# Huanglongbing or Citrus Greening
# '*Candidatus* Liberibacter asiaticus'

**Hosts:** All citrus cultivars, species, hybrids, and citrus relatives are susceptible, including *Citrus sinensis*, *Citrus reticulata*, *Citrus paradisi* × *Citrus reticulata*, *Citrus aurantifolia*, *Citrus aurantium*, *Citrus hystrix*, *Citrus limon*, *Citrus madurensis*, *Citrus jambhiri*, *Citrus* ×*nobilis*, *Citrus* ×*paradisi*, *Fortunella* spp., *Severinia buxifolia*, *Limonia acidissima*, *Balsamocitrus dawei*, *Microcitrus australasica*, *Murraya koenigii*, *Poncirus trifoliata*, *Swinglea glutinosa*, *Triphasia trifolia*, *Clausena lansium*, and *Clausena indica*.

**Disease common name:** Huanglongbing or citrus greening.

**Pathogen:** Citrus greening is caused by a phloem-limited bacterium having a Gram-negative type cell wall. The pathogen is '*Candidatus* Liberibacter asiaticus' in Asia and the Americas, '*Candidatus* Liberibacter africanus' in Africa, and '*Candidatus* Liberibacter americanus' in the Americas.

## Disease Cycle

**Inoculum:** Various indigenous rutaceous hosts serve as a reservoir for the bacterium.

**Transmission:** Inoculum is carried by two species of psyllid vectors. The Asian strain is spread primarily by *Diaphorina citri* (Figs. 1–4), which occurs throughout tropical and subtropical Asia, Saudi Arabia, Afghanistan, Reunion, Mauritius, Mexico, the Caribbean, and parts of Central and South America. In the United States, it has been found in Alabama, California, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas. The primary vector for the African strain is *Trioza erytreae*, which is found in Africa, Yemen, and nearby countries. Both insect vectors can transmit all three strains of the bacterium. These insects are not particularly efficient vectors and high numbers of insects are needed to cause serious disease outbreaks. The disease also can be graft transmitted but success of transmission is variable.

**Infection:** The bacterium is found in sieve tubes. It moves systemically from the infection site to different parts of the plant. It is distributed unevenly in the plant but is found in bark tissue, leaf midrib, roots, and different floral and fruit parts but not in the endosperm and embryo. High concentration of the bacterium has been observed in the fruit peduncles.

**Symptoms and signs:** Diseased plants may not show symptoms for years following infection. Early symptoms are blotchy mottled leaves and yellow veins (Figs. 5 and 6). The green veins and interveinal chlorosis resemble nutrient deficiency. The only definitive method of diagnosis of infected plants is by analysis of DNA by an authorized plant diagnostic laboratory. As the disease progresses, there is general yellowing of the entire canopy (Fig. 7). Chronically infected trees are sparsely foliated and show extensive twig dieback and entire shoots may become yellow. The most characteristic symptom is lopsided fruit that ripen unevenly, leaving portions that fail to ripen and remain green, hence the name greening (Fig. 8). Yields are severely reduced and remaining fruit is worthless because of small size, poor color, and bad taste. Juice from infected fruit has an unpleasant flavor. Distorted fruit and aborted seeds of sweet orange are shown in Figure 9.

**Survival:** The bacterium survives in diseased hosts.

## Disease Management

There are important regulations to prevent introduction of the disease. Use of clean bud and grafting wood is essential. Another practice is to kill the bacteria by heating wood to 48–58°C (119–134°F) for several minutes, a process analogous to pasteurization. Nursery trees

should be produced in covered, insect-proof screen houses. Strict quarantine measures are used to prevent the disease from spreading to areas where it does not yet occur. There are some attempts to control the vectors with insecticides and biological control agents. Spread of the disease in infected areas is mitigated by removal of infected trees.

## References

Bove, J. M. 2006. Huanglongbing: A destructive, newly-emerging century-old disease of citrus. J. Plant Pathol. 88:7-37.

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. Citrus psyllid nymph (*Diaphorina citri*), a vector of the disease. (Courtesy C. Hirayama)

Figure 2. Citrus psyllid (*Diaphorina citri*), a vector of the disease. (Courtesy C. Hirayama)

Figure 3. Citrus psyllid (*Diaphorina citri*), a vector of the disease. (Courtesy C. Jacobson)

Figure 4. Citrus psyllid (*Diaphorina citri*) feeding on a twig. (Courtesy C. Jacobson)

Figure 5. Variation of yellowing and mottling of leaves. (Courtesy APS)

Figure 6. Yellow mottled leaves of sweet orange. (Courtesy APS)

Figure 7. Mandarin orange with yellowing of the canopy. Pale yellow, blotchy, mottled leaves are reduced in size. (Courtesy APS)

Figure 8. Mature and misshapen fruit of sweet orange with greening symptoms. Healthy fruit (lower left). (Courtesy APS)

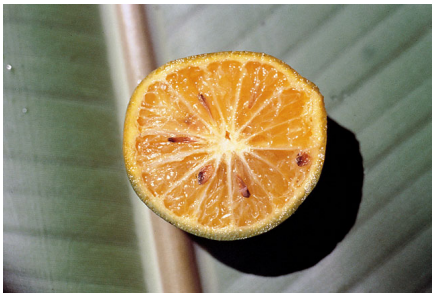

Figure 9. Distorted fruit and aborted seeds of sweet orange. (Courtesy APS)