Proc. Fla. State Hort. Soc. 70:297-300. 1957.

IRON CHLOROSIS IN AVOCADOS

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In recent years, yellowing of avocado trees has become a serious problem. In some cases yellowing is so severe that the tree defoliates and dies. In milder cases, the tree fails to set fruit or produces yellow fruit. Many of these milder cases recover without any special treatment. A large proportion of the commercial groves in Dade County show at least a few trees that lack normal green color although nitrogen, magnesium, manganese, and zinc were supplied in ample amounts. These trees are always scattered among other trees showing a normal green color.

Iron deficiency has long been suspected as the cause of this condition but foliage sprays or ground applications of iron sulfate have had little or no effect. Preliminary tests showed that ground applications of chelated iron sometimes gave improvement but results of the early tests were rather erratic. It was suspected that the alkalinity of our soil reduced the activity of some of the most commonly used chelates. Foliage sprays of iron chelates generally had little effect on color and sometimes burned the leaves.

***Procedure.* —** In July 1956, a five acre commercial grove (Grove A) was selected for a comprehensive test of various treatments. In March 1957, the test was expanded to include certain rows of trees in an adjacent 15 acre grove (Grove B).

Grove A was planted in 1950 and Grove B in 1946 and 1947. Both groves were managed similarly except that Grove A had two papaya crops planted between the rows in the period from 1950 to 1956 while Grove B had only one crop of papayas which was removed in 1950 and 1951. The papayas received heavy applications of nitrogen and potassium and considerable magnesium. They were sprayed regularly with sulfur and DDT and the avocados received the normal sprays of copper, zinc and manganese. Phosphorus was applied regularly the first few years but very little was applied after 1954.

All trees were rated according to color visually every two months. The rating scale was as follows:

1. All green.
2. Mostly green but some yellowing between the veins of the leaves.
3. Considerable yellow.
4. Mostly yellow except for green veins, with possibly some burned edges on small leaves.
5. Very yellow. Almost the last stage before defoliation.

The personal error in making these ratings is seldom more than one unit. Table 1 shows the apparent change in rating from July 26 to September 17, 1956, on trees that were untreated. It may be assumed that these changes are mainly personal error.

It is seen in Table 2 that Grove A was much more yellow than Grove B. In fact, Grove A was the most chlorotic grove that could be found and it was suspected that the heavy nitrogen application and removal of the papaya crops had mined the soil of available iron.

Most of the chelated iron treatments provided either 25 or 50 grams of iron per tree and our data give no information on the effect of rate. All of the NaFe-DPTA and NaFe-EDTA treatments were made with 50 gallons of water per tree. The treatments with Compounds 138 and 157 were applied with 10 or with 50 gallons of water per tree. FeHEEDTA was applied dry and with 5, 10, and 50 gallons of water per treatment.

Table 1. Reliability of Ratings

(Comparison of July 26 and September 17, 1956 ratings)

Apparent changes in rating	No. of trees
none	128
-1	43
-2	6
+1	71
+2	7
Total	256

Table 2. Initial Rating of Trees

Rating*	No. of trees Grove A	No. of trees Grove B
1	52	240
2	96	86
3	75	36
4	41	4
5	22	3
Total	286	369

*Rating 1 is green; 5 is very yellow

The sulfur treatment was 9 pounds of wettable sulfur and the phosphorus and magnesium treatment consisted of 4 Ibs of triple superphosphate and 4 Ibs. of sulfate of potash magnesia per tree.

Results. — The results of the treatments are shown in Table 3. Treatments were made on July 26, October 16, March 2 or May 2 and in most cases were not repeated. The initial ratings before treatment were made in the 60-day period prior to treatment. The first ratings were made 20 to 50 days later.

The response to Compound 138 was very striking. Every tree that was treated with this compound became green in two or three weeks. In the treatments with the other compounds, it was, because of a shortage of severely chlorotic trees, necessary to start with many trees that rated no worse than 3. The final rating was not much better than 2 so the response was slight. In fact, if comparisons are made with Part B of Table 3, it is seen that the improvement of untreated trees was almost as great as that caused by any of the treatments except Compound 138.

Nevertheless, the apparent initial response from most of the treatments and the fact that an apparent ultimate response was obtained with every treated tree except two of the sulfur treated and one of the Fe-HEEDTA treated trees, is strong evidence that most of the treatments were effective. Also, frequent observations of the trees appeared to show a rapid response to treatment with NaFe-DPTA, or with FeHEEDTA and 50 gallons of water. However, the ultimate recovery of most untreated trees makes the economic value of the treatments questionable.

The apparent response to sulfur or to phosphorus and magnesium is questionable, particularly since the response was always slow, very much like that in the trees that improved without treatment. If the response to triple superphosphate and sulfate of potash magnesia was real it is believed to be due to the phosphorus since some other treatments with magnesium alone failed to show an effect. However, yellow trees are found in other groves that have been fertilized regularly with 4-7.5 or 4-8-8.

The general behavior of the untreated trees suggests that the yellowing may be a cyclic phenomenon. Some trees do die but the number is only a fraction of the total number of yellow trees. Also the total number of yellow trees in Dade County appear to be little greater than it was a few years ago. Previous observations have indicated that chlorosis is most severe in early summer and diminishes by fall, but in this test, trees were found to improve in all seasons and there were some trees that became yellow while others were becoming green. A tree that becomes completely yellow stops growing and it is doubtful that it could remain in that condition indefinitely. It seems possible that the stoppage of growth could give time for the available iron supply to build up in the soil so after a rest period, the tree could resume normal growth. In Grove A, one very yellow tree was blown over so all the foliage was removed and the trunk was cut back to about four feet before setting upright. The new leaves came out with a bright green color. In this case the root system apparently was able to supply iron to a small amount of foliage although it had not been able to do so to the original canopy.

The iron contents of yellow and green leaves were only slightly different. The leaves from eight untreated trees with ratings of 4 or 5 ranged from 33 to 45 ppm. with an average of 38. The leaves from nine green trees ranged from 40 to 53 with an average of 48. After treatment, there were not many iron contents above 53 even when the trees were completely green. The principal exception was Compound 138 which increased the iron content of the leaves as much as 100 ppm. In general where leaves became green, there was also a growth response indicating increased absorption of iron. Analyses were also made for calcium, potassium, magnesium, phosphorus and manganese but the results are not listed since they are not correlated with the chlorosis.

Table 3. Change in Ratings During Test.

A Treated Trees

Treatment	No. trees	Average Ratings: Before treat.	Average Ratings: 1st After Treat.	7-23-57
138 (HFeEDDHA)	10	4.4	1.8	1.3
157 (Ber. of EDDHA)	10	3.3	2.1	1.9
330 (NaFe-DPTA)	29	3.7	1.9	1.6
NaFe-EDTA	11	3.0	1.8	1.9
Versonal-(Fe-HEEDTA)				
With 50 gal. water per tree	19	3.7	2.6	2.2
With 10 gal. or less water per tree	16	4.7	4.7	2.0
Sulfur	9	4.4	3.6	1.8
Phosphorus and Magnesium	7	3.3	2.6	1.9

B Untreated Trees

Treatment	No. trees	Average Ratings: 7/26/56	Average Ratings: 7/23/57
All with Initial Rating = 4 to 5	11	4.2	2.2
" " " " = 3.0	43	3.0	2.3
" " " " = 2.0	84	2.0	1.75
" " " " = 1.0	50	1.0	1.84
Initial Rating = 1 to 2			
Final = 4 to 5	5	1.6	4.3

It has been suggested that the chlorosis might be caused by some soil inhabiting insect or microorganism. Although certain organisms may cause chlorosis there is no evidence to show that these trees were so affected. In consideration of these organisms, it was thought that certain soil treatments might reduce the population of most such pests without hurting the trees and that an experiment was needed for information. Therefore, on August 19, 1957, the roots of some trees were drenched with emulsions of dieldrin, ethylene dibromide, and parathion. No effect is as yet visible but recovery from root damage would be expected to be slow.

Of the chelates, only HEEDTA and EDTA are available in Florida at present. DPTA is in commercial production but has not been offered for sale in the Homestead area. Compounds 138 and 157 are experimental materials furnished by Geigy Chemical Company and have not yet been produced in commercial quantity.

Summary and Conclusion. — It has been shown that a chlorosis of avocado trees on limestone soil can be corrected by certain iron chelates, but the trees frequently recover without treatment so the value of most of the chelates is questionable. It is suggested that growers try treating their severely chlorotic trees with 50 grams of iron in the form of NaFe-DPTA or Fe-HEEDTA using 50 gals. of water per tree to flush the material into the soil. These treatments have very seldom failed in our tests but the treatments have not been tried enough on severely chlorotic trees to prove that they will always be effective.

The best material tested was experimental Compound 138 (H FeEDDHA) since it always corrected chlorosis in a short time.

The iron content of the leaves from untreated trees varied from an average of 38 ppm. for yellow trees to an average of 43 ppm. for green trees. Treatment with iron chelates generally caused a small increase in iron content.

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Florida Agricultural Experiment Stations Journal Series, No. 671.