Information for pest management professionals and pesticide applicators

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Biological Fungicides: Do They Work and Are They Safe?

The term biofungicide can have several different meanings, but it is most frequently used to refer to fungicides that contain a microorganism (usually a bacterium or fungus) as the active ingredient. These microbially-based biofungicides are the focus of this article. Biofungicides can control many different kinds of fungi and water molds, although each separate active ingredient controls only certain pathogens. Some also control bacterial diseases. Virtually all of the organisms used in biofungicides on the market today occur naturally in soil or on plant surfaces, and most are approved for use in organic production.

Advances in fermentation technology have allowed mass production of highly specialized microbes that previously could only be grown in small batches on highly specific substrates, such as on roots infected with pathogens. Consumer demand for organically certifiable pesticides and increased regulatory pressure on older synthetic pesticides, especially in Europe, has fostered increased commercial interest in the production of living organisms that can suppress or kill pathogens. For these reasons and also because, as natural products, biofungicides generally have few negative impacts on health and the environment, the number available will likely continue to increase.

Since microbial biofungicides contain living organisms, their modes of action differ from those of synthetic fungicides. Some of these mechanisms include:

- Competition: The biocontrol agent is more effective than the pathogen at gathering critical nutrients or space and, therefore, must be in place before disease onset.
- Antibiosis: The biocontrol agent produces a chemical compound of some type (antibiotic or toxin) that acts against the pathogen.
- Predation or parasitism: The biocontrol agent directly attacks the pathogen.
- Induction of host plant resistance: The biocontrol agent triggers a defensive response in the host plant that limits the ability of the pathogen to invade the plant.

Most biofungicides use one or more of the above mechanisms to target only one or a few specific pests. As such, applicators should both read the label and diagnose the problem carefully to insure that the product will be effective. Biofungicides work best when applied preventively. Application after a plant is already infected has little chance of significantly altering the course of the disease for that plant, although it may decrease the ability of the pathogen to

J. K. Clark, UCIPM

Powdery mildew (above) and black spot (below) in roses are examples of diseases that can be managed with foliar applications of the biofungicide **Bacillus subtilis.**

J. K. Clark, UCIPM

Dark blotches and yellowing on a rose leaflet infected with black spot.

J. K. Clark, UCIPM

Biofungicides containing **Streptomyces** *or* **Trichoderma** *can be used to prevent infection of plants with damping off or root or seed rot pathogens such as* **Pythium.**

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WHAT'S INSIDE...

Biological Fungicides

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move from that plant to other plants, especially if the pathogen has to move through the soil to do so. Thus, an application of biofungicide is not likely to cure an infected plant; but it may protect other nearby plants in the field.

Although independent testing by university researchers and others has verified some manufacturer claims made for these products, efficacy data for many other products against pathogens on ornamentals is unavailable. For instance, as of early 2014, independent testing has not demonstrated adequate field efficacy of any biofungicide for landscape or agricultural use against Armillaria root rot (otherwise known as oak root rot). However, a number of biologicals have been found effective for control of *Pythium*, *Phytophthora*,*Verticillium*, and other pathogens on a variety of plant hosts. With these types of products, eradication of the pathogen is not the goal and is probably never achieved. Instead, biofungicides rely on a core tenet of the IPM philosophy: keeping pest levels below damaging thresholds and using biofungicides (when necessary) in combination with cultural practices that promote healthy plant growth.

Biofungicides cannot take the place of proper cultural care. They are a valuable tool for keeping a strong plant healthy, but they cannot forestall the inevitable. If your client's Japanese maples are routinely drowned, allowed to wilt, and then drowned again, adding a biofungicide will not prevent them from contracting *Phytophthora* if it is present in the soil.

If biofungicides are a useful and environmentally friendly tool in the landscape, why aren't they more widely used? One reason is that these fungicides rely on living organisms for efficacy, so they must be stored appropriately in order to retain their fungicidal properties over time. However, a more commonly cited reason is that the personal protective equipment needed to apply them is more involved than for some other compounds. Routine exposure to the proteins found in the spray mists of some biofungicides can result in the development of allergic reactions. To keep commercial applicators safe, they must wear NIOSH approved respirators when mixing, loading, or applying biofungicides in agricultural or landscape settings. This may not be immediately obvious when reading the labels, as a quick scan often only shows the following required personal protective equipment (PPE):

- Long sleeved shirt and long pants
- Shoes plus socks
- Waterproof gloves

The respirator requirement is only evident when reading the text following the list. Biofungicides are safe to use as long as mixer/loaders and applicators have and use a respirator as part of their PPE. However, a NIOSH approved respirator requires proper training and fitting in order to be effective.

When used properly and with forethought, biofungicides can be an important part of an IPM program to prevent or mitigate problems with plant pathogens in the landscape. However, nothing can ultimately take the place of proper plant selection and care.

-Steven Swain, UC Cooperative Extension, Marin and Sonoma, svswain@ucanr.edu

Table 1. Sample biofungicides available for use in California landscapes.

Active Ingredient	Sample Trade Name	Sample Diseases on Label	Types of Plants on Labels	Application Notes
Bacillus subtilis	Serenade, Rhapsody	Powdery mildew, bacterial spot and many foliar fungal and bacterial pathogens	Annual, perennial and woody plants	Foliar application
Streptomyces lydicus	Actinovate Actono-Iron	Turf diseases including Pythium, Rhizoctonia, Fusarium, powdery mildew, grey mold	Turf primarily, although used on vegetables in commercial agriculture.	Soil drench or foliar treatment
Trichoderma harzianum	Rootshield Home and Garden Fungicide	Many soil pathogens including Pythium, Rhizoctonia and Fusarium	Many woody or herbaceous plants	Application on seeds or roots prior to planting. Mostly used in nurseries.
Pseudomonas fluorescens A506	BlightBan A506	Fireblight	Apple, pear	Foliar. Used primarily in commercial agriculture. A bactericide.

IPM Certification Programs for Urban Pest Management Professionals

Many consumers are asking for environmentally-friendly services when they hire companies to manage pests in and around their homes. Likewise, a number of California municipalities, institutions, and school systems are requiring pest management contractors to provide evidence of an IPM certification or to follow specific IPM practices. At the same time, advocacy groups such as "GotAnts? Get S.E.R.I.O.U.S." http://www.gotantsgetserious.org/ are encouraging consumers to request IPM certified services; and regulatory agencies such as the Structural Pest Control Board (SPCB) and the Department of Pesticide Regulation (DPR) strongly encourage IPM principles and practices. To meet these demands, a growing number of pest management professionals (PMPs) are offering IPM-certified or "green" programs to their customers.

What is IPM Certification?

IPM certification programs verify that PMPs are using the key steps in an IPM program: pest identification, pest monitoring, preventive tactics, nonchemical tactics, and the use of pesticides only after an intolerable pest population has been confirmed. When pesticides are necessary, effective products that are safest for the environment and community are chosen. Each of the current IPM certification programs require field audits to assure that IPM standards are being met and that records for each site are being maintained.

How Can Your Company Get Certified?

Getting certified can help increase your business and bring in new customers. Three certification programs are available to structural PMPs in California: GreenPro, Green Shield, and EcoWise. Each has somewhat different requirements. There are no IPM certification programs for landscape pest management professionals, although holistic programs such as Bay Friendly Landscaping and Green Gardener include IPM within their guiding principles. If you are already certified, make sure to advertise this option and let your customers know how to request the IPM certified option.

GreenPro. The National Pest Management Association (NPMA)'s GreenPro, part of the larger QualityPro program, is the largest IPM certifier in the country. This program certifies companies rather than individuals, but each company must have at least one employee who has gone through the training program and all employees who sell or provide the GreenPro service must pass an online exam.

GreenPro service requires inspections and monitoring before any management practices are implemented, and companies must initiate preventive practices such as removal of food, water, habitat, or access to buildings before moving to use of pesticides. Pesticides are never applied on a predetermined schedule. If monitoring indicates that pesticides are required, the most environmentally sound ones are chosen in consultation with the customer. Companies must keep careful records of all services at GreenPro sites and expect to be audited. QualityPro membership, a prerequisite for GreenPro membership, requires additional service quality benchmarks and an application fee. http://www.npmagreenpro.org/

Green Shield Certified. Operated by the IPM Institute of North America, Green Shield Certified currently has three companies providing its services in California. Green Shield Certified standards are similar to GreenPro; however, this program provides a list of approved pesticides to service providers. Green Shield also certifies facilities such as schools, health care facilities, or public buildings maintained by Green Shield certified companies.

Certification, which may take 6 weeks to 6 months, is carried out by the IPM Institute via inspections of facilities or service providers' business and pest management practices. Certifiers provide recommendations of what changes would be required to meet Green Shield standards. Follow-up evaluations determine when standards have been met. Afterwards, there is an emphasis on documentation and continuous improvement. Companies can choose to certify their entire business or single services, such as ant management.

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Ask the Expert!

Q **In addition to microbial biofungicides, what are some other pesticides available for organic control of plant pathogens in the landscape?**

A Neem oil, jojoba oil, petroleum oils, plant-based oils such as thyme oil, potassium bicarbonate, sulfur, sulfur soap mixtures, copper soap mixtures, copper for dormant treatments.

IPM Certification Programs

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Certification must be renewed annually, with a fee, and on-site re-evaluation is required every 3 years. http://www.greenshieldcertified.org

EcoWise Certified. EcoWise Certified started as a project of the Association of Bay Area Governments (ABAG) and is now a project of the Bio-Integral Resource Center (BIRC). EcoWise certifies both individuals and companies that provide EcoWise Service. Currently, only California PMPs and companies can be certified. Individuals can be certified by taking an online course, followed by demonstrating IPM proficiency through an online exam or by meeting specified educational requirements defined by EcoWise Standards.

Only Branch 2 Field Representatives or Operators can be certified.

Companies can have their EcoWise Service certified by following all the requirements listed in the EcoWise Standards. Each branch that provides EcoWise Certified Service must have a certified PMP, an approved IPM toolbox, and an office and field evaluation. Part of the evaluation includes a review of a total of 10 IPM service visits covering at least three different sites.

Ecowise Certified provides a study guide for PMPs wishing to take the exam, EcoWise Standards, and an EcoWise Handbook. EcoWise certification is only available for general pest management services (SPCB Branch 2 licenses).

Recertification, for individuals and companies alike, is required every 3 years.

EcoWise Certified operations are supported by fees for individual certification and for certification of an EcoWise service at each company branch office. http://www.ecowisecertified.org

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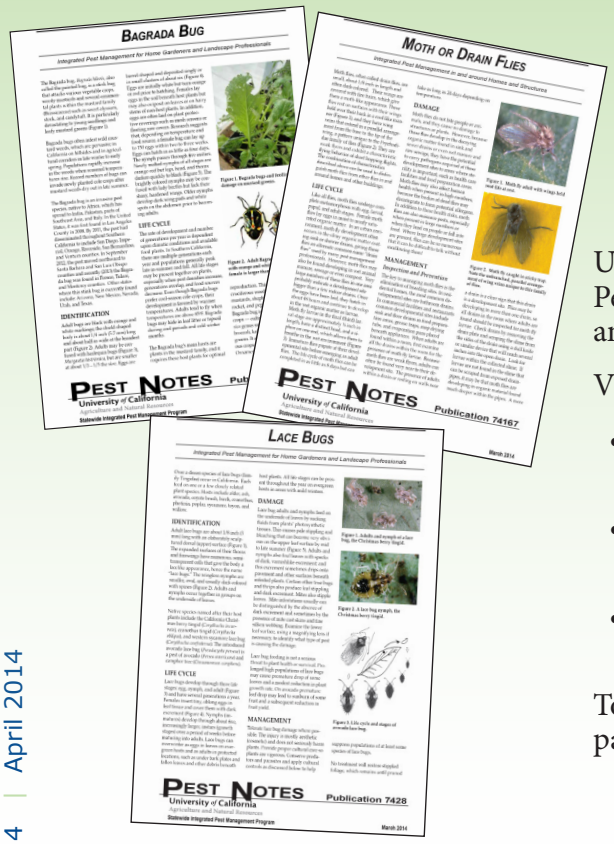

Pest Note Updates

UC IPM recently released two new titles and one revised title in its Pest Notes series of publications covering home, garden, landscape, and wildlife pests.

View them on our web site:

- Bagrada Bug
  http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74166.html
- Lace Bugs
  http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7428.html
- Moth or Drain Flies
  http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74167.html

To access almost 165 other titles, visit UC IPM's Pest Notes Web page at www.ipm.ucanr.edu/PDF/PESTNOTES/index.html.

Exotic Pests Invade California Landscapes

Over the last several decades dozens of exotic pests have invaded California landscapes, causing at least temporary havoc and sometimes severely affecting the aesthetic value of plants or even killing them. Giant whitefly, hackberry woolly aphid, eucalyptus red gum lerp psyllid, Diaprepes root weevil, myoporum thrips, light brown apple moth, spotted wing Drosophila, and olive fruit fly are just a few now established pests that were unknown in the state 25 years ago.

These invaders have come from all over the globe—Asia, Africa, Europe, Australia, Central and South America, and parts of North America. Many new pests arrived on nursery stock; others were imported with shipments of wood, produce, or packing material. Some pests were inadvertently brought in on vehicles or with travelers. Many safeguards including quarantine programs, border inspections, careful procedures at plant nurseries, and outreach programs to educate the public about not moving wood, plants, or produce into the state have had a significant effect in reducing the spread of invasive pests. However, despite these efforts, there is little doubt that new species will continue to arrive.

Five of the newest invaders of concern to landscapers are described in the following paragraphs. For information on these and other exotic pests see the web sites of the UC Riverside Center for Invasive Species Research http://cisr.ucr.edu, the California Department of Food and Agriculture http://www.cdfa.ca.gov/invasives/, or the UC Statewide IPM Program http://www.ipm.ucdavis.edu/EXOTIC/index.html.

Goldspotted oak borer. First identified in eastern San Diego County in 2004, the goldspotted oak borer, *Agrilus auroguttatus*, has killed over 25,000 California native red oaks since its arrival and has now been detected in Riverside County. Larvae feed deep within the phloem, and adults are rarely seen. Infestations are recognized by the presence of D-shaped exit holes on trees, often accompanied by bark staining and crown decline. There are currently no good ways to manage the pest in moderate to severely infested trees. Contact your agricultural commissioner if you find infestations outside the known infested area. More information is available at http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74163.html.

Walnut twig beetle and thousand cankers disease. Walnut twig beetle, *Pityophthorus juglandis*, is a tiny bark beetle that attacks only walnut trees. The beetle has been in California for many decades but recently became associated with a new fungus, *Geosmithia morbida*. The fungus kills the phloem and cambium of the tree but cannot move far within the tree on its own; it is dependent on the beetle to spread it as the beetle bores into trees to feed and reproduce. The disease caused by this beetle-fungus-complex is called thousand cankers disease because it leaves hundreds of lesions on severely infested trees. The disease can kill trees within several years and many black walnuts along roadsides and riparian areas throughout California have died. No effective management tools are available. More information is available at http://www.ipm.ucdavis.edu/PMG/menu.thousandcankers.html.

Polyphagous shot hole borer. Like the walnut twig beetle, this tiny borer, *Euwallacea* sp., spreads a fungal pathogen (in this case a *Fusarium* species) as it bores into trees. The relationship between the beetle and fungus is a symbiotic one with the beetle feeding on the fungus as it grows through the vascular system of trees. This beetle and pathogen have a broad host range and many trees have been affected including avocados, boxelder, coast live oak, liquidambar, and sycamore. Initial finds were in the Los Angeles area in 2012, but the beetle and disease have now been found as far north as Santa Cruz. More information is available at http://cisr.ucr.edu/polyphagous_shot_hole_borer.html.

T. W. Coleman, USDA-FS

D-shaped holes on California native red oaks are a clue to goldspotted oak borer infestation.

A. D. Graves, USDA-FS

Black walnut in decline due to thousand cankers disease.

A. Eskalen, UCR

Lesions on a live oak caused by the polyphagous shot hole borer*-Fusarium *complex.

G. Arakelian, LA County

Polyphagous shot hole borer.

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Exotic Pests

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Brown Marmorated Stink Bug. A native of Asia, the brown marmorated stink bug, *Halyomorpha halys*, immigrated into the United States in the 1990s but has only recently been reported in California. The bug prefers to feed on seeds and fruits, so is most damaging to fruit crops; however, it is a polyphagous feeder that may feed on fruit, leaves, or seeds of many ornamental plants as well. Landscape managers may become most aware of this new pest in the fall when it aggregates in very large numbers on trees or within dwellings, often becoming a nuisance pest. More information is available at http://www.ipm.ucdavis.edu/pestalert/pabrownmarmorated.html.

Bagrada Bug. The Bagrada bug, *Bagrada hilaris*, a colorful stink bug much smaller than the brown marmorated stink bug, prefers to feed on crucifers. It is a seed and bud feeder that can be very damaging to cole crop vegetables such as broccoli and cauliflower. In the landscape it can become very abundant on alyssum, stock, candy tuft, and mustards. The best strategy for landscapes infested with this pest is to replace alyssum and other hosts with alternative plants that it does not feed on. Populations of this pest have expanded their range from southern California up to Monterey County and will likely move further north soon. More information is available at http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74166.html.

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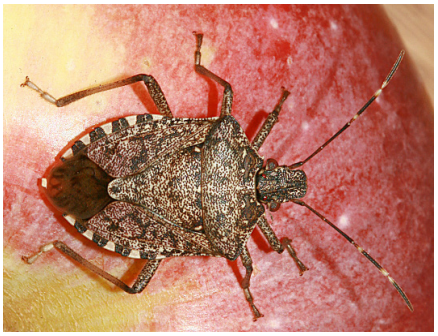
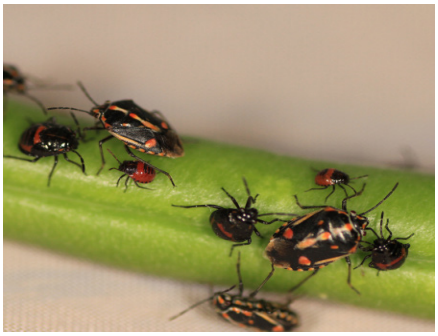


D. Shetlar, Ohio State Univ.

Adult brown marmorated stink bug.



S. Dara, UCCE , San Luis Obispo

Bagrada bug nymphs and adults.

Check out the new UC IPM Blog!

Our new blog will provide a one-stop site for UC IPM news related to pests of homes, gardens, landscapes, and structures. We will be posting articles from our newsletters as well as announcing new and revised Pest Notes and other new educational materials or activities of interest to urban and residential audiences.

View or subscribe to the blog at:
ucanr.edu/blogs/ucipmurbanpests

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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.ucanr.edu.

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.