



Citrus Feature Edition: A Focus on Huanglongbing

A Clear and Present Danger

Whether you are a backyard grower, nurturing your prized lemon tree, or a large-scale producer supporting the \$10M orange juice industry, you are an essential participant in the current battle against Huanglongbing (HLB), a disease that threatens everyone’s access to citrus fruit and its by-products. In this issue of *Network News*, we will take a close look at the realized and future impacts of HLB on citrus-growing regions of the United States and why, as a vital contributor to human health, this impact is so important to all of us.



Huanglongbing, also known as citrus greening, is a destructive citrus disease. It was first observed more than a hundred years ago in China and is the most serious threat to the citrus industry worldwide. HLB is currently jeopardizing the commercial viability of the citrus industry in the US. One of the many implications of the disease is its impact on fruit yield and quality.

Citrus Health Benefits and the Origins of Cocktails at Sea

Citrus fruits have long been valued as part of a nutritious and tasty diet. Citrus flavors and aromas are among the most recognizable and preferred worldwide. Citrus and citrus products are a rich source of vitamins, antioxidants, minerals and dietary fiber (pectin) that are essential for normal growth, development, and overall nutritional well-being. The citrus fruit contains no fat, sodium, or cholesterol and a host of studies highlight the importance of citrus consumption in protecting us from serious diseases (Ref. #1 & #2).

While fruits like limes, lemons, oranges, and grapefruits have been used in food and medicine for hundreds of years, it took the West a bit longer to catch on. Long trips at sea imparted serious dietary restrictions, which often resulted in vitamin C deficiency. The European navies in the colonial period quickly realized the need for a reliable source of nutrient to prevent scurvy, a disease caused by a deficiency in vitamin C. Thus, early predecessors of the Daiquiri and the Gin and Tonic were born, as sailors began using their daily rations of rum and gin to take the edge off of the sour limes and lemons. The bitter quinine tonic was also prescribed as an antimalarial remedy.



Citrus Production in the United States

The United States ranks as the third largest citrus-producer country in the world after China and Brazil (Ref. #3). The major citrus-producing states in the US are Florida, California, Arizona, and Texas. The US citrus-utilized production for the 2018-19 season totaled 7.94 million tons, up 31% from the 2017-18 season, while the citrus value is up 1% (Ref. #3).

Approximately half of the US citrus is sold fresh, and the remainder is sold processed, mostly as juice with California producing 85% of the fresh and Florida 77% of the processed citrus (Ref.# 4). California accounts for 51% of the total US citrus production; Florida totals 44%, and Texas and Arizona the remaining 5%. The citrus industry in Florida and California contribute more than \$10 billion to their state economies.

The US citrus industry is at great risk of losing its trees due to HLB, which would negatively affect the job force, economy and local societies. Over \$400 million in federal, state and industry funds has been invested in HLB research, but unfortunately no single solution has been developed according to the 2019 National Academy of Sciences report (Ref. #5). Since its introduction, HLB has had a devastating impact on the citrus industry. The estimate for all Florida citrus production in the 2015-2016 season was 94.2 million boxes, a 44.3% reduction from a year earlier, with a threat of losing all fresh citrus within 10 to 15 years (Ref. #4), if HLB is not controlled.

How Does the Disease Spread?

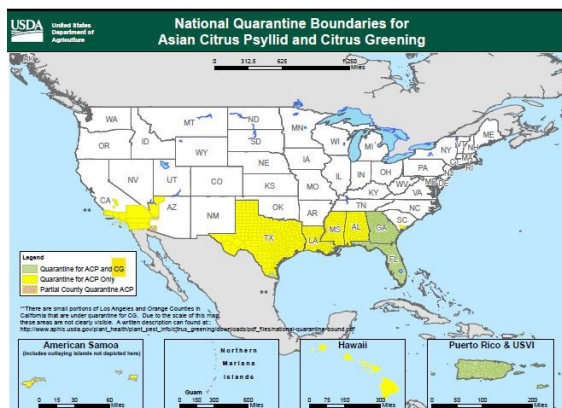
The Asian citrus psyllid (ACP), which spreads HLB in the Americas, is no bigger than the head of a pin. The infected insect spreads the disease as it feeds on the young tender leaves and stems of citrus trees. Once the ACP picks up the bacterium, it carries it for the rest of its life.

The movement of infected plants (including infected trees) and plant materials such as budwood from one place to another has also contributed to the spread of this devastating disease. Production of new trees using buds or budwood materials from infected trees is also a prime way to spread HLB.



Global Spread of HLB

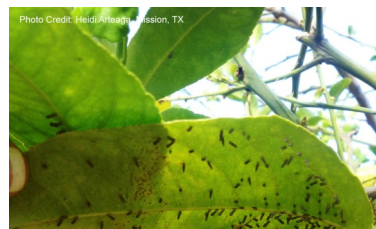
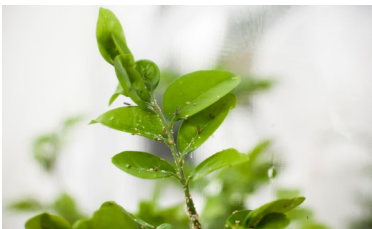
HLB is a global threat and is widespread in all major citrus-producing countries of Asia, Africa, and the Americas. Importantly, HLB and its vectors the Asian and African psyllids are expanding to new citrus production areas.



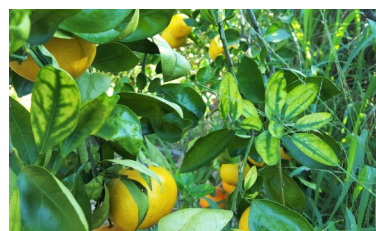
In the past 14 years, the Asian citrus psyllid (ACP) has been found in the US states of Florida, Texas, California, Arizona, Hawaii, Louisiana, Georgia, and Alabama, as well as in parts of South and Central America, Mexico and the Caribbean. Meanwhile, HLB was identified in Florida (2005), Louisiana (2008), Georgia and South Carolina (2009), Texas and California (2012), Guam (2015) and most recently in Alabama (2017). A tree infected with HLB can live for years without symptoms, allowing the pathogen to spread undetected to other trees.

What are the signs and symptoms to look for?

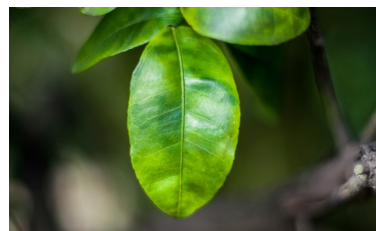
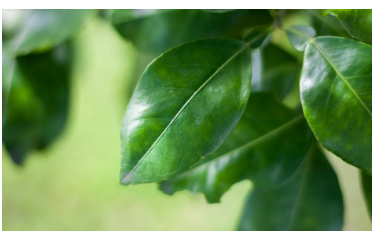
- Visible Asian citrus psyllids
- Asymmetrical blotchy mottling of leaves
- Raised, thickened, or corky veins
- Lopsided sometimes bitter, hard fruit with small, dark aborted seeds



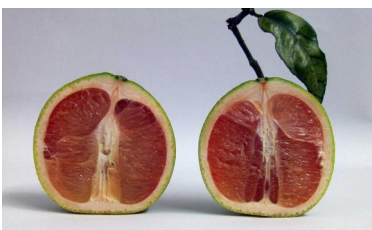
Visible Asian citrus psyllids/waxy nymphs droppings



Asymmetrical blotchy mottling of leaves



Raised, thickened, or corky veins



Lopsided, bitter, hard fruit with small, dark aborted seeds



Small and off-color fruit

Yellow shoots

Economic Impact

The effect of HLB on citrus production and economy can be assessed in three primary ways: 1) increase in mortality rates of infected trees; 2) reduction of marketable yield per tree; and 3) increased cost of production. HLB impact is dependent on several other variables including age of tree at first infection, levels of tolerance, and environmental factors. These variables may allow some trees to maintain the same or similar levels of productivity several years post-infection, while others may decline rapidly. HLB-Infected trees become unproductive within 2 to 4 years after the onset of the disease and young infected trees typically do not reach productive age. HLB reduces the quantity and quality of citrus fruits, eventually rendering infected trees useless. An infected symptomatic tree produces fruit that is unsuitable for sale as fresh fruit or for juice.

Since the discovery of HLB in Florida in 2005, citrus acreage in that state has decreased significantly (more than 45%). When the disease was identified in additional locations within the US, nurseries were required to move their production under insect protective structures. In addition, frequent (in some cases every 7 to 15 days) pesticide treatments for vector control in the field were mandated, resulting in a great increase in pesticide use, fuel and labor costs. Indirect costs have also increased due to pesticide-induced disruption of integrated management programs, including biological control, for other citrus pests. In addition, a costly eradication program was instituted to remove infected trees to protect the citrus industry.

The economic impacts of HLB in the US over the period 2012-13 through 2015-16 are estimated at a loss of \$4.4 billion in cumulative industry output, or an annual average loss of \$1.1 billion (Ref. #3). Total value-added and employment contributions decreased by an average of \$658 million and 7,945 full-time and part-time jobs respectively over this period (Ref. #5).

Impact in California

Despite California's identification and eradication of over 1,650 HLB-positive trees in urban areas, ACP have spread in all citrus producing areas of the state. No HLB-positive trees have been identified in commercial citrus yet, but this is expected to occur in the future, due to the vector's spread. According to the Citrus Research Board (CRB) data, California spent \$40-45 million per year in the past three years in anti-ACP-HLB programs.

The total economic impact of California's citrus industry is \$7.2 billion according to a new study commissioned by the CRB. This study estimates the possible impact of a potential 20% reduction in California citrus acreage or yield or a combination of the two. This projected loss could result from increased costs to meet government regulations, combating the Asian citrus psyllid and warding off the invasion of HLB (Ref. #6).

Such a reduction could cause a loss of 7,350 jobs and \$127 million in employment income and could reduce California's GDP by \$501 million in direct, indirect and induced impacts. The CRB currently devotes most of its resources to battling ACP and HLB to help ensure the sustainability of California citrus (Ref. #6).

Citrus Bearing Acreage United States 2008-2019

Year	Citrus ¹ 1,000 acres
2008	850.9
2009	844.8
2010	825.2
2011	809.2
2012	801.8
2013	791.2
2014	777.7
2015	764.9
2016	737.8
2017	711.0
2018	697.9
2019	686.2

¹Grapefruits, lemons, oranges, tangelos, and tangerines based on National Agricultural Statistics Services USDA-report 2019 (Ref #3)

Impact in Florida

Considering the challenges the industry has been facing, it is not surprising that citrus-bearing acres in Florida have decreased from 679,000 in 2003-04 to 387,100 in 2018-19 (Ref. #3). The decrease in area also mirrors the reduction in the number of citrus growers across the state, which fell from 7,389 in 2002 to 2,775 in 2017 (Figure 1) (Ref. #7). Figure 2 shows the number of juice-processing facilities decreased from 41 in 2003-04 to 14 in 2016-17. The number of packinghouses also decreased from 79 to 26 during the same period (Ref. #7).

The real cultural cost to manage HLB in orange groves for juice production in Florida is estimated to be \$663 per acre, which represents a 67% increase compared to pre-HLB levels. However, and perhaps more importantly, the real cultural cost of production per box increased by 283% (Ref. #7).

The number of orange trees in Florida has declined from about 80 million down to the current estimated 60 million trees. Grapefruit has experienced an even greater drop, going from a peak of about 14 million trees to the current approximately 5 million trees (Ref. #8). New tree plantings are at historically low levels and only about 50% of orange trees that are lost to HLB are being replaced (Ref. #4). Florida’s preliminary \$873 million on-tree value of the 2018-2019 citrus crop was 37% more than the revised value of \$637 million for 2017-2018 but it was 6% less than the \$927 million crop value of the 2016-2017 season. Florida’s citrus production in 2018-2019 is 77.3 million boxes, up 55% from the previous season’s 49.7 million boxes (Ref. #3).

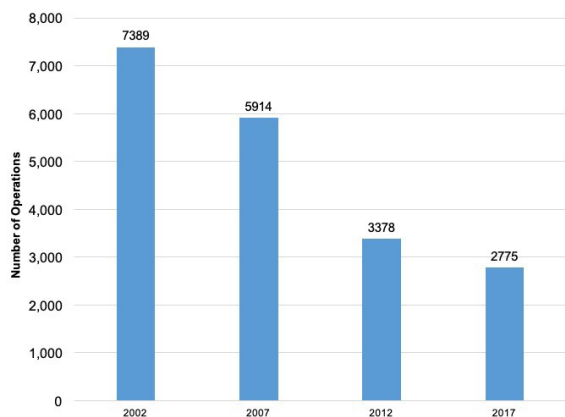


Figure 1. Number of citrus operations in Florida. Source: U.S. Department of Agriculture-National Agricultural Statistics Service.

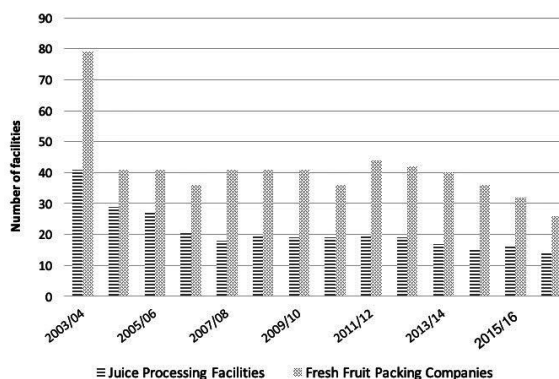


Figure 2. Number of juice processing facilities & packinghouses in Florida. Source: Florida Department of Agriculture & Consumer Services.

Impact in Texas and Arizona

The Texas citrus industry has a statewide economic impact of over \$280 million. Following the first report of HLB in Florida in 2005, efforts were made to implement state and federal quarantine measures to prevent the movement of potentially infected plant materials. The measures included the transition from open-field to enclosed nursery systems, the implementation of an area-wide psyllid control, surveys for HLB and ACP in commercial groves and residential sites, and removal of confirmed infected trees.

Despite these efforts, HLB detection sites in Texas increased to 26% and 40% of commercial groves and residential sites, respectively, by 2017 (Ref. #9). Such a rapid disease progress despite efforts and investment to slow the disease spread underscores the enormous challenges posed by HLB once introduced into a new area. At present, Arizona remains ACP infested but with no HLB finds.

Efforts in HLB Research and Management Practices

Breeding: Variety improvement researchers have developed new citrus rootstocks and scions that are ready to be tested for HLB tolerance/resistance.

Horticulture: Growing citrus plants under protective structures or in the field using individual protective covers has been proven effective in excluding psyllids.

Entomology: An understanding of transmission of the HLB associated bacteria by the ACP has been studied in the laboratory and key disruptive elements such as reflective mulch, protective tree covers and kaolin clay are used in ACP-management programs.

Pathology: Scientists are close to developing a CTV-based tool (citrus tristeza virus) to manage HLB. Understanding the below-ground pathology to improve root health can lead to better control of soil-borne root pathogens and pests that attack stressed HLB trees. For example, optimizing soil pH allows more efficient delivery of micro and macro nutrients to the tree.

Food Science: Food scientists have identified molecules/components responsible for the off-putting taste in the juice produced from HLB affected fruit.



Structures to protect against psyllids



Individual protective plant covers

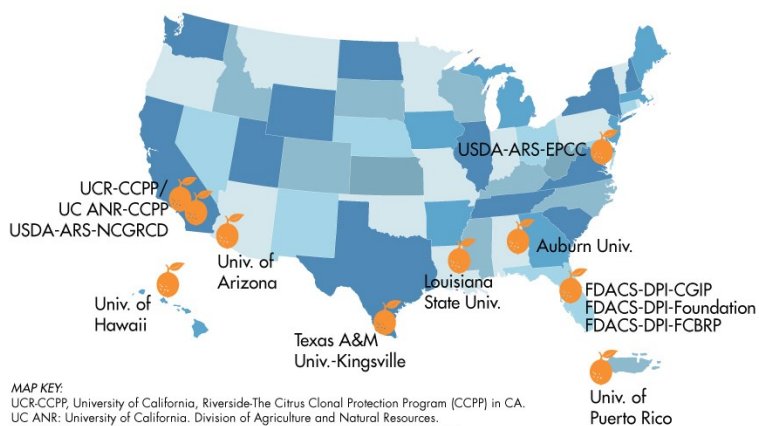
What is NCPN-Citrus Doing to Mitigate the HLB Threat?

The National Clean Plant Network (NCPN) for Citrus was established in 2010 and is part of the national network concerned with the health of vegetatively propagated specialty crops. The NCPN-Citrus clean plant centers are diligently working on engaging and supporting with their diagnostics and citrus expertise, the industry, regulatory and scientific anti-HLB efforts. NCPN-Citrus is playing a significant role in the nationwide efforts to address the HLB challenge facing the US citrus industry right now.

NCPN-Citrus is a body of researchers, extension specialists, state regulatory personnel and industry stakeholders from California, Florida, Texas, Arizona, Alabama, Louisiana, Hawaii, Beltsville and Puerto Rico, who form a network of 10 citrus centers with expertise in graft-transmissible diseases of citrus. These clean plant centers ensure that citrus trees produced in the USA are propagated using HLB-free propagative materials. Such materials are produced

under highly specialized therapy and diagnostics protocols, maintained in foundation plantings and are distributed throughout the USA under the standards of excellence established by NCPN governance.

Testing for graft-transmissible diseases in citrus is the mission of NCPN-Citrus and is paramount to ensure a thriving citrus industry. In addition, NCPN-Citrus centers seek to prevent new introductions of HLB, as well as many other citrus diseases, into the USA, safeguarding the critical supply of true-to-type, pathogen-tested citrus budwood for our nation's nurseries.



MAP KEY:
 UCR-CCPP: University of California, Riverside-The Citrus Clonal Protection Program (CCPP) in CA.
 UC ANR: University of California, Division of Agriculture and Natural Resources.
 NCGRCD: The National Clonal Germplasm Repository for Citrus & Dates (NCGRCD).
 FDACS-DPI: The Florida Department of Agriculture and Consumer Services: Division of Plant Industry
 CGIP: Florida Citrus Germplasm Introduction Program.
 FCBP: The Florida Bureau of Citrus Budwood Registration Certification Board.
 EPCC: The Exotic Pathogens of Citrus Collection in Beltsville, MD.

How do you find out if your citrus tree has HLB?

The only way to verify that your tree is infected with the HLB-associated bacteria is to have it professionally tested. If you believe that your citrus tree is diseased, you can contact the local University Cooperative Extension Agents, the Agricultural Commissioner's Office or a hot line of the State Department of Agriculture for advice.

NCPN-Citrus centers can also offer help to the public (<http://ncpncitrus.org>); however, local regulatory agencies should be consulted first. If your tree tests positive, you will be notified immediately. Once a tree has HLB, there is no cure. Over time, your tree will deteriorate, and the disease will ultimately kill the tree. All trees infected with HLB should be removed and destroyed.



Do not transport citrus plants, budwood, or plant material such as leaves, out of your area.

Only buy citrus plants locally from reputable sources.

Programs to Help Report HLB

Nationally: "Save Our Citrus" Website

<https://www.aphis.usda.gov/aphis/resources/pests-diseases/save-our-citrus/report-it>

The SAVE OUR CITRUS website from the United States Department of Agriculture (USDA) makes it easy to report diseased citrus trees. The website provides an online form under the link "Report It" that allows you to upload pictures of your tree and describe the observed symptoms.



In California: ACT Now

Abandoned Citrus Tree removal program. The program is managed by the California Citrus Mutual and allows growers to report abandoned trees that could threaten their groves. Submit your information into a form. Once submitted, California Citrus Mutual will work with officials on the ground to review and begin the conversation about tree removal.

<https://citrusmatters.cropscience.bayer.us/commercial-grower/act-program>



In Texas: Citrus Alert

The South Texas Citrus Alert website is managed by the Texas Citrus Pest & Disease Management Corporation, a Texas nonprofit corporation, that is recognized by the Texas Department of Agriculture as the entity to plan, carry out, and operate suppression programs to manage and control pests and diseases, including the Asian citrus psyllid and HLB, in citrus.

<https://www.citrusalert.com>

The website provides educational information about the identification of citrus greening and other major citrus pests.



A Message to the Public

The citrus industry is at great risk of losing its trees, which could negatively affect the US job force, economy and culture. Growers, nurseries, scientists and the government are diligently working to slow the spread of this disease, but they cannot do this without your help.

It is incredibly important to remove trees that have tested positive for HLB. Every infected tree has the potential to spread the disease to healthy trees, increasing the spread of the disease within and across citrus orchards and residential properties. It is in the best interest of the public and the citrus producers, small and big, conventional and organic, to remove and properly dispose the HLB-positive trees.

Information on HLB, other citrus diseases, clean citrus material, and best practices can be found at the CCPP partner website:
www.fruitmentor.com



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NCPN-Citrus Tier 2

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A Look Ahead: *What's Happening in the Network*

- **January 22-24, 2020** Nat'l Hop Convention & NCPN-Hop Tier 2 Meeting, Portland OR
- **January 26-28, 2020** Nat'l Sweetpotato Convention & NCPN-SP Tier 2 Meeting, Nashville TN
- **February 4-6, 2020** Unified Wine & Grape Symposium, Sacramento CA
- **February 7, 2020** NCPN-Grape Tier 2 Meeting, FPS, Davis CA

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