PP-210

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Citrus Diseases Exotic to Florida: Huanglongbing (Citrus Greening) [1]

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Citrus is susceptible to a large number of diseases caused by plant pathogens. Economic losses due to plant diseases can be severe, but fortunately, not all pathogens attacking citrus are present in Florida. Major citrus diseases currently present in Florida include tristeza, blight, greasy spot, Alternaria brown spot, Phytophthora-induced diseases, melanose, scab, canker, and postbloom fruit drop (PFD). There are other serious, exotic pathogens that have not been introduced into Florida. Any exotic diseases, if introduced, will significantly increase production costs and concomitantly decrease profitability for Florida growers. The background information for exotic citrus diseases will be presented in a series of fact sheets to provide a basis for evaluating exotic citrus pathogens that may pose potential risks to Florida and to create a decision-making framework to prevent their introduction and spread. This paper will discuss Huanglongbing (HLB), also commonly called citrus greening.

Why Are We Concerned About HLB?

Huanglongbing (HLB) is a serious disease of citrus because it affects all citrus cultivars and causes rapid decline of trees. HLB has seriously affected citrus production in a number of countries in Asia, Africa, the Indian subcontinent and the Arabian Peninsula, and was recently discovered in Brazil (2004) and Florida (2005). HLB has not been reported in Australia or in the Mediterranean Basin. HLB is vectored by psyllids. When psyllid is abundant and environmental conditions are favorable, HLB can rapidly destroy existing groves and prevent commercial production of oranges and other citrus cultivars. Mature trees if infected may decline and become non-productive and young trees that become infected never come into fruit production. In China, the disease was reported to kill young trees in 1-2 years. HLB is difficult to manage and continued production of citrus has proven difficult and expensive in areas where it is widespread. Since HLB is transmitted by the psyllid vector which has been established in Florida and weather conditions

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are apparently suitable for occurrence of HLB, there is clearly a potential for natural spread when HLB is introduced into Florida.

The Causal Agent of HLB

The causal agent of HLB is a phloem-limited bacterium that has a true cell wall, but it has not been cultured. Based on ribosomal DNA (rDNA) profiles, the bacterium was named *Candidatus* Liberibacter belonging to the alpha proteobacteria. The species, *Candidatus* L. africanus causing African HLB and *Candidatus* L. asiaticus causing Asian HLB, have been described previously. The name for new species recently found in Brazil has been proposed to be *Candidatus* L. americanus. The African HLB causes symptoms only under relatively cool conditions (20-25°C) and generally has a milder effect than the Asian HLB that causes symptoms under both cool and warm (up to 35°C) conditions. The bacterium found in Florida is the Asian form. Lack of methods to grow the HLB bacterium in culture has limited some research.

Which Cultivars Are Affected?

Candidatus Liberibacter can infect nearly all citrus species, cultivars and hybrids, as well as some citrus relatives. Sweet oranges, mandarins, and mandarin hybrids (tangelo) are highly susceptible to HLB. Lemons, grapefruit, pummelos, and sour orange are also affected and are rendered non-productive when infected. Mexican lime, trifoliate orange and some trifoliate orange hybrids are more tolerant and may show only some leaf symptoms. The HLB bacterium also can multiply in Chinese box orange (*Severinia buxifolia*) and wood apple (*Limonia acidissima*).

What Are the Typical Symptoms Caused by HLB?

Early symptoms of HLB are a leaf yellowing that may appear on a single shoot or branch (Fig. 1). The Chinese names of yellow shoot and yellow dragon are descriptive of this symptom. In early stages of infection, leaves may have a mottled or blotchy appearance (Fig. 2). The yellowing spreads throughout the tree and affected trees show twig dieback and trees rapidly degenerate into a non-productive state in 2 to 3 years. In trees with advanced stages of the disease, the leaves are small and frequently show mineral (zinc or manganese) deficiency symptoms with yellow veining (Fig. 3). Fruit are sparse, small, abnormal in appearance and fail to color properly, thus the name greening (Fig. 3). The affected fruit often contain aborted seeds and have poor juice quality.

Figure 1. Yellow shoot symptom (indicated by arrowhead) on sweet orange tree affected by greening.

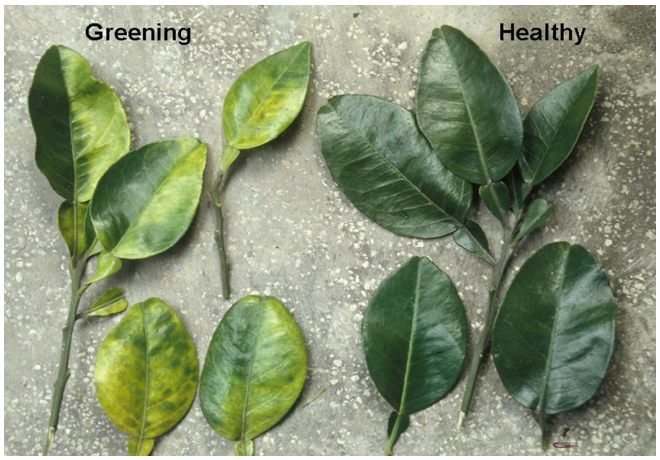

Figure 2. Leaf mottle symptom (left) caused by greening and healthy leaves (right).

How is HLB Transmitted?

The HLB bacterium is transmitted by two species of psyllids. One species, *Trioza erytreae*, occurs in Africa, Yemen, and islands in the Indian Ocean, and this vector is associated with the spread of the African HLB. The other vector is the Asian citrus psyllid, *Diaphorina citri* (Fig. 4), which is adapted to warm humid areas and is widespread throughout

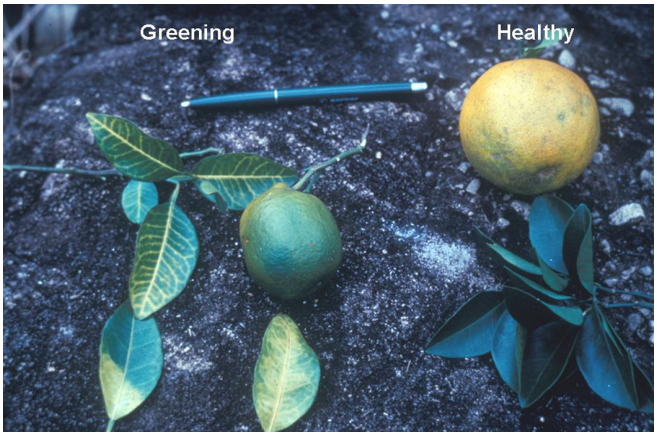

Figure 3. Small fruit with poor juice quality and leaves showing mineral deficiency symptoms (left) caused by greening.

Figure 4. The Asian citrus psyllid, *Diaphorina citri* that transmits citrus greening. Note: wings held rooflike.

Asia, the Indian subcontinent, Saudi Arabia, Reunion and Mauritius. This vector is associated with the transmission of Asian HLB. *D. citri* has also been reported in South America, Central America, Brazil, and is now well established in Florida. Either psyllid can transmit both forms of HLB under experimental conditions, and the HLB bacterium can multiply in both. Once infected, the psyllids remain capable of transmitting HLB for their entire lives, but progeny of infected psyllids are free of the bacterium. Both psyllid species feed and survive primarily on citrus and citrus relatives. HLB is also transmitted by grafting, but not all buds from infected trees carry the bacterium. Long distance spread of HLB to new locations has occurred via the movement of infected budwood and citrus. Epidemics of HLB in new areas have been observed when infected budwood is propagated and the psyllid vector is present to spread the disease in South Asia.

How to Detect HLB in the Field?

New infections of HLB in healthy plantings can be diagnosed by the yellow shoot symptom (Fig. 1). However, field diagnosis is more difficult in older plants that lack vigor or are suffering from other problems. It is especially hard to detect in dooryard plantings when trees are often in poor condition from multiple causes. In newly infected trees with yellow shoot symptoms, leaves are blotchy looking with irregular yellow areas (Fig. 2). In trees with more advanced decline, small, poorly colored fruit with aborted seeds are common. HLB also can be diagnosed by grafting onto citrus indicators, but may require multiple tests. Mandarins that are highly tolerant to CTV are useful indicators if severe isolates of CTV also exist. Electron microscopy of infected tissues is used to confirm the presence of HLB, but is not practical for large scale testing. Other molecular techniques such as serological tests and PCR-based assays for identification of the HLB bacterium have been developed.

How to Control HLB?

HLB is one of a few citrus diseases that can be considered a truly limiting factor for citrus production. It is important to keep it out of the U.S. and to be able to quickly detect any infections that may become established. It is essential to keep it out of budwood supplies and nursery stock. Control of HLB is difficult if inoculum sources are widespread and the psyllid vector is well established. There are no HLB tolerant mandarin, orange or grapefruit cultivars to replace declining trees. The general control strategy has been to eradicate all existing sources of HLB within an area, then replant with HLB-free trees grown from clean budwood. Psyllid populations must also be reduced as much as possible. Biological control of the psyllid vector is only possible in locations that do not favor buildup of psyllid populations and is often compromised when hyper-parasites are present.

What Can Growers Do?

HLB is a vector-borne disease. Preventing HLB from entering Florida is much easier than trying to

eradicate or control it. It is important to avoid bringing propagation materials from HLB-infected areas to Florida. Any citrus materials from overseas must be inspected and tested to ensure they are free of HLB. Growers are also encouraged to keep vigilant on the conditions of trees, particularly a sudden change in vigorously growing trees.

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