Original Research Article

Effect of Sulphur and Boron on growth and yield of Greengram (*Vigna radiata* L.)

ABSTRACT

A field experiment was conducted during *Zaid* season of 2021 at Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, SHUATS, Prayagraj, Uttar Pradesh to evaluate the effect of different levels of sulphur and boron on growth and yield of Greengram. The treatment consists of three different levels of Sulphur (10, 20, 30 kg/ha) and Boron (0.5, 1.0, 2.0 kg/ha). The experiment was laid out in Randomized Block Design with Nine treatments replicated Thrice. Results revealed that significantly higher plant height (39.7cm), plant dry weight (13.27g/plant), number of branches per plant (6.20), Number of pods per plant (22.60), Number of seeds per pod (7.07), test weight (33.01 g), seed yield (1.58 t/ha) and Stover yield (2.67t/ha), were obtained by the application of sulphur at the rate 30 kg/ha along with boron 2 kg/ha. The successive increase in fertilizer levels of sulphur and boron increased the growth parameters, yield attributes and yield of Greengram.

Key words*:* *Greengram, Sulphur, Boron, Growth and Yield.*

Introduction

Pulses have been regarded as the poor man's only source of protein in India. It is cultivated over an area of 23.4 million hectares, with a total production of 18.4 million tonnes. Pulses are important in agriculture and society for a variety of reasons, including their nutritional value, vegetarian diet, capacity to enhance soil fertility, minimal resource and water requirements, and so on. The ever-growing population demand for food cannot be neglected. Cereals and pulses have been major part of their diet for very long period. Cereal production in India have got the momentum that it needs to feed the growing population, but it is not the same in case of pulse production, whose relevance is in providing nutritionally balanced meals for the rising population demands requires rapid attention.

Greengram (*Vigna radiata* L.) is a one of the significant pulse crops grown in the world. It is known for its high nutritional content (24.0% protein, 1.3% fat, 56.6 % carbohydrate, 3.5% minerals, 0.43% lysine, 0.10% methionine, and 0.04% tryptophan)

(Kachroo,1970). It has been primary source of dietary plant protein. It is cultivated in all tropical and subtropical regions of the world. In India cultiv

ation of Greengram has been from prehistoric times, **(Mohbe, *et al*., 2015)**. Among the Indian states, Andhra Pradesh, Madhya Pradesh, Uttar Pradesh, Rajasthan, Bihar, Gujarat, and Orissa are the major producers of Greengram. It is grown on around 300 million hectares in India. It also contributes to the maintenance and improvement of soil fertility by allowing root nodules to fix atmospheric nitrogen in the soil. Rhizobium bacteria create nodules on the roots of Greengram, which fix roughly 35kg of atmospheric nitrogen per hectare **(Yadav, 1992).**

Nutrition management in Greengram is one of the most important aspects in increasing productivity and quality. Multi-nutrient deficit is wreaking havoc on our soils. As a result of sulphur deficiency, pulse yields are being held back significantly. Because of its high protein content, mung bean and other pulses have a greater sulphur need than cereals. Heavy sulphur mining through crop removal and widespread use of high-analysis nitrogen, phosphorous, and potassium (NPK) fertilisers that are sulphur-free, with accompanying leaching losses, are some of the reasons that have contributed to its depletion in Indian soils.

Sulphur is a vital component of plant development, ranking alongside nitrogen and phosphorus in the production of plant proteins. Sulphur insufficiency has been recorded in more than 70 nations throughout the world, including India (**Balasubramanian *et al*., 1990)**. Sulphur is also required for the production of vitamins (biotin and thiamine) (**Dharwe *et al*., 2019)**. It also containing amino acids (cystine, cysteine, and methionine) and legume nodulation (**Kokani *et al*., 2015).** Sulphur treatment resulted in the maximum seed and straw production of Greengram. It is also involved in the activation of enzymes and the production of chlorophyll.

Sulphur deficiency is growing more common all over the world (**Irwin *et al*., 2002 and Scherer, 2001)**. This nutrient presents a danger to crop production sustainability in semi-arid tropical India, where Vertisols cover around 73 million hectares, as well as in similar soils (Kanwar, 1985). Sulphur is rarely used as a fertilizer or as a component of other fertilizer by farmers. As a result, extensive regions of Sulphur shortage have been documented in this agroecological zone **(Ganeshmurthy, 1999).**

Boron is the third most prevalent micronutrient, and it is necessary for the cell walls and membranes of plants to remain stable **(Bassil *et al*., 2004)**. It increases plant growth and yield by increasing leaf area expansion, 1000 test weight, nodule development, seed production, and biological yield. It regulates important cellular processes and metabolic activities and is essential for cell differentiation at all growing tips of plants (meristems) where cell division is happening. Boron treatment maximises the light interception ratio, biomass output, leaf area index, net absorption rate, crop growth rate, and seed yield in pulses, according to **Renuka *et al*. (2002)**. Boron's structural role in cell wall development, cell division, seed development, carbohydrate transport, calcium, and potassium, as well as the stimulation or inhibition of specific metabolic pathways for sugar transport and hormone development, are thought to be the most important functions of boron in plants (**Ahmed *et al*., 2009)**.

Materials and Methods

The experiment was carried out during *Zaid* season of 2021 at Crop Research Farm (SHUATS), Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (UP). The Crop Research Farm is situated at 25˚ 39” 42” N latitude, 81˚ 67” 56” E longitude and 98 m altitude above the mean sea level (MSL). The location is located on the right bank of the Yamuna River. There are all of the necessary facilities for agricultural growing. Prayagraj has a subtropical and semi-arid climate, with temperature extremes in both winter and summer. The trail location has adequate drainage, and all physicochemical properties were assessed using the slandered techniques (Jackson, 1973). Before the crop was planted, soil samples were taken. The soil of the experimental plot is alluvium soil, nearly neutral in soil reaction (pH 7.2), medium in available N (75.3 Kg/ha), available P (31.78 Kg/ha) and available K (92.00 Kg/ha). The treatments combinations are Sulphur (10,20,30 kg/ha) and boron (0.5,1.0,2.0 kg/ha) effect is observed on Greengram. The environmental conditions prevailed during experimental period were favourable for normal growth and development of greengram crop. Randomized Block Design was used to design the experiment. Sulphur treatment included three levels S_1 (10 kg S/ha), S_2 (20 kg S/ha), and S_3 (30 kg S/ha), as well as three levels of Boron B_1 (0.5 kg B/ha), B_2 (1 spray B/ha), and B_3 (2 kg B/ha). There were nine treatments, each of which was replicated thrice. It was sown on March 10th, 2021 with a seed rate of 20 kg/ha and 30*10 cm spacing. Urea, DAP, and Murate of Potash (MOP) were used to meet the requirements for N, P_2O_5, K_2O, and S. In 2001, the Indian Institute of Pulses Research (IIPR) in Kanpur, Uttar Pradesh, published PDM-139 (Samrat), an early maturity and MYMV (Mungbeen Yellow Mosaic Virus) resistant Greengram variety with a seed production potential of 12-15 q/ha for the state of Uttar Pradesh. The possible treatment combinations are T_1: Sulphur 10 kg/ha + boron 0.5 kg/ha, T_2: Sulphur 10 kg/ha + boron 1.0 kg/ha, T_3: Sulphur 10 kg/ha + boron 2.0 kg/ha, T_4: Sulphur 20 kg/ha + boron 0.5 kg/ha, T_5: Sulphur 20 kg/ha + boron 1.0 kg/ha, T_6: Sulphur 20 kg/ha + boron 2.0 kg/ha, T_7: Sulphur 30 kg/ha + boron 0.5 kg/ha, T_8: Sulphur 30 kg/ha + boron 1.0 kg/ha and T_9: Sulphur 30 kg/ha + boron 2.0 kg/ha. Data pertaining to growth parameters were recorded at regular intervals. Post harvest studies include number of pods per seeds, seeds per pod, 1000 seed weight (g) and seed yield t/ha, stover yield and harvesting index were also calculated.

Plant height (cm): Each plot had eight rows, with one row on either side of the plot serving as a border row and the remaining rows serving as sample rows. Every plot sampling row included five tagged plants, and the average height per plant was computed by measuring the plant's height from the base to the tip using a meter scale. Height of the plants was recorded at 15,30,45,60 days after sowing.

Number of nodules: Five plants were taken with the soil ball and washed with gently running water to record the number of root nodules per plant. The number of root nodules per plant was counted and recorded later on.

Dry weight (g/plant): Five sample plants were selected and sundried at regular intervals of 15 days from sowing to harvest and dry weight of sample plants are weighted using electronic weighing machine.

Pods per plant: Five plants were removed from $1m^2$ area in each plot and the number of pods per plant was counted, with an average calculated.

Seeds per pod: Five plants were removed from $1m^2$ area in each plot and the seeds per pod was counted, with an average calculated.

Test weight (g): A random sample of 1000 seeds was taken from the harvested bulk and was weighed.

Seed yield (t/ha): Pods which were collected from each plot were beaten and seeds were collected. They were then weighed to determine the overall seed output.

Harvest index (%): Harvest index was obtained by dividing the economic yield (grain) by the biological yield (grain + straw). It was calculated for each of the plots and was represented in percentage. The following formula was used

Economic yield

$$H.I. = \frac{\quad}{\text{Biological yield}} \times 100$$

Statistical analysis: The data recorded during the course of investigation was subjected to statistical analysis by “Analysis of variance technique”. The significant and non-significant treatment effects were judged with the help of ‘F’ (variance ratio) table. The significant differences between the means were tested against the critical difference at 5% probability level. Statistical analysis was performed for randomized block design **(Gomez *et al.*, 1983)**. The data generated for one season and analysed statistically.

Results and Discussions

Growth

According to the recorded and analyses data, maximum plant height (39.7 cm), number of nodules per plant (11.53) and plant dry weight (13.27 g) were recorded inferior in treatment with application of sulphur 30kg/ha + boron 2kg/ha.

The application of sulphur and boron together had a considerable impact on plant height. The treatment that got sulphur 30kg/ha + boron 2kg/ha had the maximum plant height of 39.7 cm (T9). However, it was found to be at par with application of sulphur 30 kg/ha + boron 1 kg/ha 38.3 cm (T8). Sulphur 10 kg/ha + boron 0.5 kg/ha 28.4 cm (T1) had the shortest plant height of 28.4 cm. AT 60 DAS Maximum root nodules were observed significantly in treatment receiving sulphur 30kg/ha + boron 2kg/ha 11.53 (T9). However, it was found to be at par with application of sulphur 30 kg/ha + boron 1 kg/ha 10.60 (T8). At 60 DAS the significantly higher dry weight was observed in treatment 30 kg/ha S + 2 kg/ha B (13.27 g/plant). However, application 30 kg/ha S + 1 kg/ha B (12.51 g/plant) is statistically at par with 30 kg/ha S + 2 kg/ha B. This might be due to increase in growth attributes and the recognised significance of sulphur in cell division, photosynthetic process, and chlorophyll production. It also increases the formation of root nodules in legumes, which result in more sulphur being accessible throughout the vegetative growth stage and plant development. These findings are consistent with those of **Yadav (2005)**, **Prajapati *et al.* (2013) and Karthik *et al.* (2021)**. **Praveena *et al.* (2018)** has reported that boron shows an crucial role in tissue differentiation together with carbohydrate metabolism it is also a constituent of cell membrane and essential for cell division, maintenance of conducting tissue with Regulatory effect on other element. It is also necessary for sugar translocation in plant and development of new cell in meristematic tissue increases through all growth parameters. **Movalia Janaki *et al*. (2018)** determined the reason for increase in branches. Boron plays an important role in plant metabolism and translocation of photosynthates from source to sink.

Yield and yield attributes

The analysed data pertaining to yield parameters clearly indicates that maximum number of pods per plant (22.60), Number of seeds per pod (7.07), test weight (33.01 g), seed yield (1.58 t/ha) and stover yield (2.67 t/ha) were recorded significantly higher in treatment with application of sulphur 30kg/ha + boron 2.0kg/ha (T9).

Increases in sulphur levels led to significant increases in yield characteristics, seed and straw yields. The balanced nutritional environment appears to be responsible for the improved yield qualities. In plant adequate sulphur supply aided in the development of floral primordia, or reproductive organs, which resulted in the production of pods and seeds. Enhanced plant height, number of leaves per plant, and number of branches per plant (*i.e.*, higher growth characteristics) resulted in increased straw yield due to adequate sulphur application. Boron increases yield by increasing leaf area expansion, 1000 test weight, seed production, and biological yield. Boron regulates important cellular processes and metabolic activities and is essential for cell differentiation at all growing tips of plants (meristems) where cell division is happening **Renuka *et al*. (2002)**.

Conclusion

Based on the present study, it is concluded that application of sulphur 30 kg/ha along with boron 2 kg/ha was found the most suitable dose of fertilizer to be adopted as it recorded higher performance in growth parameter, yield attributes and yield during *zaid* season under eastern Uttar Pradesh conditions.

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Table.1 Effect of Sulphur and Boron on growth of Greengram at (60 Days after sowing)

S. no	Treatment	Plant height (cm)	Nodules/ plant (No.)	Dry weight (g/plant)
1	Sulphur 10 kg/ha + Boron 0.5 kg/ha	28.4	7.53	8.97
2	Sulphur 10 kg/ha +Boron 1 kg/ha	29.3	7.20	9.73
3	Sulphur 10 kg/ha + Boron 2 kg/ha	34.4	8.20	10.17
4	Sulphur 20 kg/ha + Boron 0.5 kg/ha	35.0	7.60	9.39
5	Sulphur 20 kg/ha + Boron 1 kg/ha	36.1	8.60	9.41
6	Sulphur 20 kg/ha + Boron 2 kg/ha	37.4	9.47	11.27
7	Sulphur 30 kg/ha + Boron 0.5 kg/ha	36.7	10.13	11.54
8	Sulphur 30 kg/ha + Boron 1 kg/ha	38.3	10.60	12.51
9	Sulphur 30 kg/ha +Boron 2 kg/ha	39.7	11.53	13.27
	F test	S	S	S
	SEm(±)	0.40	0.63	0.25
	CD (5%)	1.22	1.90	0.76

Note: All the readings mentioned above are 60DAS (days after sowing) readings

Table.2 Effect of Sulphur and Boron on yield attributes of Greengram (at harvest)

S. no	Treatment	Pods per plant (No.)	Seeds per pod (No.)	Test weight(g)	Seed yield (t/ha)	Stover yield(t/ha)	Harvest Index (%)
1	Sulphur 10 kg/ha + Boron 0.5 kg/ha	15.93	5.20	32.29	0.80	2.10	29.94
2	Sulphur 10 kg/ha +Boron 1 kg/ha	18.13	5.27	32.44	0.93	2.21	31.89
3	Sulphur 10 kg/ha + Boron 2 kg/ha	18.47	5.93	33.21	1.09	2.18	35.69
4	Sulphur 20 kg/ha + Boron 0.5 kg/ha	17.20	5.47	32.51	0.92	2.11	32.58
5	Sulphur 20 kg/ha + Boron 1 kg/ha	18.33	5.87	32.34	1.04	1.98	36.99
6	Sulphur 20 kg/ha + Boron 2 kg/ha	20.33	6.40	32.92	1.29	2.32	38.18
7	Sulphur 30 kg/ha + Boron 0.5 kg/ha	19.87	6.13	32.41	1.19	2.53	34.25
8	Sulphur 30 kg/ha + Boron 1 kg/ha	21.00	6.60	32.69	1.36	2.66	36.21
9	Sulphur 30 kg/ha +Boron 2 kg/ha	22.60	7.07	33.01	1.58	2.67	39.75
	F test	S	S	**NS**	S	**S**	S
	SEm(±)	0.19	0.19	0.29	0.04	0.09	1.30
	CD (5%)	0.56	0.58	0.87	0.11	0.26	3.90

Note: All the readings mentioned above are taken at harvest readings.