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Effect of levels of sulphur and boron on growth and yield of sesame (*Sesamum indicum* L.)

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Abstract
A field experiment was conducted during *Kharif* season of 2020 at experimental field of the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj and Uttar Pradesh, India to determine the "Effect of levels of Sulphur and Boron on Growth and Yield of Sesame (*Sesamum indicum* L.)". The experiment consisted of 4 levels of sulphur fertilizer of 10,20,30 and 40 kg/ha and 2 levels of boron fertilizer of 1.5 and 3 kg/ha. The experiment was carried out through a statistical design of Randomized Block Design (RBD) with three replications. Full doses of Nitrogen, Phosphorus and Potassium fertilizers were applied as basal. Variety used was Pragati. Report of the study indicate that, among different levels of sulphur and boron the application of Sulphur at 30kg/ha and Boron at 3 kg/ha produced significantly higher number of branches(6.00), dry weight/plant(22.9g), crop growth rate(2.93 $g/m^2/day$), relative growth rate(0.0048 g/g/day), number of capsules per plant(44.7), number of seeds per capsule(45.3), seed yield(930 kg/ha), stover yield(1602 kg/ha), biological yield(2532.67 kg/ha) and Harvest index(37.32%). However, the application of Sulphur at 30kg/ha and Boron at 3kg/ha was also found to be effective in producing in maximum percentage of oil content (48.32%) and fetched highest gross returns (66,467.00 INR/ha), net returns (41,910.00 INR/ha) and benefit cost ratio (1.70) when compared to the control (RDF).

Keywords: Sesame, sulphur, boron

Introduction

Sesame (*Sesamum indicum* L.) is one of the oil seed crop originated from South West Africa of family Pedaliaceace. It contains 46-64 percent oil with 15-16 per cent protein. About 73 percent of sesame produced in the country is used for oil extraction, 14.5 percent for domestic uses including preparation of sweets candies as condiments, culinary and confectionary purposes whereas 8.3 percent for hydrogenation and 4.2 percent is used for industrial purposes in manufacturing of paints, perfumed oils, pharmaceuticals and insecticides. Since sesame oil cholesterol free, it is also used in food industries and recommended for heart patients. It is called by different names like gingely, til, simsim, biniseed *etc.*, sesame inferred as "Queen of Oilseeds" due to rich source of poly unsaturated stable fatty acids which gives resistance to rancidity. Sesame oil consists of methionine, tryptophan, vitamin (niacin) and minerals (Ca and P). Because of pronounced antioxidant activity of seeds its oil offers higher shelf life and is known as seeds of immortality.

Sulphur as a plant nutrient can play a key role in augmenting the production and productivity of oilseeds and it has a significant influence on quality. Sulphur has long been recognized as one of the essential elements for plant growth particularly for oilseed crops. Sulphur is a constituent of three amino acids commonly found in plants viz., cystine, cystenine and methionine, which are essential components of proteins. Sulphur (S) is essential for the growth and development, plays a key role in plant metabolism, indispensable for the synthesis of essential oils, plays a vital role in chlorophyll formation Ajai Singh *et al*., (2000) [1] required for development of cells and it increases cold resistance and drought hardness and constituent of a number of organic compounds (Shamina and Imamul 2003) [7], oil storage organs particularly oil glands (Jaggi *et al*., 2000) [6].

Boron is unique among the essential mineral micronutrients because it is the only element that is normally present in soil solution as a non-ionized molecule over the pH range suitable for plant growth. It is one of the essential micronutrients required for normal growth of most of the crops. Boron is involved in pollen germination. Its deficiency and toxicity cause lower chlorophyll content and rate of photosynthesis and may induce cell wall synthesis influencing the activity of the plasma lemma and can disturb the maintenance of meristem in the plants. Higher level of boron reduced seed yield and oil content (Bolanos *et al*., 2004) [2]. It has been reported that boron is required for pollen germination and pollen tube growth.

Materials and Methods

The experiment was conducted during the *Kharif* season of 2020 at the Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Science (SHUATS), Prayagraj (Allahabad) (UP). 25.28° N latitude, 81.54° E longitude and at an altitude of 98m above mean sea level. The experiment consists of 4 levels of Sulphur (10 kg/ha, 20kg/ha, 30kg/ha and 40kg/ha) and 2 levels of Boron (1.5kg/ha and 3kg/ha). It was carried out through a statistical design of Randomized Block Design (RBD) with three replications consisted of nine treatments *viz*., T_1: Control (RDF), T_2: Sulphur at 10kg/ha + Boron at 1.5kg/ha, T_3: Sulphur at 10kg/ha + Boron at 3kg/ha, T_4: Sulphur at 20kg/ha + Boron at 1.5kg/ha, T_5: Sulphur at 20kg/ha + Boron at 3kg/ha, T_6: Sulphur at 30kg/ha + Boron at 1.5kg/ha, T_7: Sulphur at 30kg/ha + Boron at 3kg/ha, T_8: Sulphur at 40kg/ha + Boron at 1.5kg/ha, T_9: Sulphur at 40kg/ha + Boron at 3kg/ha. During the growing season, the mean weekly maximum and minimum temperature, relative humidity and rainfall were 35.82 ºC, 26.72 ºC, 91.50%, 50.62% and 11.02 mm respectively. Sesame was sown at a spacing of 30 cm × 10 cm using seed rate of 4 kg/ha. The RDF i.e full dose of Nitrogen (50 kg/ha) was applied through urea. Whereas full dose of P_2O_5 (40 kg/ha) and full dose of K_2O (30 kg/ha) were applied through DAP and MOP at the time of sowing. Observations on growth parameters, yield attributes, yield and oil content of sesame was recorded and their significance was tested by the variance ratio. (F-value) at 5% level (Gomez and Gomez, 1984). Relative economics was calculated as per the prevailing market prices of the inputs and produced during *Kharif* season.

Results and Discussion

Growth attributes

Growth parameters of Sesame *viz*, Plant height (cm), Branches per plant (No.), Leaves per plant (No), Plant dry weight (g/plant), Crop Growth Rate (g/m²/day), Relative Growth Rate (g/g/day) varied due to different treatments and are presented in Table 1. The treatment combination T_7: Sulphur at 10kg/ha + Boron at 3kg/ha resulted in higher number of branches per plant (6), dry weight/plant (22.9g), crop growth rate (2.93 g/m²/day), relative growth rate (0.0048 g/g/day). Whereas treatment combination T_9: Sulphur at 40kg/ha + Boron at 3kg/ha showed dry weight (21.9g) which was statistically at par with treatment T_7. However T_9: Sulphur at 40kg/ha + Boron at 3kg/ha showed plant height of (123.2cm) and no of leaves per plant of (49.3) which is statistically at par with T_7. Plant height at harvest stage increase with increase in Sulphur levels. This might be due to more synthesis of amino acids, increase in chlorophyll content in growing region and improving the photosynthetic activity, ultimately enhancing cell division and thereby increased the crop growth rate. Adequate supply of sulphur results in higher production of photosynthates and their translocation to sink, which ultimately increases the number of leaves. The present findings correlate the findings of previous workers Dubey and Khan. (1993) [5] and Dev and Sarawgi. (2004) [4].

Yield attributes and Yield

Yield attributes such as Capsules per plant (No.), Seeds/capsule (No.), Test Weight (g), Seed yield (kg/ha), Stover Yield (kg/ha), and oil content (%) varied due to different treatment combinations and are presented in Table 2. The treatment combination T_7: Sulphur at 30kg/ha + Boron at 3kg/ha was recorded with higher number of capsules per plant (44.7), number of seeds per capsule (45.3), seed yield (930 kg/ha), Stover yield (1602kg/ha), Biological yield(2532.67kg/ha) and Harvest index (37.32%). While the treatment combination T_9: Sulphur at 40kg/ha + Boron at 3kg/ha showed statistically at par values. Test weight (2.89) was recorded highest in T_9. However, the application of Sulphur at 30kg/ha and Boron at 3kg/ha was also found to be effective in producing maximum percentage of oil content (48.32%) and fetched highest gross returns (66,467.00 INR/ha), net returns (41,910.00 INR/ha) and benefit cost ratio (1.70) when compared to the control (RDF). The increase in number of capsules per plant with the application of sulphur and boron might be due to role of boron in fertility improvement and translocation of photosynthates. The increase in number of seeds per capsule with the application of sulphur and boron might be due to pivotal role amino acid, protein synthesis fertility improvement and in viability of seed filling. Increase in oil content might be due to higher oil synthesis and this is because of increased dose of sulphur. Similar results were reported by Choudhary *et al.* (2016) [3].

Table 1: Effect of levels of Sulphur and Boron on Growth Attributes of Sesame.

Growth attributes						
Treatments	Plant Height (cm) at 90DAS	Branches/ Plant (No.) at 90 DAS	Leaves/ Plant (No.) at 90 DAS	Dry weight (g/plant) at 90 DAS	CGR (g/m²/day) 75-90 DAS	RGR (g/g/day) 75-90 DAS
1. Control	101.1	4.67	36.7	19.0	2.7	0.0044
2. Sulphur at 10kg/ha + Boron at 1.5kg/ha	108.0	4.67	39.3	20.2	1.9	0.0028
3. Sulphur at 10kg/ha + Boron at 3kg/ha	110.7	4.67	40.0	20.5	2.4	0.0036
4. Sulphur at 20kg/ha + Boron at 1.5kg/ha	112.2	4.67	43.3	20.8	2.5	0.0036
5. Sulphur at 20kg/ha + Boron at 3kg/ha	114.0	4.67	44.7	20.9	2.3	0.0033
6. Sulphur at 30kg/ha + Boron at 1.5kg/ha	117.9	5.33	46.7	21.6	2.4	0.0034
7. Sulphur at 30kg/ha + Boron at 3kg/ha	121.2	6.00	48.7	22.9	2.9	0.0048
8. Sulphur at 40kg/ha + Boron at 1.5kg/ha	119.4	5.33	47.3	21.7	2.4	0.0033
9. Sulphur at 40kg/ha + Boron at 3kg/ha	123.2	5.33	49.3	21.9	2.3	0.0033
S.Em(±)	0.36	0.60	0.96	0.25	0.62	0.001
CD(p=0.05)	1.08	-----	2.88	0.75	-----	-----

Table 2: Effect of levels of Sulphur and Boron on yield Attributes, Yield and Oil content of Sesame.

Treatments	Yield attributes Yield Oil							
	Capsules/ Plant (No.)	Seeds/ Capsule (No.)	Test weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Biological yield (kg/ha)	Harvest Index (%)	Oil content (%)
1. Control	33.30	34.70	2.72	628.33	1224.33	1852.67	33.91	44.69
2. Sulphur at 10kg/ha + Boron at 1.5kg/ha	35.30	36.00	2.73	659.00	1330.00	1989.00	33.13	45.37
3. Sulphur at 10kg/ha + Boron at 3kg/ha	36.70	36.70	2.81	707.67	1382.33	2090.00	33.87	45.93
4. Sulphur at 20kg/ha + Boron at 1.5kg/ha	38.00	38.70	2.80	789.67	1449.00	2238.67	35.29	46.03
5. Sulphur at 20kg/ha + Boron at 3kg/ha	38.70	40.00	2.82	826.67	1491.67	2318.33	35.67	46.22
6. Sulphur at 30kg/ha + Boron at 1.5kg/ha	40.70	42.00	2.82	856.00	1513.00	2369.00	36.16	46.85
7. Sulphur at 30kg/ha + Boron at 3kg/ha	44.70	45.30	2.87	960.00	1612.00	2572.00	37.33	48.32
8. Sulphur at 40kg/ha + Boron at 1.5kg/ha	42.70	42.70	2.85	897.00	1543.67	2438.00	36.79	47.12
9. Sulphur at 40kg/ha + Boron at 3kg/ha	43.30	44.00	2.89	914.67	1562.33	2477.00	36.93	47.91
S.Em(±)	0.84	0.73	0.02	7.87	18.75	22.37	0.40	------
CD(p=0.05)	2.50	2.20	0.06	23.59	56.21	67.08	1.20	------

Conclusion

Among all treatment combinations T_7: Sulphur at 30kg/ha + Boron at 3kg/ha, was found to be best by obtaining highest growth and yield attributes and yield. It was found more productive when compared to other treatments and also control.

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