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Performance of Sulphur and Iron on Yield, Yield Attributes and Economics of Green Gram (*Vigna radiata* L.)

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ABSTRACT

A field experiment was conducted out at the Crop Research Farm, Department of Agronomy, school of Agriculture, Suresh Gyan Vihar University, Jaipur (Rajasthan) during *kharif* season of 2018 to assess the performance of sulfur and iron on yield, yield attributes and economics of green gram (*Vigna radiata* L.) cultivar "SUBH-51". The experiment was laid down in Randomized Block Design (RBD), consisting of eight treatments which was replicated thrice for comparing the performance of cultivar "SUBH-51" treated with different sources of sulfur and iron that were applied individually as well as in combination. The results indicates that treatment T_8 that consists of 12.5kg S ha^{-1} as $ZnSO_4$+12.5kg S ha^{-1} as SSP+1.0% $FeSO_4$ as foliar spray at 25 DAS were far better than rest of treatments under study. It recorded significantly highest number of pods plant^{-1} (17.75), numbers of grains pod^{-1} (13.00), 1000 grain weight (36.12 g), harvest index (45.39 %), grain yield (7.90 q ha^{-1}), stover yield (8.02 q ha^{-1}), net return (44018 Rs ha^{-1}) and B:C ratio (1.89) over rest of the treatments.

Keywords Green gram, Sulfur, Iron, Yield attributes, Yield.

INTRODUCTION

It is an ancient and well-known crop among Asian countries for its dietary nutritional value (Shanmugasundaram 2004). The mature whole or split seeds of green gram are used to make a soup (Dal) whereas immature pods and young leaves are used as vegetables. Green gram can be used in both sweet and savoury dishes. It can also be used for extracting or ground into flour called green gram flour or green mung dal flour. Green gram seeds are highly digestible and cause less flatulence than seeds of other pulses. Green gram contains 1.2g fat, 15mg sodium, 0g cholesterol, 62g carbohydrates, 16 g fiber, 24g protein, 15% vitamin C and vitamin A, 20% calcium and 80% iron (Infonet biovision). Being rich in quality protein, minerals and vitamins, green gram or mungbean is inseparable ingredients in the diets of vast majority of Indian populations. When supplemented with cereals, they

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provide a perfect mix of essential amino acids with high biological value.

Sulfur and iron are one of the most important nutrients for all plants and animals. Sulfur is considered as the fourth major nutrient in increasing agricultural crop production after nitrogen, phosphorus and potassium. As being rich source of proteins, green gram needs to be judiciously fertilized with sulfur as this element plays a key role in protein synthesis and chlorophyll development. Sulfur is a constituent of essential amino acids viz., methionine, cysteine and cysteine-the building blocks of protein. Therefore, sulfur fertilization is considered as critical for seed yield and protein synthesis and for improvement in quality of produce in legumes through their enzymatic and metabolic effects (Bhattacharjee *et al*. 2013). In addition, sulfur is required by the rhizobia bacteria in legumes including green gram for nitrogen fixation.

The sulfate ion, SO_4, is the form primarily absorbed by plants. Sulphate is soluble and is easily lost from soils by leaching. As sulphate is leached down into soil, it accumulates in heavier (higher clay content) subsoils. For this reason, testing for sulfur in topsoil is unreliable for predicting sulfur availability during a long growing season. Sulfur deficiency symptoms show on young leaves first. The leaves appear pale green to yellow. The plants are spindly and small with retarded growth and delayed fruiting. For a rapid correction of a deficiency, use one of the readily available sulfate sources. There are many sources of fertilizer sulfur available. Organic matter is the source of organic sulfur compounds and is the main source of soil sulfur in most of the soils. Other sources of are rainfall and fertilizers that contains sulfur. Some readily available sources include ammonium sulphate (24% S), potassium sulfate (17.6% S), gypsum (16.8% S) and zinc sulfate (17.8% S) Maathuis (2009) and McCauley *et al*. (2009).

Iron (Fe) is one of the essential micronutrients that enhances plant growth and reproduction (Welch 1995). Iron was the first nutrient element discovered as essential for plant life. In the plant system, iron plays an important role in a series of metabolic activities involving respiratory enzymes and various photosynthetic reactions. Iron also plays an important role in legumes including green gram for nodule formation and nitrogen fixation. It is not only essential element required by legume host plants but also the rhizobium. Failure of the infecting rhizobia to obtain adequate amounts of iron from the plant results in arrested nodule development and failure of the host plant to fix nitrogen in adequate amounts. Iron has been considered to be associated with chlorophyll formation because any of its deficiency in the plant system results in foliar chlorosis. The extent of iron deficiency in India is yellowish green discolorations appear in newly arising leaves. But veins remain green in color (interveinal chlorosis). Finally whole leaves turn to yellow in color this is called sogai disease. Foliar application of Fe solutions is one of the most widely used methods for correcting Fe deficiency in many crops. This method of application usually circumvents the problems associated with Fe application to the soil. Goos and Johnson (2000) reported that foliar sprays of Fe significantly reduced iron-deficiency chlorosis, while increased seed yield in soybean. Therefore, balanced fertilization of macro and micro nutrients particularly in combination is very important for proper growth, development and high yield production of crop plants including green gram (Sawan *et al*. 2001).

MATERIALS AND METHODS

Experimental site and crop

The present investigation was carried out at Crop Research Farm, Department of Agronomy, School of Agriculture, Suresh Gyan Vihar University, Jaipur (Rajasthan) during *kharif* season of 2018 on sandy loam soil. The experimental site is situated in the eastern boundary of Thar Desert a semi-arid land of Rajasthan at an elevation of 431 meters above sea level with 26.90 North latitude and 75.70 East longitudes.

Experimental design and treatments

The experiment consists of eight treatments including control which were tested under three replications by using Randomized Block Design (RBD). Different sources of sulfur and iron nutrients were used to test the performance of green gram cultivar “SUBH-51”.

The various treatments used in present study includes (T_1 control, T_2 1.0% $FeSO_4$ as foliar spray at 25 DAS, T_3 25kg S ha^{-1} as $ZnSO_4$, T4 25kg S ha^{-1} as SSP, T_5 25kg S ha^{-1} as $ZnSO_4$+1.0% $FeSO_4$ as foliar spray at 25 DAS, T_6 25kg S ha^{-1} as SSP+1.0% $FeSO_4$ as foliar spray at 25 DAS, T_7 12.5kg S ha^{-1} as $ZnSO_4$+12.5kg S ha^{-1} as SSP and T_8 12.5kg S ha^{-1} as $ZnSO_4$+12.5kg S ha^{-1} as SSP+1.0% $FeSO_4$ as foliar spray at 25 DAS). The results indicated that combination of 12.5kg S ha^{-1} as $ZnSO_4$+12.5kg S ha^{-1} as SSP+1.0% $FeSO_4$ as foliar spray at 25 DAS. Nutrient management was done through Urea, SSP, $ZnSO_4$ and $FeSO_4$ to supply the required nitrogen, sulfur, iron and others. Half dose of nitrogen in the form of inorganic source i.e., urea was applied after first irrigation and the second split dose at the time of pod formation whereas full dose of inorganic source of sulfur in the form of $ZnSO_4$, SSP were applied as basal dressing, Iron in the form of $FeSO_4$ as foliar spray at 25 DAS to fulfil the recommended dosage of nitrogen @ 20kg ha^{-1} and 25kg ha^{-1} sulfur of green gram.

Observations during experiment

The data on yield, yield attributes and economics were recorded in all the treatments and were analyzed statistically.

RESULTS AND DISCUSSION

Perusal of data presented in Table 1 revealed that all the yield contributing characters under study showed significant variation when treated with different sources of sulfur and iron nutrients which were either applied individually or in combination.

Yield parameters

The maximum number of pods $plant^{-1}$ (17.75), number of grains pod^{-1} (13.00), 1000 grain weight (36.12 g) and harvest index (45.39%) was recorded with treatment T_8 which consists of 12.5kg S ha^{-1} as $ZnSO_4$+12.5kg S ha^{-1} as SSP+1.0% $FeSO_4$ as foliar spray at 25 DAS. The increased number of pods $plant^{-1}$ reported in T_8 may be due to increased metabolic process in plants with sulfur application through $ZnSO_4$ and SSP which may have promoted meristematic activities resulting in higher apical growth and expansion of photosynthetic surface, which led to higher photosynthesis and hence higher photosynthate accumulation (Chaubey *et al*. 1995). On the other hand, increased availability of iron in the form of $FeSO_4$ helps in absorption of nutrients, which are expected to have efficient photosynthetic mechanism and better equipped for efficient translocation of photosynthates from source to sink, consequently resulting into higher number of pods $plant^{-1}$ (Singh *et al*. 1999).

Yield attributes

Appraisal of the grain yield data presented in Table 2 of green gram cultivar "SUBH-51" showed significant differences when subjected to different sources of nutrients. Significantly maximum yield (7.90 q ha^{-1}) was obtained when plots were treated with

Table 1. Performance of Sulfur and iron on yield attributes of green gram (*Vigna radiata* L.).

	Treatments	Number of pods $plant^{-1}$	Number of grains pod^{-1}	1000 grain weight(g)	Harvest index (%)
T_1	Control	8.48	10.33	26.13	30.06
T_2	1% $FeSO_4$ as foliar spray at 25 DAS	15.26	10.66	30.02	31.23
T_3	25 kg S ha^{-1} as $ZnSO_4$	15.48	11.42	31.73	33.59
T_4	25 kg S ha^{-1} as SSP	15.36	11.33	30.61	33.06
T_5	25 kg S ha^{-1} as $ZnSO_4$+1%$FeSO_4$ as foliar spray at 25 DAS	16.38	12.42	35.48	43.98
T_6	25 kg S ha^{-1} as SSP +1%$FeSO_4$ as foliar spray at 25 DAS	15.55	12.00	32.07	35.89
T_7	12.5 kg S ha^{-1} as $ZnSO_4$+12.5 kg S ha^{-1} as SSP	17.36	12.67	33.77	39.38
T_8	12.5 kg $ZnSO_4$ ha^{-1}+12.5 kg S ha^{-1} as SSP+1% $FeSO_4$ as foliar spray at 25 DAS	17.75	13.00	36.12	45.39
	F- test	S	S	S	S
	SEd (±)	0.98	0.73	1.63	2.51
	CD (P = 0.05)	2.10	1.56	3.51	5.39

treatment T_8 i.e., 12.5kg S ha^{-1} as $ZnSO_4$+12.5kg S ha^{-1} as SSP+1.0% $FeSO_4$ as foliar spray at 25 DAS against significantly minimum (4.73 q ha^{-1}) recorded in control. However, it was statistically at par with treatment T_5 (25kg S ha^{-1} as $ZnSO_4$+1.0% $FeSO_4$ as foliar spray at 25 DAS). Yield is a dependent character that depends upon yield contributing characters. The findings are in conformity with the work reported by Khorgamy and Farin (2009) and Valenciano *et al*. (2010), Saravana Perumal *et al*. (2019) who reported that maximum grain yield obtained in green gram may be due to increased metabolic process in plants due to sulfur application through $ZnSO_4$ and SSP, iron in ferrous sulfate also helps in absorption of nutrients, which are expected to have efficient photosynthetic mechanism and better equipped for efficient translocation of photosynthates from source to sink, consequently resulting into increased grain yield (Singh *et al*. 1999).

Table 2. Performance of Sulfur and iron on yield and economy of green gram (*Vigna radiata* L.).

	Treatments	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
T_1	Control	4.73	5.88	18937	0.87
T_2	1% $FeSO_4$ as foliar spray at 25 DAS	5.43	6.53	23052	1.03
T_3	25 kg S ha^{-1} as $ZnSO_4$	6.45	6.97	25041	1.32
T_4	25 kg S ha^{-1} as SSP	5.47	6.86	22569	1.05
T_5	25 kg S ha^{-1} as $ZnSO_4$+ 1%$FeSO_4$ as foliar spray at 25 DAS	7.79	7.72	41686	1.81
T_6	25 kg S ha^{-1} as SSP +1% $FeSO_4$ as foliar spray at 25 DAS	6.79	7.20	28830	1.50
T_7	12.5 kg S ha^{-1} as $ZnSO_4$+ 12.5 kg S ha^{-1} as SSP	7.17	7.29	36697	1.60
T_8	12.5 kg $ZnSO_4$ ha^{-1}+12.5 kg S ha^{-1} as SSP + 1% $FeSO_4$ as foliar spray at 25 DAS	7.90	8.02	44018	1.89
	F- test	S	S	-	-
	SEd (±)	0.34	0.38	-	-
	CD (P = 0.05)	0.74	0.81	-	-

From the Table 2, it was observed that stover yield of green gram cultivar "SUBH-51" when treated with different sources of sulfur and iron nutrients showed significant variation. Significantly maximum stover yield (8.02 q ha^{-1}) was found with treatment T_8 (12.5kg S ha^{-1} as $ZnSO_4$+12.5kg S ha^{-1} as SSP+1.0% $FeSO_4$ as foliar spray at 25 DAS) against significantly minimum in control (5.88 q ha^{-1}). According to Nadergoli *et al*. (2011) sulfur nutrition enhances cell multiplication, elongation, expansion and is known to impart a deep green color to leaves due to better chlorophyll synthesis, which in turn increases the effective area for photosynthesis and thus resulting increase in stover yield of a plant. In addition to sulfur, availability of iron also helps in absorption of nutrients, which are expected to have efficient photosynthetic mechanism and better equipped for efficient translocation of photosynthates from source to sink, consequently resulting into increased stover yield (Singh *et al*. 1999).

Economic attributes

Data pertaining to economics of green gram in terms of cost of cultivation, gross return, net-return (44018) and benefit cost ratio (1.89) differed significantly due to application of different treatment levels. The highest total cost of cultivation, highest gross and net return as well as benefit cost ratio was recorded in treatment T_8 (12.5kg S ha^{-1} as $ZnSO_4$+12.5kg S ha^{-1} as SSP+ 1.0% $FeSO_4$ as foliar spray at 25 DAS) against minimum recorded in control. Our results are in conformity with Usman *et al*. (2014), Atul and Singh (2017).

CONCLUSION

It is concluded from the present study that treatment T_8 which is applied with 12.5 kg $ZnSO_4$ ha^{-1} + 12.5 kg S ha^{-1} as SSP + 1% $FeSO_4$ as foliar spray at 25 DAS recorded significant improvement in enhancing yield, yield contributing characters and economics of green gram cultivar "SUBH-51" over rest of the treatments used in present investigation. It is therefore suggested and recommended that combination of sulphur and iron fertilizers can give profitable results whenever applied to grow green gram.

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