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Reaction of Types of Citrus as Scion and as Rootstock to Xyloporosis Virus

THE VIRUS of xyloporosis (cachexia) (2, 4, 10) is widespread in many commercial varieties of citrus (1, 5, 6, 8). For this reason, it is of special interest to know the reaction between it and various types of citrus that are presently used as rootstocks or may eventually be so used. This paper reports the results of tests conducted to determine this reaction for a number of different types of citrus.

Materials and Methods

In September, 1960, 2-year-old Cleopatra mandarin [*Citrus reshni* (Engl.) Hort. ex Tanaka] seedlings in the nursery were inoculated with xyloporosis virus by budding each seedling with three buds from a single old-line Barão sweet orange [*C. sinensis* (L.) Osbeck] tree on Dancy tangerine (*C. tangerina* Hort. ex Tanaka) rootstock exhibiting the gummy-peg and wood-pitting type of xyloporosis symptoms. This tree was known to be carrying both xyloporosis and tristeza viruses but neither psorosis nor exocortis viruses.

Two months later, each of two of these seedlings was budded just above the inoculating bud with one or another of 122 different types of citrus, each bud being taken from a tree of a nucellar line, except in the case of the monoembryonic types. Identical numbers of non-inoculated Cleopatra mandarin seedlings were budded with these citrus types to serve as control plants. All seedlings were cut back to allow the buds to sprout. They were inspected periodically by taking out a strip of bark at the bud-union, the last inspection being made 33 months after inoculation.

The Barão orange tree used as a source of inoculum was part of a rootstock experiment in which trees of a nucellar line of Barão orange and a xyloporosis-infected old line had been budded onto 77 different rootstocks. The experiment was set out at the Limeira Experiment Station in 1950-51. Each scion-rootstock combination was represented by three trees. All trees in the experiment were examined in March or April, 1963, by taking out a strip of bark at the bud-union.

Results

In the scion test, wood pitting and gummy-pegs started to develop as soon as ten months after inoculation in some types of citrus. Symptoms developed in 43 of the 122 types tested, or 35.2 per cent. At the end of 33 months, the symptoms were mild, severe, or very severe in the following types:

Citrus Type	Xyloporosis symptoms	
	Months to develop symptoms	Intensity
Tangelo (*C. reticulata* Blanco x *C. paradisi* Macf.)		
Orlando	10	very severe
Pina	33	mild
Seminole	18	very severe
Sunshine	18	very severe
Tresca gft x Dancy	10	very severe
Watt	33	mild
Tangerine (*C. tangerina* Hort. ex Tanaka)		
Batangas	33	mild
Chao Cho T. Chieh	33	mild
Dancy	33	mild
Mel (Honey)	33	mild
Mexirica do Rio	33	mild
Oneco	24	very severe
Osceola	24	very severe
Ponkan	33	mild
Swatow	33	mild
Weshart[a]	18	—
Wilking	24	severe
Willow Frost tetra	33	mild
Tangor (*C. reticulata* x *C. sinensis*)		
King of Siam	24	severe
Murcott Honey	24	very severe
Sabará	33	mild
Sweet lime (*C. limettioides* Tanaka)		
Americana	33	mild
Columbia	24	mild

Citrus Type	Xyloporosis symptoms	
	Months to develop symptoms	Intensity
Dourada	18	severe
Francana	33	mild
Persia	18	severe
Teheran	18	severe
Vermelha de Goias	18	severe
Sweet lemon (*C. limetta* Risso)		
Umbigo	33	mild
Acid lime [*C. aurantifolia* (Christm.) Swing.]		
Abacaxe	18	very severe
Cristal	18	very severe
Marfim	18	very severe
Rio Claro	24	severe
Mandarin lime (*C. limonia* Osbeck)		
Cravo hybrid	33	mild
Ling Ming	33	mild
Periforme	33	mild
Pook Ling Ming	33	mild
Rangpur lime (limão Cravo)	33	mild
Lemon Hybrids		
Camargo	18	severe
Dehra Dun	33	mild
Kulu	33	mild
Miscellaneous		
Calamondin[a] (*C. madurensis* Lour.)	24	—
C. celebica Koord.	33	mild

[a]All trees were dead 33 months after budding.

In all diseased trees, the symptoms were restricted to the top part of the plant except for two trees in which wood pitting and gum discoloration were found in the Cleopatra mandarin rootstock just below the bud-union, under the inoculating buds.

No xyloporosis symptoms were found in the following types: Minneola, Sampson, San Jacintho, Suwanee, Thornton, Yalaha, Webber, and Williams tangelo; Campiona, Clementine, Cleopatra, Kara, King, King tetraploide, Kinnow, Mexirica Ipanema, Mexirica do Pará, Pau, Sunki, Satsuma Owari, Satsuma Wase, and Sun Chu Shu Kat tangerine; Baia-Mexirica, Docinho S. J. R., Tangerona, and Umatilla tangor; Americano sweet lemon; Kusaie mandarin lime; Galego, Galego thornless, and Seda acid limes; the following lemon and lemon hybrids: Acido, Brazilian rough, Cidra, Eureka, Florida rough, Galego do Norte, Gigante, Perrine, and Siciliano; trifoliate orange [*Poncirus trifoliata* (L.) Raf.]; Morton, Rusk, Savage, and Troyer citrange (*P. trifoliata* x *C.*

sinensis); Citrumelo 4475; Satsumelo 10-V-3; Sacaton citraldin; Kalpi lime; Lima selvagem; sour orange (*C. aurantium* L.); Bergamoto; Eustis, Lakeland, and Tavares limequat (*Fortunella* sp. x *C. aurantifolia*); Meiwa, Nagami, and Nippon kumquat (*Fortunella* sp.); Commerce and Comprida citron (*C. medica* L.); Cuban and Zamboa shaddock (*C. grandis* Osbeck); Faustrimedin; Natsu mikan; Coachella eremocitrus; *Citrus excelsa* Wester, *C. hystrix* DC, *C. ichangensis* Swing., *C. karna* Rafin., *C. macroptera* Montr., *C. pectinifera, C. pennivesiculata* (Lushington) Tanaka, *C. taiwanica* Tanaka & Shimada (Florida), *C. Webberii* Wester, *Atalantia ceilanica* (Arn.) Oliver, *Citropsis* sp., *Feroniela oblata* Swing., *Merope angulata* (Willd.) Swing., and *Micromelum tephrocarpum* Turcz.

Tristeza wood pitting was observed in trees of 32 types. Six of these types were also exhibiting xyloporotic pitting and gummy-pegs. Some of the wood pitting found in trees of the sweet lime varieties could also be attributed to tristeza virus.

None of the control plants developed any symptoms of xyloporosis, but tristeza wood pitting was found in the trees of many types.

Different degrees of stunting were noticeable. Among those without xyloporosis symptoms but with visible stunting were Webber and Suwanee tangelo, Ponderosa lemon, sour orange, Bergamoto sour orange, Eustis, Lakeland, and Tavares limequat, and Nagami kumquat.

Examinations in the rootstock planting revealed xyloporosis symptoms in trees of 38 of the 77 rootstocks, or 49.3 per cent. In some cases, only 1 or 2 of the three trees on the same rootstock were exhibiting symptoms. The number of trees of each type affected and the severity of symptoms were as follows:

Rootstock	Number with symptoms out of 3 trees	Intensity of symptoms
Tangelo		
Minneola	1	severe
Orlando	1	very severe
San Jacinto	2	severe
Seminole	1	severe
Sunshine	1	severe
Suwanee	1	severe
Tresca gft x Dancy	2	very severe
Yalaha	1	severe
18-H-6	1	severe
Tangerine		
Chao Cho T. Chieh	3	severe
Clementine	1	severe

Rootstock	Number with symptoms out of 3 trees	Intensity of symptoms
Dancy	2	severe
Kara	2	severe
King of Siam	1	very severe
Kinnow	2	severe
Kumembo	3	very severe
Mandarin 114412	3	severe
Mandarin 114212	3	severe
Oneco	1	severe
Ponkan 18027	3	severe
Satsuma 105226	3	very severe
Sun Chu Shu Kat	2	severe
Swatow 10031	2	severe
Swatow 10032	2	severe
Swatow 14054	3	severe
Weshart	3	very severe
Tangor		
Murcott Honey	2	very severe
Umatilla	1	severe
653	3	severe
Sweet lime		
Columbia	3	severe
Persia	3	severe
Sweet lemon		
Americano	1	mild
Mandarin lime		
Ling Ming	3	mild
Pook Ling Ming	3	mild
Rangpur lime	2	mild
Miscellaneous		
Brazilian rough lemon	3	mild
Calashu	2	severe
Cowgill Narcott	3	severe

No xyloporosis (cachexia) symptoms were observed in the trees on the following rootstocks: Sampson, Webber, and Williams tangelo; Cleopatra, Cravo, Mandarin 10630, Mandarin 117477, and Sanki mandarin; Temple tangor; Caipira, Florida Sweet, Hamlin, Homosassa, Jaffa, Lamb Summer, Lue Gim Gong, Mediterranean, Navel, Parson Brown, Pera, Pineapple, Ruby Blood, Shamouti, and Valencia sweet orange; Florida rough lemon; trifoliate orange; Cunninghan, Morton, Rusk, Savage, Troyer, Uvalde, and 1416 citrange; 4475 and 4477 citrumelo; 10-V-3 satsumelo; Tavares limequat; Kalpi lime; and *C. taiwanica* (Florida). No xyloporosis symptoms were found in the nucellar Barão orange planting on the 77 rootstocks.

The final results of the examinations in the scion test trees and in the

rootstock planting revealed that 63 of the total of 152 different citrus types, representing 41.4 per cent, exhibited the wood pitting and gum impregnation or gummy-pegs of the xyloporosis type.

Discussion and Conclusions

Symptoms of xyloporosis have been reported in many varieties of citrus, citrus relatives, and hybrids (3, 4, 7, 9, 10). The results here reported enlarge the number of citrus types susceptible to this virus disease.

A different incubation period was observed for the various susceptible citrus types. Similar observations have been reported by Olson (7), who also suggests several factors that might affect the appearance of xyloporosis in some trees. Some of these factors would explain the absence of symptoms in many trees in the Barão orange rootstock planting. These factors are a possible mixture of healthy and diseased buds used in the propagation of the trees, the time required for development of symptoms, interference of some other disorders, and use of non-nucellar seedlings.

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