Chlorosis in Avocado

young trees on Guatemalan rootstocks appear less tolerant to disorder than trees on Mexican stocks

F. F. Halma and F. A. White

The following article is the first of a two-part progress report on studies of the relative susceptibility of avocado rootstocks to chlorosis.

In two experimental avocado plantings—to test the relative merits of Mexican and Guatemalan, and to a very limited extent, West Indian, varieties as rootstocks—a type of chlorosis appeared about a year after planting. The disease is characterized by yellowing of the leaves and, in severe cases, by leaf burn, dieback and death.

Most noteworthy is the fact that, so far, the disorder in the experimental plots is practically confined to trees on Guatemalan rootstocks. However, chlorotic trees on Mexican stocks in commercial orchards and chlorotic Mexican seedlings in nurseries have been observed.

The cause of the disorder has not been determined. The term chlorosis simply means a diseased condition manifested as yellowing of the normally green parts of the plant. The loss of the green coloring matter—chlorophyll—in plants is often associated with micro-nutrient deficiencies such as iron, zinc, manganese and sulphur, but it may also result from any number of different causes; namely, excess phosphate and high alkalinity, all of which complicates the problem of diagnosis. Although some 45 rootstock plots have been established, the disease is widespread only in the two plots mentioned.

Since Mexican rootstocks are used almost exclusively in commercial propagation, information concerning the relative susceptibility of Mexican and Guatemalan rootstock varieties—to a nutritional disorder such as chlorosis—is necessarily limited to experimental plots in which both types of stocks are under similar soil and environmental conditions.

One of the two experimental plots—planted in Santa Barbara County in March, 1948—consisted of 119 MacArthur trees, but early replacements reduced the number to 116. The trees were grown in Santa Barbara County and the nursery also furnished trees for six additional plots, all planted in the county. The soil in all plots is fairly heavy but well drained.

The trees were budded on seven Guatemalan rootstock varieties—Anaheim, Dickinson, MacArthur, Itzamna, Sharpless, Cabnal, and Nabal—and four Mexican varieties—Ganter, Topa Topa, Duke, and Mexicola. Seventy were on Guatemalan and 46 on Mexican rootstocks. All Guatemalan seeds were of mixed origin, but seeds of the Mexican varieties, except Ganter, came from single trees.

Chlorosis was first observed in August, 1949, about 16 months after planting. Seventy per cent—49 trees—of the trees on Guatemalan stocks showed the disorder in varying degrees. Only one tree on Mexican stock was affected but it soon recovered. As of September, 1951, about two years after the disease was first observed, 41%—20 trees—of the chlorotic trees were recovered or nearly so and 59%—29 trees—were dead or worthless. The loss, on the basis of the 70 trees on Guatemalan stock planted, amounted to 40%.

On the assumption that the disease was iron chlorosis, attempts were made to control it by applications of ferrous sulfate and sulfur in the basins occupied by the affected trees. When no improvement resulted, the trees were sprayed with a solution of various micro-nutrients. This too failed to help.

To obtain further information concerning the relative tolerance of the two types of stocks, two balled trees, one on Mexican and one on Guatemalan stocks, were planted close to several affected trees in the fall of 1950. Unfortunately they made little or no growth because of the lack of sufficient soil moisture. Additional trees were planted in late spring of 1951.

Chlorotic trees are scattered over the entire plot, and in some cases affected and normal trees on the same rootstock are only about 20 feet apart. Incidentally, an adjacent young lemon orchard shows no symptoms of the disorder.

In the six other plots established with trees from the same nursery, a total of about 550 trees were planted, some 250 of them on Guatemalan stocks. Only three trees, all on Guatemalan and in one plot, have shown chlorosis. One of the plots which is free from the disease is less than a mile from the severely affected plot.

The situation in the second experimental plot is similar to that in the Santa Barbara County plot. It was planted in June, 1949, in Orange County, between rows of old orange trees. The avocados were interplanted with Valencia orange trees on sweet orange rootstock at the same time that the plot was established. Originally the planting consisted of 117 Fuerte trees, but early replacements with commercial trees reduced the number to 102 experimental trees. Fifty-five of them are on seven Guatemalan varieties—Ana·

Concluded on page 14

Adjacent Fuerte trees on the same rootstock variety. *Left:* chlorotic; *right:* normal.

AVOCADO

Continued from page 3

heim, Dickinson, Itzamna, Nabal, Hass, Challenge, and Taft—and 45 on six Mexican varieties—Ganter, Topa Topa, Duke, Northrop, Mexicola, and Blake. Two trees are on Waldin, a West Indian variety from Florida. As in the first plot, all Guatemalan seeds were of mixed origin, but seeds of the Mexican, except Ganter, came from single trees. The trees were propagated in the Subtropical Horticulture Nursery at the University of California, Los Angeles. This nursery also furnished trees for three additional plots.

In June, 1950, one year after planting, 78%—43 trees—of the trees on Guatemalan stocks showed chlorosis in varying degrees. Only one tree on Mexican stock was affected, but it soon recovered. The two trees on West Indian stock remained normal. As of September, 1951, a little over a year after the disease appeared, 56%—24 trees—of the chlorotic trees were recovered or nearly so and 44%—19 trees—were either dead or worthless. The loss on the basis of the 55 trees on Guatemalan planted was 35%, as compared to a 40% loss in the other plot. As in the other plot, chlorotic trees are scattered throughout the area and in some cases affected and normal trees on the same rootstock variety are side by side.

Five commercial trees—presumably on Mexican stock—which were planted in place of severely chlorotic ones, so far have shown no symptoms of the disease. Also, of several hundred commercial Fuerte trees on Mexican stock—planted by the grower in 1948 and 1949 in the same orchard in which the experimental plot is located—only three show chlorosis. Neither the old nor the young orange trees are chlorotic.

Three additional plots were planted in 1949 with trees from the same nursery which furnished the Fuerte trees for the plot in Orange County. Two of them are located in Ventura County and one in Los Angeles County. Only three trees—all in one plot in Ventura County—of about 200 on Guatemalan stocks planted have shown chlorosis. None of a similar number on Mexican stock and three on West Indian are affected.

In the same orchard in which the three chlorotic Fuerte trees are located, 96 Hass and 54 Anaheim on Guatemalan as well as a similar number on Mexican and 11 on West Indian stocks were planted in 1950. A year later 5% of the Hass and 10% of the Anaheim on Guatemalan stocks showed chlorosis. However, practically all seem to be recovering. None of the trees on Mexican or West Indian are affected. Paradoxically, in the same orchard eight of about 40 Mexican seedlings planted by the grower showed the disorder a few months, then recovered.

The observations obtained during these studies, to the effect that Guatemalan stocks are far more susceptible to whatever soil condition causes chlorosis, are limited in scope. Perhaps, as the root systems expand, trees now considered recovered may again become chlorotic or hitherto normal trees on both types of stocks may show the disease.

Whether the occurrence of chlorotic and normal trees in some cases only about 20′ apart and on the same rootstock variety, is due to soil variation or genetic differences in the rootstock seedlings is an open question. All that can be said at present is that none of the 10 Guatemalan rootstock varieties used in the two severely affected rootstock plots is immune. The number of trees on these stocks varied from three to 18. This, and the fact that in one plot 14 trees on a certain variety showed 43% chlorosis and in the other, eight trees on the same variety showed 100%, stress the necessity for more extensive information for valid comparison.

F. F. Halma is Professor of Subtropical Horticulture, University of California, Los Angeles.

The late F. A. White was Farm Advisor, Santa Barbara County, University of California, at the time the study reported here was made.

The above progress report is based on Research Project No. 1458.

DORMANCY

Continued from page 10

day and greenhouse temperatures plants continued active growth, but those grown under long-day and subjected to the high temperature stresses ceased growth and within one week after the last high temperature exposure lost all or virtually all visible green tissue. These plants were dormant as they could be induced to resume growth under favorable conditions two to three months later.

When pine bluegrass was permitted to grow in a warm greenhouse under natural day-length and without the high temperature exposures, the plant was dormant by early June even though watered daily. This is similar to the field behavior. Two weeks after such dormancy had set in, watering was stopped on a series of these plants. The pots then remained dry on greenhouse benches for 5, 7, 11, 17, and 20 months. At the end of each interval, six pots were removed to a section of greenhouse having daily maximum temperatures not exceeding 75° F, and daily watering was resumed. All plants of the groups dormant 5, 7, 11, and 17 months resumed growth by the fifth day after the resumption of watering. The majority of these plants developed vigorous new shoots 3/8″ to 3/4″ long on the fourth day. In the group dormant 20 months, only two plants—out of 18—failed to grow.

New shoot growth was rapid. The average length of eight shoots of the group dormant 20 months measured 1/2″ on the fourth day, 1 1/8″ on the fifth, 1 5/8″ on the sixth, and 2 1/8″ on the seventh day after watering was resumed. Seven days after the first watering, vigorous plants averaged 27 green shoots per plant.

The greenhouse studies demonstrate that the initiation of summer dormancy in pine bluegrass is associated with long day-length and high temperatures.

Growth resumption, after extended periods of dormancy, was obtained when the plants were subjected to relative coolness and were watered. These conditions parallel those which normally prevail in the field when the plant enters and breaks dormancy.

Horton M. Laude is Associate Professor of Agronomy, University of California, Davis.

The above progress report is based on Research Project No. 1194A.

KARA

Continued from page 4

in bearing habit than most mandarins and mandarin hybrids. In off years it usually produces at least light and often medium crops. The combination of heavy yield and large size on the Riverside trees in 1952 is resulting in light crops for 1953 on most trees.

In the Riverside planting the Kara has made vigorous trees on sweet orange, sour orange, grapefruit, and Cleopatra mandarin rootstocks. On trifoliate and Rough lemon rootstocks the trees are smaller and on Cunningham citrange tree condition is poor. Fruit quality in 1952 was best on the sweet orange, grapefruit, and trifoliate stocks.

Some young plantings of Karas have been established recently in the Riverside area. One orchard of about 280 trees and another of some 170 trees are just coming into bearing. A group of Karas topworked on grapefruit in 1946 seem vigorous, and averaged moderate crops in 1952, with rather light crops set for 1953.

Near Fullerton, in Orange County, a Kara topworked on a large grapefruit tree gave fruit of good size and color in 1952. In the Piru area of Ventura County a block of 86 three-year-old Karas is just beginning to bear.

James W. Cameron is Assistant Geneticist, University of California, Riverside.

Robert K. Soost is Assistant Geneticist, University of California, Riverside.

H. B. Frost, Associate Plant Breeder, Emeritus, University of California, Riverside, introduced the Kara mandarin in 1935.

The above progress report is based on Research Project No. 261.