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## International Organization of Citrus Virologists Conference Proceedings (1957-2010)

### Title

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### Permalink

<https://escholarship.org/uc/item/48r4n4r2>

### Journal

International Organization of Citrus Virologists Conference Proceedings  
(1957-2010), 12(12)

### ISSN

2313-5123

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### Publication Date

1993

### DOI

10.5070/C548r4n4r2

Peer reviewed

# Citrus Virus and Virus-like Diseases in the Eastern Mediterranean Region of Turkey

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**ABSTRACT.** A survey of the virus and virus-like diseases of citrus in the Eastern Mediterranean region was done between 1985 and 1992, using indicator plants, ELISA or culturing techniques.

A total number of fourteen diseases was identified. The most important were the psorosis and psorosis-like pathogens (sweet orange, grapefruit, mandarin), stubborn (navel orange, grapefruit), gummybark (sweet orange) and cachexia (mandarin). Recently, the number of crinkly leaf-type infected trees has increased dramatically. Although the number of trees infected with citrus tristeza virus was very low, it remains a threat to the Turkish citrus industry due to the use of sour orange as rootstock and the high abundance of the vector *Aphis gossypii*.

Citrus is one of the most valuable export products of Turkey. This is especially the case in the Eastern Mediterranean region, where about 70% of the production is concentrated. Despite the suitability of the growing of citrus, the yield is about 40% less compared to other Mediterranean countries. Most of the citrus trees are infected with at least one virus or virus-like disease. Because of the heavy economic impact of citrus viral diseases a budwood improvement program was established at the University of Çukurova in Adana in 1986 and later a second citrus variety improvement program started its work in Antalya in 1988 (4).

Very little is published about the occurrence and distribution of citrus diseases in the Eastern Mediterranean region of Turkey other than those by foreign FAO consultants (11). The purpose of this paper is to report on the occurrence of citrus virus and virus-like diseases in the Eastern Mediterranean Region of Turkey.

## MATERIAL AND METHODS

**Survey.** Field survey and laboratory identification of diseases on citrus was done between 1985 and 1992. Apart from the general survey on navel oranges and Satsuma mandarins, several orchards of different grapefruit and mandarin varieties were inspected for virus diseases.

To identify the virus diseases observed during the survey, citrus trees revealing symptoms attributable to virus or virus-like diseases were selected and indexed for the main viruses in greenhouses. Inoculum sources were either buds, bark chips or side-grafts. At least four indicator plants were inoculated for each disease and source tree and one healthy control and a positive control, if available, were added. Test trees were indexed for citrus tristeza virus (CTV) and vein enation (VE) on Mexican lime. To detect and identify psorosis A, Madame Vinous indicator plants were used, for concave gum Kara lemon and for cristicortis Orlando tangelo. Citrus infectious variegation (CIVV) and citrus crinkly leaf type virus (CLTV) were detected on rough lemon. After inoculation all indicator plants were grown under cool temperatures (25 C maximum day and 20 C minimum night). The citrus exocortis viroid (CEVd) was identified on Etrog citron and citrus cachexia viroid (CCaVd) on Parson's Special mandarin kept under warm conditions (35 C day and 27 C night). Citrus stubborn disease (CSD) was transmitted by side-grafts to Madame Vinous sweet orange seedlings grown under warm temperatures. For the diagnosis of satsuma dwarf virus (SDV) leaf tissue extract was mechanically inoculated to white sesame (for details on indexing methods used, see 7).

ELISA was conducted on bark tissue extracts for CTV and leaf tissue extracts for citrus variegation virus CVV and CSD as described elsewhere (1,2,10). Monoclonal antibodies for CTV (3DF1 plus 3CA5) were provided by Dr. P. Moreno, Valencia, Spain. Polyclonal antibodies for CVV and CSD were provided by Dr. M. Davino, Catania, Italy and Dr. P.G. Markham, Norwich, England, respectively. *S. citri* was also cultured following the technique of Fudl-Allah, *et al.* (3) in SMC-medium (9). Various citrus viroids were purified and separated by PAGE from young citron Etrog leaves, following graft inoculation from possibly viroid infected trees (13).

## RESULTS AND DISCUSSION

During this study, fourteen virus and virus-like diseases of citrus were identified in the Eastern Mediterranean region of Turkey. The most economically important and widespread diseases were psorosis, concave gum, cristacortis and impietratura, exocortis, gummybark, cachexia, CSD and crinkly leaf-type virus. CTV and SDV were detected in some orchards, but in low incidence. Single trees infected with woody gall, wood pocket or tarocco pit are present in governmental introduction orchards in the Eastern Mediterranean.

Psorosis A and concave gum are widespread in citrus orchards in Turkey. About 47% of the navel group and 18% of Satsuma mandarins were found infected in the field surveys. Bark symptoms of psorosis A were mild, but leaf symptoms like vein banding were readily visible in spring flushes. Indexing showed that all out of the sixteen selected navel oranges and all of the twelve Satsuma mandarins were infected with psorosis A and commonly concurrently contaminated with concave gum. Also, all grapefruit other mandarin varieties and lemon tested were infected with psorosis A. Minneola tangelos trees revealed typical symptoms of cristacortis. These results indicated commercial varieties are entirely infected by psorosis and

psorosis-like pathogens in the Eastern Mediterranean.

Exocortis was widespread in citrus varieties. Because of the use of exocortis tolerant rootstocks, no bark splitting, scaling and gumming was observed in the field. However, fifteen of the sixteen navel orange trees and ten of the twelve Satsuma mandarins were tested positive for exocortis by indexing. In addition, several grapefruit and mandarin varieties were proved to be infected with exocortis. Another important viral disease of sweet orange is gummybark. Typical symptoms of gummybark like abundant gum impregnation in the bark above the bud-union and wood pitting in the trunk were observed in 28 % of the navel oranges. Cachexia is seriously affecting mandarin trees, especially Satsuma and Clementine. Typical gum pockets and conoid pits were found in the trunk of 50 % of Satsuma and Clementine trees. Furthermore, the navel group is widely infected with cachexia. Fourteen of fifteen Washington navel trees tested positive for cachexia by biological indexing on Parson's Special, although no symptoms were observed on the inoculum trees in the field. Various other viroids were detected by using page in Satsuma, Fremont and Clementine, but further studies are needed to identify them.

CSD, which is vectored by *Circulifer haematoceps* complex in the Eastern Mediterranean region of Turkey (5), is common on navel selections planted in the mid-1970s. Stubborn disease is one of the most serious of all diseases affecting citrus in this region. Washington navel was the variety most affected, sometimes 30 % of the trees being diseased. The damage caused by CSD forced growers to remove most of their plantings and since then new navel orchards have been rarely established. Star Ruby groves planted since 1987 are also heavily infected by CSD as determined by ELISA and culture of the pathogen. The CSD pathogen was also detected

in Fremont mandarins and all grapefruit cultivars by ELISA and culture.

We found CTV in low numbers. Only 0.5 % of the navel oranges and 0.04 % of the Satsuma mandarins showed CTV symptoms. However, out of these, only four of 16 navel oranges and two of 12 Satsuma mandarins trees were indexed positive on Mexican lime and these results were confirmed by ELISA. Some of the other navel oranges revealing CTV symptoms like honeycombing and inverse stem-pitting were tested positive for CSD but not for CTV. Sarkar, *et al.* (12) detected CTV in 71 of 122 suspected trees and additionally in some apparently healthy ones. Although CTV vectors like *Aphis gossypii* (8) are widespread, there is up to now no evidence for vector transmission in Turkey. CTV remains as a major threat to the Turkish citrus industry because of sour orange is the only used rootstock used in the Eastern Mediterranean, and the buds are introduced without quarantine measures into Turkey.

The first evidence of crinkly leaf-type (CLTV) in Turkey was shown in 1986 (6), but it was not of any importance until it reached epidemic levels in citrus nurseries at the end of the 1980s. Initially only lemon was affected, but later mandarin, grapefruit and sweet orange began to develop symptoms. Because of this intense and rapid outbreak, vector transmission was suspected. In laboratory experiments, the Japanese Bayberry whitefly, *Parabemisia myricae* (Kuwana) transmitted this disease from citrus to citrus. *P. myricae* was accidentally introduced into Turkey and was first detected in the Eastern Mediterranean region in 1982 (14). It is most likely that this whitefly is implicated in the rapid spread of CLTV in this region.

#### ACKNOWLEDGEMENTS

The authors gratefully acknowledge the scholarship for Dr. Ulrich Kersting from the Alexander von Humboldt-Foundation, Feodor-Lynen program, FRG.

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