Effects of chromium on

Citrus and Avocado

grown in nutrient solutions

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Rooted Prior Lisbon Lemon cuttings in soil cultures. ***Left*****—0.075 ppm chromium;** ***right*****—0.05 ppm chromium.**

Exact tests show that extremely low concentrations of chromium benefit the growth of citrus and avocado trees.

Tests were carried out in three-gallon-capacity sand or soil cultures. Plant nutrients were supplied by stock Hoagland's solutions *A, B* and *C*. Distilled water and chemically pure mineral salts were used in all the tests, and the drainage was excellent.

A preliminary test was made in silica sand cultures planted to rooted cuttings of Prior Lisbon lemon. Potassium chromate was added to the nutrient solution at each application, to give chromium concentrations of 0, 0.1, 0.5, 1, 5, 10, 25, 50, and 100 ppm—parts per million—for the experiments.

The growth obtained at 0.1 ppm chromium was distinctly better than with no chromium, and at 0.5 ppm the growth was somewhat better than with no chromium, though less favorable than at 0.1 ppm. At 1.0 ppm the growth was poorer than that of the control, and at higher concentrations the rooted cuttings failed to survive.

In a second test with Prior Lisbon lemon in the same kind of cultures, chromium concentrations were 0, 0.0125, 0.025, 0.05, 0.075, and 0.1 ppm in each application of nutrient solution. The cultures were planted on July 20 and harvested on February 25. The heights of the harvested plants were 18.5″, 19.0″, 27.8″, 32.3″, 24.0″ and 33.0″. Dry weights of the roots were 10.5, 10.5, 11.0, 11.5, 12.0, and 13.2 grams.

Harman (Mex.) avocado seedlings in soil cultures that received chromium in each application of nutrient solution. ***Left to right*****—0, 0.0125, 0.025, 0.05, 0.075, 0.30 ppm chromium.**

A third test was conducted to learn whether the use of chromium in each application of nutrient solution would benefit rooted Prior Lisbon lemon cuttings in soil cultures. Chromium concentrations were 0, 0.025, 0.05, 0.075, and 0.1 ppm. After growing from November 5 to March 16 the heights of the cuttings were 25.0″, 35.5″, 36.0″, 28.5″, and 26.5″; the fresh weights of the entire tops were 42.5, 63.0, 60.8, 54.7, and 42.2 grams; and the dry matter of the roots weighed 4.0, 5.6, 5.8, 5.0, and 5.6 grams.

To test the effectiveness of chromium in stimulating the growth of orange trees, Koethen sweet orange seedlings were grown in soil cultures from August 9 to March 15. The nutrient solution contained 0, 0.0125, 0.05, 0.075, and 0.1 ppm of chromium. At the time of harvest the heights of the seedlings were 23.0″, 30.3″, 27.0″, 30.8″, and 25.5″; the fresh weights of the entire tops were 37.5, 46.0, 50.3, 40.8, and 40.0 grams; the dry weights of the roots were 7.5, 9.4, 11.8, 9.2, and 9.0 grams.

A similar experiment was conducted with Koethen sweet orange seedlings in silica sand instead of soil cultures. The most marked stimulation of growth occurred when the nutrient solution con-

Effects of irrigation and nitrogen on

Micronutrient Concentrations

in Hass avocado leaves

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Availability of soil moisture affects the utilization of soil manganese and boron by avocado trees, and high nitrogen fertilization reduces the trees' utilization of copper.

For a long-term test, Hass avocado trees on a Mexican seedling rootstock were planted in June, 1952, on land cleared of native brush. During the first year water was applied in small basins around the trees, and thereafter a permanent irrigation system provided water near each tree by means of a sprinkler-type nozzle. During each of the first two years every tree received one-twelfth pound of nitrogen from calcium nitrate broadcast under the trees in two applications. Differential treatments were started in 1954, to evaluate the effects of three levels of irrigation and three levels of nitrogen fertilization on yield, fruit size and quality, tree growth, and chemical composition of leaves. Irrigation water was applied when soil suction—soil moisture tension—values reached 0.5, 1.0, and 10 bars—atmospheres of suction—at selected points in the root zone.

Annual Fertilizer Treatments
Pounds of nitrogen per tree

Years	Treatments		
	Zero Nitrogen	Low Nitrogen	High Nitrogen
1954	0	0.17	0.67
1955	0	0.25	1.00
1956	0	0.25	1.50
1957	0	0.25	1.50
1958	0	0.25	2.50
1959	0	0.75	3.00
Total	0	1.92	10.17

Each irrigation plot of 14 trees was divided into three subplots receiving differential nitrogen treatments. Six trees received a high level of nitrogen, based on leaf analysis, six received a low commercial level of nitrogen, and the remaining two were the check without added nitrogen. The total annual amounts of nitrogen were broadcast under the trees in three equal applications, in February, May, and August.

Because zinc deficiency symptoms were present on some trees, the whole experimental orchard was sprayed with zinc sulfate plus soda ash in June, 1956, and a soil application of one pound per tree of zinc chelate—17.7% zinc—was applied in 1958.

A sample of 20 fully developed leaves, with their petioles, was taken from one tree in each subplot in August, 1956, again in October, 1957, and in November, 1959.

Leaves from trees irrigated when soil suction reached one bar—the intermediate treatment—contained significantly higher concentrations of manganese than did leaves from trees receiving more frequent or less frequent irrigations. Apparently low soil moisture availability produced by infrequent irrigation and high soil moisture availability produced by frequent irrigation both resulted in lower manganese concentrations in avocado leaves than did an intermediate supply of soil moisture.

Leaves from trees that were not irrigated until soil suction reached 10 bars contained significantly smaller concentrations of boron than did leaves of trees receiving the frequent and the intermediate irrigation treatments. Thus it appears that avocado trees in areas where the concentrations of boron are low in the soil and water may develop boron-deficiency symptoms when subjected to an irrigation practice which allows very dry soil conditions between irrigations.

The zinc, copper, and iron concentrations in the leaves were not affected significantly by the differential irrigation treatments.

Leaves from trees treated with high nitrogen contained significantly smaller concentrations of copper than leaves from trees treated with low nitrogen or none. Zinc, manganese, boron, and iron concentrations in the leaves were not significantly affected by the differential nitrogen treatments applied. The spray and soil applications of zinc in 1956 and 1958 were possibly the reason that nitrogen fertilizers did not reduce the zinc concentration in the avocado leaves in 1957 and 1959. Analysis of zinc content was not made in 1956 because of zinc spray on the leaves.

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tained 0.075 ppm chromium in each application.

Rough lemon seedlings in soil cultures also showed considerable improvement in growth when low concentrations of chromium were applied in the nutrient solution.

Harman — Mexican — avocado seedlings were grown from December 13 to June 16 in soil cultures in the glasshouse. Chromium concentrations in the nutrient solution were 0, 0.0125, 0.025, 0.05, 0.075, and 0.30 ppm. The heights of the harvested plants were 34.5″, 55.3″, 56.0″, 59.8″, 51.8″, and 49.8″; fresh weights of the trunks were 57, 108, 102, 119, 88, and 97 grams and of the leaves 80, 115, 135, 112, 133, and 127 grams; dry weights of roots were 20.9, 21.7, 24.7, 19.3, 19.0, and 25.8 grams. The increased growth of the treated cultures over the controls indicates the stimulating effect of chromium on avocado seedlings of the Harman—Mex.—variety in soil cultures when each application of nutrient solution contained a low concentration of chromium.

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