Original Research Article

Impact of sulphur and iron fertilization on yield attributes and economics of greengram (*Vigna radiata* L.)

ABSTRACT

A field experiment was conducted during *zaid* 2021 at Crop Research Farm. Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.4), low in organic carbon (0.32 %), available N (188.3 kg/ha), available P (34.5 kg/ha) and available K (87.5 kg/ha). The experiment was laid out in Randomized Block Design with 12 treatments each replicated thrice on the basis of one year of experimentation. The treatments which are T_1 - Control (No sulphur + No iron), T_2 - No sulphur + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS, T_3 - No sulphur + 25 kg/ha $FeSO_4$ as basal dose application, T_4 - 20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS, T_5 - 20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + 25 kg/ha $FeSO_4$ as basal dose application, T_6 - 20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + No (0) $FeSO_4$ (Distilled water spraying), T_7 - 40 kg/ha Sulphur as single super phosphate + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS, T_8 - 40 kg/ha Sulphur as single super phosphate + 25 kg/ha $FeSO_4$ as basal dose application, T_9 - 40 kg/ha Sulphur as single super phosphate + No (0) $FeSO_4$ (Distilled water spraying), T_{10} - 40 kg/ha Sulphur as gypsum + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS, T_{11} - 40 kg/ha Sulphur as gypsum + 25 kg/ha $FeSO_4$ as basal dose application and T_{12} - 40 kg/ha Sulphur as gypsum + No (0) $FeSO_4$ (Distilled water spraying) used. The results showed that application of 20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + 25 kg/ha $FeSO_4$ as basal dose application recorded significantly number of nodules per plant (30.16), number of branches per plant (5.93), pods per plant (36.07), seeds per pod (12.07), test weight (37.03 g), seed yield (1421.00 kg/ha), stover yield (3306.00 kg/ha), harvest index (30.06%), gross returns (1,31,196.00 INR/ha), net return (87,806.00 INR/ha) and benefit cost ratio (2.02) as compared to other treatments.

***Key words*:** Greengram, sulphur, iron fertilization, yield attributes and economics.

Intoduction

Greengram [*Vigna radiata* (L.) Wilczek.] is an important legume crop of Asian origin and is widely cultivated in the countries of Asia, Australia and Africa continents **(Yang *et al.* 2008).** Greengram commonly known as mungbean or goldengram is one of the most important short-duration pulse crops grown in India. On an average, pulses contain 22-24 percent protein as against 8-10 percent in cereals. A good amount of lysine is present in the pulses. Greengram belongs to the family Leguminosae, which fixes atmospheric nitrogen and improves soil fertility by adding 20-25kg N/ha. It ranks third among all pulses grown in India after chickpea and pigeonpea. Pulse crops play an important role in Indian agriculture and India is the largest producer and consumer of pulse in the world. Pulses contain a high percentage of quality protein nearly three times as much as cereals. Greengram is a self-pollinated crop and is an important grain legume of the tropical area. Pulses are an important part of profitable agriculture because a large section of population has to rely on this as it is low priced source of protein **(Usman *et al*. 2007).**

Pulse crop, greengram [*Vigna radiata* (L.) Wilczek] every 100 g of edible portion of mungbean seed contains 75 mg calcium, 4.5 mg phosphorus, 24.5 g protein and 348 K Cal energy **(Meena *et al.* 2013).** The protein from pulses is easily digestible, relatively cheaper and has higher biological values. The lysine rich protein of pulses are considered to supplement the deficiency of this amino acid in cereal dietaries and because of this pulses are called as "poor man's protein" **(Ramamurthi *et al*. 2012).** A balanced fertilization of macro and micro nutrients is very important for high yield and high quality products **(Sawan *et al*. 2001)**. Mungbean is considered as poor man's meat as it contains approximately triple amount of protein as compared to rice. Mungbean has more protein contents and better digestability than any other pulse crop **(Tabassum *et al*. 2010).** The residue of greengram is also used as feed for animals and enhances the soil fertility **(Asaduzzaman. 2008).**

In year 2106-17 the total pulse grown on 238.56 lakhs hectare and production of India was 18.25 million tonnes with productivity of 765 kg/ha. India is the largest producer and consumer of pulse in world accounting for 25% of globule production and 50% consumption **(Saraswati *et al*. 2004).** Greengram occupies 30.53 lakh hectare area and contributes 15.09 lakh tonnes in pulse production in the country **(Statistical year book India,2016).** At global level India share prime position in mungbean production.In India, it is cultivated over a wide range of climatic

conditions in the states of Maharashtra, Andhra Pradesh, Rajasthan, Odisha, and Bihar. Rajasthan is one of the major mungbean growing states of the country. Whereas, potential yield level of available improved varieties of mungbean varied between 1200 to 1600 kg/ha **(Meena *et al*. 2013).**

Sulphur is considered as the fourth and essential major nutrient in increasing agricultural crop production after nitrogen, phosphorus and potassium because of its role is synthesis of proteins, vitamins, enzyme and flavoured compounds in plant. A bout 90% of plant sulphur is present in amino acid *viz*. Methionine (21% S), cysteine (26% S) and cysteine (27% S) **(Tandon *et al*. 2002**). These amino acids are the building blocks of protein. It hasa role to play in increasing chlorophyll formation and aiding photosynthesis **(Marschener. 1986)** and due to this sulphur is crucial for pulse crops. Sulphur also enhances quality of grains by increasing its nutritional values. Sulphur fertilization is considered as critical for seed yield, protein synthesis and for the quality improvement of economic produce in legumes through their enzymatic and metabolic effects **(Bhattacharjee *et al*. 2013).** Elemental sulphur is totally unavailable to plants. Gypsum has been found either superior or equal to other S containing fertilizers in pulse crops **(Kumar *et al*. 2014)**. Single superphosphate is a multi-nutrient fertilizer containing 7% P, 12% S and 21% Ca accounts for about half of total S added through important fertilizers in India. Sulphur uptake by several crops revealed that the highest sulphur requirement (12 kg/tonne of yield) has been attributed to oilseeds followed by pulses (8 kg/tonne), millets (5-8 kg/tonne) and cereals (3-4 kg/tonne) **(Tandon. 1986).**

Iron (Fe) is one of the essential micronutrient 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 photosynthesis reactions. Iron also plays an important role in legumes including green gram for nodule formation and nitrogen fixation. Iron has been considered to be associated with chlorophyll formation because any deficiency in the plant system results in foliar chlorosis. 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. **Bera *et al.* (2015)**, reported that foliar sprays of Fe significantly reduced iron deficiency chlorosis. 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

The experiment was carried out during *Zaid* season 2021 at the Crop Research Farm, Department of Agronomy, Naini Agricultureal Institute, Sam Higginbottom University of Agriculture Technology and Sciences (SHUATS), Prayagraj (U.P.), which is situated at 25^{o} 24' 33" N latitude, 81^{O} 51' 11" E longitude and 98 m altitude above the mean sea level. During zaid season 2021 on sandy loam soil soil, having nearly neutral in soil reaction (pH 7.4), organic carbon (0.32%), available nitrogen (188.30 kg/ha K), available phosphorus (34.5 kg/ha) and available potassium (87 kg/ha). The climate of the region is semi- arid subtropical. Treatments comprised of T_1 - Control (No sulphur + No iron), T_2 - No sulphur + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS, T_3 - No sulphur + 25 kg/ha $FeSO_4$ as basal dose application, T_4 - 20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS, T_5 - 20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + 25 kg/ha $FeSO_4$ as basal dose application, T_6 - 20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + No (0) $FeSO_4$ (Distilled water spraying), T_7 - 40 kg/ha Sulphur as single super phosphate + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS, T_8 - 40 kg/ha Sulphur as single super phosphate + 25 kg/ha $FeSO_4$ as basal dose application, T_9 - 40 kg/ha Sulphur as single super phosphate + No (0) $FeSO_4$ (Distilled water spraying), T_{10} - 40 kg/ha Sulphur as gypsum + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS, T_{11} - 40 kg/ha Sulphur as gypsum + 25 kg/ha $FeSO_4$ as basal dose application and T_{12} - 40 kg/ha Sulphur as gypsum + No (0) $FeSO_4$ (Distilled water spraying).

These were replicated thrice and experiment was laid out in Randomized Block Design. Pre harvest observation *viz.* number of nodules per plant, number of branches per plant, dry weight, crop growth rate (CGR) and relative growth rate (RGR). Post-harvest observation *viz.* number of pods per plant, number of seeds per pod, test weight, seed yield, stover yield and Harvest Index were also recorded. In addition to pre and post-harvest observation, economics of treatments was also studied to find out the best treatment combination for higher yield, maximum net return and highest B:C ratio of greengram.

Results and Discussion

Yield attributes

Yield attributes *viz.* number of nodules per plant, number of branches per plant, number of pods per plant, number of seeds per pods, test weight, seed yield, stover yield and harvest index

increased significantly in treatment 5 (20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + 25 kg/ha $FeSO_4$ as basal dose application). However, test weight (37.03) was found to be non-significant in with application of 20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + 25 kg/ha $FeSO_4$ as basal dose application. The maximum number of nodules (30.16) at 45 DAS, maximum number of branches per plant (5.93) at 60 DAS, maximum number of pods per plant (36.07), maximum number seeds per pod (12.17), seed yield (1421.00 kg/ha), stover yield (3306.00 kg/ha) and maximum harvest index (30.06) were recorded in treatment 5 (20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + 25 kg/ha $FeSO_4$ as basal dose application) followed by treatment 11 (40 kg/ha Sulphur as gypsum + 25 kg/ha $FeSO_4$ as basal dose application) and it was found to be at par to treatment 5 (20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + 25 kg/ha $FeSO_4$ as basal dose application).

These results obtained might be due to the important role of sulphur in energy transformation, activation of number of enzymes and also in carbohydrate metabolism. These results in close agreement with the findings of **Sharma *et al*. (2001)** and **Budhar *et al.* (2001).** These results obtained might be ascribed to process of tissue differentiation from somatic to reproductive meristematic activity and development of floral primordial might have increased with increasing sulphur levels, resulting in more number of flowers and longer pods and higher grains yield. Increase in growth parameter may be due to cell division, enlargement and elongation resulting in overall improvement in plant organs associated with faster and uniform vegetative growth of the crop under the effect of sulphur application. These results are in agreement with the finding of **Singh *et al.* (1998)**. Increased 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 higher harvest index **(Singh *et al.* 1999 and Bera *et al.* 2015).**

Economics

It is revelated from the data presented in Table 4. that treatment 5 with application of 20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + 25 kg/ha $FeSO_4$. recorded maximum gross return (1,31,196.00 INR/ha), net return of (87,806.00 INR/ha) and B:C ratio (2.02) followed by treatment 11 (40 kg/ha Sulphur as gypsum + 25 kg/ha $FeSO_4$ as basal dose application).

Conclusion

It is concluded from the experimental finding that the treatment 5 application with 20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + 25 kg/ha $FeSO_4$ was found significantly more productive and can be adopted by the farmers for getting maximum yield and returns from greengram crop as compared to other treatment combination.

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Table No. 1. Effect of sulphur and iron fertilization on yield attributes of greengram.

S.No	Treatments combinations	No. of nodules per plant At 45 DAS	No. of branches per plant At 60 DAS	No. of pods per plant At harvest	No. of seeds per plant At harvest	Test weight (g) At harvest
1.	Control (No sulphur + No iron)	20.72	4.20	27.73	9.87	33.40
2.	No sulphur + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS	23.23	4.53	29.07	10.13	34.43
3.	No sulphur + 25 kg/ha $FeSO_4$ as basal dose application.	25.14	4.60	29.87	10.27	34.87
4.	20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS.	29.34	5.73	34.93	11.73	36.37
5.	20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + 25 kg/ha $FeSO_4$ as basal dose application	30.16	5.93	36.07	12.07	37.03
6.	20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + No (0) FeSO4 (Distilled water spraying)	27.73	5.20	32.87	10.93	35.40
7.	40 kg/ha Sulphur as single super phosphate + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS	27.42	5.33	33.47	11.13	35.73
8.	40 kg/ha Sulphur as single super phosphate + 25 kg/ha $FeSO_4$ as basal dose application.	28.72	5.67	34.27	11.53	36.57
9.	40 kg/ha Sulphur as single super phosphate + No (0) $FeSO_4$ (Distilled water spraying)	26.75	5.07	32.30	10.87	35.27
10.	40 kg/ha Sulphur as gypsum + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS	28.10	5.53	33.87	11.20	36.40
11.	40 kg/ha Sulphur as gypsum + 25 kg/ha $FeSO_4$ as basal dose application.	29.78	5.87	35.93	11.93	36.83
12.	40 kg/ha Sulphur as gypsum + No (0) $FeSO_4$ (Distilled water spraying)	25.77	4.93	31.27	10.53	35.07
	F-Test	S	S	S	S	NS
	SEm±	1.83	0.15	0.70	0.23	0.10
	CD (P = 0.05)	5.35	0.43	2.04	0.68	-

Table No. 2. Effect of sulphur and iron fertilization on yield attributes of greengram.

S.No	Treatments combinations	At Harvest		
		No. of pods per plant	No. of seeds per pod	Test weight (g)
1.	Control (No sulphur + No iron)	27.73	9.87	33.40
2.	No sulphur + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS	29.07	10.13	34.43
3.	No sulphur + 25 kg/ha $FeSO_4$ as basal dose application.	29.87	10.27	34.87
4.	20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS.	34.93	11.73	36.37
5.	20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + 25 kg/ha $FeSO_4$ as basal dose application	36.07	12.07	37.03
6.	20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + No (0) FeSO4 (Distilled water spraying)	32.87	10.93	35.40
7.	40 kg/ha Sulphur as single super phosphate + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS	33.47	11.13	35.73
8.	40 kg/ha Sulphur as single super phosphate + 25 kg/ha $FeSO_4$ as basal dose application.	34.27	11.53	36.57
9.	40 kg/ha Sulphur as single super phosphate + No (0) $FeSO_4$ (Distilled water spraying)	32.30	10.87	35.27
10.	40 kg/ha Sulphur as gypsum + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS	33.87	11.20	36.40
11.	40 kg/ha Sulphur as gypsum + 25 kg/ha $FeSO_4$ as basal dose application.	35.93	11.93	36.83
12.	40 kg/ha Sulphur as gypsum + No (0) $FeSO_4$ (Distilled water spraying)	31.27	10.53	35.07
	F-Test	S	S	NS
	SEm±	0.70	0.23	0.10
	CD (P = 0.05)	2.04	0.68	-

Table No. 3. Effect of sulphur and iron fertilization on economics of greengram.

S.No	Treatments combinations	Cost of cultivation (INR/ha)	Gross Returns (INR/ha)	Net Returns (INR/ha)	B:C Ratio
1.	Control (No sulphur + No iron)	42,360.00	86,793.63	44,433.63	1.04
2.	No sulphur + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS	42,495.00	94,405.00	51,910.00	1.22
3.	No sulphur + 25 kg/ha $FeSO_4$ as basal dose application.	43,110.00	96,584.70	53,474.70	1.24
4.	20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS.	42,775.00	1,22,576.97	79,801.97	1.86
5.	20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + 25 kg/ha $FeSO_4$ as basal dose application	43,390.00	1,31,196.00	87,806.00	2.02
6.	20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + No (0) FeSO4 (Distilled water spraying)	42,990.00	1,08,366.97	65,376.97	1.52
7.	40 kg/ha Sulphur as single super phosphate + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS	42,815.00	1,15,456.00	72,641.00	1.70
8.	40 kg/ha Sulphur as single super phosphate + 25 kg/ha $FeSO_4$ as basal dose application.	43,430.00	1,21,151.97	77,721.97	1.79
9.	40 kg/ha Sulphur as single super phosphate + No (0) $FeSO_4$ (Distilled water spraying)	43,030.00	1,01,274.70	58,244.70	1.35
10.	40 kg/ha Sulphur as gypsum + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS	42,735.00	1,19,960.13	77,225.13	1.81
11.	40 kg/ha Sulphur as gypsum + 25 kg/ha $FeSO_4$ as basal dose application.	43,350.00	1,24,489.70	81,139.70	1.87
12.	40 kg/ha Sulphur as gypsum + No (0) $FeSO_4$ (Distilled water spraying)	42,950.00	98,341.97	55,391.97	1.29

Data not subjected to statistical analysis.