

Decline of Avocado Trees as Related to the Theory of Boron Deficiency

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A possible relationship between avocado tree decline and boron deficiency in the Vista District of San Diego County was suggested in 1942 and 1943. This suggestion apparently arose because of rumors that the irrigation waters are lacking in boron, an element which is essential in minute quantities for plant growth. These waters are derived from Lake Henshaw and distributed by the Vista Irrigation District. Although the symptoms of boron deficiency had not then been described for the avocado, the group of symptoms subsequently reported by Haas (2) were not observed. Likewise, no suggestion of the deficiency was found on olive or orange trees, for which the symptoms are known (5, 8). However, declined trees in several orchards were treated by their owners during 1942 and the spring of 1943 with borax (sodium tetraborate, $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$), usually at rates of one-half to one pound per tree, broadcast on the soil. By the fall of 1943, no definite improvement could be ascribed by us to these treatments. Although avocado trees showed no harmful effects of the applications, citrus trees, which were occasionally interplanted in treated avocado orchards, not infrequently developed boron toxicity symptoms. They were especially severe in the case of lime trees. The attention of local growers was therefore called (6) to the possible dangers involved in the application of excessive amounts of materials containing boron, and certain experiments were begun.

Samples of the water distributed by the Vista Irrigation District were taken at two places in August, 1943. One of these samples (Reservoir E) contained 0.06 parts per million of boron. The other (Pechstein reservoir) had 0.16 parts per million. A third sample drawn from orchard distributing lines in the District in October, 1944, contained 0.2 parts per million. These are low, but appreciable quantities of boron. They are comparable to, or greater than, the boron content of certain other good irrigation waters in southern California. (1). No authentic record of boron deficiency of irrigated tree crops where such waters are used is known to us. Waters which contain somewhat greater concentrations (0.5 to 1.0 p.p.m.) of boron have sometimes been injurious to certain trees when used regularly (4, 7). It is interesting to note that one acre foot of water containing 0.1 part per million of boron supplies the equivalent of 2.4 pounds of borax.

In August, 1943, leaf samples (without petioles) were taken for analysis from paired groups of normal and declined avocado trees in five orchards in the Vista area. Their boron content, in parts per million of dry weight, was as follows:

	Average	Range
Leaves from normal trees	7.7 to 23.5	14.10
Leaves from declined trees	7.2 to 37.1	15.26

A few leaf samples were also taken in other areas. In an orchard near Pullerton, the leaves of a normal tree contained 14.3 p.p.m. boron; the leaves of an adjacent declined tree contained 11.4 p.p.m. In another orchard near Olive, the leaves of declined and normal trees had equal amounts of boron— 10.2 p.p.m. Near Sunland, a declined tree had leaves containing 53.4 p.p.m of boron. These analyses fail to show that the boron content of the leaves of declined trees is less than that of leaves of normal trees.

Experimental applications of borax to trees in various stages of decline, and to normal trees, were made in August, 1943, in five locations of the Vista area.^a

Three methods of treatment were used. (1) The material was applied to the soil— broadcast in sprinkled orchards, in irrigation furrows, and in irrigation basins under the trees. Usually, one pound of borax was applied per tree. The penetration of boron into the root zones with this rate of application is indicated by the injury of interplanted citrus trees, mentioned above. In two . plots, five and ten pounds of borax were applied to single trees. An application at the latter rate (per unit area of soil surface) resulted in severe symptoms of boron toxicity and ultimate death of small citrus trees, but failed to cause any recognized symptom of toxicity (3) on normal avocado trees during a period of two years. After two years one tree, which was normal when treated with ten pounds of borax, was in a definite state of decline although its leaves then contained 53 p.p.m. of boron. (2) Borax crystals were inserted into three-eighths inch holes drilled into the limbs of declined and normal trees. One to three holes were bored two-thirds through the limb, the crystals inserted, and plugged with hardwood dowel pins. The quantity of borax used was liberal, judging by the amount needed to cause a response of deficient olive trees when treated by this method (8). The quantity may have been excessive, since the boron content of the leaves of one declined tree increased only 50 percent (to 16.11 p.p.m.), while in another case the leaves on a treated normal limb contained the same amount of boron as leaves on an untreated limb. (3) Solutions of borax (40 grams in one gallon of water) were injected under pressure into the trunk or main limbs of affected trees. Injury from such injections occurred infrequently and was slight.

No benefit to declined or normal trees has resulted in the two years following these treatments. The treatment of affected trees has not arrested the course of decline. Such trees have, in most cases, continued to decline. In no case have they shown an increase in vigor or amount of foliage which would indicate a recovery. Comparable untreated trees have shown similar changes.

Conclusions

The evidence which is available, derived from a consideration of the boron content of irrigation water, from analyses of leaves of declined and normal avocado trees, and from the results of experimental applications of borax, fail to indicate a relationship between boron supply and avocado tree decline in the northern part of San Diego County. There appears to be no deficiency of boron for avocados in the area investigated. Avocado trees are more tolerant than citrus trees to applications of borax

to the soil.

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