

Toxicity of Boron for Avocado Seedlings

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A previous report¹ dealt with the boron content of various portions of avocado trees and with the available boron in the soils of various avocado orchards. Symptoms were described for boron-deficiency in avocado seedlings grown in artificial cultures. The results of soil analyses indicated that the soils in avocado orchards are generally adequately supplied with available boron. It is understood, notwithstanding, that boron is being applied to the soils of certain orchards chiefly for the purpose of overcoming avocado tree decline. The view is often expressed that avocado trees are unique in being uninjured despite applications of large amounts of boron. The experiments reported herein are intended to test out this viewpoint.



Fig. 1. Toxicity or injury to avocado seedlings by a single application of 10 parts per million of boron as boric acid to the soil (air-dry soil basis) to which (left to right) .025, .050, .075, .100 and .250 grams of sulfur, respectively, had been added prior to the planting of the seed. These seedlings were healthy prior to the boron application.



Fig. 2. The toxicity of excessive boron in avocado seedlings grown in soil cultures in which no sulfur was added. The single application of boron as boric acid to the soil (air-dry soil basis) was: left to right, 0, 5, 10, and 15 parts per million of boron, respectively.

With large citrus trees in certain soils, up to one pound of borax was applied to the soil in the tree square without the appearance of any appreciable effect, whereas when additional boron was applied, serious damage resulted. In Florida orchards the borax that was washed by rain from picking boxes stored on sandy soils resulted in excess boron symptoms in the adjacent trees. The nature of the soil is important as to the quantities of boron that constitute an excess. Two factors should be given consideration: 1. Much of the boron added to soil becomes unavailable and 2. The roots of the tree, especially when mulches are not used, may be deeper than is anticipated.

In the tests made under glasshouse conditions, small asphalt-painted containers of 4000 grams (air-dry soil) capacity were filled with pasture soil (Hanford loam). Various amounts of sulfur: 0, .025, .050, .100, .250, .500, .750, 1.0, etc., up to 4 grams were mixed with the soil on August 14, 1942. An avocado seed was planted in each container of soil which from time to time received equal amounts of nitrogen in the form of calcium nitrate. Losses of nitrogen were prevented by using containers without drainage and by careful watering of the soil with distilled water. The increasing amounts of sulfur brought about increases in the soil acidity (lower pH values) and this acidity within certain limits resulted in an increase in the extent and excellence of the root systems. The pH values in the soil and in the mature lowermost leaves or their extracted juice are reported elsewhere.²

On November 28, 1944 applications of boric acid solution were made to most of the cultures in order to add 10 parts per million of boron to the soil (air-dry soil basis). This was at once followed by the usual addition of calcium nitrate solution to each soil culture. By December 19, 1944 practically all of the boron-treated cultures showed extreme injury or death, while the cultures not receiving boron were healthy. The injury usually progressed upward, the younger portions of shoots being the last to show injury, which is the converse in boron-deficiency injury. The condition of only a few of the seedlings will be illustrated and is seen in figure 1. The amounts of sulfur used in these cultures (the containers of which were 6 inches in diameter and 6.5 inches deep) were: left to right, .025, .050, .075, .100 and .250 grams, respectively. These were all healthy plants prior to the addition of the boron. Obviously the injury is extreme in most cases. At higher sulfur concentrations the damage resulting from the boron was also extreme, many of the plants were rapidly killed.

When no sulfur was added to the soil, a single addition of 10 parts per million of boron as boric acid resulted in severe damage or death of the once healthy seedlings. Figure 2 shows the condition after a single application of boron of what previously were four healthy avocado seedlings growing in soil cultures without the use of sulfur. All cultures received equal quantities of calcium nitrate solution at intervals. No boron was added to the culture to the left; 5, 10 and 15 parts per million of boron as boric acid were added once only to the soil (air-dry soil basis) of the cultures to the right. The conclusion is drawn that when excessive boron is brought into full contact with avocado roots, severe injury occurs.

1. Haas, A. E. C. Boron Content of Avocado Trees and Soils, Calif. Avocado Soc. Yearbook 1943:41-52.
2. Haas, A. R. C. pH determination in plant tissue. *Plant Physiol.* 16: 405-409, 1941.