

## Citrus Stubborn Disease

### *Spiroplasma citri*

**Hosts:** The pathogen infects *Citrus* spp. and has a wide host range in 18 dicotyledonous families and one monocotyledonous family. All noncitrus hosts are herbaceous, except those in the family Rosaceae. Examples of some common plants carrying the bacterium are periwinkle (*Vinca* spp.), *Brassica* spp., London rocket (*Sisymbrium irio*), and wild radish (*Raphanus sativus*).

**Disease common name:** Citrus stubborn disease.

**Pathogen:** *Spiroplasma citri*.

**General:** The disease is a problem in hot, dry areas of Mediterranean countries, the southwestern United States, Brazil, Australia, and South Africa. It is regarded as a great threat to the production of sweet orange and grapefruit in some Mediterranean countries and in California.

### Disease Cycle

**Inoculum:** Infected plants are the initial source of inoculum.

**Transmission:** The citrus stubborn spiroplasma is vectored by several leafhopper species, including *Scaphytopius nitridus* and *Circulifer tenellus*, which are vectors in the southwestern United States. *Circulifer haematoceps* is the major vector in the Mediterranean region, although *Circulifer tenellus* also occurs there and is a vector. The disease also is transmitted by grafting or taking bud material from infected plants. Transmission rates are affected by the grafting procedure, type of tissue, host species, and environmental factors. Uneven distribution of the pathogen in infected trees results in unpredictable transmission rates, and a significant percentage of bud and graft progeny from diseased trees may be disease free. The probability of infection from propagation using infected materials tends to be higher with navel orange and some tangelos than with 'Valencia' orange or lemon. *Spiroplasma citri* has not been mechanically transmitted other than by propagation methods nor has seed transmission been observed. However, seed coats from infected fruit are frequently infected and are good sources for obtaining cultures of *Spiroplasma citri*.

**Infection:** The pathogen is restricted to the phloem sieve tubes of infected plants and is transmitted from plant to plant by phloem-feeding leafhopper vectors in which spiroplasma multiplies.

**Symptoms and signs:** The disease is seldom lethal, but if trees are infected when young, they may remain severely stunted. Foliage of such trees is dense and upright, and leaves may be cupped and abnormally thick (Fig. 1). Leaves may be chlorotic and mottled. Such symptoms can be confused with those from phloem-constricting pathogens, such as the citrus greening disease (huanglongbing). The stem ends of fruit may not color during maturity; they can be misshapen (Fig. 2), and the seeds are frequently aborted (Fig. 3). When the disease is severe, fruit of grapefruit and sweet orange sometimes reflect a blue color. Yields are reduced drastically. Off-season flowering may occur (Fig. 4). The cambial face of rootstock bark below the bud union of stunted sweet orange sometimes exhibits pinholing, a symptom also common with *Citrus tristeza virus*-infected sour orange trees. Symptoms are less conspicuous when infection occurs late in the season.

**Survival:** *Spiroplasma citri* survives in the tissues of its many hosts.

## Disease Management

Use of pathogen-free bud and grafting materials is an effective control measure in areas where *Spiroplasma citri* and its vectors are not endemic. The strategy is to eradicate infected alternate hosts and avoid exposure of young plants. Infected orchard trees should be removed and replaced with healthy replants. Shoot-tip grafting has been effective in eliminating *Spiroplasma citri* from infected budwood. Nursery trees must be propagated from pathogen-free budwood and grown in vector-proof enclosures or in *Spiroplasma citri*-free areas. Control is clearly more difficult where vectors are endemic and reservoirs of inoculum are present in noncitrus hosts. Citrus should not be planted when the potential for natural infection is very high.

## Reference

Timmer, L. W., Garnsey, S. M., and Graham, J. H., eds. 2000. Compendium of Citrus Diseases, 2nd ed. American Phytopathological Society, St. Paul, MN.



Figure 1. Sweet orange with severely stunted appearance and dense, abnormal, upright foliage. (Courtesy APS)

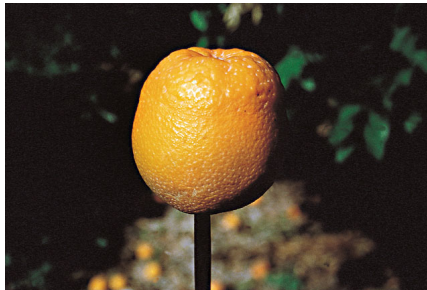


Figure 2. Irregular, acorn shape of infected orange fruit. (Courtesy APS)



Figure 3. Lemon with thickened peel at peduncle end and aborted seeds. (Courtesy APS)



Figure 4. Off-season flowering of diseased orange. (Courtesy APS)