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## Virus and Virus-like Diseases in Turkey Citriculture

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**ABSTRACT.** Citrus is one of the most important agricultural products in Turkey. Total annual citrus production is 3 million tons and 30% of this is exported. The major citrus growing areas are the Mediterranean, Aegean and Black Sea Regions. Sour orange is the main rootstock used in most citrus areas. Citrus trees are affected by a number of virus and virus-like diseases, the major ones being psorosis (*Citrus psorosis virus*), stubborn (*Spiroplasma citri*), citrus chlorotic dwarf disease, exocortis (*Citrus exocortis viroid*), cachexia (*Citrus cachexia viroid*), impietratura, citrus gummy bark, satsuma dwarf (*Satsuma dwarf virus*), cristacortis, rumple and yellow vein clearing. Although the number of trees infected with *Citrus tristeza virus* is very low, it remains a threat to Turkish citrus industry due to the widespread use of sour orange as the main rootstock.

The total citrus production in Turkey is nearly 3 million tons/year and mainly concentrated (80%) in the Mediterranean region including Adana, Mersin, Antalya and Hatay cities. The other citrus growing areas are the Aegean and Black Sea regions (1).

Because of vigorous growth and compatibility with common scion cultivars, sour orange is used as the main rootstock in the Eastern Mediterranean area of Turkey. Trifoliate orange is used as a rootstock in the Aegean and Black Sea regions.

Due to the traditional farming system and lack of sufficient quarantine regulations, graft transmissible diseases have spread to all citrus growing areas in Turkey and cause important economic losses. Besides these, use of limited number of certified nursery trees in citrus plantations is another problem of Turkish citrus industry.

The main important diseases that have been diagnosed are the following:

**Psorosis:** This disease is widespread and may be found in all old citrus orchards in Turkey. Classical bark scaling symptoms can be seen in various varieties of sweet orange including Washington navel, shamouti, Valensia and some local varieties (Finike, Dört Yol, and Trabulus). Psorosis is also observed in satsuma, Clementine, and Fremont mandarins, and Marsh seedless and Star

Ruby grapefruits. The incidence of *Citrus psorosis virus* varies from 64% to 80% in navel oranges, and 15.8% to 31% in satsuma mandarins in the Eastern Mediterranean region (6) and 50% in satsuma mandarins in the Aegean region (2).

**Concave gum/blind pocket:** Vein banding and oak leaf patterns are seen in young leaves of some trees. Wood deformations of concave gum and blind pocket also seen in old citrus plantations.

**Tristeza:** *Citrus tristeza virus* (CTV) was first reported in Turkey by Norman (13) in 1963. CTV was also reported in the Aegean region (14), and Çukurova region (4). CTV is already endemic in Aegean coast where up to 16% of satsuma trees are infected. However, very few infected trees are known (less than 1%) in the Mediterranean region. In Turkey as in most other Mediterranean countries, there is a heavy dependence on sour orange as rootstock, which is CTV-sensitive. The vector of CTV, *Aphis gossypii* Glover, is the most important aphid species on citrus and is widely distributed in the whole of the Mediterranean and Aegean regions in Turkey. CTV causes stunting, slow dieback, defoliation and overgrowth above the bud union. The dsRNA analysis showed that seedling yellows and stem pitting strains were found in citrus trees infected with CTV (8, 11)

**Stubborn:** The causal agent of stubborn, *Spiroplasma citri*, is one of the most serious pathogens in Mediterranean region in Turkey (3). Stubborn is transmitted by the leafhoppers, *Circulifer haematoceps* and *C. opacipennis* in Çukurova region (9). Stubborn causes stunting, bushy appearance, twig dieback, of season flowering, acorn shaped and lopsided small fruits, and low yields. Due to active vector transmission, more than 30% of oranges (Washington navel and Valencia) and 10% of grapefruits are infected with *S. citri* in the Çukurova region (6).

**Satsuma Dwarf:** *Satsuma dwarf virus* (SDV) was first reported in satsuma mandarin trees in the Aegean region of Turkey in 1973 (2). SDV causes dwarfing trees, gondola-shaped and little leaves, and multiple sprouting in infected trees. The virus incidence was found to be about 2% in the Aegean region and 31% in the Çukurova (6).

**Impietratura:** This disease was first reported by Chapot (5). Impietratura affects grapefruit, orange and lemon fruits. The symptoms consist of gumming of the fruit albedo, hardening of the fruit and reduction of fruit size.

**Citrus Gummy Bark (CGB):** The disease was found by Moreira (12) in Turkey. An extensive survey was made in the Çukurova region of Turkey and indicated a widespread occurrence of CGB on the sweet orange varieties Washington navel, Valencia and Dörtüol, a local cultivar (15). Discoloration and gumming above the budunion are characteristic symptoms on sweet orange scions with variable reddish-brown gum staining under the bark. CGB source trees contained a viroid complex consisting of *Citrus exocortis viroid* (CEVd), *Citrus bent leaf viroid*, Citrus viroid-II group, *Citrus viroid-III* group and *Citrus viroid IV*.

**Citrus Exocortis:** This viroid disease was reported in Turkey by Norman (13) and Moreira (12). CEVd causes stunting, bark splitting, scaling and

gumming about citrus trees budded on trifoliolate rootstock and hybrids. Azeri and Heper (2) reported that 4.26% of satsuma mandarins were infected with CEVd. Due to the use of sour orange as rootstock, symptoms are not visible in field in the Çukurova region, but indexing studies showed that the viroid is widespread in all commercial citrus varieties. Exocortis may become a serious problem for citrus growers if trifoliolate or its hybrids become used on a wide scale in this region.

**Citrus Cachexia:** This disease is widespread in most mandarin orchards in Turkey. The presence of disease was reported by Reichert (17), Norman (13) and Moreira (12). Cachexia is one of the economic important diseases in mandarin and mandarin hybrids in Turkey. Typical gum pockets of the phloem and cambial pitting of the wood with corresponding pegging of the bark were found in the trunk of the mandarin trees above the budunion in many orchards. Symptoms ranged from mild to very severe in many orchards of satsuma, Clementine and Fremont mandarins.

**Citrus Chlorotic Dwarf Disease:** This disease previously believed to be a crinkle-leaf type disease (10) is widespread in Mersin, Adana and has also begun to spread in Hatay region. Field symptoms consist of a V-shaped notch and chlorotic flecking on young leaves and warping, crinkling, inverted cupping and variegation on mature leaves. The causal agent was graft-transmitted to grapefruits, lemons mandarins and oranges. CCD disease has become an epidemic in Mersin and Adana regions. Korkmaz et al. (10) reported CCD as a new virus-like disease which is transmitted from citrus to citrus by the whitefly *Parabemisia myricae* (Kuwana). CCD was not transmitted mechanically to herbaceous plants, but transmitted by stem-slash inoculation from rough lemon to rough lemon. The ultrastructure of CCD infected bark sections on unknown filamentous material, which appeared virus-like, was detected by

Howd et al. (7). Further studies will be need for detection of this important whitefly-transmitted disease.

**Yellow Vein Clearing:** YVC is another new disease in Turkey, first seen in 2000 (16). The leaves of lemon trees infected with YVC in Çukurova region showed vein clearing which appears with yellow flecks at varying length on lateral veins. These symptoms are combined with leaf crinkling and warped symptoms on young leaves. Vein clearing symptoms are seen like water soaked underside of the leaves. Field symptoms are excellent

during spring and autumn flush, also the symptoms are constantly present on mature leaves. The fruits of infected trees are one-third smaller than healthy trees. Graft transmission studies showed that YVC was transmissible to sour orange and many lemon varieties. However, grapefruits, oranges, mandarins, mexican lime, rough lemon were not shown any YVC symptoms. YVC transmitted mechanically sour orange to sour orange and Kütdiken lemon to Kütdiken by stem slash cutting.

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