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Status of Light Brown Apple Moth in California

by Steve Tjosvold, UCCE Environmental Horticulture Farm Advisor

One of the most notable pests to recently invade California is the light brown apple moth (LBAM). In March 2007 its presence was confirmed in Alameda County California. A native of Australia, this was the first time the pest had been detected in the continental United States. The insect was classified as a high risk pest by regulatory agencies because of its potential to damage a wide range of plant species, its current limited distribution in the world, and its potential to harm agricultural commerce in California and the United States. I will summarize some of the most important facts to know about LBAM: the host plants it feeds on, its biology, current management and regulatory issues, and my local observations in the Monterey Bay area where one of the highest populations of LBAM in California exists.

What plant species are attacked and where? LBAM is native to Australia and is established in New Zealand, New Caledonia, Great Britain, Ireland, and Hawaii. In those areas, it has a broad range of plant hosts, including many landscape trees, ornamental shrubs, fruit, and some vegetable crops. It feeds on 250 plant species in over 50 families with preference for plants in the aster (Asteraceae), legume (Fabaceae), knotweed (Polygonaceae), and rose (Rosaceae) families. In California, it has been found on many other new ornamental hosts. So far, the pest has

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Viruses and Viroids as Invasive Plant Pathogens

by Deborah M. Mathews, UCCE Asst. Specialist, Dept. of Plant Pathology and Microbiology, UC Riverside

Viruses and viroids are many times overlooked as important pathogens in the ornamental plant industry since there is no cure for plants already infected. Plants with noticeable symptoms are discarded and those that appear healthy are allowed to be sold. The industry primarily relies on the propagators to ensure that healthy plants make their way into the wholesale and retail markets. Most viral screening, however, relies on tests for known pathogens. Additionally, many viral infections do not cause obvious symptoms in some hosts. These two factors combine to allow new viruses or viroids to escape detection and be introduced into the plant distribution system. So you may be asking "If they don't cause symptoms and can't be tested for, why do I care if they are there or not?" The answer is that non-detectable infections in one host can become a problem when transmitted either mechanically or by an insect vector to a host that does express symptoms or when environmental conditions cause symptoms to become noticeable. With the continual introduction of new plant varieties and hybrid species, new viruses can easily make their way into the industry. Most ornamental plants are now produced through vegetative propagation, which allows viral infections to be carried along from infected mother plants to thousands of

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Editor's Note

In this issue we focus on invasive pests and diseases. From larvae with large appetites to microbes that multiply by the millions, we describe the pests and pathogens that are invading California and your nurseries and how to manage them.

Like you, CORF News needs to tighten its budget. Printing and mailing costs are high and we are forced to cut our costs. Therefore subsequent issues of CORF News will be delivered to you in digital format. We plan on producing the same quality, unbiased information from University experts. But we also look at this change as the beginning of something new and exciting. It will arrive in your email automatically. It will be interactive and offer expandable content such as links to information, images and presentations on our new web site: **http://groups.ucanr.org/CORF**

We need to stay in touch with you. The newsletter mailing has often been the primary way many of you hear about CORF educational programs. In the future, CORF News (digital), fax, and email will be the primary ways we make sure you know about these programs. We need to know how you prefer to get this information. The insert enclosed in this issue explains the next steps to get us that information. Please do it soon. We look forward to continuing to serve the California floral and nursery industry.

–Steve Tjosvold, Editor

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not been a significant problem in fruit and vegetable operations in the Monterey Bay area. LBAM has only occasionally been found in fruit of berry crops in packing sheds. The host list is periodically updated on the CDFA website at the end of this article.

The insect has been found over hundreds of square miles in 14 California counties. The prevalence of LBAM in production and retail nurseries in the Monterey Bay area is often related to the close proximity of these nurseries to uncontrolled LBAM populations in native vegetation or urban landscapes and therefore these nurseries are subject to the migration of adult moths into the nursery even after eradicative sprays have been made. Nursery stock and field cut flower crops are particularly vulnerable to an establishment of an LBAM infestation apparently because of the diversity of potentially susceptible species and relatively minor use of insecticides in these crops. So far, cut flower and potted ornamental plants grown in greenhouses do not appear to be as vulnerable as other ornamental crops grown in the field, perhaps because of the typically more intensive insecticide programs already in place or that the greenhouse structure impedes migration of adult LBAM from infested areas into the greenhouses.

A light brown apple moth larva just outside its shelter composed of Leucodendron leaves pulled together by its silken threads. The newly hatched larva is pale yellow-green, 0.06 to 0.08 inch long, with a dark brown head. Mature larvae range from 0.4 to 0.7 inch long. The head is light yellow-brown and the segment behind the head is light greenish-brown with no dark markings.

Plant damage. Like other "leafrollers", LBAM larvae feed from within the sheltering nest constructed by drawing leaves together with silken threads. LBAM larvae are usually found within young shoot tips of plants that have elongated leaves that they can easily pull together. Host plants that are well watered and fertilized result in plenty of new growth favored by LBAM. There are observations of considerable, unsightly damage on landscape ornamentals in Golden Gate Park, San Francisco. Generally, however, plant injury in the landscape in the Monterey Bay area has appeared as minor cosmetic damage, consisting of limited feeding on leaves at the shoot tips and some malformed or distorted shoot tips. Researchers at UC Berkeley have noted that a significant proportion of LBAM larvae have been found with native parasitoids, which limit the population and plant damage. These and other researchers are evaluating the effect of these native parasitoids as well as the possibility of introducing Australian parasitoids that specifically target LBAM. Because nursery stock in the infested areas is closely inspected, infestations are eradicated before they have the chance to fully develop, so the full extent of damage has never been assessed in nurseries. So far, observations indicate that LBAM infesting nursery stock might not cause any more damage than other leafrollers such as orange tortrix, omnivorous leafroller and garden tortrix.

In Australia and New Zealand, foliar feeding is usually considered minor in fruit crops. On fruit crops, the primary concern is fruit damage. Larvae can remove the outermost layers of the fruit surface as they feed. In grape, larvae can cause extensive loss of flowers or newly set berries in the spring. Later in the season, grapes can be severely damaged by larvae feeding among the berries, allowing mold organisms to enter. Buds of deciduous host plants are vulnerable to attack in the winter and early spring.

LBAM biology. LBAM is found throughout Australia but it does not survive well at high temperatures and is a more serious pest in cooler areas with mild summers. The pest does best under cool conditions (mean annual temperature of approximately 56ºF) with moderate rainfall (approximately 29 inches) and moderate to high relative humidity (approximately 70%). Hot, dry conditions may significantly reduce populations. Two developmental models using these environmental parameters predict that LBAM could establish very well along coastal California, and one model predicts significant development in much of the Central Valley. In the Monterey Bay, some of the most established LBAM populations are in the cool and humid areas along the immediate coast.

LBAM is capable of flying only short distances to find a suitable host. Most moths fly no further than 330 feet, but some may fly as far as 2000 feet. Dispersal is most likely by movement of infested nursery plants or green waste, and on equipment and containers. Adult moths emerge after one to several weeks of pupation and mate soon after emergence. They stay sheltered in the foliage during the day, resting on the undersides of leaves. Moths fly 2 to 3 hours after sunset and before daybreak. Females begin to lay eggs 2 to 3 days after emerging, depositing eggs at night. The majority of the eggs are laid between day 6 and 10 after emergence, but females can continue to lay eggs for 21 days. Adults are less likely to leave areas with high-quality hosts. Adult life span is 2 to 3 weeks, with longevity influenced by host plant and temperature. An egg takes from 5 to more than 30 days to hatch, depending on temperature, with an average of 5 to 7 days.

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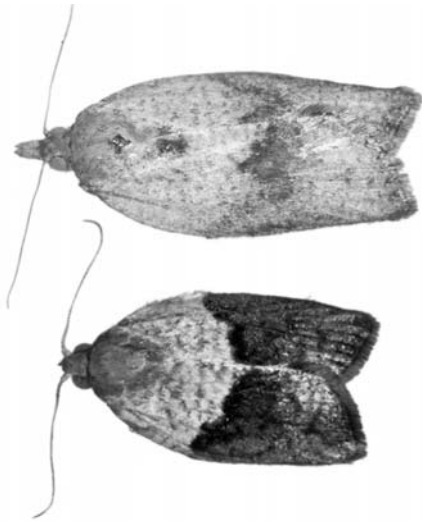

Light brown apple moth adults. Female (upper), length of wing at rest is 0.27 to 0.5 inch. Male (lower), length of wing at rest is 0.23 to 0.4 inch. There is considerable variation in color patterns of the wings, especially on the males.

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Regulatory action on nursery operations. Currently, regulations focus on regular official inspections of nurseries. If LBAM is found, then an application of insecticide is applied until the infestation is considered eradicated. Specific regulations on retail nurseries, production nurseries, and commercial operations that produce garlands, wreaths or greenery, and cut Christmas trees are applied according to whether or not those operations are within established quarantine zones or within 1.5 miles from a LBAM detection. Quarantine zones are established by CDFA based on the location of LBAM finds. Agricultural authorities will place LBAM traps in nurseries to detect the flight of male LBAM moths and inspect nursery plants for larvae and egg masses. If a suspect moth is caught, or if a larva or egg mass is found on plants, then the plants or lots are placed on hold until the insect has been positively identified by the CDFA lab.

Identification of a male LBAM moth in traps does not trigger regulatory action if the operation is within the quarantined zone. In this case, a male adult moth would clue authorities that there is a potential infestation near the trap. However, the male moth would trigger regulatory action if it was found in a nursery outside the quarantine zone. If a suspected female adult, larva, or egg mass is positively identified then all plants in the operation are placed on hold and approved chemical treatments would need to be applied to move or sell the plants.

There are several approved chemical treatments. Many nursery producers prefer to use chemical treatments that consist of an "eggs and larvae" insecticide treatment because the treated plants can be re-inspected soon after treatment (even the day after treatment), and if determined to be free of LBAM, the operation is released from the quarantine hold. The other option is the "larvae only" chemical treatment where treated plants would be held for at least 10 days and then the crop is re-inspected. If the crop is free of LBAM, the operation is released from the quarantine hold. There are special provisions for retail nurseries within the quarantine zone. There are many nuances to these regulations and there is currently discussion about significantly changing regulatory protocols. Keep abreast with the latest regulations at the CDFA website given below.

CDFA's long-term strategy is now emphasizing sterile insect release and other treatments. CDFA's attempt to control LBAM in the Monterey Bay and San Francisco Bay areas with aerial spraying of mating disruption pheromone has been stopped until environmental impact reports are completed, due to litigation initiated by concerned citizens in the path of that spraying. Following this litigation, in June 2008, the Secretary of the Department of Food and Agriculture announced that the primary strategy for eradicating LBAM would be changed from aerial treatment with pheromone to the release of sterile male LBAM. Sterile insect technology is being developed in New Zealand, Australia, and California to disrupt the mating population. It is planned to be available for initial implementation with limited releases in California beginning in 2009 and with large releases by 2011. Other treatments that will be integrated in the eradication plan include: mating disruption pheromone application in localized areas, male moth "attracticide" application, native parasitic wasp releases, and *Bacillus thuringiensis kurstaki* (Btk) or spinosad foliar ground treatments.

What to do now? The USDA and CDFA are determined to eradicate LBAM from California. To achieve eradication or to get close to it appears to be years away. In the meantime, the nursery industry will be a central focus for inspection and eradication of LBAM. As a nursery operator, you need to understand the seriousness of the regulatory action that is imposed if LBAM is found in your nursery. Take an active role to prevent the introduction of LBAM into your nursery by obtaining plant material and nursery stock only from reliable sources. Furthermore, ensure that introduced nursery stock is free of infestations with your own inspections at the time nursery stock is delivered. Set up a weekly scouting program to find leafrollers in crops. The pruning of infested shoot tips and destruction of the larvae can be sufficient to control small infestations in some instances. However, if your operation is surrounded by infested native vegetation or landscapes, an active preventative insecticide program may be necessary as an additional safeguard measure. Recommended sprays are given at the CDFA website although other insecticides could be useful.

There are other possible management tools too. I will soon begin research to evaluate the effectiveness of pheromone mating disruption within production nurseries and nursery-perimeter attractant-kill traps. My goal is to develop the use of a relatively benign method that could be integrated with other management tools to significantly lower, if not eliminate, an LBAM infestation.

The CDFA LBAM website: http://www.cdfa.ca.gov/phpps/pdep/lbam/lbam_main.html.

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Visit CORF's new web site: http://groups.ucanr.org/CORF

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rooted cuttings. Since many of these new varieties come from offshore or overseas, agriculture in the United States in general, and not just California, could be affected. Federal and state regulatory agencies are continuously on the lookout for new pathogens that might impact our agricultural industry. Over the last 5 years, there was an average of 20 reports per year detailing either new plant viruses or known viruses on new hosts worldwide, results which reflect the availability of more sensitive testing methods and more researchers willing to perform them.

The California Department of Food and Agriculture (CDFA) has a policy that all pathogens new to the state, whether previously characterized elsewhere or not, are placed on the Quarantine list until their possible threat to California agriculture and their current distribution are determined. Shipping restrictions and destruction of infected materials may be enforced on "Q" rated pathogens.

My laboratory became involved in such a situation over the last few years with the introductions of *Nemesia ring necrosis virus* (NeRNV) and *Angelonia flower break virus* (AnFBV). NeRNV is a member of the tymovirus group, which has several viruses that give identical results when using ELISA for detection. The original plant sample screened positive for *Scrophularia mottle virus* (ScrMV), another similar tymovirus, and the plants were quarantined. We had been working on the characterization of NeRNV for awhile and alerted CDFA that the virus they had detected was probably not ScrMV, but it was still a quarantine pest. After giving CDFA a summary of our research showing that NeRNV had a narrow host range and symptoms were mild in those that did become infected, along with a survey of the state that showed NeRNV could already be found in most counties, the quarantine was removed. In 2007 we detected AnFBV, a newly characterized carmovirus, in several plants in California. Before a quarantine could be put in place, we again surveyed the state and showed it was well established in California with a low risk to other crops, thus preventing the imposition of quarantine regulations.

Viroids are small pathogens composed of RNA that lack the protein coat that viruses possess, making their detection difficult except in a laboratory. There are over 30 known viroids which infect primarily grapes, citrus, potato, tomato, avocado and various ornamentals. The largest group of viroids are in the *Potato Spindle Tuber Viroid* family, or *Pospiviroidae*. They are primarily transmitted mechanically through pruning and handling of plants and most are asymptomatic in their ornamental hosts. The host ranges of many of these viroids are expanding from their original hosts to include common ornamentals such as *Petunia* and *Verbena* as seen in the table. This expansion and the discovery of new viroids are causing growing concern. In Europe, the ornamental industry is coming under scrutiny from the tomato growers as a possible source of viroids since it is common for ornamentals and tomato crops to be grown in close proximity, both in the greenhouse and in the landscape. Tomatoes express severe symptoms when infected with many of these viroids that are symptomless in their ornamental host. It is only a matter of time before similar concerns arise here in the United States.

What can the grower do to help prevent the spread of new viruses or viroids? The best strategy is a combination of buying plants from companies with clean stock programs, implementing proper hygiene in the greenhouse (tool and bench disinfection, separation of susceptible varieties, removal of weeds and other potential pathogen hosts from areas surrounding production areas), and regular scouting for symptoms and removal of plants suspected to be infected. With consistent effort, disease outbreaks and further spread of these pathogens can be minimized. ✧

Table 1. Some common viroids and their recently reported ornamental plant hosts. These viroids typically cause visible symptoms in their original hosts for which they are named, but are non-symptomatic in the additional ornamental hosts. Note that the majority of the alternate hosts are in the family Solanaceae. Some combinations have not yet been found in the U.S.

VIROID	HOSTS
Potato spindle tuber viroid PSTVd	*Brugmansia* spp. (Angel's trumpet), *Petunia x hybrida*, *Solanum jasminoides* (potato vine), *S. muricatum* (pepino), *Streptosolen jamesonii* (marmalade bush)
Chrysanthemum stunt viroid CSVd	*Argyranthemum frutescens* (marguerite daisy), *Petunia, S. jasminoides*, *Verbena x hybrida*, *Vinca* sp.
Citrus exocortis viroid CEVd	*Verbena x hybrida, S. jasminoides, Impatiens* sp.
Tomato apical stunt viroid TASVd	*Cestrum* spp., *S. jasminoides, Solanum pseudocapsicum* (jeruselum cherry)
Tomato chlorotic dwarf viroid TCDVd	*Brugmansia* spp., *Petunia, Verbena*

SCIENCE TO THE GROWER

Can we predict the invasive potential of plant introductions?

Richard Evans, UCCE Environmental Horticulturist

There are more than 17,000 non-native plant species in the U.S. Of those, about 500 are serious agricultural weeds and others have invaded natural areas, where they can replace native species and reduce biodiversity. Efforts to eradicate or control these invasive plants are enormously costly.

Many invasive plants arrive accidentally, but examples abound of invasives that were introduced intentionally, including many ornamental species. Bermudagrass (*Cynodon dactylon*), purple loosestrife (*Lythrum salicaria*), and pampas grass (*Cortaderia selloana*) come immediately to mind. In hindsight, the invasive potential of such plants seems obvious, but only a quarter of the invasive plant species in the U.S. had been listed as serious weeds elsewhere before they were introduced here. Not surprisingly, a substantial research effort has been undertaken to improve our ability to predict invasiveness.

In this article, I discuss three research articles that have taken different approaches to predicting invasive potential. Over a decade ago Rejmánek and Richardson studied several plant attributes to see which ones might be indicative of invasive potential.[1] They chose species in the genus *Pinus* for their study because of their economic importance and wide introduction around the world. They found that the invasive potential of pines could be predicted by just a few attributes: seed weight, minimum duration of the juvenile period, and the number of years between large crops of seeds. Their analytical method worked well when they checked it against pine species that are known to be invasive or non-invasive, and it appears to have been effective when applied to other pines whose invasive potential was previously unknown. In addition, they suggest criteria that may be useful for evaluating the invasive potential of other woody plants: invasive potential is likely to be greater for species that produce dry fruits containing relatively large seeds, and the potential is increased if animals are present that may disperse those seeds.

Of course, that work wouldn't address any of the invasive ornamental species I gave as examples. Daehler conducted an extensive evaluation of invasive species around the world to see if their taxonomic classification was strongly related to invasive potential.[2] Among several thousand species that had been listed as weedy or invasive, he focused on 1,340 that are considered serious weeds, 1,041 that are widespread weeds, and 381 that invade natural areas. He applied statistical analyses to test whether the number of invasive species in a plant family was larger or smaller than could be explained by chance. Among families of terrestrial plants, Poaceae (home of bermudagrass and pampas grass) and Cyperaceae (sedges) were "over-represented" by invasive species. Daehler noted that families in which pollination depends on living pollinators tend to have fewer species with high invasive potential than those that primarily are abiotically pollinated (e.g., the wind-pollinated Poaceae). Woody plant families were less likely to have invasive species, although the Tamaricaceae was over-represented (mainly because of the genus *Tamarix*), as were Salicaceae (because of poplars and willows) and Myrtaceae (because of *Melaleuca* and *Psidium*, the guava genus). In general, woody genera with high invasive potential are those that spread clonally from root suckers or adventitious roots. Orchid growers will be pleased to know that there are no members of the Orchidaceae known to be invasive. Araceae, Asclepiadaceae, Bromeliaceae, Gesneriaceae, Liliaceae, and Rubiaceae also were "under-represented" in terms of invasiveness.

Another approach was taken by Parker and others, who developed a model for identifying invasive species using four main factors: invasive behavior (based on attributes such as means of reproduction and growth habit), geographic potential (the likelihood of developing a broad range in the U.S.), damage potential (based on competition with crop species, difficulty of control, hosting diseases, etc.), and entry potential (based on evidence of cultivation in the U.S., or likelihood of accidental introduction).[3] Thirty-nine of the 50 species ranked highest for their invasive potential are plants already in cultivation in the U.S. These include several that are considered ornamentals (at least by some people), among them *Asparagus africanus*, *Cestrum elegans*, *Echinopsis spachiana*, several *Hakea* species, *Melianthus major*, *Mocanthus nepalensis*, *Nymphaea alba*, *Pinus patula*, *Polygala myrtifolia*, and *Rhamnus alaternus*.

Accurate prediction of invasive potential still depends on experiments in the region of possible introduction, and climate change could cause shifts in invasiveness, but the general classifications presented here illustrate some of the important plant attributes that growers introducing new species should consider.

1. Rejmánek, M. and Richardson, D.M. 1996. What attributes make some plant species more invasive? *Ecology* 77: 1655-1661.
2. Daehler, C.C. 1998. The taxonomic distribution of invasive angiosperm plants: Ecological insights and comparison to agricultural weeds. *Biological Conservation* 84: 167-180.
3. Parker, C., Caton, B.P. and Fowler, L. 2007. Ranking nonindigenous weed species by their potential to invade the United States. *Weed Science* 55: 386-397.

REGIONAL REPORT- San Francisco Bay Area Counties

Gladiolus Rust (Transient: Actionable and Under Eradication)

Colleen Y. Warfield, UCCE Nursery Production and Floriculture Advisor

The rural-urban interface is nothing more than a fence line in most of the highly populated Bay Area. Unfortunately, the all too familiar "not in my backyard" attitude is one that many nursery and greenhouse operators face on a daily basis. And at times you may even secretly wish that you could declare your neighbors as invasive pests and place them all under eradication. It turns out you do have a pest in YOUR backyard, but this time it's not your neighbor.

In late August, a resident in San Bruno (San Mateo County) discovered a rust-like disease infecting many of the gladiolus plants growing in her yard. On September 5, the U.S. Department of Agriculture's Animal and Plant Health Inspection Service confirmed gladiolus rust on samples of gladiolus leaves collected at the residence. Considering that the San Francisco peninsula must surely be the rust capital of the world, a rust disease would normally be 'business as usual.' Except the fungus that causes gladiolus rust is not established in the United States and is considered a quarantine pest classified as transient: actionable and under eradication.

Gladiolus rust, caused by the fungus *Uromyces transversalis*, has previously been found in two commercial farms in Florida and one nursery and two residential sites in San Diego County in 2006. Despite eradication efforts, gladiolus rust reappeared in both Florida and San Diego County in 2007. In 2008, for the third consecutive year, the rust was detected at one of the Florida farms.

Surveys conducted in the residential areas surrounding the San Bruno find revealed many more residential sites with rust-infected gladiolus. This was not too surprising given rust spores can be moved long distances by wind. While it will probably never be known how the rust pathogen was introduced into the San Bruno neighborhood, one possibility was via infected gladiolus flowers placed on a grave in the neighboring cemetery. A similar scenario played out in early March when a box of cut gladiolus flowers was shipped to Minnesota for a church-related event. When opening the box it was discovered that the flowers were infected with rust. The flowers were traced back to one of the Florida farms with a previous history of gladiolus rust.

As a commercial grower, what does this mean to you? If you are growing *Gladiolus, Tritonia, Crocosmia* or *Watsonia* you need to be aware of the risk. These plants are considered to be hosts for the gladiolus rust fungus. (As an aside, *Crocosmia* was growing alongside severely infected gladiolus plants in the San Bruno residential site, yet no *Crocosmia* plants were found to be infected). While rust diseases have the potential to cause significant damage, they can be managed by early detection and timely fungicide applications. Frequent scouting for signs of rust is important for early detection. However, under the current management and eradication plan for gladiolus rust, all host plants would have to be destroyed if the gladiolus rust pathogen were to be detected in a commercial nursery. ✧

Observations Objectionable But Not Actionable!

Few can share the same enthusiasm for plant diseases as a plant pathologist. As such, I have to carefully watch my adjectives to avoid using words like beautiful and spectacular when talking about diseased plants. A problem that I am seeing as frequently on the west coast as I did in the southeastern U.S. is foliar nematodes.

Although foliar nematodes have been around for years, I would certainly consider them a significant and emerging problem for the ornamentals industry (primarily for growers of herbaceous and woody perennials). There is currently no effective control other than exclusion and eradication. Once introduced into a nursery, spread of foliar nematodes can be rapid. I have observed foliar nematode damage on *Anemone, Buddleja, Bergenia, Lantana, Lamium, Heuchera, Polypodium, Sambucus* and *Woodwardia*. These were all plants for sale in various Bay Area retail nurseries.

Foliar nematodes are microscopic roundworms that enter the leaf through the stomates where they will feed and reproduce inside the leaf tissue causing necrotic lesions (bound by the major leaf veins), death of entire leaves, and defoliation. A link to foliar nematode symptoms can be found at the San Mateo County site: http://cesanmateo.ucdavis.edu/ under the Nursery Production and Floriculture icon. Downy mildew can cause nearly identical symptoms as foliar nematodes on some hosts. With downy mildew, look for fluffy-appearing sporulation on the underside of affected leaves. ✧

REGIONAL REPORT- Santa Cruz, Monterey Counties

Disease Risk of Stream Water Used for Irrigation in Areas with Sudden Oak Death

Steve Tjosvold, UCCE Environmental Horticulture Farm Advisor

Phytophthora ramorum is the pathogen that causes the disease known as Sudden Oak Death (SOD). This disease has killed thousands of oak and tanoaks in California and Oregon woodlands. There are hundreds of ornamental plant species that are known or suspected of being hosts of this pathogen, and infected plants can be inadvertently moved to new areas through the nursery trade. Quarantine regulations require that nursery stock is free of the pathogen.

Perennial and intermittent streams often run through areas of high incidence of SOD in California and Oregon woodlands, and *P. ramorum* can be detected in streams and other water sources in these areas. Stream water is sometimes used for irrigation by nurseries and landowners located along these streams. Consequently, *P. ramorum* could be pumped from streams, used for irrigation, and dispersed onto nursery stock or landscape hosts. With cool and damp conditions, favorable to the pathogen, disease might occur on susceptible plants. We completed a research study conducted from 2001 to 2007 to help assess risk involved with irrigating with contaminated stream water. The results provide information to help develop disease management practices for those nurseries using stream water in these areas, as well as providing some insight into the seasonal development of *P. ramorum* in woodlands. Here's a brief summary of our findings.

Monitoring streams. In our study, we were able to detect *P. ramorum* in all streams in Santa Cruz County where sudden oak death occurred. *P. ramorum* was found most frequently and occurred in highest concentrations in winter and spring, but was found less frequently and at lower concentrations at other times of the year. The irregular occurrence of *P. ramorum* in the summer was mostly associated with infected leaves from the native host *Umbellaria californica* that prematurely abscised and fell into the stream. Apparently the pathogen could produce spores when the leaves dropped into the stream water, even in dry, warm weather.

Disease occurrence. When the stream water was used for irrigating rhododendron nursery stock from 2004 to 2007, disease occurred only in three short periods of the two wettest springs (2005 and 2006) on sprinkler irrigated plants. In the spring, stream water can contain a sufficiently high *P. ramorum* concentration to cause disease, which coincides with the time that stream water may be needed for irrigation purposes. The unusually wet spring of 2006 was particularly noteworthy: stream water contained the highest levels of propagules recorded in the four years of the irrigation experiment, and disease was detected only 14 days following the first irrigation with the stream water. Disease did not occur at other times of the year. This was probably because either the *P. ramorum* levels were too low (fall), environmental conditions were not conducive to disease development (summer), or irrigation with infested stream water was not necessary because rainfall was sufficient to meet transpiration requirements of the rhododendrons (winter). These concepts are summarized in Table 1.

Disease management. Based on our study, several management practices can be recommended for nursery operators or property owners using stream water for irrigation purposes when those streams flow through areas with sudden oak death.

1. Monitoring of streams with pear baits can be useful to detect periods when *P. ramorum* is present. Following a fairly simple protocol, nursery operators could detect and quantify the concentration of *P. ramorum*. Presently a suitable laboratory with trained personnel, either on site or through commercial services, is needed to identify *P. ramorum* in pear baits. However, this procedure might be done in the field by non-technical personnel in the near future because there are simple field test

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Table 1. Disease risk of using stream water containing *Phytophthora ramorum* for irrigation.

Season	Pathogen in stream	Favorable disease environment	Irrigation need	Disease risk
Winter	+++	++++	NA	None
Spring	++++	++++	++	High
Summer	++	+	+++	Low
Fall	+	++	++	Low

REGIONAL REPORT - Santa Barbara, Ventura Counties

Three Moth Species Wreak Havoc

Julie Newman, UCCE Farm Advisor

False Codling Moth. The first ever false codling moth (FCM) trapped in the U.S. last July near Port Hueneme led California Department of Food and Agriculture (CDFA) officials to declare an emergency in Ventura County due to the devastating losses this moth could cause to the agricultural industry and to urban landscapes if it were to become established in California. The larvae of this African moth are known to infest more than 50 plant species and are especially damaging to citrus and cotton. Since 1984, FCM has been intercepted more than 1,500 times at 34 U.S. ports of entry, including California.

The USDA has been working with CDFA and the Ventura County Agricultural Commissioner in an intensive search for a second moth. If one is found, it would trigger a federal quarantine, which would be a damaging blow to local agriculture. The hope is that this is just an isolated incidence. The current strategy (as of October 2008) consists of monitoring a 10-mile radius around the original find, utilizing 36 pheromone traps per square mile. It is anticipated that monitoring will continue through summer 2009.

Gypsy Moth. CDFA established a quarantine of approximately five square miles in the Ojai area of Ventura County in October 2008. State and county inspectors are monitoring and working to contain an infestation of the European gypsy moth, a major pest of forests and landscape trees. Gypsy moth caterpillars feed on hundreds of plant species and are capable of defoliating trees at an alarming rate. A single caterpillar can eat up to one square foot of leaves per day.

Figure 1. FCM Adult Illustration courtesy of www.padil.gov.au (Simon Hinkley and Ken Walker)

Four gypsy moths were trapped in Ojai in June 2007, triggering an intensive monitoring program that detected an additional seven moths this past summer, confirming that Ojai has an actively reproducing infestation. Gypsy moth egg masses are frequently found on trees as well as vehicles, outdoor equipment and other items that can be transported out of the infested zone in the northeastern U.S. or southeastern Canada.

LBAM update. First trapped in Carpinteria in February 2008, subsequent detections were made in March, May and recently in September, totaling six LBAM to date. The Carpinteria moths appear to be hitch-hikers and not indicative of a more serious infestation. The LBAM quarantine program in Carpinteria includes routine inspection, trapping and mating disruption. Over 27,000 pheromone-treated twist-ties are deployed in the Carpinteria area at present. The ties are used for two projected life cycles. These weather-dependent life cycles generally last 1-2 months. If there are no new sightings, traps are monitored for one additional life cycle. The September detections triggered an extension of the quarantine, now estimated to end in June 2009. Extensive trapping is also underway in Ventura County, as a safeguard measure. ✧

Observations
Watch out for False Codling Moth

FCM (*Thaumatotibia leucotreta*) adults are small, brownish-gray, nocturnal moths with an average wingspan of 2/3 inch (Figure 1). Eggs are whitish, flat and oval in outline and are found on fruit or foliage. Young caterpillars are whitish and spotted; mature larvae are pinkish or orange red and over 1/2 inch long. Pupation occurs in the soil or in bark crevasses within a cocoon made of silk and debris particles. The life cycle is completed in 45-100 days, with up to 6 generations in South Africa.

Caterpillars damage fruit by boring into it, leading to secondary fungal and bacterial rots. In citrus, a distinct sunken brown patch in the skin and dark frass may mark the entry point of the larva. Infested fruit generally drops before harvest. However, a concern is that infestations that occur near fruit harvest may not be detected and infested fruit may be subsequently packaged for export. Another concern is that the larvae could potentially live inside acorns, where they would be difficult to detect, on oak trees found in California.

In addition to citrus, agricultural hosts in California include cotton, grapes, peach, plum, cherry, beans, tomato, pepper, persimmon, apricot, olive, pomegranate, English walnut, and corn. Many landscape plants are also hosts. Report any suspected finds of this moth to the Agricultural Commissioner's office.

For more information, see http://www.cdfa.ca.gov/PHPPS/PDEP/target_pest_disease_profiles/FCM_PestProfile.html. ✧

REGIONAL REPORT - San Diego County

Asian Citrus Psyllid Affects the Nursery Garden Center Industry

James A. Bethke, UCCE Farm Advisor

As we noted in the last issue of CORFnews, the Asian Citrus Psyllid (ACP), *Diaphorina citri* Kuwayama, finally reached California on September 2, 2008, triggering emergency declaration and quarantine. The first finds were in residential areas and rather widespread (http://www.cdfa.ca.gov/phpps/acp/quarantine.html#Qmaps). Since then, however, a total of 36 finds have been made from coastal San Diego County to a citrus production area in Imperial County. It appears that the insect moved into the county from Mexico- a lot faster than expected. The quarantine imposed by APHIS and the CDFA has been somewhat limited by request, which is a good thing for the citrus nursery industry. It is still, however, a very large portion of the county, about 1,811 square miles, and includes a significant number of nurseries and retail garden centers.

From the experience in Florida, where the nursery industry was responsible for the distribution of ACP through the state, APHIS and CDFA (ACP Project) are following protocols recommended by the scientific advisory committee, and under present regulations, all nursery citrus and related hosts plants in the family Rutaceae must be treated with a systemic drench and foliar spray to kill nymphs and adults of ACP, repeated every three months. (A list of approved treatments can be found at http://phpps.cdfa.ca.gov/PE/InteriorExclusion/acptreatments.pdf). A tagging system was developed to indicate when the plants were treated and when they needed re-treatment. Although host plants can be moved into the quarantine following treatment (again, a tagging system identifies treated plants moving into quarantine), plants within the quarantine boundaries may not move out of the quarantine at all. These restrictions applied to all the box stores and retail garden centers as well, and posed some interesting quandaries. First, garden centers are not set up to apply pesticides to their stock and therefore have to hold significant numbers of citrus and related host plants. Second, there are very few if any pesticides labeled for the retail garden center sites. Most of the solution options for this problem are onerous, involving moving the plants off site to treat, or re-certifying the site as a production facility.

At this point, approximately $50,000 worth of stock has been destroyed because some garden centers had no way to isolate, treat, or hold their stock. One nurseryman complained that stock worth $40,000 is on hold until he can register as a production nursery so he can make the approved treatments. Obviously, not every protocol fits every situation in every state, and compromises are going to have to be made so that this pest can be dealt with in a timely manner, yet without harming the nursery industry needlessly.

Eventually, these quandaries led to the involvement of the California Association of Nurseries and Garden Centers (CANGC) and the California Citrus Nursery Society (CCNS). They are now trying to have representatives from the industry placed on the scientific advisory committee so that their voices can be heard and to ensure that regulatory decisions are being made based on science. ✧

Observations
More Evidence of Western Flower Thrips Resistance to Conserve

Throughout California, and especially in San Diego County this year, I received many calls about western flower thrips control failures, and about Tospovirus related losses. Some of the problems were easy to handle because the grower was not using control measures directed toward thrips, and as such, the thrips population was susceptible. Unfortunately, other calls were from desperate growers that could not control thrips at all.

Recent assays of a suspected resistant thrips population led to the discovery of some very high levels of resistance to Conserve, arguably one of the best products on the market for control of western flower thrips. In addition, a trial against this population indicated that none of the common thrips control measures were effective. I don't think that surprises anyone familiar with western flower thrips control.

We tested thrips from up and down the state back in 2004-05 and found little resistance, but building tolerance to Conserve with a resistance ratio compared to a susceptible population of 24 to 1. Unfortunately, an assay in 2007 indicated that we were now seeing resistance ratios of sometimes more than 300 to 1. The Dow Chemical Company has been concerned about resistance to Conserve since its inception and has been actively monitoring resistance levels across the country. Levels in Florida were so high that Dow decided to cease sales in certain areas of at least two counties. What's the answer? Good question. It's a very difficult problem that requires significant resources and dedication to solve. ✧

Visit CORF's new web site: http://groups.ucanr.org/CORF

New U C Publications for Nursery Operators

Compiled by Steve Tjosvold

New Free Publications Recently Posted to the Online Catalog

8333 Agritourism Enterprises on Your Farm or Ranch: Understanding Regulations (http://anrcatalog.ucdavis.edu/Items/8333.aspx)

8334 Agritourism Enterprises on Your Farm or Ranch: Where to Start (http://anrcatalog.ucdavis.edu/Items/8334.aspx)

8314 Biology and Management of Horseweed and Hairy Fleabane in California (http://anrcatalog.ucdavis.edu/Items/8314.aspx)

8331 Tillage and Crop Management Effects on Air, Water and Soil Quality in California (http://anrcatalog.ucdavis.edu/Items/8331.aspx)

New Pest Notes

74146 Burning and Stinging Nettles (http://anrcatalog.ucdavis.edu/PestNotesforHomeLandscape/74146.aspx)

74145 Soil Solarization for Gardens and Landscapes (http://anrcatalog.ucdavis.edu/PestNotesforHomeLandscape/74145.aspx)

Recently Updated Pest Notes

7484 Common Knotweed (http://anrcatalog.ucdavis.edu/PestNotesforHomeLandscape/7484.aspx)

7485 Lyme Disease in California (http://anrcatalog.ucdavis.edu/PestNotesforHomeLandscape/7485.aspx)

7466 Roses in the Garden and Landscape: Insect and Mite Pests and Beneficials (http://anrcatalog.ucdavis.edu/PestNotesforHomeLandscape/7466.aspx)

University of California Research Updates

Compiled by Julie Newman, UCCE Farm Advisor

Control of soilborne pathogens in calla lily utilizing selected biological fungicides in fumigated and non-fumigated soil

Susanne Klose[1], Craig Spielman[1], Ian Greene[2], Jim Gerik[3], Husein Ajwa[1], and Cheryl Wilen[4]
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Soil fumigation with methyl bromide/chloropicrin or alternative fumigants is an essential tool for control of a multi-pest complex in calla lily production. However, none of the tested fumigants provided adequate control of root rot caused by *Pythium* spp. in highly infested fields. Therefore, a large scale field experiment, funded by the USDA Pacific Area-wide Methyl Bromide Alternatives Program, was established in a commercial field highly infested with *Pythium* spp. in Moss Landing, California, in spring 2008 to test the efficacy of selected biological fungicides superimposed on pre-plant soil fumigation and non-fumigated soil. Biological fungicides tested in this study include (1) QL Agri (active ingredient, a.i., *Quillaja saponaria* bark extract; Desert King International, San Diego, CA), (2) SilMatrix (a.i., potassium silicate solution; PQ Corporation, Valley Forge, PA), (3) Crop Gard/EF 400 (a.i., Furfural/natural herbal oils mixture; USAgriTech Inc.; Paso Robles, CA), (4) Actinovate® SP (a.i., *Streptomyces lydicus*; Natural Industries, Inc., Houston, TX) and (5) Polyversum® (a.i., *Pythium oligandrum*; Beta-Biologics™ Ltd., Toronto, Canada). Biological fungicides are applied on a monthly basis over the course of the crop using the drip irrigation system to soil fumigated with (1) methyl bromide/chloropicrin (shank application at 350 lbs/acre), (2) Inline® followed by (ftb) metam sodium (drip application at 200 lbs/acre followed by 26 GPA), and (3) to a non-fumigated soil. Preliminary results indicate higher crop densities, vitality and vigor in plots treated with Actinovate® SP and Polyversum® in all soils, especially if applied to InLine® followed by metam sodium fumigated soils. Bulb growth, root growth, density of soil-borne pathogens and bulb yield and quality will be evaluated.

Late summer solarization

Cheryl Wilen[1], Susanne Klose[2], Steve Fennimore[2], Husein Ajwa[2], Jim Gerik[3], Craig Spielman[2], and Mike A. Mellano[4]
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Solarization is normally done during the hottest part of the summer in order to maximize the capture of the heat energy of the sun. Plastic tarps are applied over moist soil and the heat is trapped under the plastic, killing many weeds and pathogens. Clear plastic is typically used because it allows the solar radiation to penetrate deeper into the soil. New plastic materials and colors are now available, including special solarization tarps which are believed to increase soil temperature relative to standard tarps. Preliminary results from a field trial at the Flower Fields in Carlsbad, CA, in 2007 showed that some non-clear plastic tarps could control weeds. In late August 2008, we expanded from the first trial to test 7 types of plastic tarps and a stream treatment, where steam was injected into clear plastic covered beds. Combinations of soil heat treatment with fumigation (i.e., Inline® followed by Metam-Na) are also included in this study. The plastic tarps being tested are black, clear, virtually impermeable film (VIF) black, VIF clear, white on black, reflective, and two types of clear solarization mulches (i.e., SolPlast and Polydak solarization mulch by SOLPLAST, S.A., Spain, and Ginegar Plastic Products, LTS, Israel, respectively). Both solarization mulches are multilayered (3 to 5 layers), and contain infrared blocker and antifog agents, which are reported to increase soil temperatures relative to standard clear plastic. The mulches will be removed after 8 weeks. Soil temperatures and weed control will be reported in future CORF updates.

2009 CORF Calendar

Event Date	CORF Event	Location
April 2	IPM Practices for Bedding Plants and Container Color (Includes tour and lunch sponsored by Ball Horticultural)	Santa Paula
April 15	Nursery Cost/Profit Estimator Program	Internet Webinar
April 21	Light Brown Apple Moth Management and Regulation Update	Watsonville
April 21	Optimizing Irrigation in Response to Cutbacks and Local Tour	Vista
May 14	IPM Practices for Bedding Plants and Container Color	Vista
May 28	IPM Practices for Bedding Plants and Container Color (Spanish Translation Available)	Pomona
June 18	Managing Runoff with Vegetated Treatment Systems: Seminar and Tour	Santa Paula
Oct. 1	ABCs of Fertilizer Management (In Spanish): Hands-On Training With Train-the-Trainer Option	Watsonville
Oct. 22	California Weed Symposium	Watsonville
Nov. 5	ABCs of Plant Pathology (in Spanish)	Fresno

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kits near commercialization that can specifically detect *P. ramorum*.

2. When propagules are present or conditions are favorable for high propagule concentrations, nursery operators or landowners would need to sanitize the water before using it for irrigation purposes or use non-infested sources of irrigation water, such as well water. Drip irrigation would greatly reduce the risk of foliar infection, but we do not have sufficient knowledge to suggest that root infections would not occur. Water sanitation could consist of various useful methods, such as sand filtration, UV radiation, ozone or chlorination.
3. Monitoring leaf wetness and temperature with electronic sensors onsite could be useful in disease management. Preventative fungicides could be applied at times when environmental conditions are favorable to disease. ✧

Web Sites Focusing on Invasive Pests

Compiled by Don Merhaut, UCCE Specialist, UC Riverside

In searching for information related to invasive pests, usually growers are most interested in web sites specifically related to California. You may want to investigate web sites hosted by other states, but due to the different climates, the invasive species and their control will be different. Therefore, I recommend surfing the web for California-specific information. Below is a list of several web sites related to invasive pests of California.

http://www.ipm.ucdavis.edu/EXOTIC/exoticabout.html This is the UC IPM Online, Statewide Integrated Pest Management Program. This site contains information about the types of plants, pests and pathogens that are invasive in California. In addition, it provides the links to other web sites to meet your more specific needs.

http://www.cal-icpc.org This site is hosted by the California Invasive Plant Council. The site deals specifically with invasive plants of California.

http://www.cdfa.ca.gov/invasives/ This site is hosted by the California Department of Food and Agriculture. However, this site is more general, covering invasive pests and diseases of animals as well as plants.

http://www.dfg.ca.gov/invasives/ This site is hosted by the Department of Fish and Game. While this site describes invasive species, it also discusses what plants of California are rare and the conservation efforts needed to save them from extinction.

Occasionally, there is a need to investigate invasive pests on a national level. In this case, you may find the web site below, hosted by the USDA, helpful.

http://www.invasivespeciesinfo.gov/unitedstates/ca.shtml This site is hosted by the United States Department of Agriculture (USDA) National Agricultural Library. The homepage gives general information. However, it is organized with a category search option, and those categories are: plants; animals; aquatics; microbes; laws and regulations; and management programs. In addition, you can look at subject matter on a national scale. ✧

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