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

ABSTRACT

At Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, UP (India), a field experimentation was undertaken in *zaid* 2021. The experimental plot's soil texture was sandy loam. At the same time pH, low organic carbon, available N, available P and available K were (7.4), (0.32%), (188.3 kg/ha), (34.5 kg/ha) and (87.5 kg/ha) respectively. The experiment was set up in a Randomized Block Design (RBD) with 12 treatments with three replica. The results showed that treatment 5 with application of 20kg/ha Sulphur as Gypsum + 20kg/ha Sulphur as Single Super Phosphate + 25kg/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.

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1. PG Scholar (Agronomy), Department of Agronomy, SHUATS, Prayagraj.

2. Assistant Professor, Department of Agronomy, SHUATS, Prayagraj.

3. Ph. D. Research Scholar (Agronomy), Department of Agronomy, SHUATS, Prayagraj.

4. PG Scholar (Agronomy), Department of Agronomy, SHUATS, Prayagraj.

Intoduction

Greengram [Vigna radiata (L.) Wilczek.] is a significant Asian originated leguminous crop that is widely grown in nations across Asia, Africa and Australia **(Yang *et al.* 2008).**

Greengram, also known as mungbean or goldengram, is one of India's most widely grown short-duration pulse crops. Pulses have 22-24 percent protein on average, whereas grains contain 8-10 percent. The pulses contain a significant amount of lysine. Greengram, a member of the Leguminosae family, contributes 20-25 kg nitrogen per hectare to atmospheric nitrogen fixation and soil fertility improvement **(Singh *et al.* 2020)** After chickpea and pigeonpea, greengram is the third most popular pulse in India. Pulses have roughly three times the quantity of high-quality protein than cereals. Greengram is a self-pollinated legume crop that is pivotal produce in tropical regions. Pulses are an essential aspect of economic agriculture because they provide a low-cost source of protein for a significant portion of the population **(Usman *et al.* 2007).** Edible parts of greengram seeds comprise 24.5 g protein, 75 mg calcium, 4.5 mg phosphorus, and 348 K Cal energy per 100 g. **(Meena *et al.* 2013).** Pulse protein is less expensive, more readily digested, and has more biological value. Pulses are known as "poor man's protein" because of their lysine-rich protein, which is thought to offset the lack of this amino acid in grain diets **(Ramamurthi *et al.* 2012).** Greengram crop residue improves soil fertility and is used as animal feed. India is the world's greatest producer and consumer of pulses, with 25% of worldwide output and 50% of global consumption. **(Saraswati *et al.* 2004).** Greengram is grown on around 30.53 lakh hectares of land in India and contributes 15.09 lakh tonnes to the production of pulses **(Statistical year book India, 2016).**

Sulphur is determined as the fourth and major key nutrient in increasing agricultural crop production after nitrogen, phosphorus and potassium (NPK) because of its vital role in synthesis of proteins, vitamins, enzyme and flavoursome chemicals (in plant). Sulphur is present in form of amino acids such as cysteine (27% S), cysteine (26% S), and methionine (21% S) in plants **(Tandon *et al.* 2002).** Sulphur is crucial for pulse crops because it helps to increase chlorophyll constitution and aids photosynthesis. Sulphur also improves the nutritional content of seeds, which improves their quality. Through metabolic and enzymatic effects, sulphur fertilisation is regarded crucial for seed production, protein synthesis, and quality enhancement of economic products in legumes **(Bhattacharjee *et al.* 2013).** In pulse crops, gypsum has been shown to be superior to or equivalent to other sulphur-containing fertilisers **(Kumar *et al.* 2014).** Single super phosphate, a multi-nutrient fertiliser comprising 7% P, 12% S, and 21% Ca, accounts for over half of the total S added through major fertilisers in India **(Tandon. 1986)**

Iron (Fe) is one of the key nutritional elements for plant enhancement and reproduction is iron (Fe). **(Welch. 1995).** Iron was the first nutrient recognised to be required for plant survival. Iron is involved in a number of metabolic functions in plants, including respiratory enzymes and different photosynthetic events. In legumes, such as greengram, iron is required for nodule development and nitrogen fixation. Because any shortage in the plant system causes foliar chlorosis, iron has long been thought to be linked to chlorophyll production **(Kumawat *et al.* 2006).** One of the most often utilised approaches for treating deficiency of Fe in numerous crops is foliar spraying of Fe solutions. This form of treatment typically avoids the issues that come with applying iron to the soil **(Bera *et al*. 2015)**.

Materials and Methods

The experimentation transpired at the Crop Research Farm of Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, UP, India, which is pinpointed at 25^{o} 24' 33" N latitude, 81^{O} 51' 11" E longitude and 98 m above mean sea level. During the *zaid* season of 2021, on sandy loam soil, with approximately neutral soil reaction, organic carbon, available nitrogen, available phosphorus and available potassium (pH 7.4, 0.32%, 188.30 kg/ha, 34.5 kg/ha and 87 kg/ha respectively). The region has a semi-arid subtropical climate. Treatments comprised of T_1 - Control (No sulphur + No iron), T_2 - No sulphur + 0.5% $FeSO_4$ Foliar spray at 25 and 45 DAS, T_3 - No sulphur + 25kg/ha $FeSO_4$ as basal dose application, T_4 - 20kg/ha Sulphur as Gypsum + 20kg/ha Sulphur as Single Super Phosphate + 0.5% $FeSO_4$ Foliar spray at 25 and 45 DAS, T_5 - 20kg/ha Sulphur as Gypsum + 20kg/ha Sulphur as Single Super Phosphate + 25kg/ha $FeSO_4$ as basal dose application, T_6 - 20kg/ha Sulphur as Gypsum + 20kg/ha Sulphur as Single Super Phosphate + No (0) $FeSO_4$ (Distilled water spraying), T_7 - 40kg/ha Sulphur as Single Super Phosphate + 0.5% $FeSO_4$ Foliar spray at 25 and 45 DAS, T_8 - 40kg/ha Sulphur as Single Super Phosphate + 25kg/ha $FeSO_4$ as basal dose application, T_9 - 40kg/ha Sulphur as Single Super Phosphate + No (0) $FeSO_4$ (Distilled water spraying), T_{10} - 40kg/ha Sulphur as Gypsum + 0.5% $FeSO_4$ Foliar spray at 25 and 45 DAS, T_{11} - 40kg/ha Sulphur as Gypsum + 25kg/ha $FeSO_4$ as basal dose application and T_{12} - 40kg/ha Sulphur as Gypsum + No (0) $FeSO_4$ (Distilled water spraying). The experiment was investigated under three replication by using Randomized Block Design. No. of nodules $plant^{-1}$, No. of branches $plant^{-1}$, dry weight, Crop Growth Rate (CGR), and Relative Growth Rate (RGR) were all observed prior to harvest as pre-harvest observations. Number of pods per plant, number of seeds per pod, test weight, seed yield, stover yield, and Harvest Index were all reported after

harvest as post-harvest observations. Aside from pre and post-harvest observations, the economics of different treatments were investigated to determine the optimal treatment combination for highest yield, maximum net return, and maximum Benefit Cost Ratio (B:C Ratio) of greengram.

Results and Discussion

Yield attributes

Yield attributes *viz.* No. of nodules per plant, No. of branches per plant, No. of pods plant^{-1}, No. of seeds pods^{-1}, test weight, seed yield, stover yield and harvest index increased significantly in treatment 5 (20kg/ha Sulphur as Gypsum + 20kg/ha Sulphur as Single Super Phosphate + 25kg/ha $FeSO_4$ as basal dose application). However, test weight (37.03) was found to be non-significant in with application of 20kg/ha Sulphur as Gypsum + 20kg/ha Sulphur as Single Super Phosphate + 25kg/ha $FeSO_4$ as basal dose application (Table No. 1). The maximum No. of nodules (30.16) at 45 DAS, maximum No. 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) was resulted under treatment 5 with application of 20kg/ha Sulphur as Gypsum + 20kg/ha Sulphur as Single Super Phosphate + 25kg/ha $FeSO_4$ as basal dose application) followed by treatment 11 (40kg/ha Sulphur as gypsum + 25kg/ha $FeSO_4$ as basal dose application) and it was found to be at par to treatment 5 (20kg/ha Sulphur as Gypsum + 20kg/ha Sulphur as Single Super Phosphate + 25kg/ha $FeSO_4$ as basal dose application) (Table No. 1 and Table No. 2).

These results obtained from Table No. 1 and Table No. 2. might be due the vital function of sulphur in energy transfiguration, incentive of a number of enzymes and carbohydrate metabolism. These investigated results in close agreement with the findings of **Budhar *et al.* (2001).** These outcome might be ascribe to process of tissue disparity from somatic to progenetive meristematic venture and floral primitive buildout might have expansion with elevated sulphur levels, produce furthermore to a greather extent of flowers (No.) and prolonged pods and elevated productivity of seeds. These results are in agreement with the finding of **Singh *et al.* (1998).** Increased iron availability aids in the absorption of nutrients, which are predicted to have a more effective photosynthetic mechanism and be better harnessed for efficient photosynthate translocation from source to sink, resulting in a higher harvest index. **(Bera *et al.* 2015).**

Economics

It is revelated from the data exhibited in Table No. 3. that treatment 5 with application of 20kg/ha Sulphur as Gypsum + 20kg/ha Sulphur as Single Super Phosphate + 25kg/ha $FeSO_4$ as basal dose application 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 (40kg/ha Sulphur as gypsum + 25kg/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 $FeSO_4$ as basal dose application was found significantly more productive and can be implemented by the growers for accquiring highest yield and net returns from (greengram) crop as compared to other treatment combination.

References

Bera, Manisankar and Ghosh, Goutam Kumar (2015). Efficacy of sulphur sources on greengram (*Vigna radiata* L.) in red and lateritic soil of west Bengal. *International Journal of Plant, Animal and Environmental Sciences.* Volume-**5**, Issue-2: 109-116.

Bhattacharjee S., Singh P. K., kumar M. and Sharma S. K. (2013). Phosphorus, sulphur and cobalt fertilization effect on yield and quality of soybean (*Glycine max* L.) in acidic soilof northeast India. *Indian J. Hill Farm.* **26**(2): 63-66.

Budhar, M.N. and Tamilselvan, N. (2001). Effect of sulphur on yield attributes and yield of rainfed greengram (*Vigna radiata* L.). *Madras Agriculture Journal.* **88**:7/9,504-505.

Kumar, R., Singh, V.Y., Singh, S., Latare, M.A., Mishra, P.K. and Supriya (2012). Effect of phosphorus and sulphur nutrition on yield attributes, yield of mungbean (*Vigna radiata* L). *Journal of chemical and pharmaceutical Research.* **4**(5):2571-2573.

Kumar, R., Lal, J.K., Kumar, A., Agarwal, 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 Society of Soil Science.*

62(2): 140-143.

Kumawat, R.N., Rathore, P.S and Pareek, N. (2006). Response of moongbean to S and Fe nutrition grown on calcareous soil of Western Rajasthan. *Indian Journal of Pulse Research.* **19**(2): 228-30.

McCauley, R.J., E. Strand. G.L., Lof, T. Schooling and T., Frymark. (2009). Evidence Based systematic review.

Meena, K.K. and Meena, R.S. (2013). Effect of sulphur and iron on yield attribute, yield and net return of greengram.*Indian J. Ecol.* **40**(1): 165-166.

Ramamurthi, K., Geetha, Lakshmi R and Sowmay, Sahadevan. (2012). Institute of Management and technology, Coimbatore. 23-25.

Saraswati, R., Krishnamurti, R. and Singgaram, P. (2004). Nutrient management for rainfed greengram. *Madras Agric. Journal.* **91**:230-233.

Sawan, Z.M., Hafez, S.A. and Basyony, A.E. (2001). Effect of phosphorus fertilization and foliar application of chelated zinc and calcium on seed, protein and oil properties of cotton. *Journal of Agricultural sciences.* **136**:191-198.

Singh, Y.P. and Aggarwal, R.I. (1998). Effect of sulphur sources and levels on yield, nutrient Uptake and quality of blackgram (*Phaselous mungo* L.). *Indian Journal of Agronomy.* 43(3):448-452.

Singh, S.N., Singh, Vikram.,Shukla, M.K. and Prasad, Pradeep (2020). Response of phosphorus levels, liquid biofertilizer and spacing on yield and yield attributes of green gram (*Vigna radiata* L.). *Journal of Pharmacognosy and Phytochemistry.* **9**(1): 1843-1847

Statistical year book. (2016). India Ministry of Statistics & Programmme Implementation, *Government of India.*

Tandon, H.L.S. (1986). *Sulphur Research an Agricultural Production in India.* II Ed. Pub. FDCO, New Delhi, pp 76.

Tandon, H.L.S. and Messick, D.I. (2002). Practice Sulphur Guide. *The Sulphur* Institute, *Washington, D.C.* pp.20.

Tabassum, A., Saleem, M. nad Aziz, I. (2000). Genetic variability, trait association and path Analysis of yield and yield components in mung bean (*Vigna radiata* L.). *Pakistan Journal of Botony.* **42**:3915-3924.

Usman, F., Hssan, A. and Ahmad, A. (2007). Arterial ischemic stroke protein deficiency in pakistan. *Rawal Medical Journal*.**32**: 205-207.

Welch R.M. (1995). Micronutrient nutrition of plants. *CRC CritRevPlant Sci.* 14:49-82

Yang, J.K., Yuan, T.Y., Zang, W.T., Zhour, J.C. and Li, Y.G. (2008). Polyphasi Characterization of munbean (*Vigna radiata* L.) rhizobia from different geographical regions of china. *Soil. Biol. Biochem.* **40**(7):1681-1668.

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 of greengram.

S.No	Treatments combinations	At Harvest		
		Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest Index (%)
1.	Control (No sulphur + No iron)	936.67	2493.33	27.30
2.	No sulphur + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS	1020.00	2605.00	28.13
3.	No sulphur + 25 kg/ha $FeSO_4$ as basal dose application.	1043.33	2685.00	27.98
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.	1326.67	3176.00	29.45
5.	20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + 25 kg/ha $FeSO_4$ as basal dose application	1421.00	3306.00	30.06
6.	20 kg/ha Sulphur as gypsum + 20 kg/ha Sulphur as single super phosphate + No (0) FeSO4 (Distilled water spraying)	1171.67	2916.67	28.06
7.	40 kg/ha Sulphur as single super phosphate + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS	1250.00	2956.00	29.72
8.	40 kg/ha Sulphur as single super phosphate + 25 kg/ha $FeSO_4$ as basal dose application.	1311.00	3101.13	29.72
9.	40 kg/ha Sulphur as single super phosphate + No (0) $FeSO_4$ (Distilled water spraying)	1093.00	2875.00	27.55
10.	40 kg/ha Sulphur as gypsum + 0.5% $FeSO_4$ Foliar spray at 25 DAS and 45 DAS	1299.00	3050.13	29.87
11.	40 kg/ha Sulphur as gypsum + 25 kg/ha $FeSO_4$ as basal dose application.	1348.33	3140.00	30.04
12.	40 kg/ha Sulphur as gypsum + No (0) $FeSO_4$ (Distilled water spraying)	1061.67	2791.67	27.55
	F-Test	S	S	S
	SEm±	37.36	55.51	0.38
	CD (P = 0.05)	109.57	162.79	1.12

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.