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Effect of boron and sulphur on performance of gram (*Cicer arietinum*)

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ABSTRACT

An experiment was conducted during 2001-02 and 2002-03 to study the effect of boron and sulphur on the growth and yield of gram *(Cicer arietinum* L.*)*. A combined dose of 10 kg borax + 30 kg sulphur/ha gave significantly maximum average seed yield (15.98 q/ha), which outyielded other treatments except the application of 0.25 % boric acid (thrice) + 30 kg sulphur/ha. Single application of boron gave higher yield than of sulphur. Pods/plant, and 100-seed weight were also significantly higher under combined application of boron and sulphur. Net return was maximum (Rs 21,082/ha) under 10 kg borax + 30 kg sulphur/ha. Boron concentration and uptake increased significantly under combined application than the control or single application of these two elements.

Key words : Boron, Sulphur, Gram, 100-seed weight, Concentration, Uptake

In calcareous belt of north Bihar, 48% soils are deficient in boron and 20% in sulphur (Sakal *et al.*, 1996). Chickepa suffers from B deficiency in such highly calcareous soils. It also requires more sulphur, which is also found deficient in many pockets of gram-growing areas (Sakal *et al.*, 1998). In Begusarai and Patna regions there is a large area of chickpea whose productivity has gone down due to deficiency of boron, and sulphur. Therefore the present experiment has been planned to study the effect of boron and sulphur on the yield of chickpea in north Bihar.

MATERIALS AND METHODS

A field experiment was conducted at Krishi Vigyan Kendra, Khodawandpur, during winter seasons of 2001-02 and 2002-03. The soil was sandy loam, calcareous with pH 8.5, medium in organic carbon (0.46%) and available phosphorus (20.6 kg/ha) and fairly rich in potassium (291 kg/ha). The available boron and sulphur were 0.17 and 6.25 mg/kg, below their critical limits of 0.53 and 10 mg/kg respectively in the calcareous soils of north Bihar.

The treatments comprised six boron- and sulphur-management treatments, *viz.* T_1, the control; T_2, basal application of borax @ 10.0 kg/ha; T_3; foliar application of 0.25% boric acid solution at 30, 45 and 60 days after sowing (DAS); T_4, basal application of sulphur @ 30 kg/ha; T_5, borax @ 10 kg/ha along with sulphur @ 30 kg/ha as basal; and T_6, sulphur @ 30 kg/ha as basal with foliar spray of 0.25% boric acid solution at 30, 45 and 60 DAS. The experiment was laid out in randomized block design with four replications. Sulphur was applied in the form of single superphosphate (SSP). The recommended doses of N and P were 20 and 40 kg/ha. Diammonium phosphate (DAP) @ 87 kg/ha and urea @ 9.4 kg/ha were applied under treatments T_1, T_2 and T_3, whereas SSP @ 231.0 kg/ha, DAP @ 7.0 kg/ha and urea @ 40.7 kg/ha were applied under treatments T_4, T_5 and T_6 to balance the N, P and S nutrients in different treatments. The crop was sown in line at 30 cm row spacing with a seed rate of 100 kg/ha on 19 November in 2001 and 12 November 2002. Weeding was done at 40 days after sowing and one light irrigation was applied at 55 days after sowing. The variety sown was white-seeded P 267. The crop was harvested on 17 April 2002 and 16 April 2003. Boron in plant extract was analysed colorimetrically using carmine in H_2SO_4 system and the total S by turbidimetric method using $BaCl_2$. The available-B in soil samples was extracted with boiling water and its content was evaluated colorimetrically using carmine in H_2SO_4 system.

RESULTS AND DISCUSSION

Yield attributes and yield

Yield attributes were significantly influenced by the application of boron and sulphur (Table 1). Highest pods/plant and test weight were recorded under 10 kg borax/ha + 30 kg S/ha. However, it was on a par with that of

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0.25% boric acid solution sprayed thrice + 30 kg S/ha. The minimum test weight was recorded in the control, where neither boron nor sulphur was applied. For pods/plant the control was on a par with 30 kg S/ha. Borax 10 kg/ha alone or 3 sprays of boric acid solution @ 0.25% were at par but produced more number of pods/plant than S alone or the control (without S or B). B or S alone recorded significantly higher test weight than the control, but were at par. The effect of S was more pronounced in test weight, because it plays a vital role in improving the vegetative structure for nutrient absorption, and provides strong sink strength through the development of reproductive structure as well as the production of assimilates to fill economically important sink (Sharma and Singh, 2005).

The highest seed and straw yields were recorded under 10 kg borax/ha + 30 kg S/ha, which was on par with that of 0.25 % boric acid sprayed thrice + 30 kg S/ha and 10 kg B/ha alone. These treatments recorded significantly higher seed and straw yields than S @ 30 kg/ha alone. The lowest yield was recorded under the control (without S and B). The marked response in yield due to B and S application may be attributed to the deficiency of available B and S in the experimental soil, as their values were less than the critical limits of 0.53 and 10.0 ppm respectively for such calcareous soils. Sakal *et al.* (1998) also reported higher yield of chickpea on application of B and S.

Nutrient uptake and net return

The B and S concentration in seed and straw was significantly affected due to different treatments (Table 2). Significantly higher concentration and uptake of Band S were recorded under 10 kg borax/ha + 30 kg S/ha than all other treatments. However, it was on a par with that of 0.25% boric acid sprayed thrice + 30 kg S/ha. Sakal *et al.* (1998) also reported similar findings.

There was significant effect of treatments on net return of gram (Table 2). Maximum net return was recorded under 10 kg borax/ha + 30 kg S/ha, which was on a par with that of 0.25 boric acid spray + 30 kg S/ha. Application of 10 kg borax/ha alone or 0.25% boric acid spray alone gave significantly higher net return than 30 kg S/ha as well as control. Data clearly indicated that boron has more beneficial effect than sulphur, which finally raised the net return, though 30 kg S/ha recorded significantly higher net return than the control.

Table 1. Effect of boron and sulphur application on yield attributes as well as seed and straw yields of gram (mean data of 2 seasons)

Treatment*	Pods/ plant	Seeds/ pod	Test weight (g)	Seed yield (q/ha)	Straw yield (q/ha)
Control	28.8	1.0	183	9.8	13.5
Borax 10 kg/ha	41.4	1.1	200	14.6	17.2
Boric acid 0.25% spray (thrice)	41.0	1.0	200	13.8	16.8
Sulphur 30 kg/ha	32.5	1.1	202	11.6	14.3
Borax 10 kg/ha + 30 kg sulphur/ha	47.9	1.1	212	16.0	18.8
Boric acid 0.25% spray (thrice) + sulphur 30 kg/ha	47.6	1.0	211	15.7	18.4
CD (P=0.05)	5.4	NS	12	1.6	2.0

Details in Materials and Methods

Table 2. Effect of boron and sulphur application on boron and sulphur concentration and uptake by gram and net return of gram (mean of two seasons)

Treatment	Concentration in seed (ppm)		Concentration in straw (ppm)		Uptake by seed (kg/ha)		Uptake by straw (kg/ha)		Total uptake (kg/ha)		Net return (Rs/ha)
	Boron	Sulphur	Boron	Sulphur	Boron	Sulphur	Boron	Sulphur	B	S	
Control	16.5	1.8	11.1	0.9	16.2	1.7	15.0	1.2	31.1	2.9	9,991
Borax 10 kg/ha	28.4	1.9	20.5	0.9	41.4	2.7	35.3	1.6	77.1	4.3	18,513
Boric acid 0.25% spray (thrice)	27.6	1.8	20.1	0.9	38.1	2.5	31.8	1.5	70.3	4.0	17,647
Sulphur 30 kg/ha	17.0	3.0	11.3	1.9	19.9	2.5	16.1	2.8	35.9	6.3	13,131
Borax 10 kg/ha + 30 kg sulphur/ha	30.7	3.1	22.7	2.0	49.1	5.0	41.8	3.8	91.0	8.8	21,082
Boric acid 0.25% spray (thrice) + 30 kg sulphur/ha	30.2	3.1	21.6	2.0	47.4	4.9	39.8	3.7	87.2	8.6	20,625
CD (P=0.05)	1.6	0.2	1.2	0.2	3.9	0.3	2.8	0.4	4.9	0.6	1,801

The combined application of boron and sulphur had more beneficial effect than their application in isolation. This clearly indicated that the crop required both the elements for its yield and net return.

It was concluded that gram in Begusarai area requires combined application of boron 10 kg/ha + sulphur @ kg 30 kg/ha, the former element giving better response than the latter when applied singly.

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