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Effect of sulphur and boron on yield of summer Sesamum (*Sesamum indicum* L.) under medium black calcareous soils of south Saurashtra region of Gujarat

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Abstract
A pot experiment was conducted at Net house, Department of Agricultural Chemistry and Soil Science, College of Agriculture, Junagadh Agricultural University, Junagadh to study the "Effect of sulphur and boron on summer sesamum (*Sesamum indicum* L.) Under medium black calcareous soils during *summer* 2016. The pot experiment comprising of different four levels of sulphur *viz.*, 0, 10, 20 and 30 kg S ha^{-1} and different four levels of boron *viz.*, 0, 1, 2 and 3 kg B ha^{-1} in Factorial Completely Randomization Design replicated three times were tested in the experiment The results revealed that the yield was significantly influenced by the various levels of sulphur and boron. The application of sulphur 30 kg S ha^{-1} and boron 3 kg B ha^{-1} significantly increased the no. of capsule $plant^{-1}$, dry matter yield (15.33 gram $plant^{-1}$) and seed yield (5.66 gram $plant^{-1}$).

Keywords: *Summer*, sesamum**,** sulphur, boron, yield

Introduction
Sesamum *(Sesamum indicum* L.) is an important oilseed crop in India next to groundnut and rapeseed-mustard. *Sesamum indicum* L. (*Syn. Sesamum orientale* L.) which is known variously as sesame, til, gingelly, simsim, gergelim etc. It belongs to order Lamiales, family pedaliaceae. Sesamum was cultivated during the valley civilization and was the main oil crop. It is one of the earliest domesticated plants. Sesamum is regarded as the oldest oil yielding plant known to human being.

Among the different nutrients, sulphur has been recognized as an essential nutrient to plants, Sulphur is one of the 17 essential nutrients required by all plants and this was demonstrated more than one and half century ago by Justus von Liebig in Germany. 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 performs many important roles in the synthesis of oils and vitamins. It is a constituent of three amino acids (cystine, cysteine and methionine) and thus play vital role for protein production (Takker, 1987) [13].

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. Boron is involved in the transportation of sugar, cell membrane, flower fertility, and in the synthesis of cell wall material. It influences transpiration through the control of sugar and starch formation. It also influences cell development and elongation (Bennett, 1993) [3].

Globally, sesamum is grown on 6.57 million hectares with production of 2.94 million tonnes and productivity of 448 kg ha^{-1} (Anonymous, 2013). India is a major producer of this crop in the world. In India, it is cultivated on 17 lakh hectares with total production of 7.48 lakh tonnes. The average productivity of the crop is 439 kg ha^{-1} and highest export (40%) of sesamum in the world (Anonymous, 2013). In Gujarat, sesamum is cultivated in an area of about 2.47 lakh hectare and producing about 1.16 lakh tonnes of seeds. The average productivity of the state is 471 kg ha^{-1} (Anon., 2011). In Junagadh district, it is cultivated in an area of about 26900 ha with production of 14300 MT and productivity of 532 kg ha^{-1} (Anon., 2011).

Generally, sesamum is cultivated as sole or mixed crop during *kharif*, *semi-rabi* and now a day in *summer* season. Sesamum being a short duration crop, fit well into various cropping systems in all the districts of the state except Dang and Valsad.

Materials and methods

A pot experiment was conducted during *Summer* 2016, to study the "Effect of sulphur and boron on summer sesamum (*Sesamum indicum* L.) Under medium black calcareous soil" at Department of Agricultural Chemistry and Soil Science, College of Agriculture, Junagadh Agricultural University, Junagadh. The detail of the methodology followed during the course of study are as below.

The soil of the experimental field was clayey in texture and alkaline in reaction (pH of 8.00 and EC of 0.58 dS m^{-1}). The soil was low in available nitrogen (212.63 kg ha^{-1}), medium in available phosphorus (28.63 kg ha^{-1}), medium in available potassium (257 kg ha^{-1}), medium in available sulphur (10.02 ppm), medium in iron (5.24 ppm), medium in zinc (0.72 ppm), high in manganese (12.78 ppm), medium in boron (0.637 ppm) and high in copper (1.21 ppm). The experiment comprised of total sixteen treatment combinations in which four levels of sulphur (0, 10, 20 and 30 S kg ha^{-1}) and four levels of boron (0, 1, 2 and 3 B kg ha^{-1}) were laid out in Factorial Completely Randomization Design with three replications. The fertilizer application was done with fixed doses of nitrogen at 50 kg ha^{-1} and phosphorus at 25 kg ha^{-1}. Sulphur and boron application was done according to the treatments. The nutrients of N and P were applied by using sources of Urea and DAP. While S and B were applied by using sources of Cosavate (WG 90% S) and boric acid (17 % boron) respectively. The sesamum variety "GT-3" was planted in fourth week of February and seed rate of 6 seed per pot. The crop was raised with all the standard package of practices and protection measures also timely carried out as they required. The experimental data recorded for yield parameters were statistically analyzed for level of significance.

Results and discussion

Effect of sulphur on yield

An assessment of data (Table-1) indicated that different levels of sulphur exerted their significant influence on number of capsule per plant. Application of 30 kg S ha^{-1} (S_3) recorded significantly the higher number of capsule per plant (34.12).The lowest number of capsule per plant 31.03 was observed under control (S_0). These results already agreement with those reported by Maragatham *et al.* (2006) [8].

An assessment of data (Table- 1) indicated that different levels of sulphur exerted their significant influence on dry matter yield per plant. Application of 30 kg S ha^{-1} (S_3) recorded significantly the higher dry matter yield per plant (14.91). The lowest dry matter yield per plant 11.83 was observed under control (S_0). These results already agreement with those reported by Shah *et al.* (2011) and Thentu *et al*. (2014) [14].

Table 1: Effect of varying levels of sulphur and boron on number of capsule $plant^{-1}$, dry matter (g $plant^{-1}$) and seed yield (g $plant^{-1}$) at harvest of sesamum

Treatments	No. of capsule $plant^{-1}$	Dry matter yield (g $plant^{-1}$)	Seed yield (g $plant^{-1}$)
Sulphur levels (kg S ha^{-1})			
S_0 – Control	31.03	11.83	5.12
S_1 – 10	31.35	13.30	5.28
S_2 – 20	32.05	14.33	5.37
S_3 – 30	34.12	14.91	5.50
S.Em±	0.36	0.11	0.06
C.D. at 5%	1.04	0.33	0.18
Boron levels (kg B ha^{-1})			
B_0 – Control	30.86	13.00	5.12
B_1 – 1	31.74	13.40	5.32
B_2 – 2	32.55	13.80	5.39
B_3 - 3	33.39	14.17	5.45
S.Em±	0.36	0.11	0.06
C.D. at 5%	1.05	0.33	0.18
Interaction (S×B)			
S.Em±	0.73	0.23	0.13
C.D. at 5%	NS	0.66	0.37
C.V.%	3.91	2.94	4.23

An assessment of data (Table- 1) indicated that different levels of sulphur exerted their significant influence on seed yield gram per plant. Application of 30 kg S ha^{-1} (S_3) was significantly highest seed yield gram $plant^{-1}$ (5.50), which was found statistically at par with 20 kg S ha^{-1} (S_2) with the value of 5.37. These results already agreement with those reported by Tulasi *et al.* (2014) [16] and Verma *et al*. (2014) [17].

Effect of boron on yield

An examination of data (Table-1) showed that different levels of boron executed their significant influence on number of capsule per plant. Application of 3 kg B ha^{-1} (B_3) recorded significantly the higher number of capsule per plant (33.39), which was found statistically at par with 2 kg B ha^{-1} (B_2) with the value of 32.55. The present findings are in close agreement with the results obtained by Hemantaranjan *et al.* (2000) [6] and Naiknaware *et al.* (2015) [9].

An examination of data (Table-1) showed that different levels of boron executed their significant influence on dry matter yield per plant. Application of 3 kg B ha^{-1} (B_3) recorded significantly the higher dry matter yield per plant (14.17), which was found statistically at par with 2 kg B ha^{-1} (B_2) with the value of 13.80. The present findings are in close agreement with the results obtained by Deasarker *et al.* (2001) [5] and Bhagiya *et al.* (2005) [4].

An examination of data (Table-1) showed that different levels of boron executed their significant influence on seed yield gram per plant. Application of 3 kg B ha^{-1} (B_3) was

significantly highest seed yield 5.45 g plant^{-1}, which was found statistically at par with 1 kg B ha^{-1} (B_1) and 2 kg B ha^{-1} (B_2) with the value of 5.32 & 5.39, respectively. The present findings are in close agreement with the results obtained by Sinha *et al.* (2008) [12] and Patil *et al.* (2006) [10]

Interaction effect on yield

The interaction effect of sulphur and boron levels on number of capsule per plant was found non- significant (Table-1).

An examination of data (Table-2) showed that different levels of boron executed their significant influence on dry matter yield per plant. Application of 3 kg B ha^{-1} (B_3) recorded significantly the higher dry matter yield per plant (14.17), which was found statistically at par with 2 kg B ha^{-1} (B_2) with the value of 13.80.

The interaction effect of sulphur and boron levels on seed yield gram per plant was found significant (Table-3), application of 3 kg B ha^{-1} (B_3) and 30 kg S ha^{-1}(S_3) recorded significantly the higher seed yield per plant at harvest 5.66 g plant^{-1}. The present findings are in close agreement with the results obtained by Karthikeyan and Shukla (2008) [7] and Tripathy *et al*. (2011) [15].

Table 2: Interaction effect of sulphur and boron on dry matter yield (g plant^{-1}) at harvest

Level of sulphur	Level of boron				
	B_0	**B_1**	**B_2**	**B_3**	**Mean**
S_0	10.74	11.46	12.52	12.60	11.83
S_1	12.80	13.11	14.62	14.18	13.30
S_2	13.91	14.22	14.95	14.57	14.33
S_3	14.56	14.80	15.30	15.33	14.91
Mean	13.00	13.40	13.80	14.17	13.00
S.Em±	0.23				
C.D. at 5%	0.66				
C.V.%	2.94				

Table 3: Interaction effect of sulphur and boron on seed yield (g plant^{-1}) at harvest

Level of sulphur	Level of boron				
	B_0	**B_1**	**B_2**	**B_3**	**Mean**
S_0	4.51	5.30	5.32	5.34	5.12
S_1	5.28	5.25	5.60	5.33	5.22
S_2	5.34	5.34	5.37	5.45	5.37
S_3	5.35	5.39	5.60	5.66	5.50
Mean	5.12	5.32	5.33	5.45	5.12
S.Em±	0.13				
C.D. at 5%	0.37				
C.V.%	4.23				

Conclusion

It can be concluded that for obtaining higher yield of *summer* sesamum (*cv*. GT-3) should be fertilized with sulphur 30 kg S ha^{-1} and boron 3 kg B ha^{-1} in medium black calcareous soils of South Saurashtra region of Gujarat.

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