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# Limitations on the Use of Volkamer Lemon as Rootstock for Citrus

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**ABSTRACT.** Performance tests revealed a number of restrictions on the use of Volkamer lemon as rootstock: intolerance to xyloporosis (cachexia) viroid, development of budunion crease with certain scion varieties and appearance of wood pitting in the presence of severe strains of tristeza virus. Typical crease symptoms occurred at the union of trees of Serrana acidless, Pera Bianchi, Pera Santa Irene, nucellar Pera Vacinada and Pera Comprida oranges and *Citrus macroptera* scion varieties. Trees of nucellar Serrana orange on the same rootstock were healthy.

Tests of four Volkameriana lemon selections for susceptibility to tristeza stem pitting virus, revealed that Acireale was more tolerant than Palermo, while Catania-1 and Catania-2 were intermediate. All selections showed good tolerance to severe strains of exocortis viroid. Orchard surveys showed the occurrence of symptoms of "citrus decline" in trees budded on Volkamer lemon.

*Index words.* xyloporosis, budunion crease, tristeza stem pitting.

There is a growing interest in the use of Volkamer lemon, *Citrus volkameriana* as rootstock for citrus, due to its tolerance to tristeza, good resistance to Phytophthora root rot and to "mal secco" caused by *Deuterophoma tracheiphila* Petri and because it induces high vigour and productivity to the scions. According to Russo (7, 8) this citrus type has many characteristics resembling those of Rangpur lime and may be identical to Canton lemon. Truly, the trees and fruits of Volkamer lemon are in many aspects nearly identical to rough lemon and only a few characteristics remind one of Rangpur lime (12, 16).

Performance tests conducted in Brazil of Volkamer lemon as a rootstock for orange and lemon scions, yielded excellent results (11, 17). This opened the possibility of using this variety as an alternate for Rangpur lime, which has ranked first in most of 100 rootstock experiments conducted in Brazil during the last fifty years (6). The outstanding behaviour of Volkamer lemon with tristeza-infected orange scions indicated that it was tolerant to this virus. This information roused a growing

interest in nurserymen and growers in the use of Volkamer lemon as rootstock in São Paulo, Brazil.

The results of the research reported here revealed some restrictions on the use of Volkamer lemon as a rootstock for certain citrus scion varieties and indicated its behaviour in the presence of major viruses.

## EXPERIMENTS AND RESULTS

### Reaction to tristeza virus.

Eight-month-old seedlings of four selections of Volkamer lemon named Acireale, Palermo, Catania-1 and Catania-2 were infected with a severe strain of tristeza virus with the brown citrus aphid, *Toxoptera citricida* Kirk. Original seeds of these lemon selections were obtained from Acireale Citrus Station, Sicily, Italy, through the kindness of Dr. Francesco Russo.

Colonies of *T. citricida* were allowed to feed for several days on a nucellar Hamlin orange tree infected with a severe strain of tristeza stem pitting virus. Aphids were then transferred to the young Volkamer lemon seedlings (about 40-50 adults aphids to each seedling) and were killed with insecticide four days later. Ten seedlings

of each selection were inoculated and another ten seedlings left as noninoculated controls.

All seedlings were cut back two months later and three new sprouts allowed to grow. On September 1980, one year after inoculation, all sprouts were peeled and rated for stem pitting, on a scale of zero (no pits) to four (severely pitted). Average results were: Palermo selection 2.9, Catania-2 2.7, Catania-1 1.6, Acireale 0.4 and all healthy controls 0.0. No significant differences in growth occurred between infected and healthy control plants.

Field observation of trees on Volkamer lemon with 21-year-old nucellar Baianinha navel orange scions, and with 12-year-old nucellar Valencia orange scions, infected with tristeza virus revealed vigorous growth and good productivity, with no visible deleterious effect due to the presence of tristeza virus.

**Reaction to exocortis and xyloporosis viroids:** Eight-month-old seedlings of Volkamer lemon growing in the field were infected with exocortis and xyloporosis viroids. Seedlings were of the Acireale selection and were grown from seeds taken from a single mother tree.

Sources of inoculum were a Barão orange tree carrying severe xyloporosis and a Hamlin orange tree carrying severe exocortis. Ten seedlings of Volkamer lemon were infected with exocortis and another ten with xyloporosis, with the use of three blind buds for inoculation of each seedling. Ten noninoculated seedlings were cut back and one sprout allowed to grow on each seedling. Periodic inspection, to May 1983 (35 months following inoculation) showed no symptoms of exocortis and xyloporosis in the seedlings.

Inspections were also made of field trees of nine-year-old Lisbon lemon budded on Volkamer lemon, known to be infected with very se-

vere exocortis and the rumple agent. All three trees inspected were healthy, vigorous, with no trunk symptoms characteristic of exocortis. Trees of same scion variety budded on Rangpur lime were stunted, with severe cracking and bark scaling in the trunk of the rootstock.

Inspections made in the same citrus collection on Volkamer lemon rootstock, revealed typical symptoms of xyloporosis (cachexia) in two trees of Uruguay sweet lime. The removal of a piece of bark at the union showed the presence of conoid pits and pegs, tissue discolorations and gum pockets in the bark characteristic of the disease (1, 2, 14, 15). Stunting of affected trees was also noticeable.

#### **Inspections for budunion crease.**

The excellent performance of trees budded on Volkamer lemon in the preliminary experiments, led to the establishment of a citrus collection on this rootstock. Varieties were of old or nucellar clones according to the material available. In some instances, nucellar and old clones of the same variety were included.

The citrus collection was established at the S. Manoel Experiment Station, in November 1974, and included: 26 oranges, 12 lemons, 10 tangerines, 2 tangors, 5 citrons, 3 sweet limes, 3 sour oranges, plus one limequat, one shaddock, one grapefruit, one tangelo and *Citrus macroptera* totaling 66 varieties. Most important commercial citrus varieties were represented in the collection to determine their behaviour and compatibility with Volkamer lemon rootstock.

Periodic observations indicated that trees made vigorous growth, with differences according to the scion species or hybrids. Average tree heights in May 1982 were: for lemons 4.25 m, Marsh seedless grapefruit 3.05 m, citrons 3.00 m, sweet limes 2.95 m, shaddock 2.90

m, sour oranges 2.81 m, tangors 2.75 m, tangerines 2.60 m, sweet oranges 2.31 m, Orlando tangelo 2.15 m, Eustis limequat 1.80 m and *Citrus macroptera*. 1.50 m. Inspections of the budunion by the removal of a piece of bark, revealed typical budunion crease symptoms (4.10) with the following scion varieties: Serrana acidless, Pera Bianchi, Pera Santa Irene, nucellar Pera Vacinada (nucellar Pera pre-immunized with mild tristeza virus) and Pera comprida oranges and *Citrus macroptera*. All trees of nucellar Serrana orange in the same collection were healthy. These trees with budunion incompatibility were conspicuously smaller than trees having Valencia, Baianinha, and Navel orange scions.

Wood pitting caused by tristeza virus was observed in the trunk of the rootstock in trees budded to the Feijão Crú and Sanguinea de Mombuca sweet oranges. Indexing showed that these trees were carrying very severe strains of tristeza seedling yellows virus.

**Reaction to citrus decline.** Ten young trees of Baianinha navel orange budded on Volkamer lemon, two years old in the nursery were inoculated with buds taken from trees showing "citrus decline." This was part of a larger experiment to study this disease which is similar to Florida blight. Two years after inoculation all trees were still apparently healthy.

Field inspections in a commercial Valencia orange grove with various rootstocks, revealed several trees with symptoms of "citrus decline" in Volkamer lemon and Rangpur lime rootstocks.

## DISCUSSION

Release of a new promising rootstock variety demands performance studies and also indexing for virus and viroid reactions and compatibility tests with major

commercial varieties. Volkamer lemon has many outstanding characteristics (8, 11, 17, 18) that recommends its use as rootstock. However, trees of certain scion varieties develop budunion crease when budded on this rootstock and symptoms were similar to those of some Pera orange and other scion varieties budded on Florida rough lemon (3, 5, 10, 13).

Pera orange is the most important scion variety grown in Brazil, and includes possibly 50 to 60 per cent of all citrus trees in the State of São Paulo. Thus, the incompatibility shown by Pera orange trees on Volkamer lemon rootstock drastically limits the use of this rootstock there.

The occurrence of budunion crease symptoms in trees of old line Serrana orange on Volkamer lemon rootstock and the absence of symptoms in the trees of nucellar line Serrana orange raises the possibility of a transmissible agent being involved in the problem. Several authors attributed budunion crease to a genetic incompatibility (4, 9, 13) but a transmissible agent has been indicated as the cause of the problem in certain stionic combinations (5).

Volkamer lemons has been shown here to be tolerant to exocortis and intolerant to xyloporosis. These results strengthen the idea that it has some characteristics of rough lemon (tolerance to exocortis, budunion crease with certain scion varieties) and some others of Rangpur lime (intolerance to xyloporosis). The use of healthy mother trees, free from xyloporosis viroid is then necessary when using Volkamer lemon rootstock.

Available information indicates that Volkamer lemon can be considered tolerant to tristeza virus. A certain variation or degree of tolerance appears however to exist among various selections, the Acireale selection being more toler-

ant. Severe tristeza seedling yellows consequently some damage to this strains may cause wood pitting and rootstock.

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