Stem Pitting in Citrus Varieties and Nucellar Clones in Rio Grande Do Sul, Brazil

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Rio Grande do Sul is the most southern of Brazilian states, and its environmental conditions are very different from those of Sao Paulo State, the leading citrus region in Brazil. Climatic conditions, especially temperatures, are intermediate between those of Sao Paulo State and the Mediterranean Basin. Citrus plantings occupy about 20,000 hectares, chiefly Valencias, which are sold as fresh fruit in local markets. Processing is beginning but there is no export.

In a previous paper (Dornelles, 1972), I reported that tristeza spread into Rio Grande do Sul, probably from Argentina, around 1944. Studies of the incidence of stem pitting in late ripening orange varieties and in their nucellar seedlings of the same varieties, led to the conclusion that the plants had been previously infected with mild strains of the virus, which protected them against severe strains introduced later (Dornelles, 1972). Cross protection between virus strains had been previously obtained by other workers (Giacometti and Araujo, 1965; Müller and Costa, 1968).

In recent years stem pitting problems increased in the State, especially in Pera orange and less severely in other varieties including old clones of Valencia orange, not previously affected. These problems occur especially in vigorous young trees, which are attached more than others by black aphids *(Toxoptera citricidus* Kirk.). The situation suggests the spread of new strains or new mixtures of strains of tristeza virus, against which there is no protection. This type of occurrence has been reported in other regions (Müller *et al.*, 1968).

Information on the behavior of available varieties and clones naturally infected with tristeza virus by the black aphid is important, both in the selection of material for direct use as stocks or scions, or in the selection of resistance or tolerance for breeding work. Salibe (1965) and Donadio *et al.* (1974), surveyed the behavior of old and new clones at the Limeira Experiment Station in Sao Paulo State which includes about the same materials present at the Taquari Experiment Station, but the reactions to natural virus infection differ in some cases. These differences may be attributed to environmental conditions but could be due to the occurrence of different virus strains. The distribution of the efficient vector, *Toxoptera citridus,* all over the country and the unrestricted exchange of plants and budsticks make the eventual spread of all strains to all citrus areas in the country unavoidable.

MATERIALS AND METHODS

From the 240 varieties of the Taquari Experiment Station citrus varieties collection, 157 varieties were studied with respect to their behavior under conditions of free infestation by black citrus aphids. Three 11- to 17-year-old trees of each variety were used. Four branches with at least three growth flushes were sampled from each tree and the bark was removed to rate the pitting as follows: 0, not pitted; 1, very slightly pitted; 2, slightly pitted; 3, medium pitted; 4, strongly pitted; 5, very strongly pitted.

Each plant was graded according to the branch most severly pitted and each variety was classified according to the tree with the highest grade. The same survey was made on 109 nucellar seedlings of Pera orange and 80 nucellar seedlings of Valencia orange, aged 14 to 17 years from seed.

Nucellar seedlings of Pera orange were

budded on Rangpur lime and two budlings from each seedling were planted in an orchard. Six years after budding each plant was thoroughly examined for visual leaf and fruit symptoms and by peeling the branches for stem pitting. Each budline was graded according to the most severely pitted tree.

Two Pera orange clones (31 and C.N.) which showed very dissimilar reactions in the survey on varieties were studied in the greenhouse. Seedlings of both clones were bud inoculated with four virus isolates from plants showing severe symptoms. After budding, the seedlings were cut back and after three years the shoots were peeled and examined for pitting. An attempt was also made to cross protect Pera C.N. seedlings with the Pera 31 isolate.

RESULTS AND DISCUSSION

In the variety collection survey, the varieties were classified as follows:

0, NOT PITTED

Oranges: India, Viradouro, Tangerina*, Natal, Dieberger, Piralima, Lancheta, Macae, Sulina, Ceu, Mandarina.

Tangerines: Cravo, Dancy, de Umbigo Ceu, do Rio, Kara, Montevideo, Satsuma, Comum, Cleopatra, Hibrida*, da Florida, Pau, Mel, Dancy C.N., Kinnow, Wilking, Willow Tetraploid.

Lemons: Deodoro, Doce, Eureka, Genova, Itália, Lunária, Siciliano, Villa Franca, Lisboa, Amber.

Acid limes: Crystal, Uraguaio.

Sweet limes: Da Persia, Da Persia Dourada, De Bugre, De Umbigo.

Shaddocks: Dr. Chico, Paraíso.

Sour orange: Double calyx.

Miscellaneous: Rangpur lime, Sampson tangelo, Thornton tangelo, Tangerona Tangor, Troyer Citrange, Citrangequat.

1, VERY SLIGHTLY PITTED

Oranges: Jaboticaba, Imperial, Sanguínea, Ruby Blood, Pera 31, Tobias, Ouro, Setubal, Valencia, Magnum Bonum, São Miguel, Barão do Bananal, Baianinha B.B., Perola, Bahia E.E.P., Monte Parnaso, José Paulino, Brinco.

Tangerines: King, Oleosa, Ponkan, Montenegrina.

Grapefruits: Pernambuco, Singapura, Marsh seedless.

Sour oranges: Agro - Sevilhana, Sem Espinho.

2, SLIGHTLY PITTED

Oranges: Coroa, Cipo, Cacau, Natal, Parson Brown, Coroa de Rei, Valencia C.N., Hamlin, Hamlin C.N.†, Shamouti, Perinha, Melrose, Melao, Itaboraí, Lue Gim Gong, São Sebastião, Serrana, Westin, Jaffa, Diva, Selecta Vermelha, Selecta Toranja, Prata, Lisa, Rosa, Hactut, Seleta São Paulo, Franck, Saude, Acoriana, Pineapple, Baianinha de Piracicaba, Fontes, Selecta Estacão, Pele de Moca, Panásia, Orvalho de Mel, Cábula, Bahia, Tomásia, Baianinha de Araras, Champagne, Washington Navel, Thompson, Abacaxi de Maracaña, Barão, Campista, D.A.C., Mangaratiba, Coronel.

Grapefruit: MacCarty.

Miscellaneous: "Limão" Rugoso Taquari.

3, MEDIUM PITTED

Oranges: Itaborai C.N., Moro Blood, Ibicaba, Natal C.N., Enterprise, Pera do Rio, Perão, Hart's Late C.N., Mortera, Monjolo, Jacinto, Golden Nugget, João Dutra, Buckeye Navel.

Tangerines: Araca, Paraguaiá, Do Para.

Lemons: Flor Branca*, Ponderosa*.

Miscellaneous: Mineola tangelo, *Citrus taiwanica.*

4, STRONGLY PITTED

Oranges: Pera C.N., Baianinha I.A.

Miscellaneous: Docinha Tangor.

5, VERY STRONGLY PITTED

Oranges: Natal de Umbigo

* varieties with doubtful botanical classification.
† nucellar clones from Limeira Experiment Station.

Varieties classified in groups 0, 1, and 2 have good growth and yield. They can be recommended for commercial planting. The varieties classified in groups 3, 4, and 5 have reduced growth and some abnormal fruits. Natal de Umbigo, the only variety classified in group 5, has very poor growth, abnormal fruit, and dieback.

Varieties Pera 31 and Pera C.N. were classified in very different groups and are not alike in fruit characteristics. In greenhouse inoculation tests their seedlings react differently. Pera 31 seedlings showed tolerance to all virus isolates used, only 3 of 36 seedlings showed symptoms of grade 1. Pera C.N. seedlings showed severe pitting with two virus isolates and 20 of 36 seedlings were pitted. Attempts to cross protect Pera C.N. with a Pera 31 isolate failed.

Table 1 shows the results of the stem-pitting survey in nucellar seedlings of Pera orange and Valencia orange. Both groups were exposed to natural infection by black citrus aphids. Growth conditions were poor and this may have prevented the development of more severe symptoms. The different reactions of the two groups of seedlings to natural infection was expected because they were of different genetic origin. Differences in reactions of seedlings in the same group may be attributed to infection with different virus strains.

Table 2 shows the results of a survey of budded progeny of Pera nucellar seedlings in comparison with the seedling mother trees.

These results show that nucellar seedlings without pitting or very mildly pitted did not transmit resistance or tolerance to their bud progeny. The majority of bud progeny of groups of mother seedlings with medium or strong pitting developed the same condition, but some were free of pitting. These results suggest that seedlings, although healthy, were not protected against the virus strains spreading in the area. One can assume also that pitted trees may have healthy bud progeny.

TABLE 1
STEM PITTING IN NUCELLAR SEEDLINGS

Stem-pitting*	Trees pitted			
	Pera Orange		Valencia Orange	
	No.	%	No.	%
0	33	30	75	94
1	37	34	4	5
2	27	25	1	1
3	10	9	0	0
4	2	2	0	0
5	0	0	0	0

*See text for explanation of grades.

TABLE 2
STEM PITTING IN BUD-PROGENY TREES OF PERA NUCELLAR SEEDLINGS COMPARED WITH THE MOTHER TREES

Stem-pitting grade of mother trees*	Bud-progeny trees			
	Total examined	Stem-pitting grade 0-1	2	3-5
	No.	No.	No.	No.
0 - 1	70	7	17	46
2	27	3	7	17
3 - 5	12	2	0	10

*See text for explanation of grades.

CONCLUSIONS

The majority of commercially important varieties in Rio Grande do Sul were graded as being free of stem pitting to slightly pitted, and did not have growth or production problems due to stem pitting. The use of Natal de Umbigo and Bahaianinha I.A. oranges and certain clones of Pera orange should be avoided.

The differences in reactions obtained in greenhouse inoculation tests between two Pera orange clones show the importance of genetic factors in tolerance to tristeza virus.

Severely pitted Pera orange seedlings transmitted this condition to the majority of their bud progeny although severely pitted trees had some healthy bud progeny.

Healthy or mildly pitted Pera orange seedlings did not transmit this condition

to their bud progeny. In regions where tristeza virus and black citrus aphids are present, a tree should not be considered cross protected against the tristeza virus strain present there unless its bud progeny also are free of symptoms.

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