

Treatment	Plant height (cm)	Branches/ plant	Nodules/ plant 30 DAS	Test weight (g)	Yield (q ha^{-1})		Protein (%)		Protein yield (kg ha^{-1})
					Grain	Straw	Grain	Straw	
Control	52.0	22.0	15.0	37.5	8.37	22.60	18.10	8.12	151.5
ES 10 kg	53.6	24.0	17.0	38.2	9.05	23.98	18.75	8.50	169.6
ES 20 kg	54.5	26.5	18.5	39.0	9.75	25.93	19.75	8.75	192.5
ES 30 kg	55.3	27.8	19.6	39.6	10.10	26.66	20.00	8.94	202.0
ES 40 kg	56.4	29.0	20.8	40.1	10.60	28.09	20.31	9.06	215.3
G 10	54.0	24.7	18.7	38.6	9.45	25.01	19.44	8.62	183.7
G 20	55.1	27.5	20.0	39.5	10.00	26.65	20.25	8.81	202.5
G 30	56.0	28.6	21.5	40.3	10.55	27.96	20.50	9.19	216.2
G 40	57.5	30.0	22.6	40.7	10.90	28.78	20.62	9.37	224.7
CD (P=0.05)	1.03	1.37	1.07	0.32	0.37	0.56	0.38	0.22	11.4

ES = elemental S, G = gypsum

Yield

Application of different sources of S significantly influenced the yield of green gram (Table 1) over control. The grain yield was significantly higher with the application of gypsum than elemental sulphur at all the levels. However, application of 40 kg S ha^{-1} as elemental S resulted in 26.6 and 24.2% increase in grain and straw yield over control, respectively. The highest grain yield was 10.90 q ha^{-1} in the treatment T_9 (40 kg S ha^{-1} as gypsum) and resulted in 30.2% increase over control. The straw yield was significantly higher with the application of elemental S and gypsum over control. The increases in straw yield due to 40 kg S ha^{-1} as elemental S and gypsum were 24.2 and 27.3% over control, respectively. Superiority of gypsum may be attributed to its high solubility resulting in adequate sulphur supply to the crop and then increased the yield of green gram. Gypsum also improves the soil physical condition of soil which ultimately results in better growth of the crop. The poor response of elemental sulphur might be due to low oxidation rate to form sulphate. Similar results were reported by Chaurasia and Chaurasia (2010) in soybean, Kumar *et al.* (2014) in pea, Singh and Sharma (2016) in lucernl and Jat *et al.* (2013) in cowpea.

Table 2: Effect of sources and levels of sulphur on uptake of nutrients (Kg ha^{-1}) in green gram (mean of 2 years)

Treatments	Nitrogen		Phosphorus		Potassium		Sulphur	
	Green	Straw	Green	Straw	Green	Straw	Green	Straw
Control	24.2	29.3	1.7	2.9	3.7	38.0	1.4	2.5
ES 10 kg	27.1	32.6	2.0	3.3	4.1	40.8	1.5	2.8
ES 20 kg	30.8	36.3	2.2	3.9	4.6	44.3	1.7	3.4
ES 30 kg	32.3	38.1	2.4	4.0	4.8	46.1	1.9	3.7
ES 40 kg	34.4	40.7	2.5	4.5	5.2	49.1	2.1	4.5
G 10	29.3	34.5	2.2	3.7	4.3	42.8	1.7	3.5
G 20	32.4	37.6	2.4	4.2	4.8	46.1	2.0	4.0
G 30	34.6	41.0	2.6	4.7	5.2	48.3	2.3	4.5
G 40	36.0	43.2	2.8	5.2	5.4	50.6	2.5	5.1
CD (P=0.05)	1.85	2.20	0.59	0.87	0.92	1.45	0.23	0.41

Quality

The protein content was higher with the application gypsum over elemental sulphur, irrespective of their doses of application. However, there is no significant difference in protein content between these two sources of sulphur. Increasing levels of sulphur increased the protein content in grain and straw of green gram and maximum values were recorded with 40 kg S ha^{-1}. The increase in protein content with S application could be due to the fact that N is an integral part of protein and the protein of green gram contains relatively large quantities of the S containing amino acids like methio nine and cystine. Furthermore, when soils are not sufficient in S, the synthesis of S containing amino acids is hampered, causing an adverse effect on the grain and protein yield. The protein production revealed favourable influence of 40 kg S ha^{-1} supplied through both the sources of S over control. This may be attributed to higher grain yield as well as increased protein content in grain of green gram. The protein yield was higher in cowpea grown with gypsum than that of elemental sulphur. Kumar *et al.* (2014) reported similar results in pea and Upadhyay (2013) in lentil.

Uptake of nutrients

Sulphur application augmented the amount of nitrogen assimilated by green gram grain and straw. Higher values of N uptake with increasing levels of S are apparently the result of favourable effect of the sulphur on nitrogen content coupled with grain and straw yield. Singh and Sharma (2016) reported similar results. Gypsum proved significantly superior to elemental sulphur in enhancing the uptake of nitrogen by green gram (Table 2). The lower values of N uptake with elemental S may be due to lower grain and straw yield of green gram. Gypsum brought about a greater uptake of P by green gram grain and straw over elemental sulphur. However, this increase in P uptake was statistical non-significant. Application of S tended to increase the uptake of P by green gram crop significantly over control. The maximum uptake of P by grain (2.8 kg ha^{-1}) and straw (5.2 kg ha^{-1}) was recorded with 40 kg S ha^{-1}as gypsum. The results corroborate with the finding of Tripathi *et al.* (2011) and Singh and Sharma (2016). This increase in P uptake by the crop may be attributed to grain and straw yield along with improved P content in green gram with S application.The uptake of K was higher with gypsum application over elemental sulphur

(Table 2). This may be attributed to higher grain and straw production of green gram with gypsum application. The uptake of K by the crop increased significantly with S application. It increased from 3.7 kg ha^{-1} at control to 5.4 kg ha^{-1} with 40 kg S ha^{-1} as gypsum. The increase in K uptake by the crop may be associated with higher yield (Ali *et al.* 2013).The sulphur uptake by grain and straw of green gram increased significantly over that of control following the application of sulphur fertilizers. The maximum uptake of S by the crop was observed in grain and straw of green gram treated with gypsum than that of elemental S.Increasing levels of sulphur tended to increase its uptake by the crop over control and maximum values of S uptake were noted with 40 kg S ha^{-1} irrespective of source of sulphur. The increase in S uptake with increasing levels of S seems to be associated with increased S availability with applied S with a concomitant increase in crop yield. Similar results were also reported by Tripathi *et al.* (2011), Misra *et al.* (2011) and Singh and Sharma (2016).

Table 3: Effect of levels and sources of sulphur on soil fertility

Treatment	pH	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	S (mg kg^{-1})
Control	8.2	129.5	10.7	161.0	8.3
ES 10 kg	8.1	129.6	11.0	165.0	8.6
ES 20 kg	8.0	130.9	11.4	168.0	8.8
ES 30 kg	8.0	138.7	11.4	169.0	9.6
ES 40 kg	7.9	139.5	11.6	170.0	10.0
G 10	8.1	130.6	11.1	167.0	8.9
G 20	8.1	132.5	11.1	167.0	9.9
G 30	7.9	140.6	11.2	168.0	10.6
G 40	7.8	145.0	11.3	169.0	11.1
CD (P=0.05)	0.21	2.61	NS	1.45	0.24

Soil fertility

Soil pH tended to decrease with increasing levels of S and gypsum was more effective in reducing soil pH than elemental sulphur. The available nutrients in soil (N, P, K and S) after harvest of the crop were not affected significantly due to sources of sulphur (Table 3). However, higher build up of these nutrients in soil was noted with sulphur levels as gypsum. The residual sulphur availability in soil was significantly influenced by levels of S. Sulphur applied at the rate of 40 kg S ha^{-1} showed significantly higher residual sulphur over other levels of sulphur. Application of sulphur might have enhanced the nutrient availability and showed more response towards the applied sulphur in the deficient soil. The lower residual sulphur of 16.6 kg ha^{-1} was recorded with no sulphur application (control). This might be due to increase in the level of sulphur doses also assured the availability of this nutrient to the crop plant in adequate amount and remained in soil substantial quantity after fulfilling the crop requirement that ultimately improved the available sulphur status in soil with its application. These results were in conformity with the findings of Kumar *et al.* (2014).

From the results, it may be concluded that the application of 40 kg S ha^{-1} through gypsum was found beneficial and effective dose for increasing productivity and quality of green gram under agro-climatic conditions of Meerut region of Uttar Pradesh.

REFERENCES

Ali, J. Singh, S. P. and Singh, S. (2013) Response of fababean to boron, zinc and sulphur application in alluvial soil. *Journal of the Indian Society of Soil Science* **61**(3): 202-206

Chaurasia, A.K. and Chaurasia, S. (2010) Effect of sources and levels of sulphur on growth, yield attributes and yield of soy bean *Annals of Plant and Soil Research* **12**(1) : 32-34.

Chesnin, L. and Yien, C.H. (1951) turbidimetric determination of available sulphate *Soil Science Society of America Proceedings* **15**: 149-151.

Himanshu, Singh, P.C. and Prakash, V. (2008) Response of summer green gram to sulphur, zinc and rhizobium inoculation. *Annals of Plant and Soil Research* **10**: 169-171

Jackson, M.L. (1973) *Soil Chemical Analysis*. Prentice Hall of Indian Private Limited, New Delhi.

Jat, S.R. Patel, B.J., Shivran, A.C., Keori, B.R. and Jat, G. (2013) Effect of phosphorus and sulphur on growth and yield of cowpea under rainfed condition. *Annals of Plant and Soil Research* **15**(2): 114-117.

Kumar R., Lal, J.K., Kumar, A., Agrawal, B.K. and Karmakar, S. (2014) Effect of different sources and levels of sulphur on yield, S uptake and protein content in rice and pea grown in sequence on an acid Alfisol. *Journal of the Indian Society of Soil Science* **62**(2) : 140-143.

Marschner, H. (1986) *Mineral nutrition of higher plants*. Academic Press Inc. USA pp. 26-369

Misra, U.S., Raizada, S. and Pathak, R. K. (2011) Effect of sulphur on yield attributes, yield and quality of pegeonpea under rainfed condition. *Annals of Plant and Soil Research* **13**: 17-19.

Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A. (1954) Estimation of available phosphorus by extraction with sodium bicarbonate. United States Department of Agriculture Circular **939**.

Singh, H. and Sharma, A.K. (2016) Response of lucerne to sulphur application in alluvial soil. *Annals of Plant and Soil Research* **18**(3) : 298-299

Subbiah, B.V. and Asija, G.L. (1956) A rapid procedure for the determination of available nitrogen in soils. *Current Science* **25**: 259-260

Tripathi, H.C., Pathak, R.K., Kumar A. and Dimree, S. (2011) Effect of sulphur and zinc on yield attributes, yield and nutrient uptake in chickpea. Annals of Plant and Soil Research **13**(2): 134-136.

Upadhyay, A.K. (2013) Effect of sulphur and zinc nutrition on yield, uptake of nutrients and quality of lentil in alluvial soils. *Annals of Plant and Soil Research* **15**(2): 160-163.