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Mosquito Management for Ponds, Fountains, and Water Gardens

Many gardeners are adding fountains, ponds, and other water features to their landscapes. Water gardens (Figure 1) are beautiful and calming, but, if not managed properly, can add an unpleasant element to the landscape—mosquitoes. How can you help your customers prevent mosquito infestations?

First, it is important to understand mosquito biology. Mosquitoes are small flies that lay their eggs in, on, or near stagnant water. The larvae, or wigglers, (Figure 2) that hatch from the eggs live in water and feed on organic debris until they transform into a motile pupa, or tumbler, and finally into the familiar adults. This process, from egg to adult, requires as little as one week when conditions are favorable. Emerging females must mate and ingest blood in order to produce new eggs.

Mosquitoes can be managed using an integrated approach that relies mostly on prevention, using biological and chemical controls when necessary. The key strategy is to eliminate all potential breeding sites; even one ounce of standing water can support a population of larvae. What can be done, however, when an outdoor space contains a water element? Here are a few tips you can pass on to your customers.

Water features in the landscape will invariably attract adult mosquitoes, but attempting to control them or prevent their egg laying is difficult. Larvae are easier to manage, since they are concentrated in known areas, don't yet bite, and can't fly away. Larvae prefer shallow water that is less than 24 inches deep, so suggest to your customers that they install water features that are deeper than 2 feet. Ponds or features that provide a steep slope or have vertical walls that quickly drop off into deep water will also be less favorable to mosquitoes. Suggest adding a fountain, waterfall, or other device that increases water circulation and reduces the stagnation that allows mosquitoes to breed.

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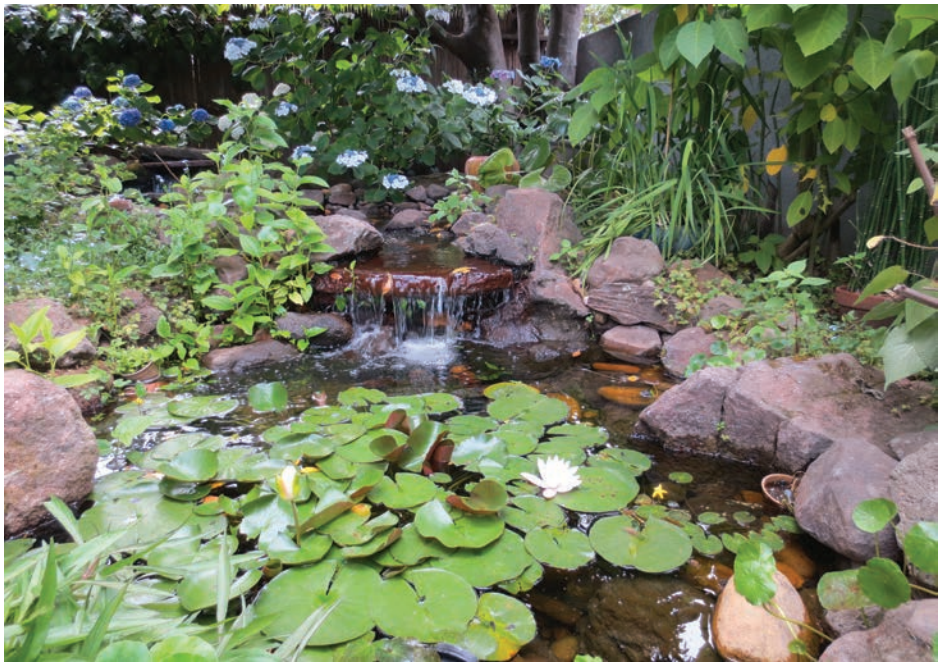

M. L. Flint, UC

Figure 1. A well-managed water garden, such as this one, keeps mosquito numbers in check.

J. K. Clark, UC

Figure 2. Mosquito larvae, like these* Culex tarsalis encephalitis *mosquitoes, must come to the surface to breathe air through abdominal siphons.

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Keep Asian Citrus Psyllid Out of Your Store

The Asian citrus psyllid (ACP), *Diaphorina citri*, (Figure 1) and Huanglongbing disease (HLB), sometimes referred to as citrus greening disease, have emerged as primary threats to citrus production worldwide. ACP and HLB also threaten citrus trees in every California backyard. ACP was discovered in California in residential citrus in 2008 and has since spread throughout most urban and suburban areas of Southern California. The California Department of Food and Agriculture (CDFA) has implemented regulations to reduce the role that retail sales of host plants may play in the spread of this pest and disease in California.

ACP and HLB affect many species of plants in the family Rutaceae, including all varieties of citrus and several ornamentals. In Florida, shipments of ornamentals, notably orange jessamine, *Murraya paniculata*, have been associated with the spread of the psyllid and disease throughout the state.

To ensure a similar scenario doesn't unfold in California, CDFA put regulations in place that restrict the movement of ACP and HLB host plants out of designated infested quarantine zones; this information is available at http://www.cdfa.ca.gov/plant/pe/interiorexclusion/acp_quarantine.html. In addition, ACP host plants within or moving into a quarantine area must receive a combination insecticide treatment consisting of a foliar pyrethroid and a soil drench containing a systemic neonicotinoid. Following treatment, host plants must ship to retail sites within three months or be re-treated. Any nursery plants found to be infested by the psyllid are put on hold until re-treated or destroyed.

Systemic neonicotinoids (i.e., imidacloprid), applied as part of the quarantine requirement, are the primary tool for sustained control of psyllids. These insecticides can persist in containerized citrus at effective concentrations for up to three months—perhaps almost twice that in some cases. Yet, during the last year, hundreds of retail nurseries and garden centers throughout Southern California have been found with ACP-infested trees. UC Riverside and Cooperative Extension personnel are investigating why these infestations are occurring in retail stores, despite the precautions being taken.

Why Aren't Existing Control Measures Adequate?

Part of the explanation might be due to how long citrus trees remain at retail locations (Figure 2). Ongoing surveys of retail nurseries and garden centers suggest it is common for trees to sit at retail sites for an extended period (Figure 3). When tested for imidacloprid residues, many trees, especially those treated more than three months previously, were below concentrations known to be effective. Thus, insufficient turnover of nursery stock may undermine prior insecticide treatments.

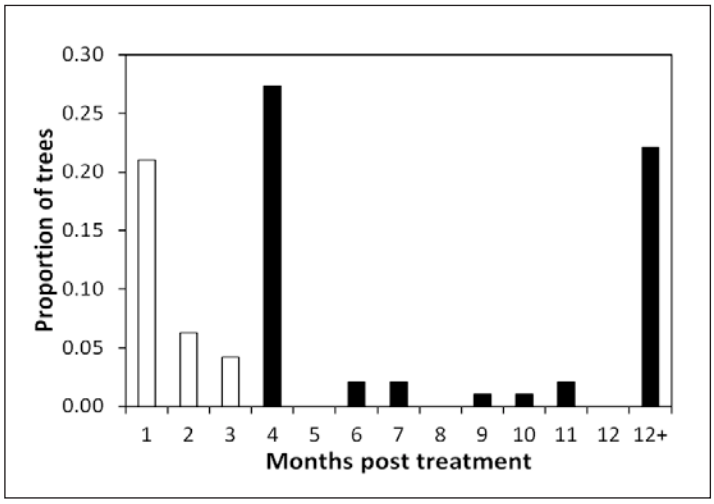

Figure 3. Estimated duration containerized citrus remain at Southern California nurseries after insecticide treatment. Results show 70% of trees were treated more than three months prior, and nearly 25% were treated more than a year earlier—well beyond the residual effectiveness range of insecticides.

The other part of the explanation may be related to horticultural practices. For example, preliminary evidence suggests that overwatering containerized citrus may limit uptake and retention of systemic insecticides. Thus, under ideal conditions the existing chemical control measures can effectively limit ACP, but they aren't guaranteed to do so. Vigilance is needed on the part of nursery personnel to maximize the effectiveness of insecticide treatments and help limit spread of ACP. To meet this goal, retail nursery and garden center employees should:

M. Lewis, UC

Figure 1. Asian citrus psyllid nymphs and adult (inset) on citrus shoot. Note the white waxy tubules nymphs produce and the feeding posture of adults.

A. Olguin, UC

Figure 2. Containerized citrus being inspected for the presence of ACP. Trees that sit at retail sites for too long aren't well protected against infestation by this psyllid.

- **Learn more about this pest and disease.** Information is available at http://www.ipm.ucdavis.edu/QT/asiancitruscard.html, http://californiacitrusthreat.org, http://peligrancitricosencalifornia.com, and http://cisr.ucr.edu/urbanACP.
- **Help maintain the quarantines.** Educate customers about ACP and HLB and their role in ensuring that infested plants aren't moved outside the quarantine zones; see http://www.californiacitrusthreat.org/areas-at-risk.php for more information.
- **Inspect containerized citrus and other host plants.** Regularly check new shoot growth for ACP eggs or nymphs, and check mature foliage for ACP adults and HLB symptoms. Report infestations or suspicious symptoms to the CDFA pest and disease hotline, 1-800-491-1899.

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What Can Gardeners Do To Help Honey Bees?

Most people have heard about the decline in honey bees (Figures 1 and 2) during the last several years. Are there things home gardeners can do to help?

Better Nutrition, Fewer Pesticides

The actual cause of the decline is still uncertain. What is known is a number of factors are probably involved. Honey bees are their most robust and able to best contend with stresses when well fed. In addition to water, honey bees require nectar sources for carbohydrates and a varied mix of pollens to provide proteins, lipids, vitamins, minerals, sterols, antioxidants, and other nutrients. Drought, flooding, and conversion of former foraging grounds into large agricultural monocultures, highways, airports, developments, and so forth have led to honey bee malnutrition in many locations.

In the last 20 years beekeepers have been encountering a series of previously exotic pests that invade the hive and kill bees, such as the varroa mite; new honey bee diseases, including *Nosema ceranae*; and many viruses.

Pesticides can also be involved in bee decline, especially when applied to plants when they are in bloom and bees are foraging. Many insecticides are highly toxic to bees including virtually all organophosphates, carbamates, and pyrethroids. If not killed in the field, foraging bees can collect residue-contaminated pollens and bring them back to the hive for immediate consumption or long-term storage. There are serious concerns over the chronic, sublethal effects of these residues on the physiology of immature and adult bees.

K. K. Garvey, UC

Figure 1. Honey bee on tidytips.

K. K. Garvey, UC

Figure 2. Honey bee and yellow-faced bumble bee on cone flower.

A newer class of insecticides, the neonicotinoids, which include imidacloprid, clothianidin, and dinotefuran, also pose hazards for honey bees. These products are systemic materials that move through the plant and are included in the nectar and pollen of flowers when they bloom. Although the neonicotinoid residues may not kill bees immediately, they may have sublethal effects, such as suppressing immune and detoxification systems, causing bees to be more sensitive to other stresses.

Use Plants and Pesticides Wisely

There are several ways gardeners can help protect bees. When customers design or replant a landscape, suggest they consider honey bees and other pollinators in their plan. Help customers find plants honey bees prefer, and suggest how to ensure several bee-friendly plants will be blooming throughout the year (Figure 3). For lists of California native plants bees visit, see http://beebiology.ucdavis.edu/HONEYBEES/floralvisits.html or the UC Urban Bee Gardens page at http://www.cnr.berkeley.edu/urbanbeegardens. Also, if bees are still visiting certain flowers, delay removing spent flowers until bee visits taper off, even if the results aren't as aesthetically pleasing.

In addition, advise customers against applying highly toxic insecticides, especially when plants are in bloom. With neonicotinoids, also avoid applying them before plants bloom, because these materials tend to be stable compounds that can remain in the soil and in plants for months. Even when plants aren't in bloom, use nonchemical management methods or pesticides with little or low toxicity to bees such as soaps, oils, or *Bacillus thuringiensis* whenever possible, as pesticides may leave toxic residues, or there may be flowering weeds or other blooms nearby.

For information about the relative toxicity of pesticides to bees, consult *How to Reduce Bee Poisoning from Pesticides* at http://www.ipm.ucdavis.edu/PDF/PMG/pnw591.pdf. Toxicity of many landscape and garden pesticides to bees is also listed in the UC IPM landscape and garden pesticide active ingredient database at http://www.ipm.ucdavis.edu/PMG/menu.pesticides.php.

K. K. Garvey, UC

Figure 3. Help customers find bee-friendly plants in your store.

—Eric Mussen, Entomology, UC Davis, ecmussen@ucdavis.edu

Mosquitoes

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Remove excess vegetation and organic debris that provide mosquito larvae with food, shelter from the sun, and hiding places from predators. For larger ponds, a pond skimmer will help keep mosquitoes and the algae that favors them under control. For customers with smaller ponds, consider stocking inexpensive pond skimmer nets. If fertilization is required, use pond spikes designed to prevent algae blooms.

In natural environments, bacteria, nematodes, other insects, crustaceans, and fish often keep numbers of mosquito larvae low. Encourage customers to conserve predators such as dragonflies and backswimmers (Figure 3), which may have colonized ponds, by avoiding broad-spectrum insecticides and to consider introducing fish. County vector control services may provide free mosquito fish (Figure 4), voracious consumers of mosquito larvae and pupae. Never release mosquito fish into natural water bodies, since these fish aren't native to California and can disrupt ecosystems.

Although these measures will prevent problems in most cases, mosquito larvae may still develop in some ponds.

J. K. Clark, UC

Figure 3. Backswimmers are predators of mosquito larvae in natural aquatic habitats.

J. K. Clark, UC

Figure 4. The mosquito fish, Gambusia affinis, *and four mosquito larvae with breathing siphons.*

In gardens with lots of plants growing in still water, it may be impossible to keep mosquitoes from breeding. Advise customers to regularly check their water features for larvae, which periodically come to the surface to breathe through abdominal siphons (Figure 4). Watch for the larvae's characteristic wriggling movement, or use fine dip nets to monitor for larvae. It is important to act quickly to kill mosquitoes when they are small, easiest to manage, and before they become adults and start biting.

Be sure your store carries larvicides specially designed for use against mosquitoes in water. Larvicides containing spores or metabolites of the bacterium *Bacillus thuringiensis israelensis* (Bti) (e.g., Mosquito Dunks, Mosquito Bits, Microbe-Lift, and other products) act as stomach poisons when ingested, killing larvae within a few days. Bti affects only fly larvae, so it won't harm predatory insects living in the pond or water feature. Another effective larvicide is the insect growth regulator (IGR) methoprene (e.g., Pre-strike Torpedos). IGRs interfere with larval molting and also take a few days to kill, but they have a broader spectrum of activity, affecting most juvenile insects and other arthropods that might be in the pond. Both Bti and methoprene are available as granules or pellets, remain effective for about a month, and as with all pesticides, should be used only according to label directions.

For more information about mosquitoes, visit http://www.ipm.ucdavis.edu/PMG/PESTNOTES/mosquitoes.html.

—Andrew Sutherland, UC Statewide IPM Program, San Francisco Bay Area, asutherl@ucanr.edu

ACP in Stores

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- **Ensure turnover of nursery stock.** Label new shipments of ACP or HLB host plants when they arrive, and use merchandising practices that encourage the sale of plants that have been onsite the longest.
- **Use appropriate horticultural practices.** Avoid overwatering citrus plants, which can flush out insecticides and reduce their effectiveness. Also, minimize pruning of citrus plants, which will increase new shoot production and increase attractiveness to ACP.
- **Consider supplementary treatments.** Homeowner formulations of carbaryl and imidacloprid are available for ACP control and can be used in stores. Insecticidal soaps and horticultural oils may also be effective. Be aware of impacts on pollinators, get good coverage, and watch for phytotoxicity.

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For more information about managing pests, contact your University of California Cooperative Extension office listed under the county government pages of your phone book, or visit the UC IPM Web site at www.ipm.ucdavis.edu.

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WHAT IS IPM? Integrated Pest Management (IPM) programs focus on long-term prevention of pests or their damage through a combination of techniques including resistant plant varieties, biological control, physical or mechanical control, and modification of gardening and home maintenance practices to reduce conditions favorable for pests. Pesticides are part of IPM programs but are used only when needed. Products are selected and applied in a manner that minimizes risks to human health, beneficial and nontarget organisms, and the environment.