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Short Communication

Response of Sesame (*Sesamum indicum* L.) to Sulphur and Boron in Upland Red Soil of Vindhyan Zone

Arvind, Surendra Singh*, P.K. Sharma and Ashish Rai

Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, 221005, Uttar Pradesh

In India, Sesame (*Sesamum indicum* L.) occupies an area of 19.47 lakh hectares with an average yield of 445 kg ha^{-1}. It is grown extensively during *kharif* season in upland soil. Sulphur (S) is a constituent of some important amino acids namely cystine, cysteine and methionine. It is necessary for chlorophyll formation and helps in synthesis of oil. Boron (B) is involved in the transportation of sugar, cell membrane, and 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). The S and B deficiency of oilseeds growing areas mainly in upland red soils of Vindhyan zone is rated to be very poor and widespread soil deficiencies of these two nutrients have earlier been reported (Singh *et al.* 2015). In S and B deficient soils, generally all crops responses to S and B application but in case of oilseeds, the response is higher. Since there is paucity of information on oilseeds to S and B in upland red soil of Vindhyan zone, the present investigation was conducted under pot condition to study the response of sesame to application of S and B levels on yield attributes, yield and nutrients uptake.

Bulk sample of upland red soil (0-15 cm depth) was collected from Rajiv Gandhi South Campus of Banaras Hindu University, located in Barkaccha, Mirzapur district in Vindhyan zone. This zone has an average elevation of 80 m and lies between the parallels of 23.52° and 25.32° N latitude and 82.7° and 83.33° E longitude. The climate of the zone is warm with an average annual temperature of 26.0 °C with rainfall of 975 mm. A pot experiment was conducted with sesame (CV-G4) during *kharif* season of 2017 in the Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (U.P.). Altogether, 32 pots were taken and filled with 10 kg of soil in each pot after processing. The experimental soil had silt loam texture with slightly acidic pH 6.21, EC 0.33 dS m^{-1}, low organic carbon 3.3 g kg^{-1}, low available S 5.75 mg kg^{-1} and low available B 0.44 mg kg^{-1}. The available N, P and K content of the soils were 112.8, 7.34 and 160.3 kg ha^{1}, respectively. The eight treatments consisted of: T_1: Control (without N, P and K fertilizers), T_2: Recommended dose of N, P and K fertilizers @ 60:60:30 kg ha^{-1} (RDF), T_3: RDF + 25 kg S ha^{-1}, T_4: RDF + 50 kg S ha^{-1}, T_5: RDF + 1 kg B ha^{-1}, T_6: RDF + 2 kg B ha^{-1}, T_7: RDF + 25 kg S + 1 kg B ha^{-1}, T_8: RDF + 50 kg S + 2 kg B ha^{-1}. The experiment was laid down in completely randomized design (CRD) with four replications. Basal application of half dose of N and full amount of P and K were made as per the treatments at the time of sowing and mixed with soil uniformly. The remaining dose of N was applied at 35 days after sowing of the crop. The sources of N, P and K were urea, DAP and MOP, respectively. The levels of S and B were applied in solution form and mixed with the soil in treated pots. The sources of S and B were gypsum (18% S) and borax (10.5% B), respectively. Standard procedures were adopted for chemical analysis of soil pH, EC (Jackson 1973); OC (Walkley and Black 1934); available N by alkaline permanganate method (Subbiah and Asija 1956); available K by ammonium acetate method (Hanway and Heidel 1952); available P (Bray and Kurtz 1945); 0.15% $CaCl_2$ extractable available S (Williams and Steinbergs 1959) and hot-water soluble available B (Berger and Truog 1939). Nitrogen content in plant samples were estimated by semi-auto nitrogen analyzer after digesting the plant material by H_2SO_4. Total P, K and S contents were determined after digesting the plant material with di-acid mixture on the ratio of 9:4 (HNO_3:$HClO_4$) (Piper 1966). Boron content in plant samples was estimated

*Corresponding author (Email: ssinghssac@yahoo.co.in)

Table 1. Effect of levels of sulphur and boron application on yield attributes and yields of sesamum

Treatments	Plant height (cm)	No. of branches plant^{-1}	No. of capsule plant^{-1}	No. of seed capsule^{-1}	Stover yield (g pot^{-1})	Grain yield (g pot^{-1})	Test weight (g)
T_1: Control	38.9	2.31	5.25	31.5	24.4	9.60	2.51
T_2: RDF	49.0	2.67	13.4	39.8	35.1	17.3	2.63
T_3: RDF + 25 kg S ha^{-1}	51.5	2.89	15.4	41.8	40.0	20.3	2.67
T_4: RDF + 50 kg S ha^{-1}	55.0	2.98	16.9	43.3	44.1	22.2	2.72
T_5: RDF + 1 kg B ha^{-1}	53.8	2.69	15.6	41.3	35.9	20.0	2.67
T_6: RDF + 2 kg B ha^{-1}	54.9	2.85	16.3	42.0	39.0	21.3	2.72
T_7: RDF + 25 kg S ha^{-1}+ 1 kg B ha^{-1}	56.0	3.21	17.9	44.0	47.7	22.9	2.75
T_8: RDF + 50 kg S ha^{-1} + 2 kg B ha^{-1}	56.2	3.37	17.8	45.8	51.9	24.4	2.81
CD (P=0.05)	2.10	0.22	0.90	3.6	1.96	1.27	0.22

RDF = Recommended dose of N, P and K fertilizers (60 kg N, 60 kg P_2O_5 and 30 K_2O kg ha^{-1})

by dry ashing in muffle furnace followed by Azomethine-H method (John *et al*. 1975).

Yield attributes and yield of sesame as influenced by S and B application are given in table 1. A critical perusal of the data would reveal that levels of S and B application singly or in combination had resulted in an increase in yield attributes of crop over recommended dose of N, P and K fertilizers (RDF). The plant height was recorded maximum (56.2 cm) with 50 kg S and 2 kg B ha^{-1} application over the recommended dose of NPK fertilizers. Application of S and B might have increased availability of S and B in highly N and S deficient upland soil which favoured better utilization by the crop. Similar results were reported by Khurana and Arora (2012). Number of branches plant^{-1} was increased significantly with application of S and B either singly or its combination and results were also confirmed to those reported by Vaghani *et al.* (2010). Application of 25 kg S along with 1 kg B ha^{-1} had resulted significantly higher number of capsule plant^{-1} (17.9). The lowest number of seeds ca1psule (31.5) was recorded under unfertilized N, P and K (control). Increase in number of capsules plant^{-1} with addition of S and B might be due to increase in S and B concentration in soil solution which is favourable in translocation of photosynthates. Application of 50 kg S and 2 kg B ha^{-1} recorded higher number of seed capsule^{-1} (45.8), which was statistically at par with application of 25 kg S and 1 kg B ha^{-1} (44.0). Similar views were reported by Abraham and Thenua (2010) and Kar and Saren (2013). The increase in number of seeds capsule^{-1} might be due to pivotal role in synthesis of amino acid and protein with addition of S and B. Application of 50 kg S and 2 kg B ha^{-1} resulted significantly higher yields of stover and seed plant^{-1} at harvest over recommended dose of NPK fertilizers (51.9 and 24.4 g pot^{-1}, respectively). Gitte *et al*. (2005) also reported that application of B, owing to its greater availability in soils for plant growth parameters like plant height, branches plant^{-1} and leaf area index ultimately dry matter plant^{-1}, which might be due to role of B in cell elongation, cell division and biomass accumulation. The data showed that S and B levels manifested their significant influence on test weight. Application of 50 kg S and 2 kg B ha^{-1} recorded highest test weight (2.81 g), which was found statistically at par with application of 25 kg S and 1 kg B ha^{-1} (2.75 g). Similar results were obtained by Jeena *et al.* (2013). It has also been reported that S and B application significantly influence dry matter and seed yield of mustard grown in higher S and B deficient upland red soil of Mirzapur (Jaiswal *et al*., 2015).

Total N, P, K, S and B uptake by sesame was increased considerably with applied S and B levels (Table 2). Higher uptake of N, P, K, S and B was obtained with 50 kg S ha^{-1} and 2 kg B ha^{-1} along with RDF over control. This may probably due to adequate availability of these nutrients with added NPK fertilizers in impoverished upland soil, which resulted in higher N, P and K uptake by sesame crop.

Sulphur and B application had significant increase in S and B uptake by seed and stover. Application of S @ 50 kg S and 2 kg B ha^{-1} along with RDF produced significantly higher total S and B uptake by crop (140.9 and 15.7 mg pot^{-1}, respectively). Since soil was highly deficient in both S and B, higher uptake of S and B by crop may be expected in upland red soil. Similar results were also reported by Singh *et al.* (2006) and Jeena *et al*. (2013).

It is inferred from the present investigation that soil application of @ 50 kg S and 2 kg B ha^{-1} along with RDF is beneficial to produce higher yield of

Table 2. Effect of sulphur and boron levels on uptake of total N, P, K, S and B by sesame

Treatments	Nitrogen (mg pot^{-1})			Phosphorus (mg pot^{-1})			Potassium (mg pot^{-1})			Sulphur (mg pot^{-1})			Boron (mg pot^{-1})		
	Grain	Stover	Total	Grain	Stover	Total	Grain	Stover	Total	Seed	Stover	Total	Seed	Stover	Total
Control	41.4	61.0	102.5	18.0	35.0	53.0	70.6	179.0	249.7	3.96	8.20	12.2	3.14	0.36	3.51
RDF	150.0	229.7	379.8	53.9	88.3	142.3	263.1	534.0	797.1	8.00	27.9	35.9	3.16	1.31	4.26
RDF + 25 kg S ha^{-1}	175.7	262.8	438.5	64.4	102.5	166.9	314.1	619.0	933.1	22.7	54.3	77.0	3.68	1.71	5.39
RDF + 50 kg S ha^{-1}	191.8	290.9	482.5	78.4	111.2	189.6	330.0	657.6	987.7	27.4	88.1	115.3	4.20	3.39	7.60
RDF + 1 kg B ha^{-1}	173.6	236.1	409.7	73.7	91.5	165.2	303.6	544.1	847.7	8.20	23.9	32.0	6.82	3.25	10.0
RDF + 2 kg B ha^{-1}	186.0	258.9	444.3	68.1	99.5	167.6	324.3	595.5	919.8	17.2	34.2	51.5	9.11	3.41	12.5
RDF + 25 kg S ha^{-1}+ 1 kg B ha^{-1}	200.9	316.3	517.2	75.3	120.8	196.0	363.5	754.5	1112.0	25.8	63.8	89.7	9.46	4.66	14.1
RDF + 50 kg S ha^{-1}+ 2 kg B ha^{-1}	213.9	345.5	559.4	88.9	134.6	223.5	383.0	813.0	1196.1	35.9	105.0	140.9	10.6	5.06	15.7
CD (P=0.05)	11.5	14.0	-	12.4	2.34	-	10.6	13.5	-	1.40	8.47	-	0.55	0.55	-

RDF = Recommended dose of N, P and K fertilizers (60 kg N, 60 kg P_2O_5 and 30 kg K_2O kg ha^{-1})

sesame grown in highly S and B deficient upland red soil of Vindhyan zone of eastern part of Uttar Pradesh. Optimum level of S and B should be applied along with the existing recommended dose of N, P and K fertilizers for enhancing productivity of sesame. The existing soil testing laboratories should be upgraded to test available S and B besides routine soil tests and balanced fertilization (N, P, K, S and B) be made accordingly.

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