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Investigation on the Incidence of Citrus Virus Diseases in Taiwan

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Citrus planting in Taiwan began with grafted trees and nursery techniques imported from Fukien and Kwangtung provinces of South China about 300 years ago. The predominant use of the tristeza-tolerant Sunki rootstock instead of sour orange might have been the result of long-term observation and screening in the absence of current knowledge of virology. The practice of grafting plus the

movement of propagating materials over a long period of time eventually brought about bud-union problems which cause decline, tree loss, low yield, etc. Studies have been made on likubin by Matsumoto *et al.*, (1961) and Su and Matsumoto (1972). This report summarizes the present situation regarding citrus virus diseases and likubin in Taiwan.

EXOCORTIS

A survey on the occurrence of citrus exocortis in Taiwan was made in the late 60's (Ling, 1972). Conspicuous loss from citrus exocortis was generally due to the use of Rangpur lime rootstock. Typical damage of stunting and bark scaling (which seems to be an unimportant factor) caused by contamination or by bud-perpetuated virus either in young nursery trees or in older trees has been common in Chiayi and other areas. In severe cases 3- to 4-year-old orange trees on Rangpur lime rootstock remained the size of nursery trees and were fruitless. To prevent further losses, besides the use of clean budwood, extension work, especially for nurserymen, regarding contamination with exocortis virus as well as the method of avoiding it with sterilants such

as a dilute solution (5 to 10 per cent) of household bleach is recommended (Roistacher *et al.*, 1969). While the hazard of spreading citrus exocortis virus in mature groves by pruning tools may not be as important as in nurseries (Gamsey and Weathers, 1972), it has been noticed that many thrifty and vigorous 15- to 20-year old Leucheng sweet orange trees on Sunki rootstock carry an exocortis virus strain which causes Rangpur lime rootgrafts to show the typical bark scaling symptom. As far as the source of exocortis is concerned, it has been found that prevalence of exocortis in local varieties of citrus is far less than that in the imported varieties. This trend agrees with the survey made in Japan by Yamada and Tanaka (1972).

PSOROSIS

Since psorosis has been proved to exist in neighboring countries, namely Japan (Tanaka and Yamada, 1961) and the Philippines (Salibe, 1966) it seemed probable that psorosis would also be in Taiwan so an investigation of psorosis in Taiwan was started in 1966. Since then, psorosis has been observed in trees of six imported varieties of sweet orange: Jaffa, Dream navel, Washington navel, Pineapple, Parson Brown, and Leu Gim Gong.

These varieties were introduced from Florida in 1953 when the Florida Citrus Registration Program was beginning its "developmental stage" as stated by Bridges (1974). Trees of Leucheng, the major local sweet orange variety, have also been found infected with psorosis virus. Marsh grapefruit and Minneola tangelo, also of the 1953 introduction, were found psorosis infected. The Minneola tangelo, at the age of 20, showed the

typical concave gum symptom of diamond-shaped concavities and had bark scaling on the main trunk as well as darkening of the xylem. Younger plants of the same origin show less prominent concavities without bark scaling.

These varieties all showed zonate young leaf symptoms in the field and produced the same reaction in the green-

house on Pineapple sweet orange indicator plants. Most citrus trees in Taiwan are so short-lived that the bark scaling symptom of psorosis was seldom seen. Nevertheless, in three "old" orchards (20 years or more) of Marsh grapefruit, Washington navel orange, and Minneola tangelo, typical psorosis bark scaling and tree decline have been detected.

CACHEXIA (XYLOPOROSIS)

In 1968, cachexia was first found in Shoufeng, Hwalien in eastern Taiwan, in a 9-year-old orchard of Orlando tangelo on Sunki rootstock. Typical lens-shaped pittings rather than those of the tristeza type were found in the trunk wood of Orlando tangelo scions together with irregular gum impregnation in the bark and pegs on the inner face of the bark. The wood and bark of the Sunki rootstock remained smooth. Cachexia symptoms were present in one half of the trees in the orchard. Specimens of infected stumps and bark were seen by

Dr. W. C. Price during his visit to Taiwan. Three years later, another orchard of the same combination in the neighboring township of Fengtien was found to have a high incidence of cachexia virus infection with typical wood and bark symptoms. In western Taiwan, Orlando tangelo on Sunki rootstock has been found free from symptoms. Murcott tanger is a late introduction from California planted to a limited extent in Taipei; no fovea symptom has been observed in this susceptible variety.

OTHER DISEASES

Prominent fruit symptoms of likubin (greening) occur in many varieties of citrus in regions south of Hsinchu (table 1). Undersized, malformed, lopsided, dull colored, inversely colored fruit with dry peduncles and stem ends and mummified fruit were usually seen on infected trees. Severe tristeza stem pitting was found in Miyu, Nanchuangcheng, and calamondin.

Fruit symptoms consisting of slight irregular depressions with an abnormal yellow color, as mentioned by Planes and

Marti (1972) were observed in Vainiglia orange of Malta origin in Puli in central Taiwan. This variety is little known in Taiwan. Ruple of lemon, described by Knorr and Koo (1969) has been found in Chiayi near the Tropic of Cancer. An "H"-grooving disorder in the trunk and main branches of a 40-year-old tree of Paiyu, suspected to be of psorosis nature, is under observation. Undoubtedly, there are still other undiscovered diseases.

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TABLE 1
INCIDENCE OF CITRUS VIRUS DISEASES AND LIKUBIN IN TAIWAN

Disease	Variety infected	Location	Remarks
Psorosis	Sweet orange: Jaffa, Dream Navel, Pineapple, Washington navel, Parson Brown, Leu Gim Gong, Leucheng. Grapefruit: Marsh. Tangelo: Minneola.	Taipei, Hsinchu, Hwalien, Tainan, Chiayi.	A 20-year-old Washington navel orange and a 24-year-old Marsh grapefruit showed typical psorosis bark scaling on the main trunk; also decline. A 20-year-old Minneola tangelo showed typical diamond-shaped concavities and bark shel-ling on the main trunk; darkening of xylem and decline.
Exocortis	Sweet orange: Leucheng, Valencia, Pineapple, Jaffa, Leu Gim Gong, Parson Brown. Grapefruit: Thompson. Lemon: Villafranca, Lisbon, Eureka and a Mediterranean variety. Tangor: Tankan.	Islandwide	Severe stunting and scaling in Rangpur lime rootstock.
Cachexia (xyloporosis)	Orlando tangelo.	Shoufeng and Fengtien of Hwalien Hsien in eastern Taiwan.	Nine and 12-year-old orchards with 40-50 percent of trees infected. No symptom on Sunki rootstock.
Tristeza	All varieties.	Islandwide.	Very strong pitting in Miyu, <i>C. taiwanica</i> , and calamondin.
Likubin	All varieties, including Minneola and Orlando tangelos, Leucheng, and Valencia oranges, Ponkan, Sunki, Tankan, Satsuma, and Kara mandarins; Marsh and Ruby Grapefruit.	Islandwide, but generally south of the line between Hsinchu and Hwalien.	Undersized, malformed, lopsided, dull colored, inversely colored fruit, dry peduncles and stem ends, mummified fruit. Blue albedo occurred in three areas in grapefruit and sweet orange varieties.