Rootstock Effect on Tristeza Stem-Pitting Expression in Sweet Orange Trees

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In areas where tristeza virus has become endemic and where new orchards are planted on tolerant rootstocks, stem pitting has become a more and more serious problem. Apparently, new strains of the virus, of increasing severity, arise and are spread by aphids. Many citrus varieties once considered to be only slightly affected by the tristeza virus soon develop marked stem pitting and accompanying symptoms, like stunting, production of small fruits, and zinc deficiency symptoms, in young leaves. This situation is occurring in Brazil, where tristeza made its appearance in 1937 and since then has become the most important virus problem affecting citrus trees.

Stem pitting was initially considered to be a problem of grapefruit, lime and some other citrus types (Grant *et al.*, 1951). By 1960, it was recognized as a serious disorder affecting Pera orange, the citrus variety most widely grown in Brazil (Grant *et al.*, 1961; Moreira, 1960). Subsequent reports (Donadio *et al.*, 1974; Rossetti *et al.*, 1965; Salibe, 1965; Salibe and Rossetti, 1965) revealed that stem pitting was becoming a growing problem to many other citrus varieties of commercial importance, particularly to certain outstanding sweet orange varieties. Growers were discouraged from planting these orange varieties such as the common clones of Pera, Barão, and Westin. Recently, poor growth of Baianinha Navel and Piralima orange trees in various orchards was found to be caused by severe stem pitting.

The importance of the problem justifies the great effort by many research workers on the study of tristeza stem pitting in Brazil and other countries. This paper presents the results of a study of the rootstock effect on the severity of stem pitting in various sweet orange scions.

MATERIALS AND METHODS

Ten rootstock experiments were established in 1965 at the "Presidente Medici" Agricultural Experiment Station in Botucatu, using nucellar clones of Hamlin, Baianinha navel, Westin, Rubi, and Itaborai oranges as scions. The rootstocks used in the experiments were: Rangpur lime, Sunki mandarin, Caipira sweet orange, Florida rough lemon, and trifoliate orange. Five experiments were conducted in the Lajeado area at an elevation of 786 meters above sea level and five similar experiments in the Edgardia area, at an elevation of 477 meters. These two areas are about 2 km apart. Each experiment consisted of one scion variety on five rootstocks, and followed a randomized-block design with six replications and two-tree plots. The effect of rootstock and locality on the vigor and production of the trees is reported elsewhere (Salibe, 1974).

These trees are free from all known viruses except a severe strain of tristeza virus. Periodical examinations showed that many trees were affected by stem pitting. To determine the extent of the damage due to the tristeza virus, a study was made on the amount of stem pitting in each tree. Samples were collected from each tree in all 10 experiments. Each sample consisted of 10 young branches, 20 cm long and 1.0 to 1.5 cm thick. Sampling was done in December 1973; all 6,000 young branches collected were from growth of that year. The bark was removed from these branches and the amount of stem pitting was rated as one

to five, ranging from slightly to very severely pitted; zero rating was given to non-pitted branches.

An average amount of stem pitting was obtained for the two-tree plots of each block in each experiment and the data were analyzed statistically by analysis of variance using the Fisher F test. Averages were compared using the Tukey test.

Stunting and yellowing of leaves were not very evident, except in a few Westin orange trees.

RESULTS

The average amount of stem pitting was significantly affected by scion variety, rootstock and locality. Scion varieties proved to have tissues with different average degrees of tolerance to the tristeza virus, in the following increasing order: Westin, 3.83;Baianinha Navel,3.16; Itaborai, 3.06; Rubi, 2.44; and Hamlin orange, 1.61. Rootstocks affected the severity of stem pitting significantly at the 95 per cent level in all orange scion varieties as shown in table 1. Total average amounts of stem pitting according to rootstocks were: trifoliate orange, 3.66; Rangpur lime, 2.77; Florida rough lemon, 2.76; Caipira sweet orange, 2.63; and Sunki mandarin, 2.27. With all scion varieties, trees on trifoliate rootstock were always more affected by stem pitting than those on the other rootstocks, while those on Sunki mandarin were, with few exceptions, least affected.

TABLE 1
AVERAGE AMOUNT OF STEM PITTING IN THE SCIONS OF SWEET ORANGE TREES ON VARIOUS ROOTSTOCKS

Rootstocks	Scion varieties						
	Westin	Baianinha		Itaborai	Rubi	Hamlin	
		Lajeado	Edgardia			Lajeado	Edgardia
Trifoliate orange	4.31 a†	4.27 a	4.05 a	3.62 a	3.10 a	3.05 a	3.17 a
Florida rough lemon	4.02 ab	3.68 b	2.83 b	3.03 a	2.26 b	1.30 c	1.23 b
Rangpur lime	3.82 ab	3.37 c	2.02 c	3.18 a	2.57 a	2.05 b	1.20 b
Caipira sweet orange	3.55 b	3.42 bc	2.40 bc	3.15 a	2.46 b	0.98 c	1.15 b
Sunki mandarin	3.45 b	3.45 bc	2.15 bc	2.32 b	1.82 c	1.07 c	0.92 b
m s d*	0.588	0.793		0.694	0.437	0.612	

*m s d = minimum significant difference at 95 per cent level.
†Values in the same column followed by the same letter are not significantly different, those not followed by the same letter are significantly different at the 95 per cent level.

The effect of locality on the amount of stem pitting was less evident, total averages being 2.97 for the Lajeado area and 2.67 for the Edgardia area. The average amounts of stem pitting shown by the orange trees in both localities are presented in table 2. These differences were statistically significant for: Westin orange on all rootstocks, Baianinha Navel on all rootstocks excépt trifoliate orange, and Hamlin orange on Rangpur lime. The analysis of variance revealed interactions of rootstock and locality in the data from the experiments having Baianinha Navel and Hamlin orange scions, and for this reason averages are compared separately, as shown in table 1.

TABLE 2
AVERAGE AMOUNT OF STEM PITTING IN ORANGE SCIONS IN TWO LOCALITIES, INDEPENDENT OF ROOTSTOCKS

Orange Scion Variety	Average amount of stem pitting	
	Lajeado area	Edgardia area
Westin	4.11	3.55
Baianinha Navel	3.64	2.69
Itaborai	2.98	3.13
Rubi	2.43	2.45
Hamlin	1.69	1.53

DISCUSSION AND CONCLUSIONS

Five sweet orange varieties of commercial importance were found slightly to severely affected by stem pitting believed to result from infection by a severe strain of tristeza virus. The amount of pitting in the twigs of these orange trees was significantly affected by different rootstocks. It is known that rootstocks have a strong influence on nutrient concentrations in the scions and we believe that this must affect the degree of tissue tolerance to the virus. Trees on trifoliate orange were found to have a consistently higher amount of stem pitting than those on the other four rootstocks while those on Sunki mandarin rootstock were generally the least pitted. Leaf analyses revealed a negative correlation between the amounts of stem pitting and copper concentrations and positive correlations between stem pitting and concentrations of manganese and iron. Copper concentrations in the leaves from the trees on trifoliate orange were substantially lower than in the leaves from scions with other rootstocks, those on Sunki mandarin having the highest copper concentrations (L.A. Lima, personal communication). The mechanism of pit formation may be related to the shortage of certain nutrients like copper, with the area of cambium cells affected by the virus being undernourished.

Rootstocks also influence the vigor of the trees. Trees on trifoliate rootstock were the least vigorous in the experimental plots, but there was no correlation between the vigor of the trees on the other rootstocks and the severity of stem pitting (Salibe, 1974).

The trees in the Lajeado area were frequently more severely pitted than those at the Edgardia area. This possibly resulted from the difference of prevailing temperatures, on the average several degrees cooler in the higher Lajeado area. The higher temperatures in the Edgardia plantation may have had some thermotherapy effect.

The data presented in this paper call attention to the problem of the continued emergence of additional severe strains of tristeza virus in countries where this virus has become endemic and emphasizes the need for preimmunization, before propagation, of all commercial citrus varieties to be grown in such endemic areas.

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