# ASIAN CITRUS PSYLLID AND HUANGLONGBING DISEASE

*Integrated Pest Management for Home Gardeners and Landscape Professionals*

The Asian citrus psyllid (ACP), *Diaphorina citri*, is a tiny mottled brown insect, about the size of an aphid, that poses a serious threat to California's citrus trees—including those grown in home gardens and on farms. The psyllid feeds on all varieties of citrus (e.g., oranges, grapefruit, lemons, and mandarins) and a few very closely related ornamental plants in the family Rutaceae (e.g., calamondin, box orange, Indian curry leaf, and orange jessamine or orange jasmine).

This psyllid damages citrus directly by feeding on new leaf growth (flush); this feeding twists and curls young leaves and kills or burns back new shoots. More seriously, the insect is a vector of the bacterium *Candidatus* Liberibacter asiaticus, associated with the fatal citrus disease huanglongbing (HLB), also called citrus greening disease. The psyllid takes the bacteria into its body when it feeds on bacteria-infected plants. The disease spreads when a bacteria-carrying psyllid flies to a healthy plant and injects bacteria into it as it feeds.

HLB can kill a citrus tree in as little as five years, and there is no known cure. The only way to protect trees is to prevent spread of the HLB pathogen in the first place, by controlling psyllid populations and removing and destroying any infected trees.

The Asian citrus psyllid is widely distributed throughout Southern California, and it is likely to continue to spread into the Central Coast and the Central Valley. HLB was found in March 2012 in a tree in a yard in Los Angeles County, which means it is now even more important to keep the psyllid populations low so they don't find infected trees like this one and spread the disease. HLB is also spreading towards the California border from Mexico.

## BACKGROUND

The Asian citrus psyllid and huanglongbing disease originated in Asia or India and then spread to other areas of the world where citrus is grown. The psyllid was first found in the United States in June 1998 in Palm Beach County, Fla., on backyard plantings of orange jessamine, *Murraya paniculata*. By 2001 the psyllid had spread to 31 counties in Florida, primarily due to the movement of infested nursery plants. Agriculture officials believe HLB was present in Florida in backyard citrus trees, and the psyllid rapidly spread the disease to other backyards and commercial citrus not long after the psyllid arrived in Florida.

In 2001, the psyllid spread to the Rio Grande Valley in Texas on nursery stock (orange jessamine); it also was detected in Louisiana. The insect subsequently spread to other states and is now found in Alabama, Georgia, Mississippi, South Carolina, Arizona, California, and Hawaii as well as Mexico.

In 2008, the Asian citrus psyllid expanded its range from Mexico to Southern California, where it was first detected in San Diego County. Over the next few years the psyllid spread throughout Southern California, particularly in urban and suburban environments, and as of 2013 a handful of detections have occurred in the southern Central Valley.

**Figure 1. Brownish adult, yellow nymphs, and white wax of Asian citrus psyllids.**

**Figure 2. Yellowish psyllid nymphs with red eyes and white waxy tubules.**

Because HLB has been found in California, there is major concern that the disease will spread further through the movement of infected plants or infected psyllids. HLB poses a significant threat to both residential citrus trees and commercial citrus production.

To protect the state's citrus from HLB, it is important to control the psyllid, prevent the accidental introduction of any infected host plant, and detect and remove any infected plants found in California as quickly as possible. The job of detecting infected trees is made difficult by the fact that it takes one to two years for symptoms of HLB to begin to show in the trees.

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## IDENTIFICATION AND LIFE STAGES OF THE PSYLLID

The adult Asian citrus psyllid is a small, brownish-winged insect about the size of an aphid (Figure 1). Its body is 1/6 to 1/8 inch long with a pointed front end, red eyes, and short antennae. The wings are mottled brown around the outer edge except where a clear stripe breaks up the pattern. The adults may have greenish, yellow, or orange abdomens depending on the time of year and the host plant they have been feeding on.

The adult psyllid feeds with its head down, almost touching the leaf, and the rest of its body is raised from the surface at an almost 45-degree angle with its tail end in the air. No other insect pest of citrus positions its body this way while feeding.

Adults typically live one to two months. Females lay tiny yellow-orange almond-shaped eggs in the folds of the small newly developing feather flush leaves of citrus. Each female can lay several hundred eggs during its life span.

The eggs hatch into nymphs that are wingless, flattened, yellow or orange to brownish, and 1/100 to 1/14 inch long (Figure 2). Nymphs molt four times, increasing in size with each nymphal stage (instar), before maturing into adult psyllids. The nymphs can feed only on soft, young leaf tissue and are found on immature leaves and stems of flush growth on citrus (Figure 3).

The nymphs remove sap from plant tissue when they feed and excrete a large quantity of sugary liquid (honeydew). Each nymph also produces a waxy tubule to help clear the sugary waste product away from its body. The tubule's shape—a curly tube with a bulb at the end—is unique to the Asian citrus psyllid and can be used to identify the insect.

There are other psyllids such as Eucalyptus psyllids, tomato psyllids, and Eugenia psyllid that can be found in home gardens. The Asian citrus psyllid is easily distinguished from these in its adult stage by the brown band along the edge of its wing with a clear area; its characteristic body tilt; and, in the nymph stage, the shape of the waxy tubules it produces.

## IDENTIFICATION OF THE HLB DISEASE

In March 2012, huanglongbing was found in a citrus tree in Southern California, and this tree was destroyed to prevent the spread of this disease. Everyone's assistance is needed to watch for additional infected trees. The disease may have already spread from this initial infection in Los Angeles in the bodies of psyllids to other citrus trees, or it may come into the state in an infected citrus tree or other host plant, illegally imported or smuggled into the state.

It could also arrive in the body of an infected psyllid that flies or rides on a plant into California from places such as Mexico where HLB and psyllids are found together. The tree that was found with HLB in Los Angeles is believed to have been infected through grafting a bud (taking plant tissue from one tree and inserting it into another to form a new branch) from another infected tree.

An early symptom of HLB in citrus is the yellowing of leaves on an individual limb or in one sector of a tree's canopy. Leaves that turn yellow from HLB will show an asymmetrical pattern of blotchy yellowing or mottling of the leaf, with patches of green on one side of the leaf and yellow on the other side (Figure 4). Citrus leaves can yellow for many other reasons and often discolor from deficiencies of zinc or other nutrients. The pattern of yellowing caused by nutrient deficiencies typically occurs symmetrically between or along leaf veins.

As the disease progresses, the fruit size becomes smaller, and the juice turns bitter. The fruit might remain partially green, which is why the disease is also called citrus greening. The fruit becomes lopsided, has dark aborted seeds, and tends to drop prematurely.

**Figure 3. Asian citrus psyllid nymphs producing waxy tubules and being tended by ants.**

**Figure 4. Huanglongbing caused asymmetrical yellow mottling of the leaves and an odd shape and greening of the fruit.**

Chronically infected trees are sparsely foliated with small leaves that point upward, and the trees have extensive twig and limb dieback. Eventually, the tree stops bearing fruit and dies. Fruit and tree health symptoms might not begin to appear until two to three years after the bacteria infect a tree.

## DAMAGE

The Asian citrus psyllid damages citrus when its nymphs feed on new shoots and leaves (flush growth). They remove sap from the plant tissue and inject a salivary toxin as they feed. This deforms new leaves by twisting and curling them and inhibits or kills new shoots by burning them back.

There are many other insect pests that can cause twisting of leaves such as aphids, citrus leafminer, and citrus thrips. The twisting of leaves doesn't harm trees and can be tolerated, but the burning back of new flush will retard the growth of young trees that are less than five years old.

Excess sap, or honeydew, that the nymphs excrete accumulates on leaf surfaces. This promotes the growth of sooty mold, which is unsightly but not harmful. Other insect pests of citrus also excrete honeydew, including aphids, whiteflies, and soft scales.

Most importantly, the Asian citrus psyllid can kill citrus trees through its feeding activity if the insect infects the tree with the bacterium that causes huanglongbing.

## MONITORING AND MANAGEMENT

In response to the establishment of ACP in California, the California Department of Food and Agriculture (CDFA) initiated an extensive monitoring program to track the distribution of the insect and disease. This program involves CDFA and other personnel regularly checking thousands of yellow sticky traps for the psyllid, in both residential areas and commercial citrus groves, in locations where the psyllid may be spreading. The program also includes frequent testing of psyllids and leaf samples for the presence of the pathogen.

Results are being used to delimit quarantine zones, guide releases of biological control agents, and prioritize areas for a residential chemical control program. As the psyllid has spread into new areas, monitoring and control resources have been reallocated. In some areas, home gardeners will need to take an active role in monitoring for the psyllid and disease, and take steps to protect their own trees.

### *Psyllid Detection and Quarantine*

As part of the monitoring program, citrus trees are examined to find the psyllid, and yellow sticky cards are hung in trees to capture adults. When a psyllid is found, a quarantine zone is established in the surrounding area. Plants and fruit that could be hosts of the psyllid (i.e. citrus and close relatives) can't be taken out of this area. Quarantine helps prevent psyllids from being moved to new, uninfested areas of California.

Whether you are inside or outside a quarantine area, it is very important to assist with the effort to detect and eradicate the Asian citrus psyllid. Your efforts will reduce the potential for this psyllid to spread huanglongbing and will provide more time for scientists to work on finding a cure for the disease. For maps and information about the quarantine areas, see the CDFA Web site, http://pi.cdfa.ca.gov/pqm/manual/pdf/420.pdf or the UC Web site www.ucanr.edu/sites/acp.

### *How You Can Help*

Homeowners can help combat the psyllid by inspecting their citrus trees and reporting new infestations of the Asian citrus psyllid. The best way to detect the psyllid is by looking at tiny new leaves (feather flush growth) on citrus trees on a monthly basis. Mature citrus trees typically produce most of their new growth in the spring and fall, but young trees tend to produce flushes of new growth periodically during warm weather. Slowly walk around each tree and inspect the flush growth. Look for signs of psyllid feeding and damage, including twisted leaves, waxy deposits (Figure 3), honeydew, sooty mold, and adult psyllids (Figure 5).

If you think psyllids are present, use a hand lens to look for small yellow eggs, psyllid nymphs with their waxy tubules, and adults. Immature stages (eggs and nymphs) are limited to tender new leaves and they don't fly, so monitoring efforts are most effective when directed toward these stages on feather flush.

If you think you have found the insect, immediately contact the CDFA Exotic

**Figure 5. Asian citrus psyllid adults and nymphs attacking young growth on citrus.**

Pest Hotline at 1-800-491-1899. CDFA staff will tell you if you are in an area that is new to the psyllid or if it is common in your area.

If you are in an area that is new to the psyllid, they will come to your residence and take a sample. If the insect is identified as an Asian citrus psyllid, then the quarantine will expand to include that location, and citrus and other Asian citrus psyllid host plants will be treated by CDFA personnel to control the psyllid.

In some areas known to be widely infested, you may need to treat for the psyllid yourself. This may be confirmed by calling the CDFA hotline. This publication provides information on how you can treat your infested trees. If you need further assistance, you can contact your local Master Gardener program (http://camastergardeners.ucdavis.edu/California_Counties_MG_Websites/) or a landscaping and pest control professional for more information about the steps you can take to control the psyllid.

Homeowner monitoring of citrus trees for symptoms of HLB is critical for early detection and management of the disease. Immediately report suspected cases of the disease to your county

agricultural commissioner's office or call the CDFA hotline. If the tree is infected with the HLB pathogen, it will need to be removed to prevent further spread. Diligent scouting for the pest and disease will help save backyard citrus trees and protect commercial citrus orchards. For additional photos of the Asian citrus psyllid and HLB symptoms, visit http://www.CaliforniaCitrusThreat.com or, for a version in Spanish, http://www.PeligranCitricosEnCalifornia.com.

## *Biological Control*

Several predators and parasites feed on different life stages of the psyllid. The nymphs are killed by tiny parasitic wasps and various predators, including lady beetle adults and larvae, syrphid fly larvae, lacewing larvae, and minute pirate bugs. Some spiders, birds, and other general predators feed on adult psyllids.

Efforts are underway to introduce parasitic wasps from the Asian citrus psyllid's native range into California. Several species of parasitoids, collected by University of California researchers, were brought to California for host-testing, mass-rearing, and release. The most promising of these, *Tamarixia radiata*, strongly prefers ACP, and under ideal conditions can significantly reduce psyllid populations (Figure 6). Females of this tiny wasp, which poses no threat to people, lay their eggs underneath ACP nymphs, and after hatching, the parasitoid larvae attack and kill the psyllid. To find evidence of this wasp at work, keep an eye out for ACP "mummies", which look like hollowed-out nymphal shells (Figure 7). This wasp has been released at hundreds of sites throughout Southern California since late 2011.

It is too early to tell what impact *Tamarixia* will have on regional ACP populations. It is unlikely that this or other natural enemies will completely eradicate ACP, and in other areas of the world where huanglongbing is present, natural enemies aren't effective enough to completely halt disease spread. Nonetheless these beneficial insects will at least help to slow the spread of the HLB pathogen, especially in areas where it is not possible or practical to institute other psyllid control measures.

## *Chemical Control*

In certain areas, the CDFA is conducting residential insecticide treatments to control the psyllid. When a psyllid is found in these areas, all citrus and other known ACP host plants on a property and nearby properties receive a combination of two insecticides. These are a foliar pyrethroid insecticide to quickly kill adults and immature psyllids it comes in direct contact with, followed by a systemic (ground drench application) insecticide to provide sustained control of nymphs tucked inside young leaves. These combination treatments are believed to provide effective protection of trees against the psyllid for 9 to 12 months, with no additional treatments needed.

Outside the areas that are part of the CDFA residential treatment program, home gardeners are encouraged to consider implementing psyllid control measures of their own if psyllids are found. Because of the great threat ACP poses to both backyard and commercial citrus and the urgency of containing the pest, many of the products used for its control are more toxic than those suggested for other pests in garden IPM programs. Home gardeners can hire a landscape pest control professional to apply insecticides or make treatments themselves. Landscape professionals have access to the same pesticides applied by the CDFA, which include the systemic imidacloprid and foliar applications of the pyrethroid beta-cyfluthrin.

If psyllids are observed, home gardeners can apply broad-spectrum foliar sprays (carbaryl, malathion) to rapidly control adults and protect plants for many weeks. The systemic insecticide imidacloprid (Bayer Advanced Fruit, Citrus & Vegetable and other products) is available for use as a soil drench, which moves through the roots to the growing tissues of the plant. This systemic insecticide provides good long-term control (1-2 months) of the nymphs, which are hard to reach with sprays because they are tucked inside the small leaves of new flush growth.

**Figure 6. *Tamarixia radiata* adult**

**Figure 7. Asian citrus psyllid "mummies" caused by *Tamarixia radiata* parasitism.**

Apply the soil drench during summer or fall when roots are active and plants are not blooming or about to bloom. Broad-spectrum foliar sprays and the systemic insecticide are toxic to honey bees, so don't apply them when bees are active during bloom. Carbaryl and malathion sprays are also very toxic to natural enemies of pests and repeated applications of these products can result in outbreaks of other insect or mite pests.

There are also a number of soft foliar insecticides such as oils and soaps (horticultural spray oil, neem oil, insecticidal soap) that can help to reduce psyllids both by killing them and by deterring them from laying eggs. These insecticides are generally lower

risk to beneficial insects (natural enemies and pollinators).

However, oil and soap insecticides must be applied to sufficiently coat the psyllid to kill it, and the residues don't last long. Thus, thorough applications are especially important and they must be made every 7-10 days when psyllids are observed.

### *Treatment Considerations*

- Always follow label instructions for the safe and effective use of the product
- Only apply pesticides if psyllids have been observed
- Only apply insecticides to host plants of psyllids (citrus and closely related hosts)
- Avoid using insecticides during blooming periods to limit impacts on bees
- Cover foliage thoroughly when spraying, including undersides of leaves

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