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Effect of Boron Fertilizer on Sugar Beet Grown on Fruitfield Sand Soil

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Abstract

Sugar beets were grown for the first time at the research farm in 2008 in a project exploring potential biofuel crops. The sugar beets grew fairly well but during the growing season nutrient deficiency symptoms were noted and at harvest yields were not as high as expected. The symptoms observed were similar to those reported for boron deficiency in sugar beet. The foliage became chlorotic (yellow) and the crown region developed dark necrotic areas resulting in cavities and abnormal crown growth. Thus, this study was initiated to investigate a possible boron deficiency by applying boron fertilizer treatments and observing effects on leaf nutrient levels and root yield of sugar beet grown on a Fruitfield soil.

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Introduction

Sugar beets were grown for the first time at the research farm in 2008 in a project exploring potential biofuel crops. The sugar beets grew fairly well but during the growing season nutrient deficiency symptoms were noted and at harvest yields were not as high as expected. The symptoms observed were similar to those reported for boron deficiency in sugar beet. The foliage became chlorotic (yellow) and the crown region developed dark necrotic areas resulting in cavities and abnormal crown growth. Thus, this study was initiated to investigate a possible boron deficiency by applying boron fertilizer treatments and observing effects on leaf nutrient levels and root yield of sugar beet grown on a Fruitfield soil.

Materials and Methods

Planting and plot design. Trial location was Field G, which has a Fruitfield coarse sand soil with approximately 1% organic matter. A soil test at the start of the study indicated boron levels to be 0.6 lb/acre at 0–8 in. depth and 1.0 lb/acre in 8–16 in. depth. Prior crop in Field G was soybeans. A John Deere 33 vegetable planter was used to plant seed of EB0718RR and EB0810RR (Syngenta/Hilleshog Seeds) on April 23. Seed spacing was approximately 4.4 in. apart in rows 30 in. apart. Boron treatments were applied to plots that were four rows, 25 ft long and were arranged in a randomized complete block design with three replications for each genotype.

Fertility and tillage. Plot area was chisel plowed approximately 14–16 in. deep and disked before planting. Fertilizer was applied preplant incorporated at rate of 56 lb/acre nitrogen, 56 lb/acre phosphate, and 250 lb/acre potash. Additional nitrogen sidedressed on May 28 (48 lb/acre), June 18 (36 lb/acre), and July 7 (36 lb/acre). Nitrogen rates were higher than planned because of abnormally high rainfall.

Irrigation. Plot was irrigated as needed with overhead sprinklers to supplement rainfall.

Pest control. Weed control was achieved with hand hoeing and three applications of glyphosate herbicide on May 23, June 12, and July 20. Cercospora leafspot, a foliar disease, and Rhizoctonia crown rot were controlled with fungicide sprays of Dithane DF, Kocide 2000, and Quadris.

Boron treatments. Solubor (20% boron) was used as boron source and applied with CO_2 pressurized sprayer with a four nozzle boom. Preplant incorporated (PPI) treatments were applied to bare ground before chisel plowing and disking and included a 1-lb and a 2-lb boron/acre rate. The foliar treatment was applied twice, on July 2 and again on July 18 at 0.25 lb boron/acre rate for a season total of 0.5 lb boron/acre.

Results and Discussion

Boron is a micronutrient used in very small amounts by plants. Soils normally supply adequate amounts of boron but deficiencies can occur when certain crops are grown on sandy soils subject to leaching. A soil test at the start of this study reported 0.6–1.0 lb boron/acre in the coarse sandy soil. Although not a high test level, this amount is probably adequate for most crops. But sugar beets are unusually high users of boron and we experienced above normal rainfall almost every month of the growing season in 2009, probably leaching some of the nutrient below the root zone. In short, we had all the elements necessary to see a boron plant deficiency.

Two genotypes, EB0718RR and EB0810RR, were used in this study and they responded identically to the boron treatments so data were combined to simplify presentation in Table 1. All boron treatments dramatically increased plant levels by July 22. At this time, plants had 18 to 22 fully developed leaves and roots weighing approximately 1.0 lb. Plants in control plots (no boron fertilizer) were starting to show chlorosis or yellowing of leaf margins and less vigorous growth. Plots of the three boron treatments were indistinguishable in the field. Sugar beet roots were harvested during week of October 12. Stand counts at harvest averaged 30,703 plants/acre and did not differ between treatments (data not presented). All three boron fertilizer treatments increased average root weights, root yield, and percent sugar content of roots. In fact, the boron treatments were so successful that larger root size and yield were easily seen at harvest. There was no evidence in this trial that one boron treatment was better than another. This study confirms that a boron deficiency can occur when sugar beets are grown on a Fruitfield sand soil and applying boron fertilizer either preplant incorporated or foliar at rates used in this study can improve root yield and sugar content.

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Table 1. Effect of boron fertilizer treatments on leaf boron content, root yield, and percent sugar.

Treatment	Leaf analysis[a] boron (ppm)	Avg root weight (lb)	Root yield ton/acre	Percent sugar	Sugar yield ton/acre
2 lb Boron PPI	38	1.91	30.22	16.2	4.90
1 lb Boron PPI	31	1.94	28.80	16.5	4.75
0.5 lb Boron Foliar	48	2.02	29.48	16.3	4.81
Control	12	1.22	18.84	14.6	2.75
LSD 5%		0.29	1.94		

[a]Boron content (parts per million) in youngest mature leaves on July 22.