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Tristeza and Stem Pitting in Brazil

STEM PITTING associated with tristeza has long been a problem on West Indian limes and on grapefruit in Brazil (4). Only recently, however, stem pitting, coupled with stunting and small-sized fruit production, was recognized (5) as a problem on the commercially important Pera sweet orange variety. Correspondence to the senior author from Jean Phillippe described stem pitting on Valencia sweet orange trees in the African Congo, and the seriousness of the tree condition there was confirmed by Harry Ford.

The present report is the result of a recent trip to Brazil by the senior author. It summarizes the general aspects of the problem of tristeza and stem pitting in Brazil.

Observations

West Indian limes (Key limes) are locally known as Limao Galego. Many trees have stem-pitted and stunted branches and yellowing and mineral-deficiency symptoms in the leaves. An outstanding grove with few tristeza virus symptoms was found at Pitangueiras. The owners had made a series of selections from surviving trees in three earlier plantings. Although no specific tests had been made, the success of this planting may have been due to the selection of surviving trees that were infected by a mild virus strain rather than a severe one. This lime planting in Pitangueiras was a distinct contrast to the one at the Limeira Citrus Experiment Station, where the trees had been inoculated with the severe strain of tristeza virus by aphids when the trees were in the nursery (1).

Trees in this latter planting were affected with branch dieback and stem pitting and were extremely stunted.

In the Rio area, Giacometti had some lime trees in his rootstock plantings that were infected with a mild strain of tristeza virus and their growth has been relatively good. In the coastal plain area, a large planting of a nearly thornless variety of West Indian lime was also observed to be growing well.

Grapefruit plantings were composed largely of the Marsh seedless variety. In the groves, stem pits ranged from very few to many deep trunk and branch pits. According to the grove owners and operators, the grapefruit trees show seasonal deficiency symptoms on the leaves and the trees were judged to be considerably smaller than they would have been in the absence of virus infection. A high proportion of fruits were small, very acid, and thick-skinned. In general, the trees in groves receiving heavy fertilizer applications were in better condition than unfertilized trees, but fruit quality was relatively poor.

In experimental field plantings of Foster and Duncan grapefruit at Limeira, where plants had been inoculated in the nursery with the severe tristeza virus strain, many trunk and stem pits were present and trees were very small with compact bunchy tops. These plantings produced no fruits of commercial value.

In the coastal plain area near Rio, where good alluvial soils exist and where rainfall is abundant, Marsh grapefruit trees were observed to have numerous deep trunk and stem pits, but fruit production and quality were relatively good.

Pera orange is the late variety most commonly exported from Brazil. In recent years, it has been subject to stem pits similar to those observed on the West Indian limes and grapefruit trees. This stem pitting has been accompanied by small fruit and stunting of the infected branches, and when trunk pits are evident, the entire tree produces small fruits. Severely infected young groves, fertilized heavily in the first few years, have produced normal-sized fruits, but there is no evidence that they will be able to continue production for long periods.

The largest numbers of groves with badly pitted Pera orange trees 4 to 8 years old were in the vicinity of Limeira. However, not all plantings in this area were uniformly infected, which indicated that in some cases the budwood may have been from trees infected with the severe tristeza virus strain and that in such cases trunk pitting started at the bud union of the Pera top and the rootstock. It was estimated that in some groves 10 to 20 per cent of the trees were from buds carrying the severe strain.

The remaining trees showed varying degrees of infection ranging from no pits to trees with one or more branches with stem pits and small fruits. These latter cases seemed to be the result of spread of the severe strain by aphids.

In the Bebedouro area, one grower indicated that 200 of 22,000 budded trees had shown trunk pitting three years after budding. These trees were scattered through his field planting and seemingly aphids had spread the virus to adjacent trees. These more recently infected trees showed no trunk pits but individual branches had stem pits and small fruits. The remaining branches were producing fruits of normal size.

From the observations, it seems evident that Pera orange budwood, free of tristeza virus or with only a mild strain of it, should be selected.

At the Experiment Station in Limeira, Pera orange has been used both as a top and as a rootstock. Evidently the Pera orange holds an intermediate position of tristeza tolerance. As a rootstock it is more tolerant to severe tristeza virus than sour orange or grapefruit, but as a top it is less tolerant than other sweet oranges tested.

In the Rio area, trunk and branch pitting on Pera orange trees was common. In one grove, the owner had used heavy applications of fertilizer and had continually pruned out all sucker growth. The Pera orange trees were not large, but excellent fruit quality and size had been maintained in spite of the stem pitting.

Sweet oranges, Baianinha, Hamlin, and Valencia were observed in many field plantings. No trunk or branch pitting could be observed without removal of the bark. Upon removal of the bark, however, varying numbers of small pits could be observed on all varieties. In general, growth of these sweet orange varieties was relatively very good even in plantings adjacent to Pera orange groves that showed deep stem pits.

Eureka lemon has been recognized as a variety that could be top-worked on sweet orange on sour orange rootstock and would continue to grow and produce lemon fruits even in areas where tristeza virus is prevalent. The tristeza virus does not readily multiply in Eureka lemon. In 1957, one of 135 Eureka lemon trees that had been inoculated with tristeza virus by aphids 7 years earlier when they were young plants showed very strong trunk-pitting symptoms. This unusual trunk-pitted Eureka lemon was thought to be a potential source of a stem-pitting virus. Therefore, in 1957, Moreira took buds from this tree and propagated them on seedlings of 3 different lemon varieties, Villa Franca, Genova, and Sicilian. Three years after grafting of the Eureka lemon propagated tops and the lemon rootstocks, no pitting was evident and

the plants are growing vigorously in the field. It is evident that the stem or trunk pitting on the Eureka lemon tree was not transmitted to the lemon rootstocks nor was it perpetuated in the Eureka lemon tops. One is forced to conclude that the stem pitting on this Eureka lemon behaved exactly as if it were caused by the tristeza virus and not due to a separate stem-pitting virus.

Discussion

There is general agreement that stem-pitting is a definite part of the tristeza virus complex and that it is transmitted from tree to tree in the field by aphids. It is also known that there are differences in the reactions of different citrus variety groups to infection by the tristeza virus transmitted by aphids (2, 4). In addition it was found that there can be various mixtures of strains or components of the tristeza virus and that some of these can produce stem pits even on a sour orange variety that ordinarily shows few or no pits (3). New or recombined mixtures of the tristeza virus complex may be the reason for deep trunk and stem pits on Pera orange in Brazil, on the Valencia orange in the African Congo, and in the case most recently reported to the writer, by J. L. Foguet, of stem pits on Mediterranean sweet orange in Argentina.

Regardless of the exact cause of these variations in the tristeza virus complex, the citrus grower is faced with the problem of what to do. The observations in Brazil indicate that some field studies should be undertaken. They may be briefly summarized as follows:

1. Determine the importance of budwood sources in relation to trunk and stem pitting.
2. Test Hamlin and Valencia orange varieties that presently do not show deep stem pits by top-working them on badly pitted lime, grapefruit, and Pera orange trees.
3. Try interplanting with Hamlin and Valencia oranges in groves of badly pitted Pera orange to determine whether such a procedure is practical for rehabilitating groves.
4. Determine the effects of fertilizer and pruning practices on stem pitting and fruit production.
5. Test for the presence of mild virus strains in outstanding trees that have survived and show little or no stem pitting in the field.
6. Select mild strains for studies to determine whether grapefruits, limes, and Pera orange inoculated with these mild strains can survive and produce good fruits under field conditions.

The results of such studies would have value, not only for Brazil, but could form a basis of knowledge for all other countries where tristeza is present or where it may occur in the future.

Literature Cited

1. Costa, A. S., T. J. Grant, and S. Moreira. 1949. Investigações sôbre a tristeza dos citrus. II-Conceitos e dados sôbre a reação das plantas cítricas ã tristeza. Bragantia 9: 59-80.
2. Costa, A. S., T. J. Grant, and S. Moreira. 1950. On a possible relation between tristeza and the stem pitting disease of grapefruit in Africa. Calif. Citrograph 35: 504, 526-528.
3. Grant, T. J. 1959. Tristeza virus strains in relation to different citrus species used as test plants. Phytopathology 49: 823-827.
4. Grant, T. J., A. S. Costa, and S. Moreira. 1951. Variations in stem pitting on tristeza inoculated plants of different citrus groups. Proc. Florida State Hort. Soc. 64: 42-47.
5. Moreira, S. 1960. Um nova problema para nossa citricultura. Rev. Agr. (Piracicaba) 35: 77-82.