Fall 2016 • *Volume 20, issue 3*

University *of* California
UCNFA News

Inside

The Nuts and Bolts of Scouting

by Julie Newman

Scouting is the backbone of integrated pest management (IPM) programs. It involves the regular inspection of plants, surrounding areas, and detection tools such as sticky traps for pests and other problems. Pests that are monitored in scouting programs include insects and other invertebrates, weeds, pathogens, nematodes and vertebrates. Natural enemies (beneficial organisms) may also be monitored. The scout is the person who does the monitoring, keeps records and summarizes monitoring information. The scout locates specific sites of infestation and identifies the type of problem, pest levels and stage in the life cycle. Monitoring data collected by the scout over time is used to determine if pest populations are increasing, decreasing, or staying the same. This data is used along with threshold levels to time the application of pesticides and other control actions. A threshold is the level at which plant injury or pest population size is sufficient to warrant control action; below this level the presence of pests and the amount of damage can be tolerated. After

Editor's Note

Two decades ago four farm advisors started the first IPM scouting demonstration programs in greenhouses and nurseries across California and the first statewide educational programs to train scouts. Today most ornamental production facilities have implemented scouting, but there are still improvements to be made. A recent case study jointly conducted by the Agricultural Issues Center and UCNFA showed that scouts in these nurseries were employees who did not have dedicated scouting responsibilities and their training was minimal. UC has repeatedly demonstrated that scouting programs can be economical and reduce pesticide use. However, to be effective you need a good scout — one that is well trained for the job and can do it consistently and regularly. So in this issue we review the basics of scouting and provide feature articles on monitoring for specific pests: pathogens, weeds, and insects and other invertebrates. In addition, we provide a fascinating look at the ways plants can monitor pests and defend themselves from these attackers in *Science to the Grower.*

- Steve Tjosvold and Julie Newman

The Nuts and Bolts of Scouting

continued from page 1

applying a pest management control action, monitoring data is used to evaluate the effectiveness of the treatment.

In this introductory article, I will describe the benefits and economics of scouting, qualities of a good scout, the relationship between scouts and the IPM team, and scouting methods that generally apply to all types of pests and beneficial organisms. In the subsequent feature articles of this newsletter issue, specific methods for scouting insects and other invertebrates, diseases and weeds will be described.

Benefits of Scouting Programs

Provides early warning of pest presence. Early detection of pests by regularly monitoring allows growers to implement appropriate control strategies before pest populations escalate, which may include the use of slower-acting methods that are more environment-friendly and safer for workers. This limits the spread of pests, including invasive species, within the nursery. Early detection and control action also reduces pest infestations on harvested plants that are sold and moved to other areas, helping nurseries comply with shipping and quarantine regulations.

Reduces pesticide use. Basing pest control strategies on scouting information along with specific pest threshold levels generally reduces pesticide use. Pesticide reduction results in improved plant quality, less problems with pesticide resistance, fewer disruptions in cultural practices and lower production costs. Additionally, reduced pesticide use improves worker safety and reduces environmental risks and potential liability issues.

Scouting Economics

Most California growers have implemented scouting programs in their nurseries, primarily in response to reducing lost revenue caused by pest and disease damage (Matthews 2013), but also to comply with pesticide, quarantine and runoff regulations. For example, a UC survey that my staff and I used in Ventura County to demonstrate practices that flower and nursery growers have implemented to reduce pesticide runoff found that 95% of the 65 nurseries sampled regularly monitored for pests and used this data in deciding when to apply pesticides.

When considering whether or not to implement a scouting program, labor costs are a primary factor. Generally, the cost of labor for applying pesticides in nurseries is greater than the cost of labor for scouting; further, the highest cost in pest management is the cost of pesticide materials, as illustrated in fig. 1 (Matthews 2013). Thus scouting is cost effective when it is offset by reductions in pesticide use.

	Nursery #1	Nursery #2	Nursery #3	Nursery #4
	In actual dollar amounts			
Chemicals	318	667	722	1,905
Chemical Treatment labor	217	625	1,778	1,273
Total chemical treatment costs	535	1,292	2,500	3,178
Scouting cost (all labor)	157	468	347	333

Fig. 1. Costs per acre of chemical treatments and scouting across four cases. The labor costs of applying chemical treatments are significantly higher than the labor cost of scouting labor, and as much as over three imes higher in Nursery #3. *Source*: Matthews 2013.

The Nuts and Bolts of Scouting

continued from page 2

Reduced pesticide use in nurseries as a result of implementing scouting programs has been documented in studies conducted by researchers and extension agents in various states. In California, a 5-year UC Cooperative Extension project involving five different types of ornamental plants demonstrated that scouting programs reduced pesticide use up to 40 percent (Newman 2014), resulting in an average overall cost savings of 20% (fig. 2). Additionally, this project demonstrated that reduced insect and disease damage (from properly timed treatments) and less phytotoxicity (from reduced pesticide use) resulted in healthier crops.

	Standard Practice	**IPM Scouting Practice**
Type of Crop		
Bedding Plants	$256	$126
Potted Flowering Plants	1125	952
Field Cut Flowers	240	202
Greenhouse Cut Flowers	995	895
Nursery Cut Flowers	508	335
Total	$3,124	$2,510

Fig. 2. Comparison of overall pesticide management costs per acre per month across five types of ornamental crops using the grower's standard practice and IPM scouting. The scouting programs reduced overall costs by an average of 20%.

Qualities of a Good Scout

The scout must have thorough knowledge of the pest complex for the specific crop varieties of the nursery and be trained in data collection techniques. The ability to identify the signs and symptoms of pests and diseases on plants and to distinguish between pests and beneficial organisms is critical. Ongoing scout training is recommended. If in-house employees are used in the nursery for scouting, they must be able to scout regularly and consistently. A limitation of in-house scouts with multiple responsibilities is that during busy periods in the nursery scouting is neglected in lieu of more immediate duties.

The Scout and the IPM Team

The scout is usually part of a team of players in the overall pest management program. In addition to the scout, other members of the team include the person responsible for making pest control decisions, such as the grower or PCA (unless decision-making responsibilities are directly assigned to the scout), and those involved in spraying pesticides and applying other control actions. Workers who are trained to look for pests and damaged plants as they irrigate, pot, prune, and so on, can also be part of the team. Requirements for a successful IPM program include good communication skills between all team members (fig. 3) and a shared commitment to base pest management decisions on monitoring data. A plan should be developed and used to ensure that team members communicate with each other on a regular basis so that everyone is on the same page.

Fig. 3. Successful IPM requires good face-to-face communication on a weekly basis between the scout and the grower, or other person who is responsible for making pest control decisions, to discuss if, when, and where control actions should be taken. *Photo*: J. K. Clark.

The Nuts and Bolts of Scouting

continued from page 3

Developing a Monitoring Plan

Monitoring methods include the visual inspection of plants in crop areas, as well as plants outside the growing area that can serve as a source for pest infestations. The entire production area should be inspected for pests and for potential issues that could contribute to plant problems and information concerning previous pest history and other potential pest problems should be collected. In addition, monitoring methods include the use of tools such as insect traps, disease detection kits, and instruments for determining soil pH and conductivity. See *Integrated Pest Management for Floriculture and Nurseries* (Dreistadt 2001) for a more complete list of tools used in scouting and table 1 for more monitoring methods.

PEST PROBLEM

	Pathogens	Abiotic Disorders	Insects and Mites	Nematodes	Weeds
visual inspection of crops	1	2	1	2	1
visual inspection of growing area and surrounding areas	1	1	1	1	1
environmental monitoring compared with optimal conditions	1	1	2	3	2
cultural care compared with recommended practices	1	1	2	2	2
on-site tools and tests (e.g., ELISA kits, traps and water chemistry meters	2	1	1	3	4
off-site laboratory tests	1	1	2	1	4
historic records compared to current scouting results	1	1	1	1	1

KEY: 1= very important method for that problem; 2=somewhat important method; 3=not important method, 4=not used or very rarely used

Table 1. Monitoring methods and the types of pests they detect. *Source:* Adapted from Dreistadt 2001.

A written monitoring plan should be developed that clearly spells out what monitoring methods are to be used and how they will be employed. Monitoring methods chosen should be appropriate to the target pests (table 1) and the crop. For crops with quarantine pests, there may be protocols that must be followed. The monitoring plan should develop a protocol for the collection and inspection of samples for each pest of interest to estimate overall pest population. The number of samples and the sampling unit should be constant over time. If the plants are small, the sample unit may be an entire plant; for larger plants the sample unit may be a set number of shoots and leaves or flower buds. The number of plants to sample depends on the value of the crop and the budget, as well as crop susceptibility to insect or disease problems. It is important that the site be sampled the same way each week to make results comparable among sample dates.

For more information on sampling methodology, see the *UC Container Nursery Production and Business Management Manual* (Newman 2014). Specific methodology used for insects and other invertebrates, diseases and weeds is also discussed in the subsequent feature articles in this newsletter.

The Nuts and Bolts of Scouting

continued from page 4

Implementing the Monitoring Plan

It is critical that propagation areas and incoming shipments from other nurseries be intensely monitored to insure that plants are free from pests and diseases when they are planted out. The scout should also inspect outgoing shipments of plants from the nursery to insure that life stages of pests, especially invasive species, do not move to other areas along with the shipment. Scouting should occur at least once a week, following the procedure outlined in the monitoring plan. Foliage and other plant parts for pests should be examined by using a using a 10 to 15X hand lens or optivisor (fig. 4). Keep in mind that pests are rarely distributed uniformly over all parts of an individual plant, and not all areas of the nursery will be infested. Although it is important to randomly select plant samples, it also helps to target hot spots where pests tend to be a problem. In addition to collecting samples using the monitoring plan protocol, be alert for any sign of pest or natural enemy presence anywhere in the nursery while scouting. Also, look for plants that are damaged by pests, adverse environmental conditions, or incorrect use of agricultural chemicals, such as pesticides and fertilizers. Record the specific location of infested plants using maps and flags so that control actions can clearly target that location. Reinspect these plants after taking action to determine if control was effective.

Fig. 4. Record keeping is essential for assessing pest and beneficial populations, conditions that promote pest problems and for evaluating the effectiveness of pest control actions. The scout in this photo is wearing an optivisor, a visor with a built in magnifying lens, similar to a jeweler's magnifying visor. *Photo*: J. K. Clark.

Record Keeping and Summarizing Data

The scout should keep written records of pest counts or degree of injury. Records of environmental conditions such as temperature and relative humidity are also important, as these can be used to predict the growth of pest and pathogen populations. See the *UC Container Nursery Production and Business Management Manual* and Jim Bethke's article in this newsletter for examples of recordkeeping forms for plant inspections. If the scout is not the pest management decision maker, he or she will need to summarize the data for those involved in pest management decision making. From such data collected over time, the scout may prepare a graph to illustrate pest population trends or compare current data with the previous collection period.

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The Nuts and Bolts of Scouting

continued from page 5

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Scouting for Diseases and Environmental Monitoring

by Steve Tjosvold

Regular scouting for the earliest occurrence of disease is essential. Check plants at least weekly for symptoms of diseases and record disease occurrence, severity and environmental or other conditions that favored the disease. Learn what diseases are known to be associated with the crops you are growing. Focus attention on diseases that historically are found in your nursery or are supported by the current environmental conditions. Look for off-color or irregular growth, wilting, soft or necrotic areas on leaves or stems. Remove root balls from containers and look for root disease symptoms: necrotic lesions, galls and rots on roots or near the root crowns. A 10x hand lens can be helpful to take a close look at unhealthy plants in the field. Sometimes characteristic spores or other signs of the pathogen might be visible and aid in field identification. Often pathogens are not readily identified in the field because identification and diagnosis may require more analysis and specialized techniques that are only available in a plant pathology laboratory.

Make note and look for patterns where unhealthy plants or unhealthy portions of the plant are found. Collect plant samples that represent all apparent developmental stages of the disease. For example, cyclamen infected with *Fusarium oxysporum* f.sp. *cyclaminis* might be first noticed when some plants begin to become less vigorous as compared to healthy plants. Corms may have some internal discoloration. With more time, wilting might occur, at first, just on one side of the plant. In the final stages of the disease, the plant leaves become necrotic and the plant collapses. If present, all these stages should be sampled. Don't forget to collect some healthy plants or plant parts that can be used to compare against the unhealthy portions.

Samples may need to be examined more closely by a plant pathologist and laboratory analysis performed to positively identify if any pathogens are present in affected plant parts. Commercially available detection kits can be used for the detection of some pathogens at the nursery, and the test takes as little as 10 minutes. ImmunoStrip® tests (AgDia Inc. Elkhart IN) use ELISA technology where antibodies are used to recognize proteins that are unique to specific pathogens such as *Phytophthora* species, bacteria and viruses. A variant of the ELISA method is a portable lateral flow device known as Pocket Diagnostic® (Abingdon Health Products, York, UK).

Diseases are mostly managed by preventative measures and chemical controls. Fungicides and bactericides usually must be applied before infection occurs. (The exception are powdery mildew diseases, which

Scouting for Diseases and Environmental Monitoring

continued from page 6

potentially could be eradicated by some fungicides.) Early detection of diseases definitely helps so protective sprays might be applied to unaffected plants. Yet, often it is impossible to see what is actually infected since overt symptoms might not have developed yet.

Since diseases must be managed preventatively, monitoring conditions that promote diseases and unhealthy plants is very important. Crops should be inspected for issues that might cause plant problems such as under- or over-watering, fertilizer injector problems, pesticide mixing problems, and thermostat inaccuracy or heater breakdowns.

Environmental monitoring, particularly humidity and leaf wetness, is especially important. The majority of fungi, aerial nematodes and bacteria that cause plant diseases require liquid "free" water on the plant surfaces before they can infect the plant. Free water could be in the form of rain, fog, dew, sprinkler irrigation water, syringing water, or even pesticide spray. Moreover, many fungi need high humidity to produce spores. Dew formation is triggered when the surface temperature of a leaf canopy drops below the dew point temperature of the surrounding air (fig 1). This typically occurs at night in greenhouses that are not ventilated and heated properly, or outside on calm clear nights. Often the period that free water exists on the plant can dramatically affect disease severity by enhancing conditions that favor infection. In table 1 you can see that the severity of gray mold (*Botrytis cinerea*) increases with longer wet periods. Other major leaf and stem pathogens are also supported by wet periods of four hours or more of continuous leaf wetness.

Fig. 1. Dew formed at night on leaf and other plant surfaces create the favorable conditions for pathogen infection. *Photo:* S. Tjosvold.

Table 1. The effect of wet period on *Botrytis cinerea* infection of 'Volare' and 'Magic Carousel' roses.

'Volare' Wet period (hours)	Disease index[1]	'Magic Carousel' Wet period (hours)	Disease index[1]
4	1.67 a	4	0.33 a
5	2.22 b	8	0.89 b
6	3.56 c	12	1.22 b
24	4.00 d	24	3.67 c

[1]Disease index (0 to 5) 0 = no infections, 5 = all or nearly all petal tissue necrotic. Numbers in the same column followed by the same letters are not statistically different. *Source:* D. Coyier 1986.

Scouting for Diseases and Environmental Monitoring

continued from page 7

Commercial disease prediction models exist for apple scab, cedar apple rust, potato late blight, tomato early blight, strawberry anthracnose, botrytis fruit rot, citrus brown spot, lettuce downy mildew, grape powdery mildew, among others. Sensors quantify and collect leaf wetness duration and models predict disease risk (fig 2). These systems can reduce the number of sprays that are needed for disease control. It has been recently suggested that disease models instead use leaf wetness data based on a simple empirical model using relative humidity. Relative humidity sensors can be standardized and calibrated more easily than leaf wetness sensors.

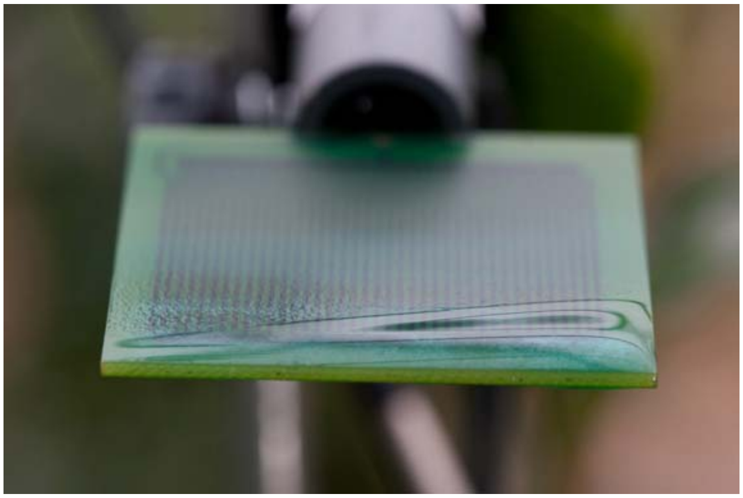

Fig. 2. Wetness sensor quantifies the potential leaf wetness that is favorable for pathogen infection. This information can be used in existing models or used empirically to predict higher risk of disease occurrence. *Photo:* S. Tjosvold.

Many current greenhouse control systems can help collect and organize data from leaf wetness, relative humidity and temperature sensors. Alternatively, a simple environmental monitoring system can be pieced together for an outdoor nursery or greenhouse using readily available sensors and dataloggers from various companies, e.g., Campbell Scientific Inc (Logan, UT), Onset (Bourne, MA), Spectrum Technologies Inc. (Aurora, IL). Most disease risk models have not been tested in ornamental crops but there is no reason why they cannot be wholly or partly used for disease risk monitoring in ornamental crops. Botrytis models have been intensively studied in other crops and should be one of the first to try in ornamental crops. Empirical evaluation of these models in the field is a first step to confirm their usefulness. Models that predict high disease risk could improve scouting efficiency by targeting more intensive scouting during these periods, help to reduce fungicide applications by predicting optimal timing of fungicides before infection occurs, and target periods when dehumidification cycles are needed in greenhouses.

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Scouting Improves Weed Management

by Cheryl Wilen

While scouting for weeds in the nursery seems straightforward, there are actually a number of details that need to be considered. The goal is not only to reduce the impact of weeds on the crop but also to make your herbicide application or other methods of weed management more reliable. In order to, the following should be considered.

What to Look For

Preemergent herbicides are applied soon after plants are placed in the bed. Uniform coverage of the media is important to provide a “layer” of protection from weed seeds germinating and establishing. However, not all weeds may be controlled by your selected herbicide. About one week after canning, plants should be

Scouting Improves Weed Management

continued from page 8

inspected for any weeds in the pots (fig. 1). If found, weeds should be removed by hand, trying not to disturb the media surface. You should also look over the bed as a whole and see if there are some sections or a pattern where there are more seedlings coming up. This

Fig. 1. Look for weeds that may come in with the liners. *Photo*: C. Wilen.

indicates that the herbicide was not applied uniformly and a reapplication may be warranted as soon as the pots are cleaned up. This is also a good time to look for weeds that are emerging in and around the bed. Weeds left uncontrolled will easily spread seeds into the bed and are also excellent places for snails to hide. Records should be kept regarding when the herbicide was applied and which weeds were not controlled.

How Long Do You Expect the Herbicide to Work?

Herbicide labels often have information about expected length of control. This should just be used as a general guide — there is no replacement for verifying control in your situation. Irrigation amount and frequency, sunlight, organic matter, etc. will modify how long an herbicide can be expected to provide control. Additionally, some weeds may "break" or not be controlled before others (fig. 2). At this stage, containers should be monitored at least every other week during cool periods of the year and weekly when warmer, as germination can be very fast as the soil temperature rises. Temperature and irrigation records are also helpful to better predict when the herbicide starts to lose efficacy. Your threshold for application of the next herbicide should be very low since almost all herbicides

Fig. 2. Weeds at various growth stages in pots. *Photo:* C. Wilen.

used in nurseries are preemergents and have limited effect on weeds once they emerge. To quantify weed emergence, it is better to use number of pots that have weeds (e.g., presence/absence) as opposed to weed cover or counts in the pots to base your decision on when to reapply. Any weeds that have emerged must be removed before the next herbicide application.

Records should include when the herbicide was applied, the date of scouting, which weeds are emerging and any areas of higher weed pressure. The records you obtain during this period can be used to predict which weeds are not controlled with the selected herbicide and how long you can expect it to work in your nursery. Over time, you will use this information to decide what and when to apply even before you see breaks in activity.

Time of Year

As noted above, scouting should be done more frequently when it's warmer than in the cooler times of the year (fig. 3). However, because some weeds grow better under cool temperatures (think of bittercress and common groundsel) and some germinate and grow better in warm temperatures (such as spotted spurge and purslane), it's important to be able to match your

Scouting Improves Weed Management

continued from Page 9

herbicide to the weeds you expect to be problems. Monitoring areas surrounding the nursery or the bed can help provide you with information about when these weeds are germinating.

Modify your herbicide choice, if needed, to have better control of the weeds that will be growing in that period.

Fig. 3. Scout for weeds at least weekly in warmer times of the year. *Photo:* C. Wilen.

Surrounding Areas

Areas around the nursery and in and around the planting beds should be monitored for weed emergence as well. This not only helps you predict which weeds can be problematic, it also gives you a chance to control them with postemergence herbicides or mechanical methods before they flower and disseminate their seeds. It also helps to identify what the reasons are for the weeds growing in those areas. Are you applying too much water? Is drainage a problem? Are there holes in the nursery cloth? Are the weeds growing in spilled potting media? Correcting the problems that encourage weed growth will have an overall positive effect on weed management in the growing areas.

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Scouting for Snails and Slugs

by Cheryl Wilen

Snails and slugs feed on a wide variety of plants in nurseries. Monitoring for these pests is important, not only to prevent economic losses due to crop damage, but also because quarantine regulations impact plants shipped out of state as well as some intrastate locations. Common snail and slug species found in nurseries include the brown garden snail (*Cornu aspersum*, formerly *Helix aspersa*), amber snail (*Succinea* spp.), gray garden slug (*Deroceras reticulatum*, formerly *Agriolimax meticulatus*), banded slug (*Lehmannia poirieri)* and the greenhouse slug (*Milax gagates).* Both snails and slugs are members of the mollusk phylum and are similar in structure and biology except slugs lack the snail's external spiral shell. Adult brown garden snails (fig. 1) lay about 80 spherical, pearly white eggs (fig. 2) at a time into a hole in the topsoil. Although the eggs are white initially, as they develop they turn brown and may be mistaken for some brands of slow-release fertilizer. Brown garden snails may lay eggs up to six times a year.

Fig. 1. Brown garden snails. *Photo:* C. Wilen.

Scouting for Snails and Slugs

continued from page 10

Snails and slugs are most active at night and on cloudy or foggy days. On sunny days they seek hiding places out of the heat and sun. In mild-winter areas such as in Southern California and in coastal locations, young snails and slugs are active throughout the year. During cold weather, snails and slugs hibernate in the topsoil. During hot, dry periods, snails seal themselves off with a parchment-like membrane and often attach themselves to the outside of pots, tree trunks, fences, or walls.

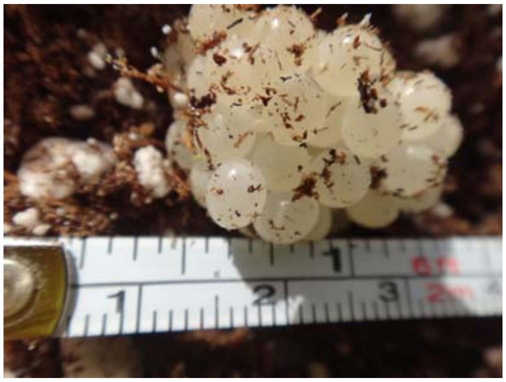

Fig. 2. Brown garden snail eggs are pearly white and may be found in clusters in the media along the inside of the pot. *Photo:* C. Wilen.

Snails and slugs often hide but can often be found attached to the outsides of pots. Slugs and snails constantly secrete mucus, which later dries to form the silvery "slime trail" that indicates the presence of these pests. The scout should be on the lookout for these trails. Other clues to their presence include feeding damage on plants (holes in the leaves) and, for some species, spiraling feces. Amber snails (fig. 3) are more difficult to detect as they are generally small (2-20 mm long) and tend to live on the media surface. Look for these snails in the pots and at the interface of wet and dry areas between the media and the container. Slugs tend to be found underneath the containers and often in the media. Slug eggs are difficult to find, but the eggs of the brown garden snail can sometimes be found in the container media, often along the inside of the pot in clusters of about 10 to 50 eggs (fig. 2). Typically these are not noticed until the plants are sized up to larger containers.

Fig. 3. Amber snails are unable to retract fully into the shell. They are generally small and may be difficult to detect. *Photo*: C. Wilen.

When monitoring for snail and slugs, the scout should check the pots by moving them, especially if can tight. Plants should be inspected frequently especially if the plants have leaves that are close to the stem where snails can hide during the day. Also inspect around the beds, including pieces of wood or stakes, near weeds and under the edges of the nursery mat.

In addition to visual observations, an effective method for sampling snails and slugs is by trapping these pests under 12-by-15 inch boards (or any easy-to-handle size) raised off the ground by 1-inch runners. The runners make it easy for the pests to crawl underneath when they seek a cool, moist location during the day. By positioning the boards around the nursery or greenhouse, one can get an idea about population pressure and hot spots. However, this method will not work for amber snails, which live on the pot media.

Another method of monitoring that is effective for the brown garden snail is to place an attractive bait containing metaldehyde in small piles strategically around the growing areas. Nearby snails will be drawn to the bait overnight and will quickly die. The next morning, the number of dead snails can be counted to get an idea about population pressure and hot spots as described above. If you have dogs wandering the nursery, place the metaldehyde in a way that it is accessible to the snails but not the dogs, such as in a commercial bait trap.

For more information, see the Floriculture and Nursery Pest Management Guidelines from UC IPM at http://ipm.ucanr.edu/PMG/r280500111.html

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UC Demonstrates Benefits of a Scouting Program for Insects and Mites

by James Bethke

During my first few years as an advisor with Cooperative Extension, I was contacted by a grower who was desperate because he could no longer kill one of his major pests, the twospotted spider mite. Obviously, the first thing I thought of was that there was miticide resistance. I knew in order to assist this grower, I was going to have to investigate his spray program and recommend a good rotational program. On my first visit, the problem was immediately apparent. On the wall outside his office was a routine spray program for a tank mix that included very few miticides, Orthene and fungicides. This tank mix was sprayed on all of his plants every Saturday, and the program was written out for an entire year.

Hopefully, you can see the issue right away. This kind of pest management program is fraught with problems and doomed to fail. The entire arsenal in his pesticide shed was exceptionally small. It was clear that he needed to increase the number of rotational products immediately. However, that was the least of his problems. Why spray all plants every time? Is every plant in the facility infested? It was clear that the grower needed some assistance in organizing an effective integrated pest management program. The most important components of IPM programs are scouting and basing pest management decisions on monitoring, rather than spraying on a calendar schedule. Therefore, our research group dedicated the time necessary to train the grower and his staff on how best to scout and treat major ornamental pests. This article describes the process and some of the results.

Mapping

The very first thing we did was to number all of the benches in the facility and create a map of the three growing areas. Fig. 1 represents of one of these growing areas. Using the maps and bench numbers, we could document plant types, plant movement and pest management trends. Following our mapping, we noticed that mite-sensitive plants such as dieffenbachia and neanthe bella palm were spread throughout all three growing areas. If the mite-sensitive plants were heavily infested, they were acting as a reservoir to infest less sensitive plants, thereby forcing the treatment of plants that were typically not infested with mites. We recommended grouping these mite-sensitive plants together. In this way, scouting and management practices could be intensified in these areas.

Scout Team

Scout. We dedicated one of our UC staff as the scout who would use indirect sampling techniques (trapping the surrounding area using sticky cards, pheromone traps, black light traps, etc.) and direct sampling (sampling the actual plant, such as leaf and stem samples, visual observations of plant parts, tapping flowers on white paper, etc.) to monitor pest populations and locations. Further, one employee at the nursery facility would be trained and shadow the scout. It is very important to have trained, knowledgeable staff as pest management scouts. They should become familiar with specific problems on specific plants, seasonal trends and thresholds. We also brought a stereomicroscope from our lab to help us identify pests, and we eventually convinced the grower to purchase one because it is very useful in identifying pests and observing mortality following spray applications.

Workers. We asked the supervisors to train their staff to notify us of any unusual looking plants or plant parts that might be indicative of a pest problem. These employees know the plants well, and would be the most apt to see problems, as they have the most contact with the plants.

Decision Maker. I served as the decision maker, the person who recognized the level of pest-required control measures and decided what control measures were to be employed. I used the weekly pest report (fig. 2) as a tool for decision making.

UC Demonstrates Benefits of a Scouting Program for Insects and Mites

Continued from Page 12

Fig. 1. Diagram of one of three growing areas at a cooperating grower's facility. The growing area is all under one greenhouse roof with four peaks. The top of the diagram represents the cooling pad of a fan-and-pad system. The references to greenhouses 1–4 are the four peaks (four different colors) or houses within the growing area. The yellow area is the center aisle. The benches under each house are numbered 31 through 58. The plant types on each bench (within colored area) are listed with the bench number. The white area above each colored bench area references hanging plants above the respective bench.

				TO COOL				
	SUCCULEN	RUBBER		HOUSE		ZAMIA		
	SPIDER SYNGONIU.	DIEFF FERN	31	syngonium in rows	32	PACHIRA		
	FERN	MARANTA		of five		ZAMIA	SAGO	
	SYNGONIUM		33		34	PACHIRA		
	SAGO			Greenhouse		SAGO		
	SYNGONIUM		35	1	36	ASPLENUM	PACHIRA	
	SAGO					SAGO		
	DIEFFENBACHIA		37		38	NEANTHE BELLA		
	SAGO					SAGO		
	DIEFFENBACHIA		39	Greenhouse	40	ZZ		
	SAGO			2		SAGO		
	DIEFFENBACHIA		41			ZZ		
	CORDATUM				SUCCULEN	GOLDFISH	ASP. FERN	HOYA
	DIEFFENBACHIA		43		44	ZZ		
	CORDATUM				SUCCULEN	GOLDFISH	ASP. FERN	PHILO
	DIEFFENBACHIA		45		46	ZZ	NEANTHE BELLA	
	CORDATUM			Greenhouse		SYNGONIUM		
	DIEFFENBACHIA		47	3	48	ZZ	NEANTHE BELLA	
	CORDATUM				SUCCULEN	GOLDFISH	ASP. FERN	
	NEANTHE BELLA		49		50	NEANTHE BELLA		
	SPIDER					SPIDER		
	D.MARGINATA		51		52	NEANTHE BELLA		
	SPIDER			Greenhouse		SPIDER		
	NEANTHE BELLA		53	4	54	D. MARGINATA		
	FERN					SPIDER		
	D. MARGINATA ZZ	CORDYLINE	55		56	D. MARGINATA		
ZZ\ PACHIRA	PHILODENDRON RUBBER PLANT		57		58	D.MARGINATA		

UC Demonstrates Benefits of a Scouting Program for Insects and Mites

continued from Page 13

Sampling Methods

Indirect Sampling. Yellow sticky cards were not employed at the facility, so we hung a yellow card under each peak and on each side of the center aisle. These cards would give us an idea of the flying insect pests in the area and those that could impact plants at the facility. Caterpillars were never a problem for this grower, so we did not employ any pheromones or black lights at the facility. We found an area of fungus gnats that needed to be monitored weekly.

Direct Sampling. Indirect sampling does not tell the whole story. Finding numerous flying pests (adults) on a sticky card does not mean that there is a growing pest population (adults and immatures) on the plants. It is a relative measure and a seasonal trend indicator, an early warning system at times. Therefore, we also employed direct sampling techniques. The scout walked the entire facility in a day looking for any obvious pest infestations like aphids, randomly turning leaves over looking for pests common on the undersides such as whiteflies and mites. Leaves or plants with obvious pest damage were observed under the microscope in search of live or dead pests. Direct sampling helps identify specific pest locations, the relative level of infestation, and the most prevalent stage of development of the pest. The development stage may be important because each stage may require that a different pest control measure be employed. Further, direct sampling helps evaluate pest control measures.

Record Keeping

Keeping records will greatly increase your ability to identify pest trends that can help to make pest management decisions. We created a scouting form specific to this facility (fig. 2). The form contained only information from

I.P.M. Scouting Summary: Insects									
Date:	3/30/06			Scout Name	MW	Total time	7.5		
PLANT/LEAF SAMPLES:									
ROW	PLANT		Aphid	Mites	Thrips	Whitefly	Scale	Fungus Gnats	Mealy Bug
4	DIEFFENBACHIA			X					
5	CROTON							X	
20	MASS CANE			X					
22	PACHIRA			X					
23	NEANTHE BELLA			DEAD MITES					
28	POLYSCIAS	**WATCH**							
30	PACHIRA			X					
30	PACHIRA TREE			X					
SECTION 2	ORCHID								X
39	DIEFFENBACHIA			X					
CH 2	FICUS			X					
28	CHINA DOLL			CLEAR					
59	COCO PALM								X LIVE
102/104	IVY			X					
62	COCO PALM			X					

Sampling revealed mites that were still moving in samples from same areas noted last week, and mite eggs and young were observed on pachira.
There was some reduction of mite population but still major pest. Polyscias leaves curled, no insect activity observed.
Hanging hoyas had aphids; removed all of the plants. The area will be monitored so there is no spread.
Coco palms under orchids had live mealy bugs and young on them, although no feeding activity seen. Did not observe whitefly this week.

Fig. 2. Weekly data sheet created for monitoring a cooperating grower's facility. There were three SECTIONS or greenhouses with multiple peaks or houses within, and each ROW represents a numbered bench in a specific house where a pest was found (or notations made) that could be cross-referenced easily with our map (fig. 1). The plant type observed on each bench is noted under the category of PLANT. The name of the scout and how much time was spent (hours) scouting is displayed above. Common insect and mite pests found in this type of production are listed as headers. An X represents the presence of the pest and sometimes descriptions are noted in the cells, and finally, a written description of the issues found during scouting, such as the severity of the infestation is written below the scouting form.

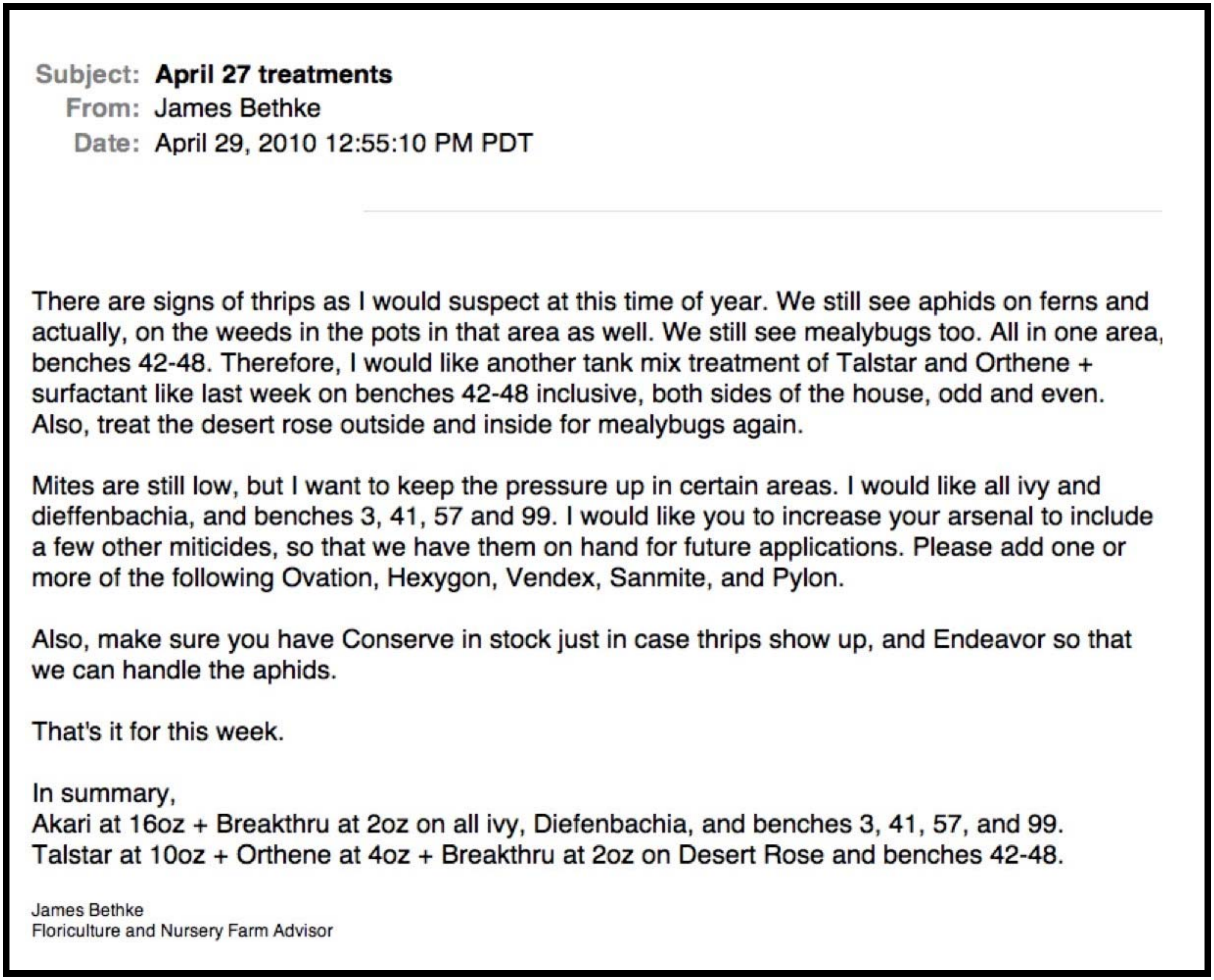
UC Demonstrates Benefits of a Scouting Program for Insects and Mites

continued from page 14

infested areas and not from every area in every greenhouse, and the reports were typically short. The form contained several categories based on our mapping. See the caption of fig. 2 for an in-depth description on how this form was used.

Recommendations

Once I received the report from the scout, I was able to provide pest management options and, very importantly, recommend treatment of specific infestations, and not the whole facility. Fig. 3 is an example of one of those recommendations. Note that it includes a suggestion to increase the number of different types of miticides so that the grower could do a more effective job of resistance management.



Subject: **April 27 treatments**
From: James Bethke
Date: April 29, 2010 12:55:10 PM PDT

There are signs of thrips as I would suspect at this time of year. We still see aphids on ferns and actually, on the weeds in the pots in that area as well. We still see mealybugs too. All in one area, benches 42-48. Therefore, I would like another tank mix treatment of Talstar and Orthene + surfactant like last week on benches 42-48 inclusive, both sides of the house, odd and even. Also, treat the desert rose outside and inside for mealybugs again.

Mites are still low, but I want to keep the pressure up in certain areas. I would like all ivy and dieffenbachia, and benches 3, 41, 57 and 99. I would like you to increase your arsenal to include a few other miticides, so that we have them on hand for future applications. Please add one or more of the following Ovation, Hexygon, Vendex, Sanmite, and Pylon.

Also, make sure you have Conserve in stock just in case thrips show up, and Endeavor so that we can handle the aphids.

That's it for this week.

In summary,
Akari at 16oz + Breakthru at 2oz on all ivy, Diefenbachia, and benches 3, 41, 57, and 99.
Talstar at 10oz + Orthene at 4oz + Breakthru at 2oz on Desert Rose and benches 42-48.

James Bethke
Floriculture and Nursery Farm Advisor

Fig. 3. An example of pest management decision making at a local cooperating grower's facility.

UC Demonstrates Benefits of a Scouting Program for Insects and Mites

continued from Page 15

Conclusions

By implementing scouting practices and focusing pesticide applications to the areas of need, we were able to demonstrate to the grower that he could reduce overall pesticide use. I felt, however, that it was critical that the grower increase the number of different chemical mode of actions because the mites in the facility were very tolerant to miticides. That initial increase in the number of pesticides increased costs initially, but the grower would benefit in the long run from better efficacy through good rotation of chemicals. The consistent spraying of a tank mix of a small number of products on a scheduled basis was causing the most serious problem at his facility. He is now employing a regimented rotation of miticides, and his mite resistance problem is under control. A good description of the miticides and rotation can be found at the following link on the UCNFA website: http://ucanr.edu/sites/UCNFA/files/181232.pdf.

As I mentioned before, the grower purchased a microscope and he and his staff use it regularly. Additionally, I was very encouraged to receive an email from him that indicated that he had improved upon our recording-keeping methods and mapping by creating his own personalized maps and forms. He got it!

James A. Bethke is County Director and Farm Advisor for Nurseries and Floriculture, UC Cooperative Extension, San Diego and Riverside Counties.

SCIENCE TO THE GROWER: Are plants intelligent enough to earn a scouting merit badge?

by Richard Evans

I know what you're thinking as you read about scouting in this issue of *UCNFA News*. You're thinking about all the time and money you'll have to spend detecting pests and deciding when a problem requires action. Wouldn't it be nice if plants could get off their butts and take care of business themselves? It's not so far-fetched. Plants may seem like couch potatoes, but there is abundant evidence that they can take an active role in scouting. They can recognize pests, count their numbers, defend themselves from attackers, warn neighboring plants that pests are present and even send out orders for pest management.

The best-known example of a plant monitoring and responding to insects is the Venus flytrap (*Dionaea muscipula*). It responds to an insect touching the trigger hairs located on each leaf-like lobe of the trap. The trap snaps shut when two trigger hairs are bent, or when one hair is bent twice, within about 15 to 20 seconds (Escalante-Pérez and others 2011). Yes, plants can count and tell time! The flytrap doesn't waste much energy on false alarms, either. It secretes digestive chemicals only after the trapped insect triggers the hairs three more times (Böhm and others 2016).

Another well-known response is that of the sensitive plant, *Mimosa pudica*. It folds its leaflets in response to physical disturbance, apparently as a defensive response to herbivores. Since many leaf disturbances are non-threatening, it would be to the plant's benefit if it could decide whether to respond, rather than wasting energy every time the wind blows. Monica Gagliano, an Australian ecologist, made a remarkable discovery when she conducted experiments on potted *Mimosa* plants (Gagliano and others 2014). She constructed a device that dropped the plants from a height of about 6 inches every 5 seconds. Leaflets closed after the first drop, but the plants stopped responding after a few more drops, and all leaflets were open by the time the plants had been dropped 60 times. The plants recognized that the

SCIENCE TO THE GROWER: Are plants intelligent enough to earn a scouting merit badge?

continued from Page 16

disturbance was annoying, but not threatening. Or maybe they got bored. However, if the plants were disturbed in a different way, like shaking them from side to side, the leaflets closed again. If Gagliano commenced dropping them again, the plants didn't respond. They remembered that dropping 6 inches wasn't going to damage them. In fact, the plants remembered for as long as 28 days! Even more amazing is that *Mimosa* plants growing in low light conditions, where leaf exposure to light is essential to maximize photosynthesis, are more likely to ignore leaf disturbances than plants exposed to high light conditions. Apparently they recognize that when light is in short supply it's worth spreading leaves to photosynthesize, even if it increases the risk of getting chomped.

These are both examples of rapid plant responses that we can easily observe. But plants have a surprisingly large array of senses, and most of their responses to pests seem subtle to us, but perhaps not so subtle to the attackers. In addition to sensing light and moisture, they can detect gravity, pressure, surface texture, air and soil volumes, nutrients like nitrogen and phosphorus, toxic chemicals, chemical signals from plants and other organisms, and microbes. For instance, tobacco and soybean plants can detect the footsteps of caterpillars crawling on leaves. Glandular trichomes — hair-like cells on plant surfaces — get ruptured when caterpillars crawl by. Within seconds, the leaves create toxins that provide protection until the plant can synthesize and release systemic compounds to resist attack (Peiffer and others 2009). Goldenrod plants that detect the pheromone sex attractant of a gall-forming fly initiate chemical changes that make the plants unappealing to egg-laying female flies (Helms and others, 2013).

Plants have other early-warning systems, too. They can detect the presence of insect saliva, pheromones, skin (cuticle) and frass (Ray and others 2015). Plants recognize that these are evidence of insect presence. They even remember these cues of potential insect attack so that they can defend themselves quickly and vigorously the next time insects seek a meal (Conrath, 2011). For example, plants may detect insect egg-laying from physical signals, insertion of the eggs into plant tissue, or chemical signals released by the eggs or the female insect. Detection of egg laying can lead to all sorts of responses. When the Colorado potato beetle lays eggs on potato leaves, the leaf cells within a couple of millimeters of the egg mass undergo a hypersensitive response which kills the cells that have attached eggs. When these cells dry out, the eggs fall off the plant, where emerging insect larvae are likely to be eaten themselves (Balbyshev and Lorenzen 1997). Rice plants respond to leafhopper egg-laying by releasing a chemical that kills the eggs (Suzuki and others 1996). When elm leaf beetles lay eggs on elm trees, the trees release a volatile chemical that attracts a parasitoid wasp species that specializes in attacking elm leaf beetle eggs (Meiners and others 2000).

Sometimes the plant summons a parasite that attacks the insect larvae instead of eggs. After cabbage butterflies lay eggs on a black mustard plant, the plant produces a volatile compound that attracts a parasitic wasp to feeding caterpillars (Pashalidou and others 2015). This plant can even detect what sort of insect eggs have been laid. If a black mustard plant detects egg laying by a butterfly whose larvae adore the taste of black mustard leaves, the plant goes into defense mode. If the eggs are deposited by a species whose larvae are likely to move on without doing much damage, the mustard plant doesn't waste energy building up its defenses (Pashalidou and others 2013).

The Scots pine has a particularly remarkable response to egg laying by sawflies. Exactly three days after eggs are laid, the pine needles produce a chemical that summons an insect that parasitizes sawfly eggs (Hilker and others 2002). Why wait three days? Because that is when the insect predator is most successful at parasitizing the eggs.

However, early warning systems don't always prevent attacks. You may know that when insects do start gnawing, plants react by producing defensive chemicals to limit the damage. This might surprise you, though: plants can also hear insects having a meal. Heidi Appel and Rex Cocroft, researchers at the University of Missouri, recorded the acoustic vibrations that caterpillars make while eating leaves, then played back those recordings later to other plants that hadn't been touched by the caterpillars. Those plants responded by producing defensive chemicals that made them unappealing to the caterpillars (Appel and Cocroft

SCIENCE TO THE GROWER: Are plants intelligent enough to earn a scouting merit badge?

continued from page 17

2014). Remarkably, the plants could distinguish these caterpillar feeding sounds from acoustically similar insect sounds, which did not stimulate production of chemical defenses by the plant.

Sometimes plants ask for assistance from others. Aphid-free fava bean plants that are connected via a mycorrhizal network to plants that have suffered aphid attacks will produce chemicals that repel aphids and attract aphid parasitoids (Babikova and others 2013). Common bean plants attacked by twospotted spider mites react by producing methyl salicylate, a volatile chemical signal that can attract insect predators. However, if the bean plants have formed mycorrhizal associations prior to attack and the spider mites have been present for more than three days, the mycorrhizae modify the chemical signal to make it strongly attractive to the predatory mite *Phytoseiulus persimilis*, which can control the spider mite infestation (Schausberger and others 2012).

Plants even warn their neighbors and family of insect threats. Rick Karban's group at UC Davis found that sagebrush plants can communicate with each other through emission of volatile chemicals. When they clipped leaves of a plant to simulate an insect attack, both the clipped plant and its neighbors were subsequently less likely to suffer insect damage (Karban and others 2006). Sagebrush plants even recognize their close relatives through these volatile emissions. Closely related plants experienced less insect damage than neighboring plants that were more distantly related (Karban and others 2013).

These studies demonstrate that plants can take care of pest scouting and implement their own integrated pest management program. So why don't they get off their lazy roots and do it? Part of the answer has to do with the fact that all of these ways to combat pests evolved over many millions of years of natural selection. The fittest survive and pass on their genes to the next generation, but they rarely survive undamaged because pests are not usually eliminated completely in natural systems. And the pests can evolve, too, so that they can trick, avoid, or overcome plant defenses. The problem may be compounded by us, because these pest scouting traits in plants have been neglected in most breeding and selection of commercial cultivars.

There may be ways we can take advantage of the pest management skills in plants, or even enhance them. Some researchers already are trying to genetically modify plants — mostly food crops, so far — to increase their production of volatile compounds that repel pests and attract insect parasites. A British group genetically engineered wheat to produce a pheromone that repels aphids, and demonstrated that the transformed wheat plants were aphid-free. However, aphids reared in the presence of those wheat plants lost most of their sensitivity to the pheromone within five generations (Bruce and others 2015), so it isn't a promising long-term solution. Many of the plant-pest interactions I've described are complex, and some scientists think that current methods of genetic engineering are unlikely to work on such complex interactions (Stenberg and others 2015).

Another interesting idea is for growers to use detection of the volatile compounds released by plants in their scouting programs. A group of biologists and engineers in Missouri and Michigan built an instrument they called an "adaptive two-dimensional microgas chromatograph" —basically a mechanical sniffer — with the idea that it could be used to detect plants under attack (Liu and others 2012). The device would be pulled between rows of crop plants, where it could alarm the grower when it detected production of pest-induced plant volatiles. Unfortunately, last I heard they did not have sufficient funding to construct and test an instrument that could be used in the field. Maybe someone needs to get to work on a money detector.

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SCIENCE TO THE GROWER: Are plants intelligent enough to earn a scouting merit badge?

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SCIENCE TO THE GROWER: Are plants intelligent enough to earn a scouting merit badge?

continued from page 19

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INSECT HOT TOPICS: Chinese Rose Beetle

by James A. Bethke

This column focuses on insects that pose a threat to the ornamental plant production industry and have good potential for invasion and establishment in California.

As some of you are probably aware, the California Department of Food and Agriculture has been fighting a persistent infestation of the Japanese beetle in small residential areas near Sacramento. I have written about the threat that the Japanese beetle poses to California landscape and agriculture in a previous issue of "Insect Hot Topics" *(UCNFA News, Spring 2014, Volume 18. issue 1)* Recently, inspectors intercepted a package of purple sweet potatoes from Hawaii and found a very similar beetle, the Chinese rose beetle (*Adoretus sinicus* Burmeister), which is an economically important pest in Southeast Asia, China and many Pacific islands including Hawaii (McQuate and Jameson 2011). It is thought to originate from Japan and Taiwan. The Chinese rose beetle is noteworthy and everyone should be on the lookout for this pest.

The Japanese beetle is a very serious landscape pest and anyone who has lived back east is very familiar with the damage and nuisance the Japanese beetle presents. The Chinese rose beetle is equally as polyphagous and could be a threat to landscapes, ornamental production and agriculture in California. Like other chafers, adults are generalist foliage feeders and can feed on over 500 plant species (Hession et al. 1994). According to McQuate and Jameson (2011 and references therein), host plants include broccoli, cabbage, cacao, Chinese broccoli and cabbage, chiso, corn, cotton, cucumber, eggplant, ginger, grape, green beans, jack fruit, okra, peanuts, Oriental persimmon, raspberry, roses, salak palm, soybean, star fruit, strawberry, sweet potato, taro and tea.

The adult Chinese rose beetle is reddish brown and about ½ inch long (fig. 1). Adults come out at dusk and feed for a couple of hours before retreating to the duff at the base of nearby plants. The Chinese rose beetle causes very characteristic feeding damage, producing paired holes in leaves and often leaving a narrow strip of leaf intact in the middle. The characteristic interveinal feeding is caused by the beetle's unusual mouthparts. When feeding on a leaf surface, the beetle uses only one side of its mouth at a time. Dr. Arnold Hara from the University of Hawaii says that leaves can look like lace or like they have been peppered with buckshot, and there may be

Fig 1. Chinese rose beetles feeding on rose. *Photo:* Dr. Arnold Hara, University of Hawaii, College of Tropical Agriculture and Human Resources.

INSECT HOT TOPICS: Chinese Rose Beetle

continued from page 20

nothing left but the veins (fig. 1).

Like other scarab beetle grubs found in California and elsewhere, grubs are c-shaped and live in rich soil, leaf litter, decaying vegetation, or compost, where they feed on dead plant tissues. They are not known to be live root feeders causing root damage.

Like other invasives, control options are far and few between. There are no current biological control options, and pesticide control options are limited, especially considering the wide range of crops that can be attacked. General broad-spectrum products such as organophosphates and carbamates and are considered suppressive. Additionally, tests of synthetic lures developed for Japanese beetles and other scarab beetles failed to demonstrate attractiveness for Chinese rose beetles, which poses a challenge to trapping and detection.

Pesticides, kairomones (plant-based attractants) and pheromones (sex and aggregation) are critical for managing existing pest populations as well as for countering new invasions that are likely to occur, largely due to the movement of agricultural goods. Hopefully, research will identify good management options in the future.

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REGIONAL REPORT—— UC Cooperative Extension

Santa Cruz/ Montery Counties

Field observations: Foamy bark canker and sudden oak death
***by* Steve Tjosvold**

Foamy bark canker has been detected for the first time in Santa Cruz County and sudden oak death has been found for the first time in San Luis Obispo County. Growers in these counties should be on the lookout for these pathogens and be aware of the quarantine regulations that may affect them.

REGIONAL REPORT: San Diego and Riverside Counties

continued from page 21

Foamy Bark Canker

In early September 2016, CDFA identified foamy bark canker (*Geosmithia pallida)* from beetle galleries found in a canyon live oak (*Quercus chrysolepsis*). This was the first official detection of foamy bark canker in Santa Cruz County and the first detection on this oak species. The sample was found in the Santa Cruz Mountains, close to the Santa Clara County border on a homeowner's property.

Declining oak species have been found in urban landscapes and open spaces throughout the coast range of California. The disease is associated with the western oak bark beetle. Symptoms occurring on the trunk and primary branches include wet discoloration seeping through the beetle's entry holes. The seepage is often "foamy." The understanding of disease biology and management are only beginning to be understood.

Declining coast live oak (*Quercus agrifolia*) trees have recently been found throughout urban landscapes in Los Angeles, Orange, Riverside, Santa Barbara, Ventura and Monterey counties. A fungus associated with a specific beetle is causing the decline by spreading what is known as foamy bark canker disease.

Fig. 1. Suspect foamy bark canker in Santa Cruz County November 2015. *Photo:* Nigel Belton.

See link http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=18801.

Sudden Oak Death

Sudden oak death *(Phytophthora ramorum)* was detected for the first time in San Luis Obispo County during the 2016 citizen scientist-based sudden oak death survey (SOD Blitz) of California forests and parks. Positive samples were found on California bay laurel throughout much of the county in native landscapes, making it the 16th *P. ramorum*-positive county in the state and the southern-most wildland detection. Mortality of susceptible true oaks is not yet evident, suggesting the outbreaks are recent. Because these are the first detections of the pathogen south of Monterey County, the UC Berkeley Garbelotto lab will be working closely with the California Department of Food and Agriculture and USDA Animal and Plant Health Inspection Service to validate the data for regulatory use. This finding may expand the quarantine and therefore may affect nurseries located in the expanded quarantine.

Many common nursery crops are susceptible to the pathogen which and can infect leaves, stems and roots. Soil can be infested with long-lived chlamydospores and mycelium in plant debris and fallen leaves. Although the disease is usually not serious on ornamental crops, there is concern that the pathogen could be moved on nursery stock to new areas and eventually infect new landscape and forest hosts. There are federal and state quarantines that require inspections for nursery stock shipments from quarantined counties and periodic annual inspections and sampling of hosts. If the pathogen is detected eradication of the pathogen is necessary and affected plants will be destroyed.

Although hosts of *P. ramorum* show a range of symptoms, in general the disease is characterized by irregular necrotic leaf lesions, rather than distinct leaf spots. Leaf infections can develop down the petiole and

REGIONAL REPORT—-Santa Cruz/Monterey Counties

continued from page 22

into twigs. Often, such as in camellia, infected leaves fall off before the lesion reaches the petiole. Infections may occur initially on stems or move into stems and cause blights in which stems and associated leaves wilt, become necrotic and die. A distinct dark line can mark the advance of the infection on some species. Root infections are not commonly seen because they are either not common or symptoms are not expressed.

Fig. 2. Rhododendron leaves infected with *Phytophthora ramorum*. *Photo*: S. Tjosvold.

Symptoms are not always readily apparent on nursery stock, and a weekly systematic monitoring of introduced stock or other plant material by a trained nursery scout helps ensure that the pathogen has not been introduced. For high-risk incoming shipments, unload nursery stock in an area that can be cleaned of leafy debris, because infected leaves often drop from plants. Sweep debris from the receiving area and delivery truck and bag for disposal. Loading and delivery areas should be as far from production areas as possible.

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REGIONAL REPORT —UC Cooperative Extension

Salts at work Again
by James Bethke

A pest control advisor (PCA) who wanted me to visit a cut foliage producer in San Diego County recently called me. The grower was complaining about what he thought was a pathogen on his eucalyptus (fig. 1), and he wanted me to identify it and make a recommendation on how to clear it up. The grower, the PCA and I stood in the eucalyptus and discussed the situation at length, and I took many samples. As the discussion continued I asked what species or varieties were affected. The grower said all of them were affected. It is not common for all species and varieties to be affected by a pathogen all at the same time and on so

REGIONAL REPORT: San Diego and Riverside Counties

continued from page 23

many acres of rolling hills. There's usually a pattern. I asked him if he grew other cut foliage and if they were affected. The answer again was yes, all of them. So, we took a walk around the growing grounds and each plant type had different symptoms (fig. 2) but they were all being affected by the same thing, be it pathogen or arthropod or some abiotic factor. I asked about his watering and fertilizer regimen. That was the key factor in the problem. The owner was very concerned about the cost and scarcity of water so he only allowed two hours of watering through a two-gallon emitter on a weekly basis. That's not enough, and if you do that long enough, salts will build in the soil root zone and stunt and burn the new growth. Further, that damage to the roots will cause the entry of secondary pathogens that may also cause plant damage. This is why every plant type throughout the entire growing grounds was affected.

Fig. 1. Leaf damage on eucalyptus thought to be a pathogen but no pathogens were present. Salt damage was occurring on all plants grown in the field. *Photo:* J. Bethke.

A second recent call was very similar. A grower of barrel cacti was concerned about yellowing and lack of roots. Again his watering regimen was based on the scarcity and cost of water. He was using city water but the quality of the city water was questionable. A simple recommendation of a good flush of water for about 8 hours and give the plants a little liquid feed fertilizer worked. Voilà, very happy, green and root-growing cacti in about two weeks.

Fig. 2. Tip burn damage to leucadendron likely caused by heavy salt content in the soil. *Photo:* J. Bethke.

The cost of water has caused many field producers (ornamentals and permanent crops) to reduce their water usage significantly. As that water evaporates and transpires (ET), salts are left behind in the root zone. If salts buildup, they may cause root and plant damage. In this situation, a soil analysis would indicate a high electrical conductivity (EC) or total dissolved salts (TDS). If this is the case, a simple soil flush with water could help leach the salts below the root zone. In the long run, this can be managed by applying enough water at each irrigation to meet the water demands of the plant (ET) and an extra portion of water for irrigation inefficiency and salt leaching. For more information on salinity and management, see the resources below.

REGIONAL REPORT: San Diego and Riverside Counties

Continued from page 24

Resources

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CDFA NURSERY ADVISORY BOARD REPORT

by James A. Bethke and Loren Oki

On Wednesday September 14, we convened at the California Department of Food and Agriculture (CDFA) Building in Sacramento. There was a full agenda, which included a visit from California Secretary of Agriculture Karen Ross. We began with a roll call and introductions. The room was packed and the majority of the representation at the table was from San Diego County, including the County Ag Commissioner, the San Diego Farm Bureau Executive Director, numerous owners and myself. Updates included the following topics: medical cannabis, State Interior Quarantines and the PD/GWSS program. There was also an introduction to the "Systems Approach to Nursery Certification" and a business meeting.

Amber Morris is now in charge of the Cannabis Cultivation Program at CDFA. Amber gave us an update on the new provisions being instituted at CDFA concerning cannabis. There will be six different license types: one from the CDFA concerning nurseries and cultivation, four from the Department of Consumer Affairs, and one from the Department of Public health.

CDFA NURSERY ADVISORY BOARD REPORT

Continued from page 25

Each cultivated plant will be tagged and tracked, but the industry is requesting that the tracking be by area and not by plant. There will likely be tracking of plant parts from individual plants as well. The nursery industry was surveyed for input into the seven CDFA goals located at the following web site: cdfa.ca.gov/is/mccp. One thing was made clear; nurseries must sell to a distributor not to the public. There is a lot of information on that web page, so if you are interested, please check out the site. However, just remember that the University of California will not be assisting growers of cannabis in any way. We are federally funded and the feds still consider cannabis a Schedule I drug.

At this point in the meeting, we were interrupted by a visit from Secretary Ross. It was a great discussion with her, but the only thing I think is worth reporting was that she was clearly distressed by the unfair way agriculture is being treated in the state legislature and that the media is playing along. She explained that the environmental justice and civil rights groups are in their prime and are well represented at the statehouse.

Concerning quarantine efforts updates, the glassy-winged sharpshooter program has been documenting excellent success. An update on the HLB/ACP state interior quarantines was provided: HLB has been detected in Mexicali, which means the inevitable is here. There are presently no fruit fly quarantines. Twist ties will no longer be used in LBAM quarantines because the CDFA has moved from an eradication effort to a control program. The Japanese beetles are still under eradication just outside the Sacramento area. However, there is an effort to stop pesticide treatments by concerned citizens. Activists have gathered in treatment areas so that applications cannot be made. Establishment of the Japanese beetle in California would make it difficult on shipping nurseries.

David Cox from LE Cooke updated us on the Systems Approach for Nursery Certification (SANC) Program. There was nothing really new to report at this time. There are eight nurseries in the pilot program and completion of phase one should be complete by the end of 2016. The Nursery Advisory Board made a motion to make sure that a nursery from California was included in the pilot program, and that motion passed.

Loren Oki and I will keep you up to date on information from future Nursery Advisory Board meetings.

James A. Bethke is County Director and Farm Advisor for Nurseries and Floriculture, UC Cooperative Extension, San Diego and Riverside Counties, and Loren Oki is UC Cooperative Extension Landscape Horticulture Specialist, Department of Plant Sciences, UC Davis.

CAMPUS AND COUNTY NEWS: Maggie Reiter is a new environmental horticulture advisor

submitted by Paulina Jacobs-Sanders

We are happy to welcome Maggie Reiter, a new UC Cooperative Extension environmental horticulture advisor in Fresno, Madera, Tulare and Kings counties. Maggie received an undergraduate degree in horticulture and a master's degree in applied plant science, both from the University of Minnesota. Her studies focused on turf grass science and her thesis evaluated low-input fine fescue species for golf course fairways. Her relationships with University of Minnesota extension agents were tremendously influential and encouraged her to pursue a career as a Cooperative Extension advisor in Central California.

CAMPUS AND COUNTY NEWS: Maggie Reiter is a new environmental horticulture advisor

submitted by Paulina Jacobs-Sanders

In Maggie's words:

I look forward to building a research and extension program that will meet local and statewide needs. Although horticultural industries in the Central Valley are extremely diverse, my focus will be turf grass and turf alternatives, to provide information on plant selection and best management practices. My research goals will build on the work of my predecessors and continue to explore alternative grasses and groundcovers, lower-input systems, degraded water applications, and multifunctional landscapes. I am also interested in enhancing urban green space and policy related to these fields.

GLEANINGS FROM MEETINGS: 2016 California Nursery Conference

by Lorence Oki

The California Nursery Conference was held in Watsonville, California on October 25th. Seventy-five attendees listened to 12 presentations on diseases, pests, weeds, water quality, online training, and laws and regulations. We were fortunate to have Dr. Sarah White, associate professor of horticulture in the Plant and Environmental Sciences Department at Clemson University, on the program who presented her research on biological water treatment systems. Other speakers included Keane Goh (California Department of Pesticide Regulation), Walter Mayeda (County of Santa Cruz Agricultural Commissioner's Office), Karen Suslow (NORS DUC) and eight UC speakers (Jim Bethke, Matthew Daughtry, Dave Fujino, John Kabashima, Loren Oki, Laura Sims, Steve Tjosvold and Cheryl Wilen). To see the presentations, go to: http://ucnfa.ucanr.edu/2016_California_Nursery_Conference/.

California Nursery Conference

Continued from page 27

UCNFA would like to give special recognition to the eight vendors that supported the conference with sponsorships: BioWorks, BlueRock, Crop Production Services, Dramm, Gowan, Neudorff, Nufarm and OHP.

Loren Oki is UC Cooperative Extension Landscape Horticulture Specialist, Department of Plant Sciences, UC Davis

New Publications from Agriculture and Natural Resources

compiled by Steve Tjovold

The Safe and Effective Use of Pesticides, 3rd Edition

This revised edition is in a new format that makes it even easier to study for the DPR exams. $42

Authors: S. Whithaus and L. Blecker

Publication Number: 3324

http://anrcatalog.ucanr.edu/Details.aspx?itemNo=3324

Asian Citrus Psyllid & Huanglongbing Disease: Pest Notes for Home and Landscape

This is a free updated Pest Note that's targeted for home and landscape but of interest to nursery growers. Asian citrus psyllid (ACP) can carry Huanglongbing (HLB) disease, which poses a serious threat to citrus trees grown in California's home gardens and farms. Learn to identify and manage this pest and the disease it carries.

Authors: E. Grafton-Cardwell and M. Daugherty

Publication Number: 74155

http://anrcatalog.ucanr.edu/Details.aspx?itemNo=74155

UCNFA News is published by the University of California Nursery and Floriculture Alliance, a statewide partnership of researchers and educators, growers, floriculture associations and allied industry.

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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.

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