Asian Citrus Psyllid and Huanglongbing Disease

Integrated Pest Management for Homes, Gardens, and Landscapes

The Asian citrus psyllid, *Diaphorina citri* (or ACP), 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 (Figure 1) feeds on all varieties of citrus (e.g., oranges, grapefruit, lemons, and mandarins) and several closely related ornamental plants in the family Rutaceae (e.g., calamondin, box orange, Indian curry leaf, and orange jessamine/orange jasmine).

This psyllid damages citrus directly by feeding on new leaf growth (flush) (Figure 2). This feeding can burn back new shoots or cause leaves to twist or notch as they mature (Figure 3). 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. All commonly grown citrus varieties are susceptible to the disease. 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 is becoming more widespread in the Central Valley and further north. HLB was found in March 2012 in a tree in a yard in Los Angeles County. Since then, more than a dozen additional infected trees have been found and removed in a nearby residential area.

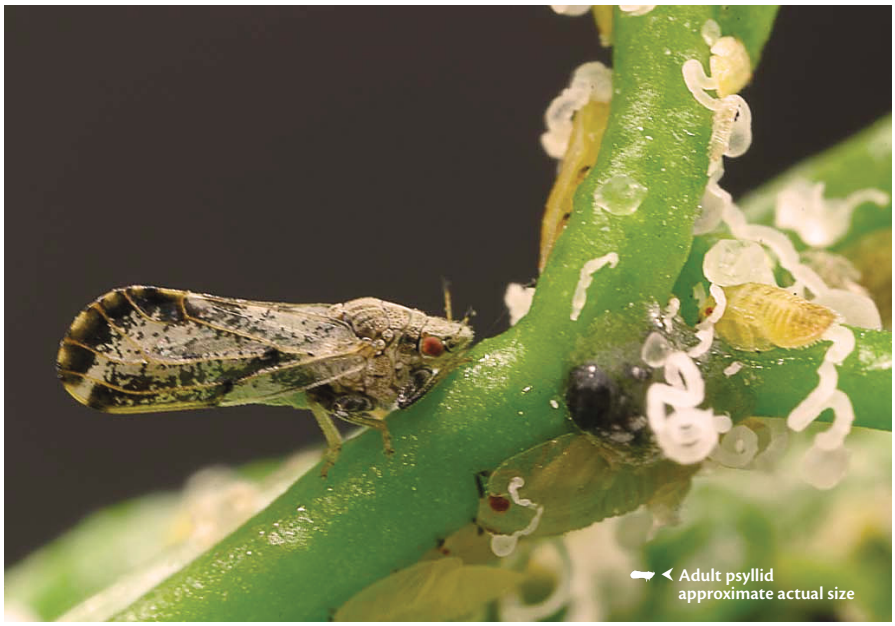

Figure 1. Brownish adult, yellow nymphs, and white wax of the Asian citrus psyllid, *Diaphorina citri*.

Figure 2. Asian citrus psyllid adults and nymphs attacking young growth on citrus.

Figure 3. Young citrus leaves infested with Asian citrus psyllid nymphs may begin to curl and twist.

The presence of huanglongbing in pockets of Southern California means it is now even more important to keep the psyllid populations low so they don't find infected trees and spread the disease.

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,

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Florida, 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 psyllid-infested nursery plants. HLB spread equally rapidly. First found in 2005 in Florida, it now infects trees in all commercial citrus orchards in that state. 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 was also detected in Louisiana. The insect then 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, likely from Mexico, to Southern California, where it was first detected in San Diego County and soon after in Los Angeles. Over the next few years the psyllid spread throughout Southern California, particularly in urban and suburban environments, but also in commercial groves. The psyllid has since expanded its range to the Central Valley and the Central Coast, and has been found as far north as the Bay Area and nearby Sacramento.

In March 2012, huanglongbing was found in a citrus tree in Southern California. This tree 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), and was destroyed to prevent further spread of the bacterium. Nonetheless, the disease may have already spread from this initial infection in Los Angeles in the bodies of psyllids to other citrus trees. Alternatively the bacterium may be introduced into California again in an infected citrus tree or other host plant, illegally imported or smuggled into the state from areas such as Mexico where both the insect and disease are present. Indeed, additional infected citrus trees have now been found in residential areas of Los Angeles County near the first case, all of which have also been removed.

To protect the state's commercial and residential 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, but psyllids can pick up the disease and spread it within a few months. Therefore, it is important to closely monitor citrus trees for psyllids and immediately report any suspected plant symptoms.

Figure 4. Yellowish psyllid nymphs with red eyes and white waxy tubules.

IDENTIFICATION

Psyllid Life Stages

The adult Asian citrus psyllid is a small brownish-winged insect about the size of an aphid. 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 at the back. 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 newly developing "feather flush" leaves of citrus. Each female can lay several hundred eggs during her lifespan.

Figure 5. Asian citrus psyllid nymphs producing waxy tubules and being tended by ants.

The eggs hatch into nymphs that are wingless, flattened, yellow or orange to brownish, and 1⁄100 to 1⁄14 inch long (Figure 4). 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 5).

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 from its rear end 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.

HLB Disease

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

Figure 6. Huanglongbing causes asymmetrical yellow mottling of the leaves and an odd shape and greening of the fruit.

of the leaf and yellow on the other side (Figure 6).

Citrus leaves can yellow for many other reasons and often discolor from deficiencies of zinc or other nutrients. However, 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.

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 may not begin to appear for two or more 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 (honeydew) that the psyllid 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 important, 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) began 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 ACP Distribution and Management Web site (see REFERENCES).

How You Can Help

Homeowners and landscapers can help combat the psyllid by inspecting their citrus trees and reporting new infestations of the Asian citrus psyllid or suspected cases of the disease. The best way to detect the psyllid is by looking at tiny new leaves (feather flush growth) on citrus trees whenever new leaves are forming on the tree. Mature citrus trees typically produce most of their new growth in the spring and fall, but young trees and lemons 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.

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 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, CDFA may come to your residence and take a sample. If the insect is identified as an Asian citrus psyllid, then the quarantine may expand to include that location, and citrus and other

ACP host plants will be treated with insecticides by CDFA personnel to control the psyllid.

In areas known to be widely infested with the psyllid, you may need to treat for the psyllid yourself. This can 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 UC Master Gardener program (see REFERENCES) or a landscaping and pest control professional for more information about the steps you can take to control the psyllid.

Monitoring citrus trees for symptoms of HLB disease is also critical for early detection and management. Immediately report suspected cases of the disease to your county agricultural commissioner's office or call the CDFA hotline. If the tree is found to be infected with the HLB pathogen, it will be removed immediately to prevent further spread of the disease.

Diligent scouting for both the pest and the disease will help save backyard citrus trees and protect commercial citrus orchards. For additional photos of the Asian citrus psyllid and HLB symptoms, visit the California Citrus Threat Web site (see REFERENCES).

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, have been 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 7).

Females of this tiny wasp, which poses no threat to people, lay their eggs

Figure 7. *Tamarixia radiata* adult.

underneath ACP nymphs, and after hatching, the parasitoid larvae feed on 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 8). This wasp has been released at thousands of sites throughout Southern California since late 2011. More recently, releases of a second wasp (*Diaphorencyrtus aligarhensis*) that attacks the younger ACP nymphs have begun in Southern California.

It is too early to tell what impact *Tamarixia* and other parasites and predators will have on regional ACP populations. It is unlikely that natural enemies will eradicate ACP, and in other areas of the world where huanglongbing is present, natural enemies aren't effective enough to halt disease spread. Nonetheless these beneficial insects will at least help to reduce psyllids, especially in areas where it is not possible or practical to institute chemical psyllid control measures. Visit the ACP Distribution and Management Web site (see REFERENCES) to see a map of where these parasites have been released in California.

Ant Control

It is very important for homeowners to assist the natural enemies by controlling ants around their trees. Ants "farm" the psyllid honeydew and protect psyllids from predators and parasites in order to preserve this food source for their colony.

Ant control is especially important in areas of California where the very aggressive Argentine ant is found, which can reduce *Tamarixia* and *Diaphorencyrtis* attack rates on ACP by upwards of 80%. For information on ant identification

Figure 8. Asian citrus psyllid "mummies" caused by *Tamarixia radiata* parasitism.

and management in the landscape, see the UC IPM Pest Notes: *Ants* (see REFERENCES).

Chemical Control

In areas where the psyllid is newly arrived, or residential citrus is close to commercial citrus, the CDFA is conducting residential insecticide treatments to control the psyllid. When a psyllid is found in these areas, all citrus and other ACP host plants on a property and nearby properties receive a combination of two insecticides. This consists of a foliar pyrethroid insecticide to quickly kill adults and immature psyllids by direct contact, followed by a systemic (ground-drench) insecticide to provide sustained control of nymphs tucked inside young leaves. This combination of treatment may protect trees against psyllids for up to 3 months. Home gardeners are encouraged to be vigilant and consider supplementary applications of their own when they see psyllids on new flush.

Because of the threat ACP poses to both backyard and commercial citrus and the urgency of containing this pest, home gardeners outside the areas that are part of the CDFA residential treatment program are encouraged to consider implementing psyllid control measures of their own if psyllids are found.

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.

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 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.

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 bloom to limit impacts on bees.
- Thoroughly wet the foliage when spraying, including undersides of leaves.

Apply the soil drench during summer or fall when roots are active. Broad-spectrum foliar sprays and the systemic insecticide are toxic to honey bees, so don't apply them when the citrus trees are blooming.

There are also a number of organic and "soft" foliar insecticides such as oils and soaps (horticultural spray oil, neem oil, insecticidal soap) that can help to reduce psyllids. These insecticides are generally lower in risk to beneficial insects (natural enemies and pollinators); however, they are also less persistent so applications need to be made frequently when psyllids are observed (every 7-14 days). Oil and soap insecticides must make direct contact with the psyllid so should be applied carefully to achieve full coverage of the tree. See the "Active Ingredients Compare Risks" button in this publication online for more information about potential hazards posed by these materials.

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AUTHORS: E. E. Grafton-Cardwell, Entomology, UC Riverside and Lindcove Research and Extension Center, and M. P. Daugherty, Entomology, UC Riverside.

TECHNICAL EDITOR: K. Windbiel-Rojas

EDITOR: C. Laning

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Pest Notes are available at ipm.ucanr.edu.

For more information, contact the University of California Cooperative Extension office in your county. See your telephone directory for addresses and phone numbers, or visit: ucanr.edu/County_Offices.

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