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Effect of potassium and sulphur on performance of green gram (*Vigna radiata*) in alluvial soil

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ABSTRACT

A field experiment was conducted during Kharif season of 2012 and 2013 on sandy loam soil of a farmer field at Panwari (Agra) to study the effect of graded levels of K and S on growth, yield, quality and nutrient uptake of green gram (Vigna radiata). The experiment was laid out in randomized block design with three levels each of K (0, 30 and 60 kg K_2O ha^{-1}) and S (0,20 and 40 kg S ha^{-1}) and three replications. The results revealed that growth and yield parameters of green gram increased significantly with increasing levels of K upto 60 kg K_2O ha^{-1}. The mean grain (1.15 t ha^{-1}) and straw (2.05 t ha^{-1}) yields with 60 kg K_2O ha^{-1} were 42.0 and 55.3% higher than the control, respectively. Increasing sulphur levels upto 40 kg S ha^{-1} showed significant improvement in plant height, pods/plant, grains/pod and test weight over the control. Similarly, application of 40 kg S ha^{-1} resulted in 18.9% higher grain yield (1.07t ha^{-1}) than the yield obtained in the control (0.90 t ha^{-1}). Similar increase in straw yield was recorded with 40 kg S ha^{-1} by 22.1% over control. The uptake of N, P, K and S in green gram crop increased significantly with increasing levels of potassium. The content and yield of protein in green gram grain increased significantly with the addition of K upto 60 kg K_2O ha^{-1} and sulphur upto 40 kg S ha^{-1}. The nutrient uptake in green gram increased significantly with increasing levels of S and maximum values of nutrient uptake were recorded with 40 kg S ha^{-1}.

Keywords: Green gram, nutrient uptake, potassium, sulphur, quality, yield.

INTRODUCTION

Green gram (*Vigna radiata*), an important Kharif pulse crop, is highly nutritious. However, the productivity of this crop is very low, mainly because of its cultivation on marginal land under reduced rate of fertilizer. Among the several constraints, improper nutritional management is an important impediment for increasing the productivity of legumes. Leguminous crops like green gram has a high potassium (Singh *et al.* 2016) and sulphur (Singh and Sharma, 2016) requirement due to their many functions in plant growth. Potassium is important for growth and development of plants. The quantity of K absorbed by roots is second to that of nitrogen for most of the cultivated plants. Due to intensive cropping, continuous manuring and limited or no use of K fertilizers, the available K status of the soils has depleted. Soils have begun to show response to K application particularly under intensive use of N and P fertilizers. Sufficient amounts of K is required for improving the yield and quality of different crops because of its effect on photosynthesis, water use efficiency and plant tolerance to diseases, drought and cold as well for making the balance between proteins and carbohydrates. Sulphur plays an important role in growth and development of crops. It plays an important role in the formation of S-containing amino acids like cystine (27% S), Cysteine (26% S), methionine (21% S), which act as building blocks in the synthesis of proteins. It has role to play in increasing chlorophyll formation and aiding photosynthesis. Sulpher also plays a role in the activation of enzymes, nucleic acids and forms a part of biotin and thiamine. In recent years, an increased frequency of sulphur deficiency has been observed in crops and S may become a factor limiting yield and quality of crops. Green gram, one of the important kharif pulse crop, is sensitive to the deficiencies of potassium and sulphur. So far, inadequate information is available regarding the effect of K and S on green gram in Agra condition. This study was, therefore conducted to evaluate the effect of K and S on the yield, nutrient uptake and quality of green gram.

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MATERIALS AND METHODS

The present investigation was carried out at Panwari village of Agra district (U.P.) during Kharif season of 2012 and 2013. The soil of the experimental field was sandy loam in texture having pH 7.9, organic C 2.7 g kg^{-1}, available N 155 kg ha^{-1}, available P 8.0 kg ha^{-1}, available K 106 kg ha^{-1} and available S 16 kg ha^{-1}. The nine treatment combinations which were tried in green gram (K-851) consisted of potassium as muriate of potash at three levels viz. 0, 30 and 60 kg K_2O ha^{-1} and sulphur as elemental sulphur at three levels viz. 0, 20 and 40 kg S ha^{-1}. The experiment was laid out in randomized block design with three replications. A basal dose of 20 kg N and 60 kg P_2O_5 ha^{-1} for green gram was applied uniformly in all the plots. Nitrogen supplied by diammonium phosphate was compensated. Full dose of P was applied at the time of sowing. Potassium and sulphur were applied as per treatments at the time of sowing. Green gram was sown on July 1, 2012 and July 4, 2013 and harvested on October 3, 2012 and October 7, 2013. Grain and straw yields of the crop were recorded at maturity. The growth and yield attributes were recorded at harvest. The grain and straw samples were wet digested in HNO_3 and $HClO_4$ mixture and analyzed for P by vanadomolybdate yellow colour method (Jackson 1973), K by flame photometer and S by turbidimetric method (Chesnin and Yien 1951). Nitrogen content in grain and straw of the crop was determined by Kjeldahl method (Jackson 1973). Protein content was computed by multiplying the percentage of N with 6.25.

RESULTS AND DISCUSSION

Growth and yield attributes

All the growth and yield attributing characters were affected significantly by different levels of K and S (Table 1) over control. The significantly taller paltns (77.3 cm), higher pods/plant (22.2), grains/pod (11.4) and test weight (42.4 g) were recorded at 60 kg K_2O ha^{-1} followed by 30 kg K_2O ha^{-1} and control. Potassium plays a crucial role in meristematic growth through its effect on the synthesis of phyto hormones. Among various plant hormones, cytokinin plays an important role in growth of plant.Beneficial effect of K on growth and yield attributes have been reported by Brar *et al.* (2004) and Singh *et al.* (2016). Application S increased the plant height, significantly over the control. This increase may be due to involvement of S in bio synthesis of Indole 3 acetic acid. The maximum value of pods/plant (20.7), grain/pod (12.8) and test weight (41.9 g) were recorded with 40 kg S ha^{-1}. These increases in yield attributes may be attributed to increased growth of plants with S application which later on get converted in to reproductive phase (Jat *et al.* 2012). The uptake of nutrients in grain and straw was worked out by multiplying content values with yield data.

Table 1: Effect of potassium and sulphur on growth and yield attributes of green gram (mean of two years)

Treatment	Plant height (cm)	Pods/ Plant	Grains/ Pod	Test wt. (g)	Yield (t ha^{-1})		Protein (%)		Protein yield (kg ha^{-1})
					Grain	Straw	Grain	Straw	
Potassium (kg ha^{-1})									
0	71.1	15.6	9.2	38.3	0.81	1.32	25.76	8.71	208.6
30	75.0	19.4	10.3	40.1	1.00	1.63	27.14	9.66	271.4
60	77.3	22.2	11.4	42.4	1.15	2.05	27.79	10.05	319.6
SEm±	1.09	0.47	0.15	0.43	0.05	0.10	0.21	0.13	11.5
CD (P=0.05)	2.36	1.02	0.33	0.94	0.11	0.23	0.45	0.28	25.0
Sulphur (kg ha^{-1})									
0	72.1	17.5	9.8	38.6	0.90	1.49	25.70	8.41	231.3
20	74.5	19.0	12.4	40.3	0.99	1.68	26.80	9.35	265.3
40	76.1	20.7	12.8	41.9	1.07	1.82	28.20	10.61	301.7
SEm ±	1.09	0.47	0.15	0.43	0.05	0.10	0.21	0.13	11.5
CD (P=0.05)	2.36	1.02	0.33	0.94	0.11	0.23	0.45	0.28	25.0

Yield

Grain and straw yield of green gram increased significantly with potassium application over the control. The mean yield of green gram grain increased by 23.4 and 42% over control owing to addition of 30 and 60 kg K_2O ha^{-1}, respectively. The corresponding increases in straw yield were 23.5 and 55.3%. As K is essential for grain development, the favourable effect of high doses of K on growth and yield attributes of green gram was mainly responsible for higher grain and straw yields. The results confirm the finding of Singh *et al.* (2016).With successive increase in S levels, grain and straw yields of green gram increased significantly upto 40 kg S ha^{-1}. The highest grain and straw yields were recorded with 40 kg S ha^{-1}, which registered 18.9 and 22.1% higher grain and straw yield over the control. The increase in yield owing to S application may be ascribed to improved growth and yield attributes and yield is directly related to these attributes. Increase in yield with S application is quite obvious as the soil under study was deficient in available S. Jat *et al.* (2012) and Singh *et al.* (2016) also reported similar results.

Quality

Increasing levels of K and S significantly increased the protein content in green gram grain and straw from 25.76 to 27.79% and 8.71 to 10.05% with 60 kg K_2O ha^{-1}, respectively. The corresponding increases in protein content in grain and straw with 40 kg S ha^{-1} were from 25.70 to 28.20% and 8.41 to 10.61%. The increase in protein content owing to S addition might be attributed to its involvement in amino acid synthesis. Singh and Sharma (2016) also reported an increase in protein content in green gram with S application. Corresponding application of K and S also increased the protein yield from 208.6 to 319.6 and 231.3 to 301.7 kg ha^{-1}, respectively. The increases in protein yield were significant upto 60 kg K_2O and 40 kg S ha^{-1} over the control. Protein yield is the function of protein content and grain yield. Since, variation in protein content has genetic and bio-chemical limitation, the protein yield is more influenced by grain yield and thus followed almost trend similar to grain yield. Singh and Sharma (2016) also reported similar results.

Table 2: Effect of potassium and sulphur on uptake of nutrients (kg ha^{-1}) by grain and straw of green gram

Treatment	Nitrogen		Phosphorus		Potassium		Sulphur	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Potassium (kg ha^{-1})								
0	33.2	17.6	2.1	1.8	6.3	25.8	2.1	1.8
30	38.5	24.2	2.8	2.5	9.0	35.4	2.7	2.6
60	47.8	32.3	4.0	4.4	12.0	49.0	3.5	4.1
SEm±	1.87	1.45	0.19	0.16	0.45	1.85	0.24	0.28
CD (P=0.05)	4.05	3.15	0.42	0.35	0.97	4.01	0.53	0.61
Sulphur (kg ha^{-1})								
0	35.2	19.8	2.5	2.3	8.1	31.5	2.1	1.8
20	39.0	24.5	3.0	2.9	9.0	37.1	2.7	2.8
40	45.0	30.1	3.5	3.4	10.2	41.6	3.5	4.0
SEm±	1.87	1.45	0.19	0.16	0.45	1.85	0.24	0.28
CD (P=0.05)	4.05	3.15	0.42	0.35	0.97	4.01	0.53	0.61

Nutrient uptake

The N uptake by green gram grain and straw increased significationaly over control due to 30 and 60 kg K_2O ha^{-1}, (Table 2). This increase in N uptake by green gram grain and straw may be ascribed to higher grain and straw production due to K addition. Brar *et al.* (2004) and Singh *et al.* (2016) observed the same trend of results in pea and cluster bean, respectively. The N uptake by green gram grain and straw increased significantly with sulphur application which is apparently the result of favourable effect of this element on N absorption coupled with

greater green gram grain and straw production. Ali *et al.* (2013) and Singh and Sharma (2016) also indicated an increase in N uptake by fababean and lucerne, respectively due S application. Application of K resulted in significant increase in P uptake due to 30 and 60 kg K_2O ha^{-1} over the control. The results indicated a beneficial effect of K on the obsorption of phosphorus by the crop. Singh *et al.* (2016) also reported an increase in P uptake with K application. The phosphorus uptake by green gram grain and straw tended to increase with sulphur application over control. Singh and Sharma (2016) also reported similar results.

The K uptake by the green gram grain and straw increased from 6.3 to 12.0 and from 25.8 to 49.0 kg ha^{-1}, respectively as the dose of K was increased from 0 to 60 kg K_2O ha^{-1}. This increase in K uptake may be ascribed to higher grain and straw production and K content in green gram due to K application (Brar *et al.* 2004). The addition of 5 also increased K uptake by grain and straw from 8.1 to 10.2 and from 31.5 to 41.6 kg ha^{-1} as the dose of S was increased from 0 to 40 kg S ha^{-1}. Higher uptake of K might be due to higher grain and straw yield as the differences in percent K content were only marginal in all the cases (Ali *et al.* 2013).

Sulphur uptake increased significantly with the increasing levels of K upto 60 kg K_2O ha^{-1} over the control and the increases were 28.6 and 66.6% due to 30 and 60 kg K_2O ha^{-1}, respectively. The increases in S uptake by straw were also significant over control. Ali *et al.* (2013) also reported similar results. The S uptake by grain and straw increased from 2.1 to 3.5 and from 1.8 to 4.0 kg ha^{-1} with 40 kg S ha^{-1}. This increase in S uptake may be ascribed to the higher grain and straw production as well as improvement in S content with its addition (Singh and Sharma 2016).

It may be concluded from the results that, in light textured soils deficient in K and S, application of K and S are required to harvest optimum crop yield, nutrient uptake and quality of produce. Application of 60 kg K_2O and 40 kg S ha^{-1} was found optimum for maintaining higher green gram yield and quality in sandy loam soil of Agra region of Uttar Pradesh.

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