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UC IPM

Integrated Pest Management for Home Gardeners and Landscape Professionals

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Asian Citrus Psyllid and Huanglongbing Disease

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

The Asian citrus psyllid (Figure 1), *Diaphorina citri*, is a tiny, mottled brown insect about the size of an aphid. This insect poses a serious threat to California's citrus trees because it vectors the pathogen that causes huanglongbing disease (HLB). This disease is the most serious threat to citrus trees worldwide—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 several closely related ornamental plants in the family Rutaceae (e.g., calamondin, box orange, Indian curry leaf, and orange jessamine/orange jasmine).

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Figure 2. Adults feed on and deposit yellow-orange eggs on the newly developing citrus flush.

Figure 3. Yellowish psyllid nymphs with red eyes and white waxy tubules.

The Asian citrus psyllid (or ACP), damages citrus directly by feeding on newly developed leaves (flush) (Figure 2). However, more seriously, the insect is a vector of the bacterium *Candidatus* Liberibacter asiaticus, associated with the fatal citrus disease 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 5 years, and there is no known cure or remedy. All commonly grown citrus varieties are susceptible to the pathogen. The only way to protect trees is to prevent the spread of the HLB pathogen by controlling psyllid populations 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. The first tree with HLB was found in March 2012 in a home garden in Los Angeles County and a few years later was found in residences in Orange and Riverside Counties. Spread of the disease began to rapidly accelerate in these areas in 2017. Removal of infected trees by the California Department of Food and Agriculture (CDFA) has occurred wherever they have been found.

The presence of HLB in pockets of Southern California emphasizes that it is critical to control psyllid populations so that disease spread is limited.

BACKGROUND

The Asian citrus psyllid and the HLB disease originated in eastern Asia or the Indian subcontinent and then spread to other areas of the world where citrus is grown. The psyllid was first found in the United States in 1998 in Palm Beach County, Florida on backyard plantings of orange jessamine, *Murraya paniculata,* and spread rapidly over a 3-year period. HLB spread equally rapidly in Florida.

In 2008, the Asian citrus psyllid was first detected in California. 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 San Francisco Bay Area and sites near Sacramento.

The first infected tree found in California is believed to have been the result of illegal grafting of an infected bud (taking plant tissue from one tree and inserting it into another to form a new branch). The infected tree was destroyed to prevent further spread of the bacterium. Since that time, additional infected trees have been found in southern California's residential areas; these may have resulted from illegally imported diseased trees, illegal grafting of infected budwood, and, more recently, the natural spread of the bacterium by the psyllid. CDFA is continuing to detect and eliminate infected trees.

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 several years for symptoms of HLB to begin to show in the trees. Meanwhile, psyllids can pick up the HLB pathogen as nymphs and spread it only a few weeks after the tree is infected when they fly away as adults. Therefore, it is important to monitor and control psyllids in citrus trees and immediately report any suspected plant symptoms to the county agricultural commissioner.

Figure 4. Asian citrus psyllid nymphs on young citrus leaves.

Figure 5. Young citrus leaves infested with Asian citrus psyllid nymphs curl and twist as the psyllids feed and grow.

IDENTIFICATION

Psyllid Life Stages

The adult Asian citrus psyllid is a small brownish-winged insect about the size of an aphid. Its body is ⅛ to ⅛ 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 back end in the air (Figure 1). No other insect pest of citrus positions its body this way while feeding.

Adults typically live 1 to 2 months. Females lay tiny yellow-orange almond-shaped eggs in the folds of the newly developed leaves of citrus. Each female can lay several hundred eggs during her lifespan.

The eggs hatch into nymphs that are wingless, flattened, yellow or orange to brownish, and 1/100 to 1/14 inch long (Figure 3). Nymphs molt 4 times, increasing in size with each nymphal stage (instar), before maturing into adult psyllids. Late instar nymphs have distinctive red eyes. The nymphs can only feed on soft, young plant tissue and are found on immature leaves, stems and flowers of citrus (Figure 4).

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 (Figure 3) from its back 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 interrupted by a clear area, its characteristic body tilt, and, in the nymph stage, the shape of the waxy tubules it produces.

Damage

The Asian citrus psyllid damages citrus when its nymphs feed on new shoots and leaves. They remove sap from the plant tissue and inject a salivary toxin as they feed. This toxin can inhibit or kill new shoots, deforming new leaves

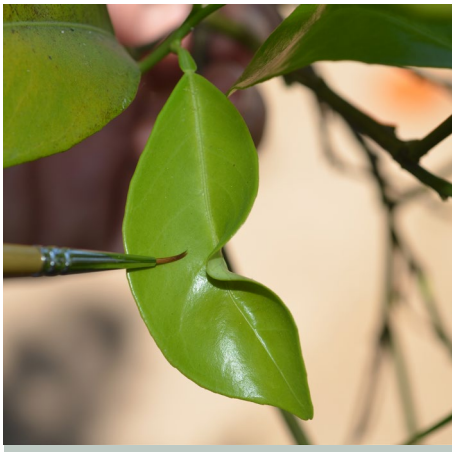

Figure 6. Notching of mature leaf resulting from psyllid feeding when the leaf was young.

by twisting and curling them (Figure 5). If the leaves mature after sustaining this damage then they will have a characteristic notch (Figure 6).

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 death of new growth will retard the growth of young trees that are less than 5 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 importantly, the Asian citrus psyllid, through its feeding activity, can inoculate the tree with the bacterium that causes HLB, ultimately killing the tree. It only takes a few psyllids to spread the disease.

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 of the leaf and yellow on the other side (Figure 7).

Citrus leaves can turn yellow for many other reasons and often discolor from deficiencies of zinc (Figure 8) or other nutrients. However, the pattern of yellowing caused by nutrient deficiencies typically occurs symmetrically (equally on both sides of the midvein), between or along leaf veins.

As the disease progresses, the fruit size becomes smaller, and the juice turns bitter. The fruit may 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 2 or more years after the bacteria infect a tree.

MONITORING AND MANAGEMENT

In response to the establishment of ACP in California, 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 throughout the state. The program also includes frequent testing of psyllids and leaf samples for the presence of the pathogen.

Monitoring results are being used to delimit quarantine zones, guide releases of biological control agents, intensify testing for HLB, and prioritize areas for chemical control programs. In areas where HLB has been found, home gardeners need to take an active role in controlling the psyllid throughout the year by watching for disease symptoms and supporting disease testing and tree removal activities.

Figure 7. Huanglongbing causes asymmetrical yellow mottling of the leaves.

Figure 8. Symmetrical mottling of citrus leaves due to zinc deficiency.

ACP and HLB Quarantines

ACP quarantine zones have been established throughout the state that restrict movement of citrus trees and fruit in order to prevent psyllids from being moved to new, uninfested areas of California. Additional, more restrictive HLB quarantine zones have been established to help keep HLB from spreading. Citrus trees and close relatives that could be hosts of the psyllid can't be taken out of quarantine areas. Fruit can be moved, but only if it is washed and free of stems and leaves that could harbor psyllids.

Whether you are inside or outside a quarantine area, it is very important to assist with the effort to reduce Asian citrus psyllids and report suspected HLB symptoms in your trees. Your efforts will slow the spread of HLB and

provide time for scientists to work on finding a cure for the disease. For maps and information about the quarantine areas, see the UC ANR ACP Distribution and Management website (see REFERENCES).

How You Can Help

Residents and landscapers can help combat the psyllid by inspecting their citrus trees and reporting infestations of the Asian citrus psyllid in areas where they are not known to occur or suspected cases of the disease. For more photos of the Asian citrus psyllid and HLB symptoms, visit the California Citrus Threat website (see REFERENCES).

The best way to detect psyllids is by looking at tiny newly-developing leaves on citrus trees whenever flush (clusters of new leaves) is forming. Mature citrus trees typically produce most of their new growth in the spring and fall, but young trees and lemons tend to flush periodically year round during warm weather.

Slowly walk around each tree and inspect the flush. Look for signs of psyllid feeding and damage, including twisted or notched leaves, nymphs producing waxy deposits (Figure 3), honeydew, sooty mold, or 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 found on tender new leaves and they don't fly, so monitoring efforts are most effective when directed toward these stages on citrus 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.

Figure 9. *Tamarixia radiata* adult.

Figure 10. Asian citrus psyllid "mummies" caused by *Tamarixia radiata* parasitism.

In areas known to be widely infested with the psyllid, you will 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, 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 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 at 1-800-491-1899. If the tree is found to be infected with the HLB pathogen, it will be removed immediately to prevent further spread of the disease. It is critical that residents cooperate with tree removal.

Symptoms of HLB take a long time to develop after a tree is first infected, perhaps upwards of 2 years or more for mature trees. However, infected trees can be a source of the bacterium for the psyllid much sooner. This means that in areas where HLB is known to be present, just because a tree looks to be free of HLB symptoms does not mean that it hasn't been infected. Therefore, for residential areas where HLB is becoming widespread it is worth considering proactive removal of your citrus trees, even if they have not yet tested positive for the disease, to help contain HLB spread. At the very least, in these high HLB risk areas, home gardeners should be discouraged from planting new citrus trees given the high potential for them to become infected in the near future.

Biological Control

A number of predators and parasites feed on ACP. 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.

Several species of tiny parasitoid wasps, 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* (Figure 9), strongly prefers ACP nymphs, and under ideal conditions can significantly reduce psyllid populations.

Females of this tiny wasp, which poses no threat to people, lay their eggs 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 10).

Figure 11. Ants tend psyllid nymphs, protecting them from natural enemies in order to harvest their honeydew.

This wasp has been released at thousands of sites throughout Southern California since early 2012. More recently, *T. radiata* releases have been made in Central California and a second wasp (*Diaphorencyrtus aligarhensis*) that attacks the younger ACP nymphs was released in Southern California.

Tamarixia and other natural enemies have reduced ACP populations in Southern California, but they have not eradicated the pest and have not halted the spread of HLB. In the absence of ants, 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 website (see REFERENCES) to see a map of where these parasites have been released in California.

Ant Control to Protect Natural Enemies

Ants directly interfere with biological control of ACP, so it is very important for residents to control ants around their citrus trees. Ants "farm" the psyllid honeydew, feed it to their young, and vigorously protect psyllids from predators and parasites (also called natural enemies) (Figure 11). Ants do this 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. Argentine ants can significantly reduce *Tamarixia* and *Diaphorencyrtis* attack rates on ACP. For information on ant identification and management in the landscape, see the UC IPM *Pest Notes: Ants* (see REFERENCES).

Chemical Control

In areas where ACP has newly arrived, or where residential citrus trees are close to commercial citrus operations, CDFA conducts residential insecticide treatments to control psyllids. When a psyllid is found in these areas, all citrus and other ACP host plants on a property and nearby properties receive an application of two insecticides: a foliar pyrethroid insecticide to quickly kill adults and immature psyllids by direct contact and a soil-applied systemic insecticide to provide sustained control of nymphs tucked inside young leaves. This combination of treatments may protect trees against psyllids for many months. Home gardeners are encouraged to be vigilant and consider supplementary applications of their own when they see psyllids on their trees.

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 their own psyllid control measures if psyllids are found in their area.

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 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 of the nymphs for 1 to 2 months. Nymphs are hard to reach with foliar sprays because they are tucked inside the small, developing flush.

Apply the soil drench during summer or fall when roots are actively growing. Broad-spectrum foliar sprays and systemic insecticides 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 to 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.

Treatment Considerations

- Always follow label instructions for the safe and effective use of the product.
- Only apply insecticides if psyllids have been observed in your area.
- 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.

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WARNING ON THE USE OF PESTICIDES

Pesticides are poisonous. Some pesticides are more toxic than others and present higher risks to people, nontarget organisms, and the environment. A pesticide is any material (natural, organic, or synthetic) used to control, prevent, kill, suppress, or repel pests. "Pesticide" is a broad term that includes insecticides, herbicides (weed or plant killers), fungicides, rodenticides, miticides (mite control), molluscicides (for snails and slugs), and other materials like growth regulators or antimicrobial products such as bleach and sanitary wipes that kill bacteria.

Always read and carefully follow all precautions and directions provided on the container label. The label is the law and failure to follow label instructions is an illegal use of the pesticide. Store all chemicals in the original labeled containers in a locked cabinet or shed, away from food or feeds, and out of the reach of children, unauthorized persons, and animals. Never place pesticides in food or drink containers. Consult the pesticide label to determine active ingredients, correct locations for use, signal words, and personal protective equipment you should wear to protect yourself from exposure when applying the material.

Pesticides applied in your garden and landscape can move through water or with soil away from where they were applied, resulting in contamination of creeks, lakes, rivers, and the ocean. Confine pesticides to the property being treated and never allow them to get into drains or creeks. Avoid getting pesticide onto neighboring properties (called drift), especially onto gardens containing fruits or vegetables ready to be picked.

Do not place containers with pesticide in the trash or pour pesticides down the sink, toilet, or outside drains. Either use all the pesticide according to the label until the container is empty or take unwanted pesticides to your local Household Hazardous Waste Collection site. Contact your county agricultural commissioner for additional information on safe container disposal and for the location of the Hazardous Waste Collection site nearest you. Follow label directions for disposal of empty containers. Never reuse or burn the containers or dispose of them in such a manner that they may contaminate water supplies or natural waterways.

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This and other 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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