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Evaluation of Indicators for Xyloporosis and Exocortis in Texas

CHILDS (1) advanced the hypothesis that xyloporosis and cachexia are caused by the same virus. Moreira (3) considered that the bark shelling of Rangpur lime and of *Poncirus trifoliata* and some of its hybrids (i.e., Morton citrange) is caused by exocortis virus. In limited previous trials in Texas (6), the results were in agreement with the views of Childs and Moreira.

Budwood-source trees of many varieties of citrus in Texas have been found to carry viruses that cause gum stain, pitting, and pegging in Orlando tangelo (cachexia) and sweet lime (xyloporosis) as well as bark shelling in Morton citrange (exocortis) and Rangpur lime rootstocks (Rangpur lime disease); some trees are apparently free of these viruses (6).

The objective of the present trials was to evaluate the sweet lime, Orlando tangelo, Rangpur lime, and Morton citrange as indicators for xyloporosis and exocortis viruses. The present article adds further data in support of the hypotheses of Childs and Moreira. It also extends the list of seedling-line and old-line varietal selections considered to be virus-free (4). It reports further that a bark-splitting disorder of sweet lime rootstock was associated with exocortis virus in the absence of xyloporosis virus.

Methods and Materials

Neither psorosis nor tristeza virus was found in the bud-source trees tested; the progeny of these trees, except the limequats, grew

vigorously on sour orange rootstock. Most of the old-line trees are registered as psorosis-free by the Texas Department of Agriculture and many of the bud-source trees are currently used by commercial nurserymen.

Each bud-source tree was propagated on 3 or more seedlings of the following virus-indicator rootstocks: Columbian sweet lime for xyloporosis; Orlando or Sunshine tangelo for cachexia; Morton citrange for exocortis; and Rangpur lime for Rangpur lime disease. The plants in this virus-indexing program were set out at various spacings. Those budded in 1952 were spaced 14 x 5 feet in the field. Plants propagated since 1952 were similarly spaced or were left at close spacing in the nursery row.

The test trees were set out in plantings of Rio Farms, Inc., at Monte Alto, and in Experiment Station plantings at Weslaco and Crystal City, Texas. The rootstocks were examined periodically for the charac-

FIGURE 1. *Rootstock disorders associated with Clementine tangerine tops in Texas. A. Bark shelling of Rangpur lime rootstock. B. Bark splitting without wood pitting or stunting of Columbian sweet lime rootstock. Orlando tangelo rootstocks were free of the gum stain and wood pitting symptoms associated with xyloporosis (cachexia).*

ceristic symptoms of exocortis and Rangpur lime disease or cachexia and xyloporosis. As was reported in Florida (1), phloem discoloration was very pronounced in cachexia-infected Orlando tangelo trees, but was less marked in sweet limes infected with xyloporosis.

Results

Virus transmission tests and resulting symptoms.—Budwood from 3 trees (a Clementine tangerine, a Kennedy lemon, and a Pineapple orange) caused exocortis symptoms on Morton citrange, Rangpur lime disease on Rangpur lime (Fig. 1,A), bark splitting without wood pitting or stunting of sweet lime rootstock, and no cachexia on Orlando tangelo (Table 1). The bark-splitting symptom was especially pronounced in Clementine tangerine trees grown on sweet lime rootstocks (Fig. 1,B) at Crystal City. Childs (2) noted in Egypt a "bark furrowing" of lime and lemon trees which may be of similar cause. In California (8), Palestine sweet lime plants grafted with scions from an exocortis-infected, cachexia-free lemon tree developed shallow elongated cracks in the outer bark of the sweet lime trunks but no xyloporotic wood pitting.

Morton citrange budded with Frost Eureka (nucellar) lemon scion developed bark shelling but those on Rangpur lime did not; a bud-union and rootstock disorder is associated with use of this Eureka clone on Troyer citrange rootstocks (9); in California the disorder seems to be independent of exocortis virus.

Budwood of 9 different selections caused only xyloporosis symptoms on sweet lime and cachexia symptoms on Orlando tangelo and Rangpur lime rootstocks. The Shamouti orange budwood for this test came from the direct vegetative descendant of a tree in Palestine, where xyloporosis was first reported, and symptoms of xyloporosis that developed on sweet lime root and on Orlando tangelo root budded with Shamouti were similar to those resulting from buds of various grapefruit and sweet orange scions originating in this country.

Budwood of many different trees caused xyloporosis (cachexia) symptoms on sweet lime and tangelo rootstocks, as well as exocortis (Rangpur lime disease) symptoms on Morton citrange and Rangpur lime rootstock.

VIRUS-FREE CLONES.—Fifty-two trees of 22 varieties indexed since 1952 were free of recognized virus symptoms. These varieties are made

TABLE 1. VIRUSES OCCURRING IN TEXAS CITRUS AS INDICATED BY DEVELOPMENT OF INDICATED DISEASES IN BUDDED ROOTSTOCKS TESTED FOR 4 OR MORE YEARS[a]

Budwood-source group and variety	Absence (0) or presence (X) of budwood trees tested	Rangpur lime disease on Rangpur lime	exocortis on Morton citrange	xyloporosis on sweet lime	cachexia on Orlando tangelo
GRAPEFRUIT, RED:	No.				
Ballard Red	1	0[b]	0	X	X
California Red No. 3 nuc.	1	0	0	0	0
Curry Red Radiance	1	X	X	X	X
Fawcett Red	1	0[b]	0	X	X
Goodwin Red	1	X	X	X	X
Henninger Ruby	1	0[b]	0	X	X
Henninger Ruby nuc.	1	0	0	0	0
Riddle Red Gold	1	X	X	X	X
Shary Red	2	X	X	X	X
Webb Red Blush	11	X	X	X	X
Webb Red Blush	1	0[b]	0	X	X
Webb Red Blush nuc.	16	0	0	0	0
GRAPEFRUIT, WHITE OR PINK:					
Duncan	1	X	X	X	X
Marsh	1	0[b]	0	X	X
Marsh (Frost) nuc.	1	0	0	0	0
Marsh (Garner) nuc.	1	0	0	0	0
LEMON:					
Eureka (Frost) nuc.	1	0	0[c]	0	0
Kennedy	1	X	X	0[d]	0
Lisbon	1	X	X	X	X
Meyer (tristeza-free)	1	0	0	0	0
MANDARIN:					
Clementine	1	X	X	0[d]	0
Dancy nuc.	2	0	0	0	0
False Hybrid satsuma	1	0	0	0	0
Hybrids (Florida)	2	0	0	0	0
Orlando	1	0	0	0	0
Ponkan	1	X	X	X	X
Temple	1	X	X	X	X
Thornton nuc.	1	0	0	0	0

TABLE 1. (Continued)

Budwood-source group and variety	Absence (0) or presence (X) of				
	budwood trees tested	Rangpur lime disease on Rangpur lime	exocortis on Morton citrange	xyloporosis on sweet lime	cachexia on Orlando tangelo
SWEET ORANGE:	No.				
Curry	2	0	0	0	0
Hamlin	2	0	0	0	0
Jaffa-Joppa	8	X	X	X	X
Lue Gim Gong sport (Texas seedless)	1	X	X	X	X
Marrs	1	0	0	0	0
Pineapple	1	X	X	X	X
Pineapple	1	X	X	0[d]	0
Pineapple	1	0[b]	0	X	X
Rico No. 1	1	0[b]	0	X	X
Rico No. 5	1	0	0	0	0
Rico No. 6	1	0	0	0	0
Ruby nuc.	1	0	0	0	0
Shamouti	1	0[b]	0	X	X
Summerfield navel	1	X	X	X	X
Tarocco	1	0	0	0	0
Texas navel	1	0[b]	0	X	X
Valencia	3	0	0	0	0
Valencia	1	X	X	X	X
Valencia nuc.	5	0	0	0	0
Washington navel	1	0	0	0	0
Washington navel (Frost)	1	0	0	0	0
MISCELLANEOUS:					
Chinese shaddock	1	X	X	X	X
Eustis limequat	1	0	0	0	0
Rangpur lime nuc.	1	0	0	0	0

[a]Portions of the data in this table have been published (6).

[b]The Rangpur lime shows cachexia-like symptoms when cachexia-infected, exocortis-free tops are used. Thus, the Rangpur lime is also an indicator plant for cachexia, particularly in the absence of exocortis.

[c]Bark shelling similar to that expected of Frost Eureka lemons on Troyer citrange rootstock.

[d]Bark splitting without pitting.

up of a few old-line trees and many seedlings; most of the varieties grown commercially in Texas are represented. Some of the seedlings were introduced as nucellars from California and others as hybrids from Florida; some were found as fruiting adult seedlings in Texas. Others are Texas-grown juvenile seedlings that have fruited since 1954.

Indexing of certain other juvenile seedlings is not yet complete. Even so, these selections are provisionally considered virus-free because they have never been budded to old-line clones. Virus-free nucellars of Dancy tangerine and Minneola and Wekiwa tangelos are especially important since the old-line trees of these varieties in Texas are infected with psorosis virus.

Discussion and Conclusions

The results in Texas to date are in agreement with the hypothesis (1) that xyloporosis of sweet lime and cachexia of Orlando tangelo are caused by the same virus. The sweet lime, however, appears not to be a specific indicator for xyloporosis, since it showed bark-splitting symptoms in the presence of exocortis virus. Such symptoms were not observed in virus-free sweet lime seedlings or in the sweet lime rootstock of virus-free budded trees. On the grounds that recognizable symptoms are expressed faster, are more specific, and are more easily identified, the Orlando tangelo seems preferable to the sweet lime as an xyloporosis (cachexia) indicator plant in Texas.

The results in Texas to date are in general agreement with the hypothesis (3) that exocortis disease and Rangpur lime disease are caused by the same virus. However, Frost nucellar Eureka lemon scions caused bark-shelling symptoms similar to those of exocortis on Morton citrange, but not on Rangpur lime rootstock. Morton citrange would not appear to be an acceptable exocortis indicator for Eureka lemon scions. Because it is faster growing than Morton citrange in Texas, is less sensitive to salinity, is compatible with lemons, and shows recognizable symptoms of exocortis virus more rapidly, Rangpur lime is preferable to the Morton citrange as an exocortis indicator in Texas. Morton citrange, however, is preferred to the trifoliate orange as an exocortis indicator in Texas because the trifoliate orange grows poorly in presence of saline water and calcareous soils.

If only a single indicator variety could be used in Texas, the Rangpur lime would be chosen, but only for use on noncalcareous soils. It shows clear-cut symptoms of either exocortis or xyloporosis; thus

either virus can be detected (5). However, *when Rangpur lime plants show exocortis symptoms, it is extremely difficult, and usually impossible, to detect whether or not xyloporosis virus is also present.*

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