Exocortis Disease of Citrus

top-root relationships of trifoliate orange and its hybrids studied in search for cause of root disease

W. P. Bitters

The citrus root disease called exocortis is present in most areas where trifoliate orange—*Poncirus trifoliata*—is used as a rootstock.

Trifoliate orange stock is desirable for citrus because of its effect on yield, fruit quality, fruit size, hardiness, resistance to nematodes and other characters. However, there is inadequate information on all the attributes of some of its hybrids—particularly the citranges—as rootstocks.

In commercial orchards of California general use of trifoliate stock has been restricted because of the extreme variability in size and appearance of citrus trees budded upon it, and the frequent presence of exocortis. In part, the variability in tree size and the presence of exocortis may be directly related.

The merits of trifoliate orange as a stock and the prospective use of it and its hybrids in California led to extensive investigation into the nature of exocortis to learn whether it might be prevented.

Approximately 600 trees representing 100 different combinations of trifoliate orange, or its hybrids—as roots or as tops—were examined for symptoms of exocortis in the rootstock and variety plots at Riverside, during the winter of 1950–51. Most of the trees were over 20 years of age, but a few combinations were under 10 years.

The most striking symptom of exocortis is the shelling or scaling of the trifoliate orange bark. In trees which develop scaling, the diameter of the stock is generally reduced to the point where it is nearly equal to the diameter of the top and fluting of the stock is not conspicuous. Top growth is usually, but not always, retarded at the time scaling is first evident. The degree of such stunting varies with the scion variety and the time at which scaling first appears. Scaling has not been observed on nursery trees but has occasionally appeared on seedling trees.

Symptoms

The first symptom of scaling is evident below the bud union on the outer bark of the stock. This may occur either at or below the ground line or at the bud union. Bark scaling also extends below ground onto the roots. Frequently large roots and portions of the root crown may die.

Small oblong or elongated areas of dead bark appear as the first visible symptom of scaling. Such bark later separates from the margins of the live bark, but remains partially attached to the living bark beneath. The bark lifts up in scales $\frac{1}{16}$″ to $\frac{1}{8}$″ thick, $\frac{1}{4}$″ to 1″ wide and 1″ to 5″ in length. A small amount of gum is frequently present beneath the scales. Scaling of the bark generally becomes extensive and severe. The trees are seldom killed, but ultimately become worthless.

Observations

Of 128 trees on trifoliate orange roots—32 combinations—only three of the combinations examined showed evidence of exocortis.

Five trees of Chase Eureka lemon at 22 years of age were severely affected. The size and general appearance of the trees indicated the disease was of long duration. They were markedly stunted and thinly foliated. The trifoliate stock was of small diameter, badly scaling, and not fluted.

Two trees of Temple orange at 17 years of age also were severely affected.

Twenty-five trees of the Valencia combination which were part of some Valencia orange rootstock trials were available for study. In 1947, at an age of 18 years,

Continued on next page

Trifoliate orange stock budded to Valencia orange, 22 years old, showing the development of the first stages of exocortis.

Troyer citrange stock budded to CES Eureka lemon, eight years old, showing an atypical citrange union, the stock being smaller than the scion.

Troyer citrange stock budded to Monroe Lisbon lemon eight years old, showing a healthy normal union and larger growth of the citrange stock.

EXOCORTIS

Continued from preceding page

two of the 25 trees—during trunk measurements—were observed for the first time to display evidence of exocortis. The general health and vigor of these trees had not been affected in 1951. The scaling of the bark was confined to a small area of the trifoliate stock. The bud source of these Valencias came from a single tree which also provided budwood for 15 trees of Savage citrange and for 10 trees of Cunningham citrange. The Savage and the Cunningham trees show no symptoms of the disease.

In these trials no external evidence of the disease was found in 20 grapefruit trees and 25 Washington Navel orange trees budded on trifoliate orange stock. This does not imply that different sources of these same varieties would not impart exocortis to the stock when budded upon trifoliate orange.

Of 69 trees on Cunningham citrange stock—16 combinations—only trees budded to the same strain of Chase Eureka lemon as budded on trifoliate orange showed symptoms of the disease. The bark scaling on the citrange stock of 10 trees examined extended up to the ground line but not up to the bud union as it did with trifoliate orange. There was no external evidence of the disease in the 6–8 inches of the stock exposed above ground. These trees were much larger and in better health than the trees budded on trifoliate orange. These trees were pulled in 1950 and it was observed that the bark shelling extended to the very extremities of the root system.

Of 97 trees on Morton citrange stock examined—5 combinations—only one combination displayed definite symptoms of the disease. Of 13 trees of the CES Eureka lemon strain budded on Morton and planted in 1943, all showed severe exocortis extending to the bud union when examined in 1948. Symptoms were undoubtedly evident sooner. The tops were markedly stunted and the trees were in very poor condition. Twenty-five Washington Navel trees 22 years of age on Morton show no symptoms of the disease. Two navel trees out of 20 in a younger planting—and with a different top source—showed questionable symptoms of exocortis at 3–4 years of age, but this condition is not presently apparent. All other combinations with Morton citrange are healthy.

Of the four combinations on Troyer citrange only those budded to the same strain of CES Eureka lemon as that used on Morton citrange appear to be in distress. Twenty such trees planted in 1944 and 20 planted in 1945 were markedly stunted, off-color, and sparsely foliated in 1951. No above ground shelling of the bark was evident. The poor condition of such trees was evident within a few years after planting. Similar trees of the same age but budded on sour orange stock have grown normally. In all other combinations, growth of the Troyer citrange stock is larger than the scion but in this instance the Troyer stock is much smaller than the scion.

Fifteen of the Eureka trees on Troyer stock were pulled in February, 1952. Nine trees had evidence of exocortis at or below the crown roots. The bark was stripped from the bud union area at this time. Not only was there a sharp line of demarcation at the bud union of the lemon and citrange, but the wood of the citrange was stained and discolored. Whether these symptoms are related to exocortis is not yet established.

That some trees will grow satisfactorily on Troyer is demonstrated by 40 Monroe Lisbon lemon trees. They are the same age as the Eureka lemons on Troyer stock and are growing normally. In 1951 they were better trees than similar tops the same age budded on sour orange. Twenty of the Monroe Lisbon lemon trees were pulled in February, 1952, and there was no evidence of exocortis on the Troyer roots.

None of three combinations budded on Rusk citrange and Savage citrange had any indications of exocortis in 1951. A few trees of Washington Navel orange budded on Coleman citrange and examined a year previously also showed no exocortis symptoms.

Seedlings and Cuttings

Of 38 seedlings or cuttings examined there was no evidence of any bark disorders identified as exocortis. Several seedlings out of the 17 Sanford citrange F_2—second generation—seedlings examined in 1950 did show a peculiar type of rough scaling bark extending up the trunk and into the branches. No transmission tests were conducted, so the nature of the condition is debatable. However, in the other rootstock experiments several stocks, a hybrid—shaddock crossed with St. Michael sweet orange—and the Clementine mandarin have occasionally displayed bark irregularities which could be confused with exocortis. Clementine produces only gametic seedlings and the shaddock hybrid produces a high percentage of gametic seedlings. Such irregularities could be hereditary but that has never been established as a fact.

Genetic Factors

Genetic factors must be considered in the examination of the exocortis problem. Many F_2 seedlings are characterized by the expression of a wide range of characters. Exocortis itself may not be inherent but there is a chance that some weakness may exist in certain progeny which predisposes it to such diseases.

None of the eight trifoliate orange hybrid combinations budded on sour orange, sweet orange, or Sampson tangelo showed any indication of exocortis. Many of these trees are 33 years of age. Some grapefruit trees on sweet orange stock planted in 1917 and topworked to Morton citrange in 1944 have remained healthy.

It appears probable from these investigations that exocortis is not due to inherent factors, but may be of a virus nature.

An experimental planting made in 1951 at Riverside—using roots of trifoliate orange, Morton citrange, and Troyer citrange—will permit further investigation of the problem of exocortis.

W. P. Bitters is Associate Horticulturist, University of California College of Agriculture, Riverside.

The above progress report is based on Research Projects 193C and 194.

Morton citrange stock budded to Eureka lemon eight years old, showing the scaling extending to the bud union.

Trifoliate orange stock budded to Eureka lemon, 22 years old, showing the reduction in size of the stock, prodigious scaling and lack of fluting.