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Inside

Plant Selection for Vegetated Buffers: Plant Size vs Nutrient Uptake Efficiency

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In previous newsletters, we addressed important considerations for the construction of non-vegetated and vegetated drainage channels that can be used to remediate the negative environmental effects of agricultural pollutants in storm water and irrigation runoff (Merhaut 2011; Merhaut and Corkidi 2011). Different studies have compared vegetated and unvegetated systems for wastewater treatment and have emphasized the key role of plants for nitrogen (N) and phosphorus (P) removal. N and P are two essential plant nutrients, but also two important water pollutants. This article refers to the relevance of proper plant selection to optimize the function of vegetated buffers to mitigate N and P runoff and leaching.

The use of different types of vegetated buffers (bioswales, filter strips and constructed wetlands), is one of the best management practices (BMPs) that has been recommended for filtering the excess of fertilizers and other pollutants from urban and agricultural runoff. These buffers reduce the movement of sediment and the delivery of various contaminants to water bodies. However, their effectiveness depends on several factors, such as size, runoff flow, climate, soils, vegetation cover and plant species.

Editor's Note

Complying with increasing water quality regulations continues to be a challenge for California greenhouse and nursery growers. Irrigation and storm runoff that leaves the operation must meet local, state and federal water quality standards. The focus of this newsletter is on methods that can be used to treat runoff so that it can safely leave the growing grounds and/or be reused for irrigation. Articles include the use of vegetated buffers, slow sand filters and polyacrylamide (PAM) polymers, including the latest UC research findings. We also discuss the importance of water quality management plans, which should include strategies to treat runoff in addition to practices that reduce runoff quantity and pollutant loads.

♦ **Julie Newman and Steve Tjosvold**

PLANT SELECTION FOR VEGETATED BUFFERS:

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In an on-going study on plant selection for vegetated buffers, we are comparing the ability of different plants to accumulate nitrogen (N) and phosphorus (P). In this article, we report results related to the nutrient uptake efficiency of two species of grasses that were established in a bioswale constructed near the Santa Clara River in Ventura County (fig. 1). Several stream reaches of this watershed have been included on the State 303 (d) list due to impairments that include benchmark exceedances of nutrients and agricultural pesticides. A series of bioswales were designed and constructed to evaluate their effectiveness in reducing pollutant discharge and improving water quality. The bioswales also served as a BMP demonstration. By monitoring the content of N and P in the water drained over the length of the bioswales, it was found that these systems were able to remove approximately 90% of the nitrate, ammonium and phosphate. However, these bioswales were seeded with six different summer and winter varieties of grasses so it was not clear how each plant species contributed to the overall nutrient removal efficiency. Therefore, we conducted a greenhouse experiment (fig. 2) to compare the growth and nutrient uptake of *Muhlenbergia rigens* and *Sporobolus airoides*, two of the warm season grasses selected for this area.

Plant Size vs Plant Nutrient Uptake Efficiency

S. airoides and *M. rigens* were very different plants in terms of size and absolute nutrient uptake. It has often been considered that plant species with greater above and belowground biomass can take up and store more nutrients and therefore have greater capacities for nutrient removal (Jiang et al. 2011). However, our results suggest that plant size is not always a good indicator of plant nutrient uptake efficiency. *M. rigens* had greater shoot and root dry

Fig. 1. Bioswale established in the Santa Clara River watershed for research and demonstration of agricultural best management practices (BMPs) to improve water quality. Photo by Maren Mochizuki.

Fig. 2. Greenhouse experiment to compare the growth and nutrient uptake of different species that could be used to optimize the function of biofilters to reduce nitrogen and phosphorus runoff and leaching. Some plants are taller and larger than others, but which ones can take up more nutrients?

Table 1. Growth response and nutrient uptake of *Sporobolus airoides* and *Muhlenbergia rigens* grown at 150 mg/L N during fourteen weeks.

	Shoot dry mass (g)	Root dry mass (g)	Shoot N %	Shoot N (mg)	Shoot P %	Shoot P (mg)
Sporobolus airoides	3.18 ± 0.52	1.10 ± 0.19	2.0 ± 0.09	55.9 ± 7.2	0.23 ± 0.015	6.22 ± 0.81
Muhlenbergia rigens	11.97 ± 1.4	4.92 ± 1.07	1.19 ± 0.06	140.97 ± 12.6	0.146 ± 0.023	16.57 ± 0.83

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Fig. 3. *Sporobolus airoides (*alkali sacaton), left, photo ©1995 Saint Mary's College of California; *Muhlenbergia rigens* (deergrass), right, photo by Mike Evans. *S. airoides* can reach 2 to 3 feet in height and can be found in alkaline flats, prairies, sandy plateaus and coastal scrub. *M. rigens* grows 2 to 4 feet tall by 4 feet wide and occurs in valley grasslands, streamsides and meadows, as well as mixed conifer forests and oak woodland plant communities. Both species flower in the summer, and tolerate periodic flooding and drought. In our growth experiment, *M. rigens* was taller and larger than *S. airoides*, but *S. airoides* was more efficient in taking up nitrogen and phosphorus.

mass and accumulated a higher content of shoot N and P than *S. airoides* (table 1). However, nutrient uptake efficiency refers to the content of a nutrient per unit of plant biomass (i.e., mg of nutrient × mg of plant biomass), not to their content in the total biomass of the plant (absolute content of nutrient). While *M. rigens* had more shoot N and P than *S. airoides*, the latter species had double the concentration of shoot N and P (table 1). Therefore, *M. rige*ns had more N and P because it was larger, but *S. airoides* was more efficient because it had more N and P concentrated in less amount of biomass.

Our results show significant differences in biomass production, and content and concentration of shoot N and P that could influence the contribution of these species for N and P removal, indicating that proper plant selection can optimize the function of vegetated buffers to mitigate N and P runoff and leaching. In addition, with proper plant selection, minimal maintenance of vegetated buffers can be achieved while maintaining optimal nutrient uptake. However, further studies are needed to extrapolate growth responses of these plants under natural conditions, since nutrient removal is not only influenced by plant nutrient uptake but also by their effects on microbial activity.

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References

Jiang FY, Chen X, Luo AC. 2011. A comparative study on the growth and nitrogen and phosphorus uptake characteristics of 15 wetland species. Chemistry and Ecology 27 (3): 263-272.

Merhaut D. 2011. Get cultured: drainage channels and vegetated strips in nurseries. UCNFA News 15(2): 7.

Merhaut D and Corkidi L. 2011. Get cultured: drainage channels and vegetated strips in nurseries. Part II. UCNFA News 15(3): 11-14.

Update of Slow Sand Filtration Research

by Loren Oki

Water discharges from California nursery and greenhouse production facilities are regulated by the Irrigated Lands Regulatory Program of the State Water Resources Control Board. These discharges include runoff from irrigation, drain tile flows, and storm water runoff and can contain pollutants generated from the activities associated with the production of horticultural crops. These pollutants — which might include pesticides, nutrients from fertilizers, sediments, pathogens and heavy metals — can reach and impair surface and groundwater. For more information on the Irrigated Lands Regulatory Program, go to: http://www.swrcb.ca.gov/water_issues/programs/agriculture/.

To comply with these regulations, many nursery and greenhouse operators have captured runoff to prevent it from leaving the growing grounds and reuse it for irrigation. This not only prevents potential downstream and groundwater pollution but also conserves water. However, the captured water still contains the pollutants, and the plant pathogens are of specific concern. Irrigating plants with the captured water that contains pathogens can cause widespread disease.

Treatment methods to remove the pathogens are typically based on exposing the water to chemicals, heat, or radiation (e.g., chlorine, pasteurization, and UV, respectively). However, these methods require large inputs of chemicals or energy. Alternative sustainable methods have become more prevalent and include the use of constructed wetlands and slow sand filters. These methods, previously discussed in *UCNFA News* [(Oki and White 2011) (see References below)], require no chemicals and less energy to remove plant pathogens from captured runoff. This article focuses on the slow sand filtration treatment method in which microbial activity removes or deactivates pathogens so they are unable to cause disease.

Introduction

Slow sand filters have been used for centuries to produce drinking quality water and only recently have become of interest to treat runoff from horticultural operations. Probably because of their similar names, slow sand filters are often confused with rapid sand filters. Slow sand filters and rapid sand filters are both used to physically remove particulates. However, rapid sand filters are distinctly different from slow sand filters because they are not capable of removing smaller particles, substances dissolved in the water and most pathogens.

Slow sand filters (SSFs) consist of a sand bed about 3 feet deep, submerged in another 3 feet of water. The quality of the sand is critical for optimal treatment performance. The sand grains should be round, not sharp, and about 0.3 mm in diameter (about 60 mesh). The sand serves as a substrate on which a community of microbes grows that is responsible for the treatment. Water flow through SSF systems is gravity driven and they can be designed to only require that the water be lifted up to the top of the filters to create a pressure head. Controlling the flow rate of water through the sand bed is also critical for treatment and flow rates should be about 800 gallons per day per square yard of sand surface area. At that rate, a sand bed in a 20 foot diameter tank is required to treat 25,000 gallons of captured runoff per day. A recommendation is to capture runoff in a large tank or pond and pump the captured water to the sand beds. This is because the flow through the sand beds needs to be slow and continuous and runoff usually occurs in surges, depending on the timing of irrigation cycles. Another tank is necessary to collect the treated water to be used for irrigation.

It is also recommended that two sand beds are installed so that while one is shut down for maintenance, the other can remain operational. SSF systems need relatively little maintenance but require periodic

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cleaning of the sand surface as the layer of microorganisms ("schmutzdecke") thickens at the sand bed surface and restricts flow. The frequency of the cleaning depends mainly on the particulate content of the water being treated. These particles, typically sediment, clog the filters which restricts the flow of the water. Pretreating the water to remove the sediment will be necessary to extend the time between cleanings. This can be accomplished by slowly flowing the water through settling ponds or using flocculants.

Research Project

In the experimental system we constructed at UC Davis, irrigation runoff was collected, inoculated with the water mold *Phytophthora capsici*, and then provided to sand beds that were constructed using washed and oven-dried sand (see fig. 1). It took less than 21 days for the SSFs to establish the microorganism community and remove the pathogen from the water. The sand beds were not inoculated with microorganisms that would grow on the sand because these microorganisms are probably present in the captured irrigation runoff water.

To see if water flow rates through the sand bed could be increased, the pathogen-inoculated water was provided to three sets of sand filters flowing at different rates. The filters flowing at the higher rates were able to remove the pathogen, but they also clogged more rapidly. So, slower flows will allow the filters to perform for longer periods between maintenance.

Very little is known about the microorganisms that grow on the sand and provide the treatment. To determine if a SSF established using our system of runoff water inoculated with *P. capsici* would remove other pathogens, we established a set of five filters at our research facility at UC Davis. On the same day, we also set up five more filters in Felton (Santa Cruz County) and provided water from Lompico Creek, which has been found to contain many species of *Phytophthora*. After allowing 30 days for the SSFs to establish, we moved the filters from UC Davis to the site in Felton and introduced the stream water to them. The filters from UC Davis were immediately able to remove all of the other species of *Phytophthora*.

Fig. 1. Slow sand filters were constructed to study their efficacy in removing *Phytophthora capsici* from irrigation runoff. Graduate students Mike Harris and Corey Barnes (hidden) are collecting water samples from the filters to be examined for presence of the pathogen. Photo by Loren Oki.

It is most likely that the composition of pathogens present in nursery irrigation runoff shifts depending on the health of the crops. Some diseases are constantly present or may come and go, but another may appear unexpectedly. To test whether SSFs can adjust to the presence of a previously unseen pathogen, an experiment was set up to see if SSFs exposed to runoff inoculated with one pathogen could later remove a different one. For this test, we used *P. capsici* and *Fusarium oxysporum* which are distinctly different organ-

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isms; *Phytophthora* is a member of Kingdom Chromalveolata and has cell wall material of β1,3 glucans and *Fusarium* is a fungus with cell walls of chitin. Therefore, degradation of these cell walls would involve different biochemical processes and the microorganisms that would disrupt those pathogens through cell wall degradation would most likely be different. A set of filters was allowed to establish with runoff inoculated with *P. capsici* for six weeks. Then the inoculum was switched to *F. oxysporum* f.sp. lycopersici and that runoff was provided for another six weeks. The SSFs were able to remove *P. capsici* but not *F. oxysporum*, confirming studies by others that special conditioning of the SSFs is required to facilitate removal of *Fusarium*. A second set of SSFs was initially exposed to *F. oxysporum* for six weeks and then exposed to *P. capsici* with similar results.

Slow sand filters used in practice are vulnerable to system failures. It was speculated that the most likely interruption would be the failure of the pump that supplies water to the sand bed, which would cause the sand to become exposed to the air. To test the effects of a pump failure, the SSFs used in the above study, inoculated with *P. capsici* or *F. oxysporum* for a total of twelve weeks, were not supplied water for seven days, after which time the pumps were restarted. It was found that the interruption did not affect the ability of the SSFs to remove *P. capsici* but the SSFs continued to be ineffective in removing *F. oxysporum*.

For further examination of the composition of the microbial community, samples from the sand beds used in the experiments have been collected and submitted to the UC Davis Genome Center for analyses. Early results show a very complex mixture of organisms and analyses continue.

Another group of plant pathogens of concern are the viruses, and there is little work on the effectiveness of SSFs in removing these pathogens. We have conducted a study testing the efficacy of SSFs in removing plant virus with encouraging results. See the *UCNFA News* article by Deborah Mathews listed in the References for more details.

This research was supported by grants from the USDA-ARS Floriculture and Nursery Research Initiative, the Fred C. Gloeckner Foundation and the California Association of Nurseries and Garden Centers. At this time, more information about this work is available online and listed in the References below (Lee and Oki in press). Details on designing slow sand filtration systems are also available in the References.

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References

Hendricks D (ed). 1991. *Manual of Design for Slow Sand Filtration Systems*. Denver, CO: American Water Works Association Research Foundation. 288 p. http://protosh2o.act.be/VIRTUELE_BIB/Watertechniek/350_Waterbehandeling/353.1_HEN_E5_Manual_Design.pdf.pdf.

Huismans L,Wood WE. 1974. Slow sand filtration. Geneva: World Health Organization. 120 p. http://www.who.int/water_sanitation_health/publications/ssf/en/index.html.

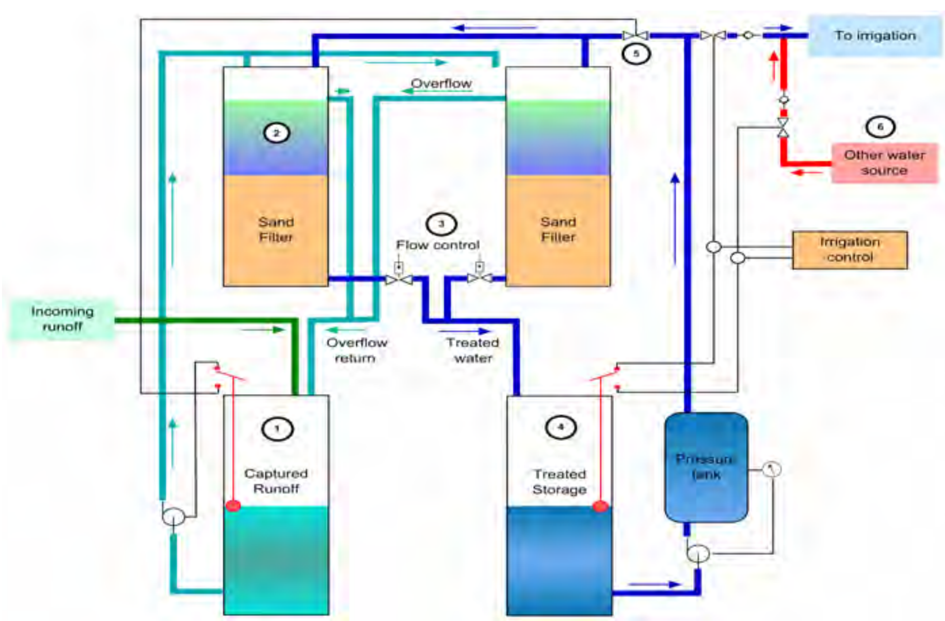
Lahkou ML 2000. Slow sand filtration. In: Tech Brief. A National Drinking Water Clearinghouse Fact Sheet. June 2000. No.14. 4 p. http://www.nesc.wvu.edu/pdf/dw/publications/ontap/2009_tb/slow_sand_filtration_dwfsorn40.-pdf.

Oki LR. In press. Slow sand filters effectively reduce *Phytophthora* after a pathogen switch from *Fusarium* and a simulated pump failure.Water Research. http://www.sciencedirect.com/science/article/pii/S0043135413004843.

Mathews D. 2013. Disease focus: Do you know what might be lurking in your irrigation water. UCNFA News 17(1): 9-10. http://ucanr.edu/sites/UCFNAnews/Disease_Focus/Do_you_know_what_might_be_lurking_in_your_irrigation_water/.

Oki LR., White SA. 2011. Ecological approaches used in nurseries to treat water. UCNFA News 15(2): 1-6. http://ucanr.edu/sites/UCNFAnews/newsletters/Download_UCNFA_News_as_PDF34772.pdf.

Washington State Department of Health. 2003. *Guidance Document: Slow Sand Filtration and Diatomaceous Earth Filtration for Small Water Systems.* DOH PUB. #331-204. April 2003. 118 p. http://www.doh.wa.gov/Portals/1/Documents/Pubs/331-204.pdf.



SCIENCE TO THE GROWER: How to handle salt in a recirculating irrigation system

by Richard Evans

One way to reduce water and fertilizer consumption and environmental pollution associated with ornamental crop production is to use a recirculating system, in which drainage water is captured, supplemented with fertilizer, and reapplied. However, growers who want to use a recirculating system face lots of questions about how to monitor salinity and specific ions (both nutrients and potentially toxic ions), how and when to add fertilizers, and how to manage flushing when necessary (among other issues). This article discusses research related to monitoring a recirculating nutrient solution and deciding how to manage it when salinity gets high.

Ideally, recirculating systems only require additions of fertilizer and water. In the less ideal world of the nursery or greenhouse operator, salinity usually builds up because some constituents of the water accumulate instead of being taken up by the crop. In such cases, the nutrient solution is recirculated until the total salinity or a potentially toxic ion reaches a maximum acceptable concentration. Then the solution must be partially or completely replaced. The water flushed from the system may require treatment to meet water quality standards before it is discharged.

Nutrients in a recirculating system are usually managed by measuring the electrical conductivity (EC) of the irrigation solution and adding fertilizer to restore an EC set-point. There are two problems with this. First, EC does not indicate the concentration of each nutrient, so the nutrient solution could become imbalanced. Second, sodium and chloride in the irrigation water may accumulate over time and contribute significantly to the EC, so nutrients will represent a declining proportion of the EC at the set-point.

An Italian research group has taken an interesting approach to solving these problems (Massa and others 2010). They studied the impact of three closed-loop nutrient solution strategies on tomato plants growing in rockwool slabs in a greenhouse. They started with well water that had a high sodium chloride (NaCl) concentration and an EC of 1.5 dS/m. They added a complete nutrient solution that raised the EC by about 1 dS/m.

Here's the setting. In Method A, they replaced crop water uptake with the full-strength nutrient solution in well water. They expected that the concentration of nutrients would remain relatively constant, and that NaCl would accumulate and raise the EC over time, so they would flush the system and start fresh when the EC reached 4.5 dS/m. In Method B, they maintained a target nutrient solution EC of 3 dS/m. Since accumulating NaCl represented an increasing proportion of the total EC, they had to dilute the fertilizer concentration when they replaced crop water uptake with the nutrient solution. When the nitrogen concentration fell below 14 ppm, they flushed the system and started fresh. Method C was similar to Strategy A, except that when the EC reached 4.5 dS/m they replenished the system with unfertilized well water. They continued this strategy until the nitrogen concentration fell below 14 ppm, then flushed the system and started over again. In Method D, the experimental control, they irrigated with the nutrient solution without capturing and recirculating the drainage water, using a leaching fraction high enough to keep the drainage EC below 3.5 dS/m.

At the end of the experiment, Massa's group found that total plant growth and tomato fruit yields and quality were unaffected by irrigation management

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strategy. However, all three recirculation management methods used less than half as much water and fertilizer as the freely draining control method. Method B used the least fertilizer and Method C used the least water. The authors conclude by recommending the use of a recirculating system that sets a maximum acceptable EC and allows for temporary nutrient depletion.

However, it is important to note that these results probably depend on knowing the nutrient uptake characteristics of the crop. Massa's group had previously done careful experiments to establish the rates of nutrient and water uptake by the tomato cultivar they studied, and this information enabled them to establish appropriate concentrations of all nutrients in the fertilizer solution. Without that information, the nutrient concentrations might have strayed from the desired values over time, and yields might have been different. It also stands to reason that managing a recirculation system used for growing a single crop would be much easier than one intended for a mixture of crops.

Richard Evans is Cooperative Extension Environmental Horticulturist, Department of Plant Sciences, UC Davis.

References

Massa D, Incrocci C, Maggini R, Carmassi G, Campiotti CA, Pardossi A. 2010. Strategies to decrease water drainage and nitrate emission from soilless cultures of greenhouse tomato. Agricultural Water Management 97: 971–980.

DISEASE FOCUS: Mixed infections cause problems with accurate disease diagnosis

by Deborah M. Mathews

Often I am told by a grower that they sent a sick plant sample to a lab and it came back as pathogen X, Y or Z. They treated for that cause, but problems are still present; can I take a look? What I usually find is that there are mixed infections of several pathogens, even different pathogen types, and when coupled with some horticultural issues, the cure may not be a simple one. It is easy for a typical diagnostician to see the "individual trees" but not the "forest" in this case. If a pathogen is dominant, or grows out faster in a culturing assay, it can mask the presence of one or more other pathogens. As a result, further assays are not conducted, which can miss another important player in the disease cycle.

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Another problem is that many clients send samples that are almost dead to the lab. By that time, the actual pathogen that was causing the problem has died and secondary opportunistic organisms are the ones detected, not the actual pathogen that started the problem. This is very common with diagnoses of *Fusarium* since many species of this fungus are saprophytic and feed on already dead tissues, but are not pathogenic themselves. Commercial testing labs usually only identify organisms to the genus level, not species, so it is difficult to assess the causal agent in these cases.

Fig. 1. Palm frond with canker caused by *Phytophthora palmivora*. Ideal isolation area of advancing disease margin is shown inside red box. Photo by Deborah Mathews.

I commonly find that field-grown plants that are wilting have more than one pathogenic fungus or water mold (*Phytophthora* or *Pythium*) in the root system. Recently I tested some rosemary plants that were showing wilting symptoms in warm temperatures and some dieback. Results from culturing assays showed that the root balls contained *Pythium, Rhizoctonia* and *Fusarium*; an antibody lab test revealed a fourth pathogen, *Phytophthora.* This or similar pathogen combinations complicate fungicide applications since many fungi require treatment with a product that has a distinct mode of action, which may not be effective against a broad range of pathogens. Plants may still be able to thrive if only one pathogen is present, but if there are multiple infections, there may be a compounding effect (synergism). The presence of a plant virus and/or environmental factors such as drought or extreme heat cause further stress on the plant. This makes the end result much worse than the effect of any individual pathogen alone.

Some good ways to provide optimal samples for diagnosis are:

- Send the entire plant, roots and shoots wrapped separately, early in symptomatic development, not already half dead.
- For larger specimens where a subsample needs to be sent, try and collect young feeder roots. If lesions are present, remove a section with a healthy portion of the plant and the margin with the canker or dead portion (fig. 1). The pathogen will most easily be recovered from the advancing margin, not the already dead part.
- Send two to three examples of the problem if possible to help ensure successful isolation.
- To avoid cross contamination, wear disposable gloves while collecting samples or wash hands well between plants.

So take care in diagnosing your plant disease problems. Finding the solution is not always easy.

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INSECT HOT TOPICS: Brown marmorated stink bug

by James A. Bethke

The brown marmorated stink bug (BMSB) became a serious agricultural pest and urban nuisance in the eastern United States in just a few short years. You can bet that it will also become a serious threat to the movement of plants, and hence a serious concern for the ornamental plant production industry in California.

BMSB, *Halyomorpha halys* Stål (Insecta: Hemiptera: Pentatomidae), is native to China, Japan, Korea and Taiwan. It is a major economic pest in these countries, attacking a variety of high value crops. In the United States, BMSB was first collected in Pennsylvania in 1998 — researchers speculate that it arrived on a cargo ship from Asia — and it currently has been sighted in 29 states. In the Pacific Northwest, it has become established in Oregon and it has been found in Vancouver, Washington; in California, it was first found established in Los Angeles County in the urban environment.

The California Department of Food and Agriculture (CDFA) border check stations have intercepted BMSB 24 times from 2006 to 2010 in vehicles coming from the eastern United States. From 2002 to 2006, BMSB has been observed in the following 10 California counties: Alameda, Contra Costa, Monterey, Riverside, Sacramento, San Diego, San Francisco, San Joaquin, Santa Clara and Solano. All of these detections have been associated with people, vehicles or parcels that originated from infested areas in the eastern United States.

BMSB can cause severe damage to a variety of host plants. Some reports in Pennsylvania have indicated that peach growers lost as much as 50 to 60% of their crop to BMSB, which feeds directly on the fruit. Other fruits that BMSB attacks include apple and pear. BMSB also damages vegetable crops such as corn, beans, peppers and tomatoes, and many ornamental plants such as butterfly bush (*Buddleia* spp.), empress tree (*Paulownia tomentosa*), hibiscus, zinnia and sunflower.

Unfortunately, when the cooler weather begins in early winter, BMSB aggregates in urban areas, including homes, looking for a warm place to overwinter. They are no threat to humans, but they are not called stink bugs for no reason; if disturbed, they will emit a strong unpleasant odor. When it begins to warm again in the spring, the aestivating adults will migrate back to host plants, mate, lay their eggs and cause plant damage.

USDA-ARS researchers have documented two full generations of BMSB in eastern states beginning with the previous year's overwintered adults in the spring. A similar generational trend will likely be seen in California. BMSB nymphs develop through five nymphal stages before becoming adults. It is hypothesized that a second generation will be present by August that will become the overwintering generation, likely following the same developmental trend as that the glassy-winged sharpshooter. Warm spring and summer conditions could permit the development of a third generation in California. However in parts of sub-tropical China, records indicate that four to six generations per year may be possible.

BMSB is morphologically similar to many other stink bugs, including numerous species found in California. To distinguish them from other stink bugs, look for both white and black bands on the last two antennal segments with alternating white and black triangles on the outside edge of the abdomen (fig. 1). If you have a mobile device, you could download an app called *Stink Bug Scout*. This app helps identify stink bugs using lots of photos.

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Fig. 1. Brown marmorated stink bug adult (top) and fifth instar nymph (bottom). Photo by Stephen Ausmus: USDA-ARS.

Currently the CDFA rates BMSB as a "B"-rated pest like the glassy-winged sharpshooter. This means that nursery stock found infested must be cleaned before it can be sold, and our border stations can require treatment or reject shipments that are infested. However, CDFA has not enacted any additional quarantine regulations, nor are they conducting any surveys or other treatments for BMSB in natural environments.

For more information about the brown marmorated stink bug, see the following web sites:

http://www.ipm.ucdavis.edu/pestalert/pabrownmarmorated.html

http://www.ces.ncsu.edu/depts/ent/notes/O&T/trees/note148/note148.html

http://www.oregon.gov/ODA/PLANT/docs/pdf/ippm_bmsb_alert2010.pdf?ga=t http://www.wpdn.org/webfm_send/129

http://acwm.lacounty.gov/pdf/Brownmarmorated.pdf

http://www.epa.gov/pesticides/controlling/stinkbugs/

http://www.ars.usda.gov/is/AR/archive/jul09/bug0709.htm

http://www.ars.usda.gov/is/AR/archive/jul09/bug0709.pdf

http://westernfarmpress.com/management/brown-marmorated-stink-bug-latest-invasive-pest-threat-us-crops?page=2

http://stream.ucanr.org/fps_stinkbug/index.html

http://westernfarmpress.com/management/brown-marmorated-stink-bug-latest-invasive-pest-threat-us-crops

http://entnemdept.ufl.edu/creatures/veg/bean/brown_marmorated_stink_bug.htm

http://ento.psu.edu/extension/factsheets/brown-marmorated-stink-bug

http://www.ndsu.nodak.edu/ndsu/rider/Pentatomoidea/Species_Cappaeini/Halyomorpha_halys.htm

http://pmtp.wsu.edu/BMSB.html

http://www.massnrc.org/pests/linkeddocuments/BMSBFactSheet.pdf

http://njaes.rutgers.edu/pubs/plantandpestadvisory/2011/fr061411.pdf

http://ucanr.org/blogs/blogcore/postdetail.cfm?postnum=6120

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REGIONAL REPORT: Improving water quality with polyacrylamide (PAM) polymers

by Steve Tjosvold

Federal and state water quality regulations require that growers implement management practices to minimize impairments to surface and ground water quality. Many nursery operators have made significant progress in mitigating this problem. They use retention ponds and water recycling that can significantly control and reuse excess runoff from irrigations (tailwater), but these practices can be expensive and may not be suited for all production facilities. Nursery operators use drip irrigation to increase irrigation efficiency for larger nursery stock and slow release fertilizers to maximize nutrient uptake by the crop. Integrated pest management is practiced to reduce pesticide use. But additional management tools are still needed to help minimize impairments to water quality.

Many research studies in field crops have repeatedly demonstrated that linear anionic polyacrylamide (PAM), a chemical polymer, can significantly reduce sediment and nutrient concentrations in tailwater. PAM has been used successfully in furrow and sprinkler irrigation to improve soil infiltration, reduce soil erosion and improve water quality by causing sediment — which contains nitrogen, phosphorus and adsorbed pesticides — to form clumps and settle out before moving off site in tailwater. PAM has been proven to be nontoxic to humans and safe to use in field crops. It is inexpensive and a readily available product too. It is approved for water quality mitigation by the USDA Natural Resources Conservation Service (NRCS) and the California's Regional Water Quality Control Boards (RWQCBs). PAM has been successfully used in furrow and sprinkler irrigation to improve infiltration, reduce erosion and improve water quality. These techniques can be adapted for use in field or greenhouse ornamental production.

Water Quality Efficacy of PAM in Furrow Systems

Most applications of PAM in furrows are done by adding dry or liquid product to water flowing in the head ditch or the main line (if gated pipe is used) at a rate to achieve a 2.5 to 10 ppm concentration. The application is made continuously during the irrigation or until the water advances almost to the end of the furrows. An alternate application method ("patch method") involves applying granular PAM to the first 3 to 5 feet of the head of each furrow. Granular PAM slowly dissolves during the irrigation, releasing product into the water. Tablet forms of PAM can also be applied to the beginning of each furrow. Since the PAM tablet dissolves slowly, this application method releases less product into the irrigation water than the other methods described, and can be less effective in controlling sediment and associated nutrients and pesticides. However, because the tablet formulation of PAM dissolves slowly, it may last for several irrigations, thereby saving labor.

Water Quality Efficacy of PAM with Overhead Sprinklers

Applications made before sprinkler irrigating, such as by spraying PAM solution or broadcasting dry product on the surface of the soil, are less effective than continuously injecting a low rate of PAM into the irrigation water. Injecting PAM at a high rate for a short period at the beginning of irrigation is less effective in controlling sediment and nutrients in runoff than a continuous application at a low concentration during the entire irrigation. UC

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Fig.1. Runoff from overhead sprinkler water treated with 5 ppm PAM (right) and untreated runoff (left). Photos by Michael Cahn.

studies have demonstrated that injecting PAM to achieve a 5 ppm concentration in the irrigation water provided the highest reduction in sediment, nutrients and pesticides in the tail water using the least amount of product in most cases. In some fields, 2.5 ppm of PAM was equally effective as the higher rate in the control of suspended sediments. In fields where very little runoff occurs during the first few hours of an irrigation, product can be saved by making an initial application during the first half hour and then applying product again when runoff becomes significant.

For more information, see "A Guide to Using Polyacrylamide (PAM) Polymers for Control of Irrigation Runoff on the Central Coast" by Michael Cahn, UC Cooperative Extension Irrigation and Water Resources Advisor, Monterey County. This publication is available online at http://cesantabarbara.ucanr.edu/files/75493.pdf.

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UC Cooperative Extension Ventura and Santa Barbara Counties

Retirement News

I retired from the University of California Cooperative Extension on July 1 after over 28 years of service. It's been a very rewarding career and a fantastic place to work! Although I am looking forward to this next chapter of my life, I have enjoyed working with all of you and will certainly miss you. Unfortunately, due to budget constraints, my position may not be replaced. However, this is not a final goodbye. Although this is my last regional column article for UCNFA News, I will continue to work as co-editor and assist UCNFA in any educational events planned in Ventura or Santa Barbara counties. I also plan to assist Michael Parrella and Don Merhaut on their Hansen Trust research projects currently underway. Thank you so much for all the support you have provided me over the years and best wishes.

Julie Newman

REGIONAL REPORT: Water quality management plans and retirement news

by Julie Newman

Water Quality Management Plans

Growers who are enrolled in the Central Coast regional water board's conditional waiver program must have a farm water quality management plan. Plan requirements include a site map identifying runoff discharge locations, a description of the typical runoff, types of chemicals applied, and a description and time schedule of management practices to mitigate runoff and groundwater leaching. A complete list of requirements is described on page 20, item #44 of the waiver, which is available on the regional water board website (http://www.waterboards.ca.gov/centralcoast/water_issues/programs/ag_waivers/).

The Los Angeles regional water board's conditional waiver program also requires a "Water Quality Management Plan" (WQMP). Growers who belong to a cooperative waiver group are not required to develop an individual plan but instead provide information that has been used to compile the group WQMP. For example, in Ventura County, growers completed a management practices survey which the Ventura County Agricultural Irrigated Lands Group (VCAILG) used to compile the group WQMP. The survey is available at http://www.farmbureauvc.com/pdf_forms/MgtPractSurvey.pdf.

Even if your nursery business is conducted in an area where water quality management plans are strictly voluntary, you may still want to consider developing one because the process will help you determine if any problems exist that contribute to water pollution. Addressing these problems helps to comply with existing water quality regulations and may prepare you for more stringent requirements down the road. Moreover, a water quality management plan may be used to complete documents required by regulatory agencies and demonstrates your good stewardship.

Last fall, UCNFA presented a workshop on developing a farm water quality management plan. The PowerPoint of that

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presentation is available on my website at http://ceventura.ucdavis.edu/files/152724.pdf. Here is a summary of information presented at the workshop.

Know what's in your runoff. Before you start developing a water quality management plan you must be familiar with the potential risk that runoff from your operation poses if it moves off site and enters a water body. It's important to be aware of any impaired water bodies that may be impacted by discharges from your operation. Inventory agrochemicals used in the nursery, especially those likely to be present in runoff. Know the basic properties of the pesticides that are used and how they potentially impact local water. Monitor runoff flow and basic nutrient concentrations in discharges. It is also recommended that you test for other contaminants according to the products used, such as specific pesticides that you suspect may be present in runoff. Compare results of your water analyses against local, state, and federal water quality standards and regulations for potential noncompliance issues. Establish and maintain water quality runoff records and use them for planning and evaluating future improvements.

Develop your goals. The first step in developing a water quality management plan is to think about your goals. A management goal is an economically achievable technology or process for effectively limiting runoff and groundwater leaching. Management goals are general; for example, "Establish an IPM program to reduce pesticide use."

Compile a list of management practices. The next step is to develop a list of practices that could potentially mitigate runoff and leaching. A management practice is a specific practice for accomplishing the management goal. For example, "Base decisions to use pesticides and other control options on monitoring information." Management practices are usually called "best management practices (BMPs), but the "best" practices vary with on-site specifications.

Lists of BMPs are available that can be employed to protect water quality. Check with your Cooperative Extension office, local USDA Natural Resources Conservation Service (NRCS), or Resource Conservation District (RCD). A checklist of practices specific for ornamental production is available on my website at http://ceventura.ucdavis.edu/files/153137.pdf and in *Greenhouse and Nursery Management Practices to Protect Water Quality,* available at http://anrcatalog.ucdavis.edu/Details.aspx?itemNo=3508. These checklists can be used as a template for your plan.

Conduct a water quality audit. A water quality audit or self-assessment is a way to evaluate current management practices that may impact water quality. It can be conducted by going through your compiled list of BMPs and checking off the ones that you have already implemented. This exercise will increase your awareness of the variety of practices to mitigate runoff and leaching and provide a convenient way to identify areas that may require improvements.

Develop and implement the plan. After you complete the audit, the next step is to go back through the list and highlight the BMPs applicable to your operation that you have **not** implemented. Select BMPs from those highlighted which would help you meet your plan objectives and help comply with regulations. Which BMPs you select depends on economics and specific conditions unique to your operation. The easiest and least costly BMPs

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Fig. 1. Impoundments such as detention basins capture runoff water so that it remains on the nursery site. This helps to prevent the movement of pollutants into water bodies. Photo by Julie Newman.

to implement are often practices that reduce the quantity of runoff and pollutant loads. However, you may still need to adopt practices and technologies that treat and contain runoff, such as the use of impoundments (fig. 1) and the use of other practices described in this newsletter such as vegetated buffers, slow sand filtration and PAM.

Once you determine which BMPs you plan to implement, the final step is to develop a schedule for implementation. This may require a financial analysis to determine when any needed capital would be available for construction, materials, or labor. If you require a loan or other financial assistance, funding for BMP implementation may be available from various sources such as the NRCS.

Once your plan is completed, it's important to keep it updated. Record all management practices that you implement and the date of implementation. Evaluate the effectiveness of the implemented BMPs and make adjustments accordingly.

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UC Cooperative Extension San Diego and Riverside Counties

REGIONAL REPORT: European pepper moth update and retirement news

by James A. Bethke

European Pepper Moth Update

After our first encounter with the European pepper moth (EPM) in San Diego County and the ensuing quarantine actions nationwide, the interest and intensity of the regulatory action has subsided. However, there have been new reports of serious damage on new hosts, specifically in the ornamental plant industry across the country. Therefore, it makes sense to review what has been learned, the research on this pest that is in progress and the need to be vigilant.

Background. EPM, *Duponchelia fovealis* Zeller, can be a very serious pest to agricultural crops and in ornamental plant production. The caterpillars easily avoid detection by feeding near the base of plants below the soil line; sometimes they burrow

Dave Shaw (right) , a valuable team member who recently retired, being presented a plaque by James Bethke (left) in recognition of over 30 years of service to UC.

Retirement News

I'm sure you have heard how our University of California workforce is aging and nearing retirement in mass. With the added difficulty of the budget battles in California, it has been difficult to replace all the knowledge base that we have lost. Unfortunately, our UC Cooperative Extension San Diego office staffing has been dwindling as well, and we recently lost a valuable member to retirement. David Shaw has been with the University of California since 1983 and with our office since 1988. Dave has a master's degree in water science and a bachelor's degree in plant science from the University of California, Davis. He is a member of the International Society of Arboriculture, the International Society of Arboriculture - Western Chapter and the San Diego Golf Course Superintendents Association.

Dave was very adept at assessing the needs of his clientele and presenting an exceptional set of educational programs for professionals in the landscape, turf grass and Christmas tree industries. His educational programs focused on soil and water management, pest management, cultural practices, toxicology and environmental safety, and economics to promote healthy plant materials and commodities. Through the years, his research projects encompassed recycled water use, irrigation needs of ornamental plants, integrated pest management and weed control.

Dave helped build a reputation of excellence with local landscape and turf management professionals. Not only did he work with professional businesses, he always found the time to consult with private homeowners, using his knowledge and experience in landscape and turf management as well as irrigation, arboriculture, and insects and mites that affect plants. His vast knowledge of ornamental landscape plants and his expertise in irrigation management will be greatly missed.

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into the stems causing complete collapse of the damaged plant. The moth originates in the Mediterranean area where it is a significant pest of agricultural crops including peppers, squash, tomatoes, corn, etc.; it has entered the United States and Canada on ornamental plants and fruit.

EPM was found on begonia in the San Marcos area of San Diego County back in 2004 and again on other hosts in April and July of 2010. Current detection maps indicate that the moth is now widely distributed in San Diego County from south Chula Vista to the Riverside County border, with heavy concentrations in the Vista/San Marcos areas. In addition, it has now been detected in 22 other counties in California and in 17 other states.

Current Research. The goals of our research efforts in San Diego County are to allow growers to more effectively manage EPM, eliminate pest spread and minimize the potential for economic losses through crop destruction. We have a colony of this pest and active research projects at the Center for Applied Horticultural Research in Vista.

Current research projects include:

- Determining efficacy of registered and unregistered products, including biorationals.
- Evaluation of biological control agents.
- Developing a best management practice (BMP) based on LBAM.
- Determining the biology of the insect at constant temperatures to develop degree day models.
- Testing of host plants and identifying the types of damage observed.

Many of these objectives have been reached and presentation of the information is in progress.

Brief findings. A BMP has been established and is being revised as new research warrants (Bethke and Vander Mey 2012). Much of the information collected was used to create a Pest Management Guideline for EPM, which will be available shortly. Keep checking the *UC IPM Pest Management Guidelines for Floriculture and Nurseries* web page (http://www.ipm.ucdavis.edu/PMG/selectnewpest.floriculture.html).

One of our most recent research findings includes the development of EPM at constant temperatures. Preliminary data shows that the warmer it is, the faster the pest develops (table 1), as you would expect. A predictive model is presented in fig. 1 that represents the development time for EPM at any selected temperature. Dr. Rebeccah Waterworth, Department of Entomology at UC Riverside, analyzed the data, which will be used to develop a degree-day model.

Recent reports. A new detection with a new state record was observed in Maryland recently (Gill 2013). Gill reported that EPM was observed in June 2013 on zonal geraniums in Maryland. Gill identified the EPM boring into the stems at the soil line and causing significant damage.

A new state detection has also been reported in Georgia. In May of 2012, Cooper (2012), a news editor with the University of Georgia College of Agricultural and Environmental Sciences, noted that EPM had caused significant damage to lantana at a local greenhouse production facility. Additionally, a colleague recently admitted to me that she found EPM damaging Christmas cactus in New York.

Lastly, here in San Diego County, a local grower with a serious infestation in a mother block of poinsettia contacted us. We already knew that EPM was damaging potted poinsettias during the fall season, but to find it on an established planting is worrisome. In addition, we have seen significant damage to potted rosemary (fig. 2). Clearly, the host list and damage list for ornamental plant production is growing.

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Table 1. Temperature and average days for total development of European pepper moth (EPM).

Temperature °F	Temperature °C	Average days from egg hatch to
60	15.5	105.4
70	21.1	40.0
80	26.6	25.2
90	23.5	23.5

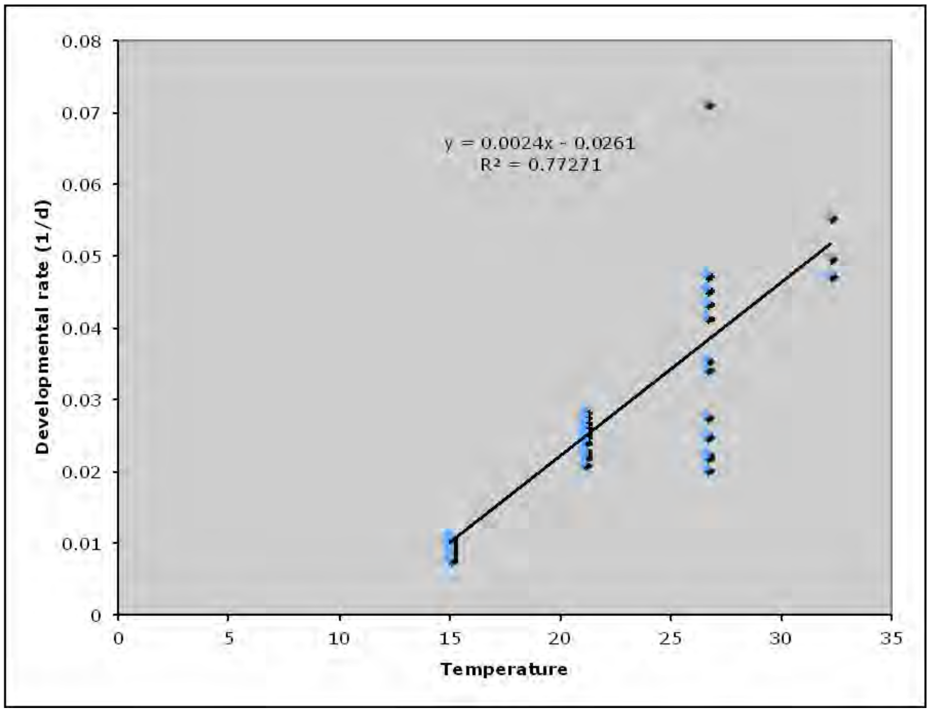

Fig. 1. Temperature development over time (1 over the number of days of development, 1/d, left axis) of EPM at selected constant temperatures in degrees centigrade (lower axis). Each point on the graph represents a single individual insect. The line and equation in the figure represents a potential predictive development model.

Monitoring. It will be important to monitor for this pest especially if there are susceptible host plants. In many cases in ornamental plant production, the mere presence of the pest will require preventative treatment applications to prevent damage and movement of the pest. Detection can also be used to co-ordinate biological and chemical control measures. Water traps have been used quite successfully in San Diego County. These methods require the use of a pheromone, which is now readily available from sources in Canada, the Netherlands and the United States.

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Management. The most effective products so far have been acephate and Bt. Preventative applications of Bt have been successful in protecting poinsettias in the early stages of production. Other products known to be effective against worms (caterpillars) may be effective against EPM, but this insect is very difficult to contact with insecticides because of its behavior. As with other moth species, treating the insect in the early instar stages is the most effective.

Fig. 2. EPM larva established on the lower leaves of rosemary. Photo by Bryan Vander Mey.

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References

Bethke JA,Vander Mey B. 2012. European pepper moth: A new invasive moth threatens California agriculture. UCNFA News. *http://ucanr.edu/sites/UCNFAnews/Feature_Stories/European_Pepper_Moth__A_New_Invasive_Moth_Threatens_California_Agriculture/.*

Cooper D. 2012. Unwelcome guest: The European pepper moth arrives in Georgia. Growing Georgia. *http://growinggeorgia.com/features/2012/05/unwelcome-guest-european-pepper-moth-arrives-georgia/.*

Gill, S. 2013. European pepper moth found in Maryland greenhouses. Greenhouse Management. *http://www.greenhousemanagementonline.com/European-pepper-moth-found-in-Maryland-greenhouses.aspx.*

New publications from Agriculture and Natural Resources

compiled by Steve Tjosvold

Floriculture and Ornamental Nurseries: UC IPM Pest Management Guidelines
These official UC-approved guidelines for pest monitoring techniques, pesticide use, and nonpesticide alternatives are essential tools for anyone making pest management decisions in the field. This guideline covers floriculture and ornamental nursery plants. Order this publication for $15.00, or access it for free as an HTML web page or as a PDF document.

Publication Number: 3392
http://anrcatalog.ucdavis.edu/Details.aspx?itemNo=3392

Grasshoppers: Pest Notes for Home and Landscape
Grasshoppers are sporadic pests. However, in some years large populations may build up in foothills and rangelands, especially after a wet spring and then migrate into gardens and nurseries, often defoliating everything in sight. Free.

Author: M. L. Flint
Publication Number: 74103
http://anrcatalog.ucdavis.edu/Details.aspx?itemNo=74103

Horsehair Worms: Pest Notes for Home and Landscape
Horsehair worms belong to the phylum Nematomorpha (from the Greek meaning "thread-shaped"), class Gordioida. They are also called Gordian worms because they will often twist into a loose, ball-shaped knot resembling the baffling one created by Gordius in the Greek myth. They occur in water sources such as ponds, rain puddles, swimming pools, animal drinking troughs, and even domestic water supplies. Free.

Author: H. K. Kaya
Publication Number: 7471
http://anrcatalog.ucdavis.edu/Details.aspx?itemNo=7471

Low-Cost Methods of Measuring Diverted Water
California Water Resources Board rules say you have to measure and report the amount of water you divert from surface waters for farming. Pasture and low-value crops can't cover the cost of commercial measuring tools, but there are cheaper alternatives. Free.

Author: L. Forero, A. Fulton
Publication Number: 8490
http://anrcatalog.ucdavis.edu/Details.aspx?itemNo=8490

Moles: Pest Notes for Home and Landscape
Moles live underground in a network of shallow tunnels where they capture worms, insects, and other invertebrates. Their burrowing can dislodge plants and dry out their roots; in lawn areas the resulting mounds and ridges are unsightly and disfiguring.

Author: R. Baldwin, T. Salmon, et al.
Publication Number: 74115
http://anrcatalog.ucdavis.edu/Details.aspx?itemNo=74115

Oak Pit Scales: Pest Notes for Home and Landscape
Several Asterolecanium species of pit scales attack many common deciduous and evergreen oaks in California. The valley oak is especially susceptible. Pit scales suck juices from twigs and cause twig dieback, which first becomes apparent in mid- to late summer. A severe infestation delays leafing-out for as long as 3 weeks in spring and heavy attacks year after year may kill young trees. Free.

Author: P.M. Geisel and E.J. Perry
Publication Number: 7470
http://anrcatalog.ucdavis.edu/Details.aspx?itemNo=7470

Pitch Canker: Pest Notes for Home and Landscape
Pitch canker is a disease of pine trees that is caused by the fungus *Fusarium circinatum*. The fungus causes infections (lesions) that can encircle or girdle branches, exposed roots, and the main stems (trunks) of pine trees. The tips of girdled branches wilt as a result of obstructed water flow, causing the needles to turn yellow, and then red. Free.

Author: C. L. Swett, T. R. Gordon
Publication Number: 74107
http://anrcatalog.ucdavis.edu/Details.aspx?itemNo=74107

UCNFA Educational Programs for 2013

information at http://ucanr.org/sites/UCNFA/

2013 Water Treatment Conference
September 25, 2013 San Marcos Community Center

Jim Bethke (UC Cooperative Extension, San Diego and River Counties) and Loren Oki (UC Davis) will host morning seminars featuring California researchers and an afternoon tour of local nurseries showcasing water treatment systems. The Trade Show will feature vendors of water treatment products and services.

2013 California Nursery Conference
October 9, 2013 Etiwanda Gardens

John Kabashima (UC Cooperative Extension, Orange County) and Loren Oki have assembled speakers who will present the latest information on invasive pests, water management and regulatory issues. The Trade Show will include vendors of goods and services relevant to the California nursery industry.

ABCs of Fertilizer and Plant Nutrition (English and Spanish)
October 21, 2013 Watsonville UCCE Auditorium
October 22, 2013 Kearney Agricultural Research and Extension Center, Parlier

This road show is part of the "ABCs" series of workshops providing basic horticultural information to nursery and greenhouse workers. Don Merhaut (UC Riverside) and Maria de la Fuente (UC Coopertive Extension, Monterey, Santa Clara and San Benito Counties) will review the nutrients needed for plant growth and how to use fertilizers to provide those nutrients.

2013 Nursery/Floriculture Insect Management Symposium
December 12, 2013 Watsonville Elks Lodge

Host Steve Tjosvold (UC Cooperative Extension, Santa Cruz and Monterey Counties) has gathered an international group of well-known researchers to update growers on managing insects in the nursery and greenhouse with biocontrol agents as well as reduced-risk pesticides. The Trade Show will include vendors of pest control products and services.

BMP Workshops

Watch for a series of free workshops demonstrating the use of an online tool to generate a set of unique best management practices (BMPs) for controlling multiple pests in individual California nursery and greenhouse operations. These workshops will take place between late August and October 2013 in Modesto, Parlier, Watsonville or Salinas, Ventura, Irvine and San Marcos.

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Get timely information on news and other events of interest to the California ornamental horticulture industry.

Find links to Facebook pages for nursery and floriculture businesses, organizations and people in the industry.