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EFFECT OF PHOSPHORUS AND SULPHUR ON QUALITY, NUTRIENT CONTENT AND UPTAKE AND RESIDUAL SOIL FERTILITY IN GREENGRAM

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ABSTRACT

An experiment was conducted at College of Agriculture, Nagpur to study the effect of different levels of phosphorus and sulphur on quality, nutrient content and uptake and residual soil fertility of greengram during *kharif* season of 2016 -17 in factorial randomized block design with four different levels of phosphorus *viz.*, P_1- 30 kg P ha^{-1}, P_2- 40 kg P ha^{-1},P_3- 50 kg P ha^{-1} and P_4- 60 kg P ha^{-1} and three different levels of sulphur *viz.*, S_1- 10 kg S ha^{-1}, S_2- 20 kg S ha^{-1}, and S_3- 30 kg S ha^{-1} replicated thrice. The soil was clayey, low in nitrogen, medium in phosphorus and high in potassium with pH 7.6. Quality characters and nutrient content and uptake viz., protein content and protein yield kg ha^{-1}, phosphorus content in seed and straw and its uptake, sulphur content in grain and straw and its uptake, available phosphorus and sulphur in soil were significantly more with the application of 60 kg P ha^{-1}. In case of sulphur application, the quality characters and nutrient content and uptake by seed and straw were significantly increased due to application of sulphur @ 30 kg ha^{-1} which was followed with sulphur @ 20 kg ha^{-1}. Based on present investigation it can be inferred that application of 60 kg phosphorus ha^{-1} and 30 kg sulphur ha^{-1} improved the quality characteristics and the uptake of nutrients (viz., P and S) by greengram.

(Key words: Phosphorus, sulphur, nutrient content, nutrient uptake, quality, greengram)

INTRODUCTION

Greengram [*Vigna radiata* (L.)] is one of the important food legume grown in India and third most important pulse crop in India after chickpea and pigeonpea. The greengram is native to India-Burma region of South-East Asia. Greengram is grown principally for its high protein seeds that are used as human food, which can be prepared by cooking, fermenting, milling or sprouting. Greengram contains about 25 per cent protein this being about two third of the protein content of soyabean and twice that of rice. The protein comparatively rich in lysine, an amino acid. Greengram seeds are rich in carbohydrate 57-58 per cent, 1.1 per cent fat, 9.7 per cent water, 3.3-3.8 per cent fibre and 4-4.8 per cent ash also rich in vitamins and minerals. Phosphorus is the second most important nutrient next to nitrogen. Its deficiency is usually the most important single factor which is responsible for poor yield of pulses on all soils. It is the major constituent of protein and nucleic acid. Legume as such have a relatively high phosphorus requirement and being utilized by plant and bacteria .Phosphorus has an important role in legumes. It stimulate early root development, enhances the activity of rhizobia and increases the formation of root nodule there by fixing atmospheric nitrogen.

Phosphorus plays a crucial role in mungbean production, phosphorus is an equally essential nutrient as a constituent of nucleoprotein, enzyme and high energy bonds. Phosphorus plays an important role in the nutrition of legume and improves biological nitrogen fixation. It also plays a vital role in the formation and translocation of carbohydrate, root development, crop maturation and resistance to disease pathogens and improve the greengram quality

The sulphur is essential for protein synthesis. The quality of grain increases with increase in protein and oil percentage. Sulphur also promote nodulation in legume by fixing atmospheric nitrogen. It play vital role in chlorophyll formation. It act as a biological agent in the chain of fatty acids. Sulphur is best known for its role in the formation of amino acid methionine (21%S), cysteine (26%S) and cystine (27%S) and these are building block of proteins, hence it is vital for protein production. Application of Sulphur increases the concentration as well as total uptake of N, P, K, Ca, S, Zn and B at different stages of crop growth.

Sulphur is one of the essential plant nutrients for all plants and is indispensable for the growth and metabolism .The legume crops are more susceptible for sulphur deficiency. Since mungbean is a legume crop it is quite likely that it may respond sulphur. Sulphur has a number of

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oxidizing function in soil and plant nutrition. Moreover, it is also associated with production of crops of superior nutrional and market quality.

MATERIALS AND METHODS

A field experiment was conducted at Agronomy farm, College of Agriculture, Nagpur during *kharif* season of 2016-17.The experiment was laid out in factorial randomized block design with one factor using four different levels of phosphorus *viz.,* 30, 40, 50 and 60 kg P ha^{-1} and three different levels of sulphur *viz.,*10, 20 and 30 kg S ha^{-1} as another factor forming twelve treatment combinations replicated thrice. The soil of experimental plot was clayey in texture, low in available nitrogen (205.36 kg ha^{-1}), medium in phosphorus (19.33 kg ha^{-1}) and organic carbon (0.58 %) and very high in available potash (341.0 kg ha^{-1}) and slightly alkaline in reaction (pH 7.6).

The crop variety PKV-Greengold was used with gross plot size of 3.6 m × 4.8 m and net plot size was 2.7 m × 4. 2 m. Full dose of phosphorus and half dose of nitrogen were applied at sowing and remaining half dose of N was applied at 30 DAS. The quality characters *viz.*. protein content and protein yield (kg ha^{-1}) was estimated with Nuclear Magnetic Resonance (NMR) Sepctrometer (Reaney, 1999) and phosphorus and sulphur were estimated with Olsen's method (Jackson, 1971) and Turbidimetric method (Chesnin and Yein, 1951) after harvest of the crop. The available phosphorus and sulphur in soil before and after harvest were also estimated. Respectively uptake of phosphorus and sulphur were calculated by given formulas

$$\text{Uptake of phosphorus by seed (kg ha}^{-1}\text{)} = \frac{\text{Seed yield (kg ha}^{-1}\text{) x phosphorus content seed (\%)}}{100}$$

$$\text{Total uptake of Phosphorus} = \text{P uptake by seed + P uptake by straw}$$

$$\text{Uptake of sulpur by seed (kg ha}^{-1}\text{)} = \frac{\text{Seed yield (kg ha}^{-1}\text{) x sulphur content in seed (\%)}}{100}$$

$$\text{Total uptake of sulphur} = \text{S uptake by seed + S uptake by straw}$$

RESULTS AND DISCUSSION

Effect on quality parameters

The data pertaining to various quality parameters studied viz., protein content (%) and protein yield (kg ha^{-1}) as influenced by various treatments are presented in table 1.

Phosphorus levels

Data in table 1 revealed that protein content (%) and protein yield (kg ha^{-1}) in greengram were affected due to different levels of phosphorus and protein yield (kg ha^{-1}) was significantly more with the application of 60 kg P ha^{-1} which was at par with the application of 50 kg P ha^{-1} and significantly superior over 30 and 40 kg P ha^{-1}.

Kadam *et al.* (2014) reported that the increase in protein content on addition of phosphorus might be due to significant role of phosphorus promotes root growth and thus increase the uptake of nitrogen ,which resulted in increased protein content. Tiwari *et al.* (2015) reported that application of 60 kg P ha^{-1} significantly increased protein content and protein yield of greengram. The increase in protein yield of greengram was due to the increase in protein content and seed yield due to application of higher levels of phosphorus to greengram.

Sulphur levels

Data revealed that the protein content (%) and protein yield (kg ha^{-1}) of greengram were affected due to application of sulphur and significantly maximum protein yield was obtained with the application of sulphur @ 30 kg ha^{-1} amongst at par with the application of 20 kg S ha^{-1}. Protein content of greengram was highest with the application of sulphur @ 30 kg ha^{-1} amongst all other treatments. Kaisher *et al.* (2010) reported that increased the availability of sulphur and thus nitrogen availability was increased sulphur also synthesized some sulphur containing amino acids like cystine, cysteine and methionine ,thus resulting in increase in the synthesis of protein. Patel *et al.* (2010) reported that highest protein content (22.84 and 20.85) and protein yield (250 and 228 kg ha^{-1}) were observed with the application of 30 kg sulphur ha^{-1}.This might be due to cumulative effect of increase in protein content and seed yield of greengram crop due to sulphur application.

Effect on nutrient content and uptake

Data pertaining to nutrient content and uptake in seed and straw yield in greengram as influenced by various treatments are presented in table 1.

Phosphorus levels

Different levels of phosphorus significantly influenced nutrient content (phosphorus and sulphur) and its uptake by greengram. Highest nutrient content (phosphorus and sulphur (%) and nutrient uptake (kg ha^{-1}) were recorded with the application of 60 kg phosphorus ha^{-1} but it was followed with 50 kg P ha^{-1} and significantly superior over 30 and 40 kg P ha^{-1} to greengram. Kumawat *et al.* (2009) observed the effect of application of phosphorus on greengram and reported that significantly highest phosphorus content of greengram seed (1.34 %) and straw

(0.64 %) were noticed with 60 kg P ha^{-1}.This might be due to increase in availability of phosphorus with increasing level of phosphorus application. Tanwar *et al*. (2002) reported that increased level of phosphorus @ 60 kg ha^{-1} significantly increased the phosphorus uptake by greengram. This might be due to more availability of phosphorus in soil solution at higher levels of phosphorus resulting into more uptake of phosphorus. Tiwari *et al*. (2015) recorded that highest sulphur content in grain and straw was recorded with the application of phosphorus @ 60 kg ha^{-1}. This might be due to increase in availability of sulphur with increasing level of phosphorus application. Kumawat *et al*. (2009) reported that application of phosphorus in deficient soil increased concentration of both phosphorus and sulphur in soil solution. The total phosphorus and sulphur uptake by crop was also increased significantly with increased levels of phosphorus.

Sulphur levels

Different levels of sulphur significantly influenced the nutrient content (phosphorus and sulphur) and their uptake by greengram. Highest nutrient in seed and straw and their uptake was observed with the application of sulphur @ 30 kg ha^{-1} and was followed by 20 kg S ha^{-1}.

Das (2017) observed that highest phosphorus content in seed and straw was registered with the application of sulphur @ 30 kg ha^{-1}. This might be due to synergistic effect of sulphur on phosphorus availability with increasing levels of application. Niraj and Vedprakash (2014) showed that total phosphorus uptake of greengram was significantly influenced by different levels of sulphur application. Highest total phosphorus uptake was recorded with the application of sulphur @ 30 kg ha^{-1}. This might be due to the increased levels of phosphorus application which provided more availability of nutrients resulting into higher growth attributes and higher uptake by plants. Meena *et al*. (2013) reported that application of sulphur @ 30 kg ha^{-1} increased the total nutrient concentration and uptake of P and S by greengram. Different levels of S improved the uptake of S significantly in the seed, stover and as well as total uptake by the crop. Kaisher *et al*. (2010) recorded that the total sulphur uptake by crop increased significantly with increase in the levels of sulphur up to 30 kg ha^{-1}. This might be due to more availability of sulphur resulting into more uptake of sulphur and also the yield was more that had increased the uptake.

Effect on residual soil fertility status in soil

Data pertaining to available nutrients (phosphorus and sulphur %) in soil as influenced by various treatments are presented in table 1.

Phosphorus levels

Different levels of phosphorus significantly influenced available phosphorus in soil. The highest available phosphorus content in soil (27.53 kg ha^{-1}) was recorded with the application of phosphorus @ 60 kg ha^{-1} (P_4) and significantly superior over lower levels but found to be followed by phosphorus @ 50 kg ha^{-1}(P_3). Rajender *et al*. (2002) reported that the residual available phosphorus content in soil was increased with each increasing levels of phosphorus. The highest available sulphur content in soil was also recorded with the application of phosphorus @ 60 kg ha^{-1}.These findings are similar to Mir *et al*. (2013), who observed that the nutrient status of soil after harvest of greengram was significantly influenced with increasing levels of phosphorus in greengram.

Sulphur levels

Residual available phosphorus content in soil was increased with each increasing levels of sulphur. The highest available sulphur content in soil was recorded with the application of sulphur @ 30 kg ha^{-1}. Residual available sulphur content in soil was increased with each increasing levels of sulphur. The highest available sulphur content in soil was recorded with the application of sulphur @ 30 kg ha^{-1}(S_3) and was found significantly superior over lower levels but found to be at par with 20 kg sulphur ha^{-1}(S_2). Meena *et al*. (2013) reported highest available sulphur in soil with the application of sulphur @ 30 kg ha^{-1}.

Interaction effect

Interaction effect between phosphorus and sulphur levels were found significant in case of quality parameters and non-significant in nutrient content and uptake of greengram.

Based on present investigation it can be inferred that application of 60 kg phosphorus ha^{-1} and 30 kg sulphur ha^{-1} improved the quality characteristics (protein content and protein yield) and the uptake of nutrients (viz., P and S) by greengram.

Table 1.Quality parameters and nutrient content and uptake, residual fertility status in soil of *kharif* greengram as influenced by different levels of phosphorus and sulphur

	Quality parameters		P content and uptake				S content and uptake				Available nutrient status	
	Protein content (%)	Protein yield (kg ha^{-1})	P content grain (%)	P content straw (%)	P uptake grain (kg ha^{-1})	P uptake straw (kg ha^{-1})	S content grain (kg ha^{-1})	S content straw (kg ha^{-1})	S uptake grain (kg ha^{-1})	S uptake straw (kg ha^{-1})	Available P in soil (kg ha^{-1})	Available S in soil (kg ha^{-1})
Phosphorus levels(P)												
P_1 - 30 kg P ha^{-1}	19.38	169	0.95	0.44	9.09	8.57	0.49	0.11	4.94	1.83	22.13	17.13
P_2 - 40 kg P ha^{-1}	20.97	226	1.08	0.58	10.64	11.79	0.50	0.12	6.15	2.25	25.75	19.19
P_3 - 50 kg P ha^{-1}	21.35	256	1.17	0.60	12.98	13.22	0.52	0.13	7.51	3.04	26.94	20.09
P_4 - 60 kg P ha^{-1}	22.95	281	1.34	0.64	14.03	14.08	0.53	0.14	8.34	3.66	27.53	21.12
SE (m) ±	-	8.83	-	-	0.36	0.30	-	-	0.29	0.22	0.40	0.34
CD at 5%	-	25.90	-	-	1.07	0.90	-	-	0.85	0.65	1.23	1.05
Sulphur levels (S)												
S_1 - 10 kg S ha^{-1}	19.80	223	1.10	0.55	10.99	10.98	0.56	0.17	6.21	2.26	24.74	17.58
S_2- 20 kg S ha^{-1}	20.85	228	1.15	0.57	11.72	11.96	0.57	0.18	7.21	2.81	25.75	19.35
S_3 - 30 kg S ha^{-1}	22.84	250	1.16	0.58	12.76	12.81	0.59	0.19	7.70	3.40	26.40	21.09
SE (m) ±	-	7.64	-	-	0.33	0.27	-	-	0.19	0.21	0.38	0.32
CD at 5%	-	22.43	-	-	1.02	0.87	-	-	0.55	0.61	1.18	1.02
Interaction (P XS)												
SE (m) ±	-	15.29	-	-	0.66	0.54	-	-	0.38	0.42	0.76	0.64
CD at 5%	-	44.86	-	-	-	-	-	-	-	-	-	-

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