A Report on Exocortis Virus in Taiwan

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THE WIDESPREAD occurrence in Taiwan of tristeza virus and its efficient vector (*Toxoptera citricidus* Kirkaldy)—and their association with likubin, a destructive disease of citrus (4)—led to the suggestion that rootstocks tolerant of tristeza virus, such as Rangpur lime and trifoliate orange, should be used. Before these rootstocks can be recommended for general use, however, an investigation of the presence of exocortis virus in Taiwan is needed, since neither stock is tolerant of exocortis virus. Experiments were therefore carried out under greenhouse conditions from November 1968 through July 1969 in which candidate trees were indexed for the presence of exocortis virus. The results are reported below.

Materials and Methods

Thirty candidate trees, which had been used as sources of commercial budwood, were indexed in the greenhouse on Arizona 861 Etrog citron (1). Buds of the candidate tree and the indicator were inserted at about the same time into Eureka lemon, sweet orange, shaddock, or calamondin seedling rootstocks at least 2 years old—neither rough lemon nor Ponderosa lemon seedlings were available. Each candidate tree was indexed in from 1 to 5 indicator plants. Ten control plants were inoculated with buds of greenhouse-grown nucellar Eureka lemon trees. Tools were disinfected with solutions of sodium hydroxide plus formaldehyde or sodium hypochlorite (3, 5). The seedling rootstocks were topped to encourage growth of the citron shoot and desprouted carefully to prevent contamination (5). The shoots were inspected weekly for symptoms.

Results

Lemon seemed to be the most satisfactory understock for indicator plants when neither rough lemon nor Ponderosa lemon was available (Table 1). Sweet orange seedlings were unsatisfactory. Thirteen of the candidate trees carried exocortis virus, as judged by presence of symptoms in indicator plants 2–7 months after inoculation. Ten of these candidate trees had been tested in Eureka lemon understocks and 3 in sweet orange. The citron buds in 9 plants died; those in 5 other plants failed to sprout (Table 1). The citron buds in 6 sets of indicator plants grew but failed to develop symptoms. The principal symptoms in the indicator plants were leaf epinasty, cracking, and scarring of the abaxial surface of the midrib; but in many cases the veins, including veinlets, on the lower surface of the leaves were abnormally

TABLE 1. RESULTS OF INDEXING CANDIDATE CITRUS TREES FOR EXOCORTIS VIRUS BY SIMULTANEOUSLY INSERTING AN ARIZONA 861 ETROG CITRON BUD AND A BUD FROM THE CANDIDATE TREE INTO A SEEDLING ROOTSTOCK

Candidate tree indexed	Location of candidate tree	Seedling rootstock	Result of indexing[a]	Time (weeks)[b]
Grapefruit, Marsh	N.T.U. orchard	Lemon	2/5	20
Marsh	Taoyuan	Shaddock	0[c]	
Thompson	N.T.U. orchard	Lemon	5/5	9
Orange, Bergamot	N.T.U. orchard	Lemon	0/5[d]	
Shuehkan	Mucha, Taipei	Sweet orange	0/3	
Shuehkan	Taitung	Sweet orange	0[c]	
Shuehkan	Taitung	Sweet orange		
Valencia	Taitung	Calamondin	0	
Valencia	Taitung	Sweet orange	0	
Dwarf Ponkan	Mucha, Taipei	Sweet orange	0/3	
Tankan	Shehding, Taipei	Sweet orange	0/4	
Tankan	Shehding, Taipei	Sweet orange	0/5	
Tankan	I-lan	Sweet orange	1/2	28
Tankan	I-lan	Sweet orange	1/3	28
Nagami kumquat	I-lan	Shaddock	0[c]	
Lemon, Eureka	Chia-yi	Lemon	1/1	28
Eureka	Funlu, Chia-yi	Sweet orange	3/4	20
Eureka	Pingtung	Lemon	3/3	16
Eureka	Pingtung	Lemon	3/3	8
Eureka	Pingtung	Lemon	3/3	8
Eureka	Taitung	Lemon	0[c]	
		Calamondin	0[c]	
Eureka	Hwalien	Sweet orange		
Eureka	Hwalien	Lemon	2/3	8
Eureka	Taoyuan	Lemon	1/1[c]	16
		Calamondin	0[c]	
Eureka	Taoyuan	Shaddock	0[c]	
Lisbon	Chia-yi	Shaddock		
Lisbon	Hwalien	Lemon	0/1	
Lisbon	Hwalien	Lemon	0	
Lisbon	Taoyuan	Lemon	2/3[c]	8
		Calamondin		
Villafranca	Chia-yi	Lemon	4/5	8

a. Number of seedlings with symptoms/number inoculated.
b. Time in weeks for citron shoots to develop symptoms.
c. Citron bud died.
d. 0, citron bud failed to sprout.

darkened. The degree of leaf twisting varied. Stems were also dwarfed, showed epinasty, and developed small corky lesions. Yellow blotching of stems was not common; neither was vertical cracking. Drying of mature leaves, as mentioned by Calavan et al. (2), was not observed.

Exocortis virus was detected in Marsh and Thompson grapefruit, in Lisbon, Eureka, and Villafranca lemon, and in tankan. The infected trees were located in various parts of Taiwan (Table 1).

The 10 control plants grew normally, showing no symptoms of exocortis. Several citron plants, from the same source, propagated

on lemon seedlings by conventional top grafting or by budding also developed no symptoms of exocortis.

Discussion and Conclusion

Lemon trees were introduced into Taiwan from California early in this century (6). In view of the fact that an extremely high percentage of trees in California are infected with exocortis virus, the presence of this virus in Taiwan could be presumed. Indexing 30 citrus trees sampled at random in Taiwan has proved the presumption to be correct. Of the 19 groups of test plants in which the Etrog citron buds grew, 13 (68 per cent) exhibited exocortis symptoms. Candidate trees that were negative in these tests were mostly local varieties—tankan, shuehkan, and ponkan—which, with one exception, were tested on sweet orange seedlings. Whether these varieties are less prone to exocortis virus infection; whether, being native, they merely escaped infection; or whether the sweet orange rootstock had an effect on production of exocortis symptoms remains to be determined.

Citrus rootstocks in Taiwan are almost exclusively sunki; stocks intolerant of exocortis virus, such as trifoliate orange and Rangpur lime, are scarce. This scarcity may very well be due to the presence of exocortis virus in Taiwan, although exocortis is not known to the citrus industry of Taiwan. Now that exocortis virus is known to be present—and in view of the transmissibility of the virus on contaminated tools (3)—investigation of the incidence of exocortis virus in the major varieties of tankan, ponkan, and Leucheng sweet orange is urgently needed. Rangpur lime and trifoliate orange cannot be safely recommended as understocks until more is known of the distribution of exocortis virus in Taiwan and suitable precautions are taken.

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