

## Further Study of the Tolerance to Tristeza Virus of Citrus Varieties Suitable for Rootstocks in Brazil

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THE PRESENT PAPER reports additional results, obtained from 1963 to 1968, from a trial laid out in 1950 at the Limeira Citrus Experimental Station to study the tolerance of rootstocks to tristeza virus. Results obtained earlier have been reported elsewhere (2, 3, 4, 5). The occurrence of a new strain of tristeza virus that severely damages Rangpur lime in the Capão Bonito area (7) emphasized the need for studying the tolerance to tristeza virus of various rootstocks suitable for the many commercial varieties of citrus known in Brazil. The symptoms of hassaku dwarf described in Japan have many similarities to tristeza Capão Bonito. The two diseases may be caused by the same virus complex.

### *Materials and Methods*

Nucellar lines of Valencia and Barão sweet orange, Dancy tangerine, Duncan and Foster grapefruit, and Beledy lime were budded on seedlings of 400 rootstock varieties and inoculated in the nursery with a severe strain of tristeza virus (2). Trees of 77 stionic combinations found to be tolerant of the virus were transplanted to the field in 1950-51. Three trees of each scion variety on each different rootstock were planted in a soil classified as

Ortho Dark Red Latosol, with no irrigation. The area is frost free with annual temperatures ranging from  $-0.5^{\circ}\text{C}$  to  $39.2^{\circ}\text{C}$ . The rainfall oscillates from 1100 to 1400 mm per annum, occurring mainly from September through March.

The yield of each tree in the experiment was obtained by counting the number of fruit. The vigor was determined by measuring the trunk circumference and the height of trees.

### *Results and Discussion*

Only data from the trees on rootstocks with superior performances, with each scion variety studied, are reported here (Tables 1 and 2).

The varieties in decreasing order of yield from 1955 to 1962 were Dancy tangerine, Barão orange, and Valencia orange (5). In the period 1963 to 1968, the decreasing order was Valencia orange, Dancy tangerine, and Barão orange. The total production of Barão orange, however, was almost 70 per cent less than that of Valencia orange. This alteration in productivity reflects the intolerance of the Barão orange to tristeza virus. The best rootstocks for Valencia orange were Rangpur lime, Troyer and Morton citrange, mandarin 117477, citrumelo 4475, and Florida sweet orange. For Barão orange the best ones were Morton

TABLE 1. AVERAGE NUMBER OF FRUIT (N) PER TREE PER ANNUM FROM 1963 TO 1968 AND AVERAGE TRUNK CIRCUMFERENCE IN CENTIMETERS 10 CM ABOVE BUD UNION (C) OF THE TREES ON THE BEST ROOTSTOCKS STUDIED FOR 3 TOP VARIETIES

| Rootstock group and variety | Valencia orange |     | Barão orange |    | Dancy tangerine |    |
|-----------------------------|-----------------|-----|--------------|----|-----------------|----|
|                             | N               | C   | N            | C  | N               | C  |
| Tangerine types             |                 |     |              |    |                 |    |
| Rangpur lime                | 1868            | 107 | 1044         | 79 |                 |    |
| Mandarin 117477             | 1694            | 95  | 925          | 81 | 1629            | 82 |
| Sunki                       | 1271            | 93  | 985          | 80 |                 |    |
| Clementine                  | 1100            | 94  | 679          | 77 | 1536            | 86 |
| Cleopatra                   | 906             | 87  | 901          | 80 | 1648            | 97 |
| Sun Chu Sha Kat             | 685             | 99  | 1005         | 83 | 1493            | 96 |
| Trifoliate orange types     |                 |     |              |    |                 |    |
| Troyer citrange             | 1815            | 80  | 870          | 56 |                 |    |
| Morton citrange             | 1721            | 84  | 1091         | 75 | 1612            | 66 |
| Citrumelo 4475              | 1542            | 80  | 855          | 51 |                 |    |
| Sweet orange varieties      |                 |     |              |    |                 |    |
| Florida sweet seedling      | 1525            | 90  | 936          | 79 |                 |    |
| Lue Gim Gong                | 456             | 68  | 879          | 59 | 925             | 75 |
| Ruby Blood                  | 733             | 88  | 756          | 74 | 1053            | 82 |
| Homosassa                   |                 |     | 738          | 78 | 1135            | 88 |
| Tangelo varieties           |                 |     |              |    |                 |    |
| Orlando                     | 1319            | 96  | 692          | 73 | 1067            | 81 |
| Sunshine                    | 873             | 99  | 793          | 71 |                 |    |
| Tangelo (18-H-6)            |                 |     | 430          | 69 | 1463            | 95 |

TABLE 2. AVERAGE TRUNK CIRCUMFERENCE IN CENTIMETERS 10 CM ABOVE UNION (C) AND HEIGHT (H) OF THE TREES IN METERS ON THE BEST ROOTSTOCKS STUDIED FOR FOSTER AND DUNCAN GRAPEFRUIT AND BELEDY LIME

| Rootstock group and variety | Duncan grapefruit |     | Foster grapefruit |     | Beledy lime |     |
|-----------------------------|-------------------|-----|-------------------|-----|-------------|-----|
|                             | C                 | H   | C                 | H   | C           | H   |
| Tangerine types             |                   |     |                   |     |             |     |
| Rangpur lime                | 88                | 4.8 | 52                | 3.6 |             |     |
| Temple tangor               | 83                | 4.1 | 71                | 3.9 |             |     |
| Cleopatra                   | 59                | 3.3 | 83                | 4.0 | 99          | 4.2 |
| Mandarin 117477             | 83                | 4.0 | 65                | 3.4 |             |     |
| Pook Ling Ming              | 70                | 4.1 | 60                | 3.3 | 80          | 4.3 |
| Trifoliate orange type      |                   |     |                   |     |             |     |
| Morton citrange             | 64                | 3.7 | 68                | 4.2 | 91          | 4.5 |
| Tangelo varieties           |                   |     |                   |     |             |     |
| Orlando                     | 54                | 3.1 | 87                | 4.3 | 69          | 3.7 |
| Sampson                     | 55                | 3.3 | 75                | 4.2 |             |     |
| Tangelo 18-H-6              | 87                | 3.6 |                   |     |             |     |
| Swanee                      | 78                | 3.6 |                   |     |             |     |
| Sweet orange varieties      |                   |     |                   |     |             |     |
| Hamlin                      |                   |     | 82                | 4.2 |             |     |
| Caipira                     | 81                | 3.6 |                   |     |             |     |
| Homosassa                   | 81                | 3.6 | 80                | 3.6 |             |     |
| Shamouti                    | 75                | 3.7 |                   |     | 64          | 3.4 |

citrange, Rangpur lime, Sun Chu Sha Kat, and sunki. Cleopatra mandarin, mandarin 117477, Morton citrange, Clementine mandarin, Sun Chu Sha Kat, and 18-H-6 tangelo induced the best reaction as rootstocks for Dancy tangerine.

Trees on the various sweet orange types used as rootstocks always produced less than those on the best rootstocks of the other groups, except for the trees on Florida sweet orange (Table 1). This rootstock variety was not used with Dancy tangerine as a scion.

Pera and Lamb Summer orange as rootstocks induced poor vigor and productivity in all trees except those of Dancy tangerine. Sweet orange trees on Lamb Summer orange rootstock died after a few years of growth. The fair growth of the trees of Dancy tangerine on this rootstock indicates that the scion variety affected the intolerance of the rootstock to tristeza virus (1).

However, all 6 tangelo and miscellaneous varieties, including Florida rough lemon, used as rootstocks induced lower yields than the best rootstocks of the other groups.

Duncan and Foster grapefruit and Beledy lime trees developed severe wood-pitting symptoms due to tristeza virus. Growth and production

of these trees were reduced, and the fruit were always of small size and of no commercial value. More recent experiments demonstrated, however, that the preimmunization of virus-free clones of these varieties with mild strains or complexes of tristeza virus provides protection against severe strains, which make possible their commercial cultivation (6).

Duncan grapefruit trees grew better than those of Foster grapefruit when budded on the rootstocks of the tangerine group. Rangpur lime, Temple tangor, and mandarin 117477 were superior rootstock varieties for Duncan grapefruit. Foster grapefruit trees were better on Cleopatra tangerine rootstock.

Orlando and Sampson tangelo rootstocks induced fairly good growth of Foster grapefruit trees, but not of Duncan grapefruit. The best tangelo rootstocks for Duncan grapefruit were 18-H-6 and Swanee.

Within the sweet orange group, the Hamlin, Homosassa, and Cai-pira varieties resulted in better growth of the grapefruit tops.

The best Beledy lime trees were those on Morton citrange rootstock, followed by those on Pook Ling Ming (Rangpur lime type) and Cleopatra tangerine. All other Beledy lime rootstocks made poor growth.

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