INTERACTION OF BORON SUPPLIED BY SOIL WITH FOLIAR SPRAYS IN SUNFLOWER

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Abstract

The objective of this study was to evaluate the interaction of boron supplied by soil in association with one or two foliar sprays of B in sunflower development and yield, in soils classified as Oxisol of clay texture. Two experiments were carried out in field conditions, at Chapadão do Sul, Mato Grosso do Sul State and Chapadão do Céu Goiás States, Brazil, using sunflower hybrids Agrobel 960 and M 734, respectively. Treatments were five doses of B applied in the furrow at sowing (0.0; 1.5; 3.0; 4.5; 6.0 kg of B/ha); the same five doses of B applied at sowing associated with a foliar spray of 0.4 kg of B/ha at 25 days after plant emergence; and the same five doses of B at sowing associated with two foliar sprays of 0.4 kg of B/ha at 25 days after emergence and at R4-R5 growth stage. There was no response in sunflower yield to the treatments with B (means of 2130 kg/ha and 2626 kg/ha for M 734 and Agrobel 960, respectively). B contents in soil were enough for the adequate development and production of the sunflower. The concept that B fertilization must be always recommended for the development of high-yield crops may not be adequate.

Introduction

Sunflower (*Helianthus annuus* L.) is a plant species characterized by little efficiency in taking advantage of boron (B) from soil (Blamey and Chapman, 1982). Compared to other agronomic crops, sunflower has high demand for B, often presenting in the main Brazilian growing area deficiency symptoms of the nutrient, mainly in anthesis and maturity stages, with drastic reduction of achene production. For this reason, it has been used as a plant test to evaluate the B availability in soil (Schuster and Stephenson, 1940).

Due to sunflower reaction to low Boron content in soil, the search for genotypes less sensitive to the nutrient deficiency is important by establishing a program of genotype selection, and considering the efficiency of B absorption and use (Furlani et al., 1990).

In the field, with adequate conditions of soil moisture, the effects of B deficiency in the vegetative growth stages are only visible if this deficiency is extremely severe. However, it is common to recommend foliar spray with B at about 25 days after plant emergence, even without visible symptoms.

According to Gupta (1993), soil moisture seems to affect the B availability much more than any other nutrient. The reduced solution in soil in connection with a shorter mass flow and a shorter diffusion, as the limited flow transpiration in plants during a dry period can be a causal factor of B deficiency, despite an adequate supply of the nutrient in soil.

The objective of this study was to evaluate the interaction of B supplied by soil in association with one or two foliar sprays of B in sunflower development and yield.

Materials and Methods

Two experiments were carried out in field conditions, at Chapadão do Sul (Campo Bom farm) and Chapadão do Céu (Barra Bonita farm) counties, in Mato Grosso do Sul and Goiás States, Brazil, respectively, in the 2003 growing season. Sunflower Agrobel 960 was sowed on February 13 and harvested on June 6 at Campo Bom farm. Sunflower M 734 was sowed on February 14 and harvested on June 10 at Barra Bonita farm.

The sowing fertilization rate was 300 kg/ha of 05-20-20 (N-P-K) plus a top-dressing fertilization of 45 kg of N/ha (ammonium sulfate), 25 days after emergence. The boron source applied in soil was boric acid (B(OH)3), managed with the sowing fertilization. Foliar sprays were done with sodium borate (Na2B8O13.4H2O). B sources were applied using a sprayer with constant pressure of 276 Kpa maintained by compressed CO2 equipped with a bar of 1.5 m wide and with four nozzles (AVI 110 015), with a water carrier of 200 L/ha.

Soils of two experiments were classified as Oxisol of clay texture. Texture and chemical analyses of the soils collected before sowing are shown in Tables 1 and 2.

The trials followed a randomized complete block in a factorial design 3x5 (three treatments and five doses of B), with five replications. Treatments were five doses of B applied in the furrow at sowing (0.0; 1.5; 3.0; 4.5; 6.0 kg of B/ha); the same five doses of B applied at sowing associated with a foliar spray of 0.4 kg of B/ha, at 25 days after plant emergence; and the same five doses of B at sowing associated with two foliar sprays of 0.4 kg of B/ha, at 25 days after emergence and at the R4-R5 growth stage.

Sunflower yield (kg/ha), 1000-achene weight (g) and plant height (cm) were evaluated.

Table 1. Texture and chemical analyses of the soil at Campo Bom farm, collected from 0-10cm. Chapadão do Sul, MS, Brazil, 2003.

pH	**Al**	**H+Al**	**Ca**	**Mg**	**K**	**SB**	**CTC**	**V**	**C**	**P**
$CaCl_2$	................................cmol$_c$/dm^3................................							%	g/dm^3	mg/dm^3
5.30	0.00	3.97	3.15	1.08	0.10	4.33	8.30	52.17	25.26	9.60

B	**Zn**	**Cu**	**Mn**	**Fe**
........................mg/ dm^3........................				
0.16	2.47	1.05	15.03	138.06
Sand: 343 g/kg		Silt: 66 g/kg		Clay: 591 g/kg

Table 2. Texture and chemical analyses of the soil at Barra Bonita farm, collected from 0-10cm. Chapadão do Céu, GO, Brazil, 2003.

pH	Al	H+Al	Ca	Mg	K	SB	CTC	V	C	P
$CaCl_2$	....		$cmol_c/dm^3$			....		%	g/dm^3	mg/dm^3
5.24	0.00	4.34	2.67	1.21	0.09	3.97	8.31	47.77	24.12	5.07

B	Zn	Cu	Mn	Fe
....	....	mg/dm^3	....	....
0.19	2.12	1.29	13.81	132.81
Sand: 404 g/kg		Silt: 39 g/kg		Clay: 557 g/kg

Results and Discussion

There was no response in sunflower yield to the treatments with B (means of 2,130 kg/ha and 2,626 kg/ha for M 734 and Agrobel 960, respectively), as shown in Tables 3 and 4. Mean yield of the two experiments was 2,378 kg/ha, showing that the conditions for sunflower development were favorable.

Table 3. Yield (kg/ha) of sunflower M 734, after treatments with doses of B applied at sowing, associated with a foliar spray 25 days after plant emergence (DAE), and associated with two foliar sprays 25 DAE and at the R4-R5 growth stage. Chapadão do Céu, GO, Brazil, 2003.

Sunflower yield (kg/ha)				
B (kg/ha) by soil	B (kg/ha) by foliar spray			Mean
	0.0	(0.4 at 25 DAE)	(0.4 at 25 DAE and at R4-R5)	
0	2172	2234	2247	2217
1.5	2215	2171	2155	2180
3.0	1973	2101	2182	2086
4.5	2019	2101	2235	2119
6.0	2040	1971	2138	2050
Mean	2084	2116	2191	2130

The means of 1000-achene weight and plant height were 53.0 g and 196 cm and 43.3 g and 187 cm, for M 734 and Agrobel 960, respectively, comparable with the characteristics of the two hybrids.

In spite of the B content in soil (Tables 1 and 2) being considered low for agronomic crops, especially for sunflower, the results of the present study could be due to the high contents of organic matter in soil, the adequate rain distribution during the main crop-growth stages, which made possible the exploration of a great volume of soil, and consequently of water and nutrients, by sunflower roots.

The classification of B content in soil as low can be due to the extraction method of soluble B (hot water), which probably is underestimating the content of B available for the plants or is due to the differences between the contents of B in soil and the contents of this nutrient available for the plants.

Table 4. Yield (kg/ha) of sunflower Agrobel 960, after treatments with doses of B applied at sowing, associated with a foliar spray 25 days after plant emergence (DAE), and associated with two foliar sprays 25 DAE and at the R4-R5 growth stage. Chapadão do Sul, MS, Brazil, 2003.

Sunflower yield (kg/ha)				
B (kg/ha) by soil	B (kg/ha) by foliar spray			Mean
	0.0	(0.4 at 25 DAE)	(0.4 at 25 DAE and at R4-R5)	
0	2745	2623	2412	2593
1.5	2532	2528	2668	2576
3.0	2739	2758	2472	2656
4.5	2555	2668	2570	2598
6.0	2807	2653	2652	2704
Mean	2676	2646	2555	2626

Another important question was the sowing data, carried out in the recommended period. The rain during the growing cycle was 552 and 577 mm, at Campo Bom and Barra Bonita farms, respectively, which provided good plant development and high sunflower yield (Tables 3 and 4).

The results indicate that no foliar spray with B should be recommended in areas without water restriction, and soils with high organic matter content, heavy clay texture, and with a content of B/ha over 0.16 mg/dm3. This information will help in turn the possible reduction of the production costs and labor.

No visible symptoms of B toxicity were observed on leaves, when B doses were increased up to 6.0 kg/ha. This result indicates that there is no narrow limit between B contents which have caused deficiency and those which have caused toxicity to sunflower crop, in clay soils.

Conclusions

Boron content in soil was enough for the adequate development and production of sunflower. The concept that B fertilization must always be recommended for the development of high-yield crops may not be adequate.

References

Blamey, F.P.C. and Chapman, J. 1982. Differential response of two sunflower cultivars to boron fertilization. *In:* Proc. 10th Int.. Sunflower Conf., Surfer's Paradise, Australia. Int. Sunflower Assoc., Paris, France. p. 92-94.

Furlani, A.M.C., Ungaro, M.R.G., and Quaggio, J. A. 1990. Comportamento diferencial de genótipos de girassol: eficiência na absorção e uso do boro. Revista Brasileira de Ciência do Solo. 14:187-194.

Gupta, U.C. 1993. Boron and its role in crop prodution. CRC Press, Boca Raton. 236p.

Schuster, C.E. and Stephenson, R.E. 1940. Sunflower as an indicator plant of boron deficiency in soil. Journal American Society Agron. 32:607-621.