THE EFFECT OF BORAX ON THE YIELD, APPEARANCE, AND MINERAL COMPOSITION
OF SPINACH AND SUGAR BEETS

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THE use of boron in relation to plant growth has become a subject of intensive study throughout the world in recent years. Much has been written regarding the crop response which may be expected from applying boron to natural soils and to sand and water cultures.

Symptoms of boron deficiency have been described by various authors for a variety of crops. The writers have grown 27 different crops in greenhouse pot cultures or in field experiments in an attempt to acquaint themselves with these symptoms. To date the symptoms exhibited by sugar beets (3), 2 canning beets (5), mangels, chicory, alfalfa, and clover (4) have proved to be most valuable in making recommendations for the application of borax on Michigan soils.

Some investigators have concerned themselves with the role of boron in plant growth and with the influence which boron may have on the passage of other ions into the roots of growing plants. Schmidt (12) found nitrate assimilation to be increased in sugar beets and barley which were inadequately supplied with boron. He believes the physiological breakdown of the plant tissue to be due to a toxic concentration of nitrate nitrogen.

In their most recent review of the literature on the function of boron in the plant, Dennis and Dennis (7) cited eight publications in which the investigators reported that boron deficiency was accompanied by an increase in content of nitrogen in the plant and two publications in which the opposite was the case. In two publications the writers reported increases in the calcium and phosphorus content and a decrease in the potassium content of boron-deficient plants.

Dmitriev (8) found that borax applied for clover lowered the percentage of ash, total nitrogen, and phosphorus in the plant, but did not affect calcium content. Joret and Malterre (10), on the other hand, found that 15 kg of Na₂B₄O₇ added to normal complete fertilizer increased the percentage of nitrogen and phosphorus in sugar beet roots and tops.

Some investigators have maintained that boron does not function within the plant but in the nutrient medium, thereby affecting the intake of nutrients. Maier (11) claims to have disproved this theory by applying boron to the above ground parts of plants and thus preventing the appearance of boron deficiency symptoms.

It is the purpose of this paper to present the results of field and greenhouse experiments which may furnish more evidence of the need of certain crops for boron and to present analytical data which may be useful in studying the functions of boron in plants.

EXPERIMENTAL

FIELD TESTS

Sugar beets were grown on Wisner silt loam, a soil containing free carbonates at the surface but little organic matter than is found in Thomas sandy loam. In this experiment borax was applied as a side dressing on June 20, after the beets were blocked. Application was made with a band drill at rates of 20 and 40 pounds per acre. The borax in each case was mixed with 150 pounds of 2-12-6 fertilizer. The plants which served as the controls received the 2-12-6 fertilizer without added borax.

Spinach was grown on Thomas sandy loam, a soil containing free carbonates at the surface and from 14 to 18% of organic matter in different parts of the field. Borax was applied in the basic fertilizer mixture at rates of 0, 10, 20, 40, and 80 pounds per acre. All fertilizers were broadcast and worked into the soil immediately before the spinach was planted. The basic fertilizer consisted of the following materials at the rates per acre indicated 3-12-12, 500 pounds; NaI, 0.5 pound; ZnSO₄, 4.0 pounds; MgSO₄, 25.0 pounds; MnSO₄, 25.0 pounds; FeSO₄, 2.0 pounds; NaCl, 10.0 pounds; and CuSO₄, 5.0 pounds. One treatment included only the 3-12-12 fertilizer. Treatments were replicated five times and were arranged in randomized blocks. Spinach was planted on May 5 and was harvested on July 6.

Samples of both spinach and sugar beets were saved for analysis at the time of harvest. The spinach tissue, roots, and tops separately, was analyzed for its content of boron, nitrogen, iron, calcium, and magnesium. The sugar beet tissue, roots only, was tested for its content of sucrose, boron, nitrogen, and iron. Analytical methods are described below.

GREENHOUSE TESTS

As several investigators had reported a relationship between the boron and nitrogen contents of plants, an experiment was set up to study the effect of varying nitrate levels in the soil on the yields, appearance, and composition of sugar

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1. Contribution from the Soils Section, Michigan Agricultural Experiment Station, East Lansing, Mich. Authorized for publication by the Director as Journal Article No. 499 n.s. of the Michigan Agricultural Experiment Station.
2. Figures in parenthesis refer to "Literature Cited", p. 234.