The IPM Practitioner
Monitoring the Field of Pest Management
Volume XXXIII, Number 5/6, May/June 2011 (Published October 2012)

# Pyrethroid Perimeter Sprays in Structural Pest Control

By William Quarles

Over the last 20 years, there have been significant changes in the methods of structural pest control. For instance, there has been a general switch from spray formulations to baits for pests such as cockroaches. Termite baits have been developed, and sales are currently about 30% of the termiticide market (Quarles 2010; Quarles 2009a).

Businesses have evolved a more professional outlook, as reflected by the term Pest Management Professional or PMP in industry publications. This phrase is not just a change of nomenclature. Many companies now emphasize IPM methods that require more knowledge and more training (Quarles 2009b).

However, a major holdover from earlier techniques is the application of perimeter sprays outside structures to reduce problems with ants, spiders, and occasional invaders. Residual pesticide sprays are applied to walls and foundations and to the soil and turf to provide a pesticide barrier completely surrounding a building. Unfortunately, these sprays are washed off during rainfall and end up in creeks, rivers, estuaries and wetlands (Moran 2010; Meta Research 2010).

Initially, the problem was mostly with organophosphate pesticides, such as chlorpyrifos and diazinon. Overuse of chlorpyrifos and diazinon led to toxic contamination of California creeks, rivers, and bays that put aquatic life at risk (Johnson 2004).

Organophosphate contamination of water from structural pest control is no longer a problem. The Food Quality Protection act in 1996 led to a ban of organophosphates such as chlorpyrifos and diazinon for structural pests (Quarles 1996).

After chlorpyrifos and diazinon were banned, water quality in urban areas of California temporarily improved. However, perimeter sprays continued, and a major consequence of the organophosphate ban was an increase in the amount of pyrethroids applied, and the introduction of new materials such as indoxacarb, fipronil, and the neonicotinoids imidacloprid, dinotefuran, and thiamethoxam (CA DPR 2010; Moran 2010).


Photo courtesy Pestec and Diane Agurto

Perimeter sprays are not necessary to manage ants. Exclusion, sanitation, habitat management, spot treatments, and ant baits can get the job done. Here a liquid bait station is being filled with a low toxicity borate bait.

## Natural Pyrethrins

Like many other useful materials, pyrethroids evolved from a natural product. A type of chrysanthemum, *Chrysanthemum cinerariaefolium*, produces insecticides. These daisy-like dried flowers are called

### In This Issue

**The IPM Practitioner**
Monitoring the Field of Pest Management

The *IPM Practitioner* is published six times per year by the **Bio-Integral Resource Center (BIRC)**, a non-profit corporation undertaking research and education in integrated pest management.

| | |
|---|---|
| **Managing Editor** | William Quarles |
| **Contributing Editors** | Sheila Daar<br>Tanya Drlik<br>Laurie Swiadon |
| **Editor-at-Large** | Joel Grossman |
| **Business Manager** | Jennifer Bates |
| **Artist** | Diane Kuhn |

For media kits or other advertising information, contact Bill Quarles at 510/524-2567, birc@igc.org.



**Manuscripts**
The IPMP welcomes accounts of IPM for any pest situation. Write for details on format for manuscripts or email us, birc@igc.org.

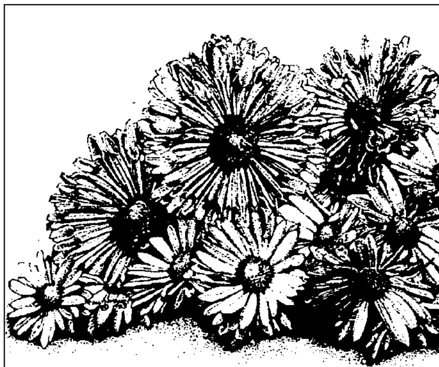


**Subscriptions/Memberships**
A subscription to the IPMP is one of the benefits of membership in BIRC. We also answer pest management questions for our members and help them search for information. Memberships are $60/yr (institutions/ libraries/businesses); $35/yr (individuals). Canadian subscribers add $15 postage. All other foreign subscribers add $25 airmail postage. A Dual membership, which includes a combined subscription to both the *IPMP* and the *Common Sense Pest Control Quarterly*, costs $85/yr (institutions); $55/yr (individuals). Government purchase orders accepted. Donations to BIRC are tax-deductible.
FEI# 94-2554036.

**Change of Address**
When writing to request a change of address, please send a copy of a recent address label.



# Update



**Pyrethrum, *C. cinerariaefolium***

pyrethrum, and the dried, powdered flowers were first used as an insecticide in the U.S. about 1860 (McLaughlin 1973).

Most of the insecticidal activity of pyrethrum comes from natural compounds called pyrethrins. Flowers can be extracted with solvents to produce solutions of pyrethrins. The natural pyrethrins are useful broadspectrum insecticides that are still used in organic farming and structural pest control (Farinas 2012; CA DPR 2010: Olkowski et al. 1991).

Pyrethrins are quickly inactivated by sunlight. This quick inactivation means that there are few water contamination concerns because the pesticides are usually destroyed within 3-12 days after they are applied (Moore 1973).

## Synthetic Pyrethroids

To make pyrethrins more resistant to sunlight, however, the synthetic pyrethroids were developed. Examples are permethrin, deltamethrin, cyfluthrin, and bifenthrin. These manmade pesticides have half lives of a month or more. They are more potent insecticides than pyrethrins and have greater acute toxicities to mammals. Natural pyrethrins contain only carbon, oxygen, and hydrogen, but pyrethroids can contain in addition chlorine, fluorine, and cyanide groups (Farinas 2012).

For instance, currently one of the most problematic pyrethroids is bifenthrin. It contains fluorine and chlorine atoms that give it longterm stability. Its half life in aquatic sediments is 8-16 months, and it is 21x more toxic to the aquatic test organism, *Hyalella azteca*, than the often used permethrin. Another pyrethroid, cypermethrin, is 29x more toxic than permethrin to *H. azteca* (Moran 2010; Johnson et al. 2010).

Because pyrethroid synthesis produces structural isomers, spray formulations are often complex mixtures. Structural isomers have the same chemical composition, but each one has a different three dimensional structure. Some of the isomers are more potent insecticides than others. For instance, cyfluthrin is composed of four isomers. *Beta*-cyfluthrin is enriched in insecticidally potent isomers and is also more acutely toxic to mammals than cyfluthrin (Farinas 2012).

## Pyrethroids in California Water

Several studies have shown pyrethroid toxicity in creeks, rivers, and wetlands. Much of the contamination is due to stormwater runoff from structural pest control applications. Water contamination due to pyrethroids has been found throughout California. During winter storms, more than 50% of sediment samples in a 13 km (7.8 mi) stretch of the American river are toxic to the aquatic organism *Hyalella azteca*. The pyrethroid bifenthrin was found in 11 of 12 runoff sources into the river (Weston and Lydy 2012; Moran 2010).

In a study of 155 sediment samples from four Southern California bays, estuaries, or marinas, pyrethroids were detected in 35% of the samples, and the highest concentrations were found near stormwater drains (Lao et al. 2012).

When runoff from residential sources around Sacramento, California were monitored for a year, pyrethroids were found in every sample. Bifenthrin was found at levels of 73 ng/liter in water and 1211 ng/g in sediments and was of the greatest toxicological concern. [The bifenthrin 96 hour LC50 for mortality to *H. azteca* is 7.7 ng/liter.] Stormwater runoff was of more importance than irrigation runoff in transport of pyrethroids into urban creeks (Weston et al. 2009).

Analysis of outflows from urban runoff, water treatment plants, and agricultural drains in California showed nearly all urban runoff samples were toxic to *H. azteca*, frequently exceeding toxic thresholds by a factor of 10. Pyrethroids were also often found in wastewater effluent, but seldom in agricultural discharges (Weston and Lydy 2010).

When 30 creeks in 8 geographical locations of California were sampled near sources of residential stormwater outflows, all 30 creeks showed toxicity to the aquatic test organism, *H. azteca*, at temperatures of 15°C (59°F). Pyrethroids were found in all sediment samples at toxic concentrations. Worst contamination was near Los Angeles, Central Valley, and San Diego regions, but creek toxicity was found in all regions tested. Bifenthrin accounted for 67% of the mean observed pyrethroid toxicity statewide. Cypermethrin and cyfluthrin were also important sources of pyrethroid toxicity (Holmes et al. 2008).

## Pyrethroids Nationwide

Pyrethroids are not only contaminating streams in California. They are found in stream sediments nationwide. A recent study found pyrethroids in 78% of stream bed samples from 36 streams in 25 states. Bifenthrin was the most frequently detected pyrethroid (Hladik and Kuivila 2012). Investigation of seven U.S. cities found pyrethroids more often in water samples from Dallas/Fort Worth than in the other cities, suggesting a regional variation of the problem (Kuivila et al. 2012).

Photo courtesy Pestec and Diane Agurto

**Carlos Agurto of Pestec points to an ant trail.**

## Perimeter Applications

According to Moran (2010), "reported professional use remains the vast majority (nearly 90%) of all estimated urban high-use pyrethroid use, both in terms of aquatic toxicity equivalents and in terms of total pounds of pesticide active ingredient." Urban high use pyrethroids include bifenthrin, cypermethrin, cyfluthrin, *beta*-cyfluthrin, permethrin and others shown to be a water quality problem.

A survey by Meta Research shows that about 83% of the pyrethroids used in California structural pest control are applied outside. About 50% of those applications are perimeter applications of pesticides made to control ants, spiders, and occasional invaders. The average perimeter treatment is a continuous band application 2 feet up (0.6 m) on walls and foundations and 5 feet out (1.5 m) horizontally on soil or turf. Hard surfaces such as patios and driveways are often treated during a perimeter application (Meta Research 2010).

## Pyrethroid Formulations

Problems with water quality can vary with the pyrethroid formulation and with the application surface. Applications to impervious surfaces cause the most problems. The most problematic formulation consists of solid particles suspended in a liquid or suspended concentrate (SC). When different kinds of formulations were applied to turf, soil, or concrete, the greatest washoff was seen with SC formulations applied to concrete (Jorgenson

Photo courtesy Pestec and Diane Agurto

**A borate liquid ant bait station is installed in a planting bed.**

et al. 2012). Washoff is greatest when the pesticide is applied just before a rainstorm, but bifenthrin and permethrin can be measured in rain runoff from concrete 7 months after the initial treatment (Jiang et al. 2012).

## Pest Management Awareness

Pyrethroids are currently the most commonly used broadspectrum, nonfumigant insecticides in California structural pest control (CA DPR 2010). And outdoor applications of pyrethroids have resulted in increased contamination of water due to pesticide runoff in urban watersheds (Moran 2010).

Though water contamination with pyrethroids continues to be a problem, there are signs of some positive changes. Problems with pesticide contamination of water led to creation of the EcoWise Certified® Program in California in 2006 (Quarles 2006). An EcoWise Certified Service must adhere to EcoWise Standards (see www.ecowisecertified.org). EcoWise Pesticide Application Standards are designed to reduce pesticide exposures and pesticide contamination of water (EcoWise 2012). Pest Management Professionals can be trained and certified through an online course (see www.birc.org).

**Pyrethroid perimeter sprays are not used by EcoWise Service Providers.**

Other certification programs such as GreenPro Certified® and Green Shield Certified® also allow companies to provide professionally recognized services that can reduce water pollution (Quarles 2009b).

## Pyrethroids Peak in 2006

Pyrethroid applications in California structural pest control peaked in 2006. And California Pesticide Use Data for 2010, the latest year with available data, show more than a 60% reduction in pyrethroid applications compared to 2006 (see below). Certified services, in part, have led directly to a reduction in pyrethroid applications, but certification programs may have also indirectly raised awareness of the problem. Knowledge of the problem may have led to voluntary reduction in overall pyrethroid use (see below).

Some of the reduction seen between 2006 and 2010 might also be due to the economic recession, which may have led homeowners to save money, putting pests at a lower priority. The recession may explain some of the pyrethroid reduction, but the use of some pesticides increased, and the percent reduction in pyrethroid applications (-62.5%) is greater than the percent reduction in overall pesticide use (-30.4%). Furthermore, pyrethroids as a percentage of total non-fumigant pesticides declined from 34.7% to 27.9%. So there was a switch from pyrethroids to alternative formulations (see below and Table 1).

## Reduction of Pyrethroids

As we see in Table 1, from 2006 to 2010, total structural pesticide applications in California were reduced by nearly one-third, and structural fumigants were reduced by more than 10%. Structural fumigants account for the major portion of applied pesticides in structural pest control.

If we look only at non-fumigant pesticides, over the four year period, non-fumigant pesticide applications in CA were reduced by more than 50% (-53.4%). Pyrethroid applications were reduced even more (-62.5%). There were also reductions in new pesticides such as fipronil (-61.4%) and imidacloprid (-36.9%) that might have an effect on water quality. The really good news is that there were large reductions in cypermethrin (-71.5%), a pyrethroid with especially high toxicity to aquatic organisms (CA DPR 2010; 2006; Moran 2010).

The bad news is that applications of the more potent and persistent pyrethroids, bifenthrin (-35.6%) and cyfluthrins (-36.3%), that have a potent toxic effect on aquatic organisms have decreased less than the overall average for pyrethroids (-62.5%). Amounts actually increased compared to 2005 levels (CA DPR 2005; 2006; 2010).

Also, the pesticide use data presented in Table 1 is for the whole state of California. Pyrethroid use is not uniform across the state, and percentage applications in some areas may not have decreased as much as the statewide number (Weston and Lydy 2012).

## New Label Restrictions

The California Pesticide Use Data show that IPM certification programs and voluntary reduction by pest management companies have led to reduced applications of most pyrethroids. However, applications

**Table 1. Pesticide Active Ingredients Used in California Structural Pest Control**

| Pesticide | 2005 lbs active ingredient | 2006 lbs active ingredient | 2010 lbs active ingredient | % change from 2006 to 2010 |
|---|---|---|---|---|
| Bifenthrin | 38,487 | 85,438 | 54,988 | -35.6 |
| Cyfluthrins* | 36,093 | 74,620 | 47,505 | -36.3 |
| Cypermethrin | 200,696 | 186,633 | 53,121 | -71.5 |
| Permethrin | 390,451 | 486,071 | 146,791 | -69.8 |
| Pyrethrins | 2,750 | 3,299 | 4,240 | +28.5 |
| Other pyrethroids | 27,892 | 24,803 | 15,839 | -36.1 |
| Total pyrethroids | 696,369 | 860,864 | 322,484 | **-62.5** |
| Total Non-fumigant Pesticides | 2,224,694 | 2,480,088 | 1,154,634 | **-53.4** |
| Sulfuryl fluoride (fumigant) | 3,316,778 | 2,838,379 | 2,544,945 | -10.3 |
| Total Pesticides | 5,541,472 | 5,318,467 | 3,699,579 | **-30.4** |
| | | | | |
| Boric Acid | 88,726 | 87,464 | 153,708 | +75.7 |
| Chlorfenapyr | 7,562 | 5,207 | 16,990 | +226 |
| Dinotefuran | 0 | 4.8 | 25 | +420 |
| DOT (disodium octaborate tetrahydrate | 348,326 | 286,029 | 297,066 | +3.8 |
| Fipronil | 66,679 | 98,610 | 38,016 | -61.4 |
| Imidacloprid | 51,195 | 65,962 | 41,592 | -36.9 |
| Indoxacarb | 0 | 0 | 474 | --- |
| Thiamethoxam | 0.2 | 4.5 | 610 | --- |

*includes cyfluthrin and *beta*-cyfluthrin
Data from CA DPR 2010, CA DPR 2005, CA DPR 2006, www.cdpr.ca.gov

of bifenthrin, cyfluthrin, and *beta*-cyfluthrin have not been reduced enough in some areas to solve the problem. The problem has been addressed by reevaluation of pyrethroids by regulatory agencies and new label restrictions on pyrethroid applications (CA DPR 2012).

New pyrethroid labels by the EPA and the California Department of Pesticide Regulation generally prohibit applications in rainstorms and to standing water on turf and soil. Applications to impervious surfaces have been restricted, but perimeter applications to soil surfaces are still permitted.

California regulations were effective starting July 19, 2012 and cover 17 pyrethroids that are applied by California pest management businesses. Applications to vertical surfaces such as walls, foundations and fencing are generally limited to spot treatments, crack and crevice treatment, pin stream treatment of one-inch (2.54 cm) wide or less. But perimeter band treatments "up to a maximum of two feet (0.6 m) above the grade level" are still allowed on vertical surfaces (CA DPR 2012).

## Horizontal Surfaces

Applications to horizontal surfaces such as soil surface, mulch, gravel, lawn, turf and groundcover are limited to spot treatments, pin stream treatments, or a continuous perimeter band treatment "three feet wide (0.9 m) or less from the base of the building outward." The perimeter band treatment, however, cannot be applied to any impervious surface in that area.

Broadcast treatments are not allowed within two feet (0.6 m) of any impervious surface. Broadcast termiticides used in construction pretreatment must be covered with waterproof covering before rainstorms.

Applications to windows, doors, and horizontal impervious surfaces are limited to spot treatments, crack and crevice treatments, and a pin stream treatment of one-inch wide (2.54 cm) or less. Granular formulations cannot be used on

Photo courtesy Pestec and Diane Agurto

**Carlos Agurto installs a large KM Ant Pro® liquid ant bait station.**

impervious surfaces and granules applied to soil, turf, mulch, gravel or groundcover must be swept off if they land on impervious surfaces.

## Prohibited Applications

Applications during rainstorms, applications to horizontal surfaces with standing water, to sewers, storm drains or gutters, and to drainage systems that link to sewers and storm drains are prohibited. However, applications underneath eaves are allowed during rain.

Applications to horizontal surfaces that drain toward aquatic habitats less than 25 feet (7.6 m) away are prohibited. Application to plants, shrubs and trees is prohibited if there is standing water in the dripline or perimeter of the plants. Preconstruction termiticides cannot be applied within 10 ft (3 m) of a storm drain downgradient from the application.

Subsurface injections into soil, injections into structural materials, rod and trench termiticides, applications to underground nests, baits, foggers, and applications underneath eaves are exempt (CA DPR 2012).

## Alternatives to Perimeter Sprays

New pyrethroid label restrictions are good news for aquatic creatures, but pyrethroid perimeter sprays were too entrenched in the pest management business model to be eliminated by regulators. Perimeter sprays evolved as a business model along with the explosion of suburban development in the 1950s. The market was driven by homeowners who saw pest free surroundings as an essential part of good property management. Pest control companies were hired to provide often unneeded calendar sprays as a preventive measure (Quarles 2009c).

But pests can be managed without perimeter sprays. An IPM program of exclusion, sanitation, habitat management, spot treatments with pesticides, and ant baits can be effective in managing ant invasions. Spiders can be discouraged by destroying their webs and controlling their food supply (Quarles 2007, Hedges 1997; Klotz et al. 1997).

## Conclusion

Pyrethrins and pyrethroids can be useful tools for a pest management professional when they are used responsibly as part of an IPM program. However, perimeter applications of pyrethroids with long lasting residuals and high toxicity to aquatic organisms have become a problem. The problem has been addressed by IPM certification programs, voluntary reduction in applications, and new labels that prevent the most damaging applications. IPM alternatives to perimeter sprays are available, and IPM Certified Services in California are leading the way.

*William Quarles, Ph.D., is an IPM Specialist, Executive Director of the Bio-Integral Resource Center (BIRC) and Managing Editor of the IPM Practitioner. He can be reached by email,birc@igc.org.*

# *Update*

## References


CA DPR (California Department of Pesticide Regulation). 2005. 2005 Annual Statewide Pesticide Use Report Indexed by Commodity.www.cdpr.ca.gov

CA DPR (California Department of Pesticide Regulation). 2006. 2006 Annual Statewide Pesticide Use Report Indexed by Commodity. www.cdpr.ca.gov

CA DPR (California Department of Pesticide Regulation). 2010. 2010 Annual Statewide Pesticide Use Report Indexed by Commodity. www.cdpr.ca.gov

CA DPR (California Department of Pesticide Regulation). 2012. Department of Pesticide Regulation announces new restrictions to protect water quality in urban areas. CA DPR Press Release, July 18, 2012. www.cdpr.ca.gov/docs/press-rls/2012/120718.htm

Casida, J.E. 1973. *Pyrethrum, the Natural Insecticide*. Academic Press, New York. 329 pp.

EcoWise. 2012. *EcoWise Certified Standards for IPM Certification in Structural Pest Management*. Version 2.2, February 5, 2011. 40 pp. Bio-Integral Resource Center, PO Box 7414, Berkeley, CA 94707. www.birc.org/EcoWiseCertified.htm

Farinas, G.R. 2012. *Analysis of Pyrethroid Residues in Sediments from San Diego County Streams using Liquid Chromatography Triple Quadrupole Mass Spectrometry*. MS Thesis, San Diego State University. 67 pp.http://sdsu-dspace.calstate.edu/bitstream/handle/10211.10/2437/Farinas_Grace.pdf?sequence=1

Hedges, S. 1997. Ants. In: Mallis, pp. 503-599 of 1453 pp.

Hladik, M.L. and K.M. Kuivila. 2012. Pyrethroid insecticides in bed sediments from urban and agricultural streams across the United States. *J. Environ. Monitoring* 14:1838-1845.

Holmes, R.W., B.S. Anderson, B.M. Phillips et al. 2008. Statewide investigation of the role of pyrethroid pesticides in sediment toxicity in California's urban waterways. *Environ. Sci. and Technol.* 42(18):7003-7009.

Jiang, W.Y., D. Haver, M. Rust and J. Gan. 2012. Runoff of pyrethroid insecticides from concrete surfaces following simulated and natural rainfalls. *Water Research* 46(3):645-652.

Johnson, M., B. Luukinen, J. Gervais et al. 2010. Bifenthrin technical fact sheet. National Pesticide Information Center, Oregon State University Extension. 12 pp. http://npic.orst.edu/factsheets/bitech.pdf

Johnson, W. 2004. Diazinon and pesticide related toxicity in bay area urban creeks: water quality attainment strategy and total maximum daily load (TDML). San Francisco Regional Water Quality Board, 1515 Clay St., Oakland, 94612. 120 pp. www.waterboards.ca.gov/.../urbancrks-diazinon/b_final_staff_report

Jorgenson, B.C., C. Wissel-Tyson and T.M. Young. 2012. Factors contributing to the off-target transport of pyrethroid insecticides from urban surfaces. *J. Agric. Food Chem.* 60:7333-7340.

Klotz, J.H., L. Greenberg, H.H. Shorey, and D.F. Williams. 1997. Alternative control strategies for ants around homes. *J. Agric. Entomol.* 14(3):249-257.

Kuivila, K.M., M.L. Hladik, C.G. Ingersoll et al. 2012. Occurrence and potential sources of pyrethroid insecticides in stream sediments from seven U.S. metropolitan areas. *Environ. Sci. Technol.* 46(8):4297-4303.

Lao, W.J., L. Tiefenthaler, D.J. Greenstein et al. 2012. Pyrethroids in Southern California coastal sediments. *Environ. Toxicol. Chem.* 31(7):1649-1656.

Mallis, A. 1997. *Handbook of Pest Control*, 8th ed. Mallis Handbook and Technical Training Company. Cleveland, OH. 1453 pp.

McLaughlin, G.A. 1973. History of pyrethrum. In: Casida, pp. 3-15 of 329 pp.

Meta Research. 2010. California 2009 urban pesticide use pattern study. Meta Research and Pyrethroid Working Group. 19 pp. www.cdpr.ca.gov/docs/registration/reevaluation/chemicals/pyrethroids

Moore, J.B. 1973. Residue and tolerance considerations with pyrethrum, piperonyl butoxide and MGK 264. In: Casida, pp. 293-306 of 329 pp.

Moran, K. 2010. Pesticides in urban runoff, wastewater, and surface water. Annual Urban Pesticide Use Data Report 2010. San Francisco Estuary Partnership. 38 pp. www.up3project.org/documents/up3use2010_Final.pdf

Olkowski, W., S. Daar and H. Olkowski. 1991. *Common Sense Pest Control*. Taunton Press, Newton, CT. 715 pp.

Quarles, W. 1996. Food Quality Protection Act. *IPM Practitioner* 18(10):10-12.

Quarles, W. 2006. EcoWise Certified, an IPM certification program. *IPM Practitioner* 28(1/2):11-13.

Quarles, W. 2007. IPM for the Argentine ant. *Common Sense Pest Control Quarterly* 23(2/3):8-20.

Quarles, W. 2009a. IPM reduces pesticides, cockroaches, and asthma. *IPM Practitioner* 31(9/10):1-8.

Quarles, W. 2009b. Mainstream pest management and IPM (Green) certification. *IPM Practitioner* 31(1/2):1-6.

Quarles, W. 2009c. Rethinking the American lawn. *Common Sense Pest Control Quarterly* 25(1):3-10.

Quarles, W. 2010. Baits or Barriers? Field efficacy of subterranean termite treatments. *IPM Practitioner* 32(9/10):1-9.

Weston, D.P., R.W. Holmes and M.J. Lydy. 2009. Residential runoff as a source of pyrethroid pesticides to urban creeks. *Environ. Pollution* 157(1):287-294.

Weston, D.P. and M.J. Lydy. 2010. Urban and agricultural sources of pyrethroid insecticides to Sacramento-San Joaquin Delta of California. *Environ. Sci. Technol.* 44(5):1833-1840.

Weston, D.P. and M.J. Lydy. 2012. Stormwater input of pyrethroid insecticides to an urban river. *Environ. Toxicol. Chem.* 31(7):1579-1586.

## Conference Notes

# ESA 2011 Annual Meeting Highlights

*By Joel Grossman*

*These Conference Highlights are from the Nov. 13-16, 2011, Entomological Society of America (ESA) annual meeting in Reno, Nevada. ESA's next annual meeting is November 11-14, 2012, in Knoxville, Tennessee. For more information contact the ESA (10001 Derekwood Lane, Suite 100, Lanham, MD 20706; 301/731-4535;* http://www.entsoc.org

### Indoor-Outdoor Stink Bug Trap

Traps have been used for monitoring and mass trapping stink bugs since at least 2002, said Qing-He Zhang (Sterling International, Inc., Spokane, WA 99216; qing-he.zhang@rescue.com). In 2010, Sterling International began designing prototype stink bug traps for the larger consumer market using elements of existing RESCUE!® Japanese beetle and yellowjacket traps. By January 2011, after going through 10 designs, the company produced a reusable RESCUE! stink bug trap catching 50 stink bugs per day per trap. The high-tech design lures stink bugs in, but prevents them from getting out.

Multiple lures are available for baiting the trap to catch multiple stink bug species. Traps are sold with a two week supply of attractant pheromone; seven week pheromone supplements are also available. In early spring, instead of pheromone an attractive blue light can be used on top of the trap. The blue light is also effective indoors, and there is no odor.

Recommended trap placement for early summer is in deciduous trees, with only the bottom fins of the trap touching vegetation. Mid- to late-summer, traps are placed on posts with only the trap fins touching the posts. Late winter, indoor traps capture stink bugs migrating into homes where they like to spend the winter.

The RESCUE! stink bug trap is available in hardware stores such as Ace, Costco, Wal-Mart and Home Depot. Local and national TV and radio news coverage has featured the trap.

### Urban Citrus Psyllid Traps

"Current detection methods for Asian citrus psyllid (ACP), *Diaphorina citri*, in urban areas rely on the use of yellow sticky traps," said Kris Godfrey (CDFA, 1220 N St, Sacramento, CA 95814; kgodfrey@cdfa.ca.gov). "However, two new traps with a slightly more greenish hue have been introduced and have captured more ACP adults in some commercial citrus settings."

In urban Los Angeles, California and on lemons in Weslaco, Texas ACP capture was compared for four commercial traps, including: a yellow corn root trap; a yellow panel trap; a green ACP trap; and a green panel trap. Yellow traps captured the most ACP adults in urban areas. Traps were more effective when placed in lemon or lime trees than in kumquat trees.

### Microbe Dispenser Controls Asian Citrus Psyllid

Asian citrus psyllid is a vector of greening disease (Huanglongbing), which can lead to discolored, bitter, unmarketable citrus fruits and eventual tree death, said Andrew Chow (USDA-ARS, 2413 E Hwy 83, Bldg 200, Weslaco, TX, 78596 ;andrew.chow@ars.usda.gov). [*See July/August 2010 IPMP, New Invasives Threaten California Crops and Ornamentals*] In California, Florida, and the Rio Grande Valley of Texas, agricultural areawide

## EcoWise News

The EcoWise Certified program is expanding. The latest addition to the list of EcoWise Service Providers is the Anaheim branch of Western Exterminator Company. Keith Willingham, a longtime champion of IPM methods and green pest management will be in charge of the EcoWise service. Western Exterminator Company's San Jose Branch was certified last year.

A list of EcoWise Certified Practitioners can be found on the website at www.ecowisecertified.org. Newly certified EcoWise IPM Practitioners include Herminio Lopez of Pestec and William Denison of the Dewey Pest Control Branch in Pacheco.

Hearts Pest Management down in San Diego has reason to celebrate. They have just joined the EPA's PESP (Pesticide Environmental Stewardship) program. According to the EPA's Frank Ellis, "PESP is an exciting, voluntary program to reduce the risks from the use of pesticides. I am pleased that your company is taking a leadership role, along with our other members, in working with EPA on environmental stewardship."

According to Hearts CEO Gerry Weitz, "Hearts is growing at an 11% rate via "organic company growth" with a 25% rate of growth in green branded services."

Gerry said, "Hearts Pest Management is constantly looking outside the traditional box of IPM toward a new and exciting role in the natural balance of our habitat. Expanding the envelop of IPM, we are currently experimenting with indoor deep cleaning and allergen service, focusing on those areas of the home that your cleaning crew doesn't reach."

"We now have on staff a company blogger, Donna Walker, who has extensive experience as a park docent and the San Diego Archeological Center. She regularly writes about insects and arachnids with great passion and respect."

Hearts has a blog at www.heartspm.com/blog where you will find a recent article about Mud Daubers and a most unusual article on prehistorical pests.

# Conference Notes

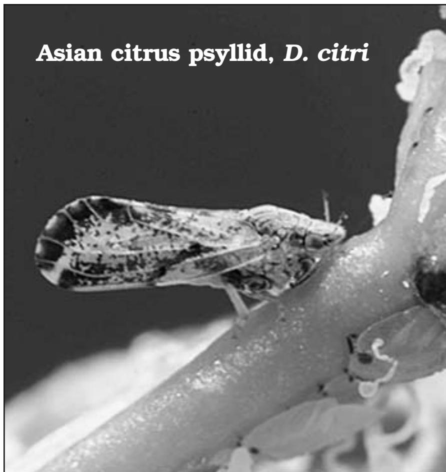



Photo courtesy Michael E. Rogers

spray programs need augmentation for infestations in residential orchards and backyards, trailer parks, and other non-agricultural locales.

In California CDFA uses foliar sprays and soil drenches for small residential ACP infestations that might spread to agricultural citrus. In Florida, where ACP is more widespread, biological control agents such as the parasitoid *Tamarixia radiata* are released around private residences.

Asian citrus psyllid adults are attracted to the odor and color of citrus flushes. Besides a phototactic response to color, the pest has a thigmotactic (touch) response to texture. These responses are used to design attract-and-kill devices or dispensers to attract ACP and disseminate insect-killing pathogens such as *Isaria fumosorosea* for ACP control on residential and organic citrus.

The USDA (Peoria, IL) has formulated insect pathogens such as *Isaria fumosorosea* into dispensers which infect individual psyllids that spread the pathogens throughout the pest population, potentially creating epizootics. In South Texas tests of the USDA pathogen dispenser, an *Isaria fumosorosea* strain isolated from whiteflies killed 93% of ACP adults and nymphs in four days.

### Soap Cleans Up Asian Citrus Psyllids

Asian citrus psyllid is a vector of greening disease (Huanglongbing), which results in abnormal juice flow and dry fruit, and for which there is no cure, said David Hall (2001 South Rock Rd, Fort Pierce, FL 34945; david.hall@ars.usda.gov). ACP was in Florida in 1998; greening disease arrived by 2005. By 2001, the pest reached Texas. Now ACP is in all the Gulf States, Arizona and California.

Two insecticidal soaps (50% concentrations of potassium salts of fatty acids) labeled for home use were tested against ACP and two of its natural enemies. M–Pede® and Safer® Insecticidal Soap Concentrate were equally effective against adult ACP: 0.8% concentrations killed about 90% of adults; 2% concentrations provided 100% adult ACP mortality. Dried soap provided little residual control.

The soaps killed 100% of ACP nymphs. Egg survival was better: 2% soap provided 63% egg mortality. Unfortunately, about 80-90% of the adult parasitoid *Tamarixia radiata* were killed by the soaps. The soaps were relatively nontoxic to a lady beetle predator, killing only 5-15%. Since "soap costs much less than conventional pesticides," soaps are an alternative for organic citrus groves and urban landscapes.

### Earthworm Compost Boosts Bumble Bees & Pollination

"Soil quality enhancement with earthworm compost increases

## Insecticides Cause Evolutionary Changes

One of the hot research topics right now is the relationship between ecological interactions and evolution. Usually, we think of evolution as a slow process involving many lifetimes. When genetic changes are seen, it is often in bacteria that have very fast generation times.

Cornell University researchers have recently published an article that shows evolutionary changes can occur in plants in as little as three generations. The article also shows that apparently even negative processes are needed to maintain the biological world order.

Insects eat plants and most gardeners and farmers see this as a bad thing. The Cornell University researchers wanted to measure changes in plants that occur as a result of exclusion of insect herbivores. The pyrethroid insecticide esfenvalerate was used to prevent insect attacks on stands of evening primrose, *Oenothera biennis*. The protected stands were compared to controls where insect attacks were allowed.

Plants protected by insecticides changed genetically over the course of three generations. Protected *O. biennis* stopped producing defensive compounds such as ellagitannins. Changes also occurred in plant phenology. Unprotected plants have a defensive strategy of late flowering to avoid attacks of the moth, *Mompha brevivitella*. Protection of the plants with insecticide led to a genetic change toward early flowering within three generations.

Suppression of insects on evening primrose had other consequences. Where insects were suppressed, evening primrose was outcompeted by dandelion, *Taraxacum officinale*. The insects that were feeding on evening primrose were even more damaging to dandelion. Where insect suppression occurred, populations of dandelion exploded.

This experiment has rather profound implications. Food we eat gets some of its taste from defensive compounds produced by plants. Using calendar sprays of insecticides to constantly keep plants insect free could lead to changes in taste if seeds from protected plantings are reused each year.

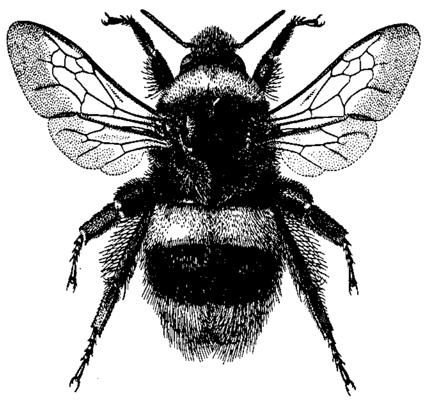
Also, if evolutionary changes can happen in three generations, plants might be able to compensate for some of the negative consequences of global warming. Evolutionary changes might be fast enough to keep up with the swift climate induced ecological changes in some cases.

Agrawal, A.A., A.P. Hastings, M.T.J. Johnson, J.L. Maron and J.P. Salminen. 2012. Insect herbivores drive real-time ecological and evolutionary change in plant populations. *Science* 338:113-116.—*BQ*

# Conference Notes

attractiveness of flowers to pollinators," and boosts bumble bee health and fertility along with pollination, said Yasmin Cardoza (North Carolina State Univ, Campus Box 7613, Raleigh, NC 27695; yasmin_cardoza@ncsu.edu). When cucumber soils were amended with earthworm compost, bumble bees, *Bombus impatiens*, found the first cucumber flowers faster and visited longer. As well as bumble bees, cucumbers in soils amended with vermicompost also had more of other native pollinators.

More than an NPK soil nutrient availability effect was involved, as flowers had more sugars and proteins for pollinators. "It is possible for plants grown in organically amended soils to be better hosts for pollinators," perhaps by better floral resources boosting nutritional value, said Cardoza. Moreover, bumble bee workers fed flowers from plants grown in vermicompost (VC) had significantly more and larger ovarioles (egg tubes), as well as a higher number and larger oocytes (ovary cells), which are "a measure of nutritional quality."



**Bumble bee, *Bombus sp.***

"Pollen and nectar fractions of flowers from plants grown in vermicompost were found to have higher protein concentration compared to those plants grown in control soil," said Cardoza. Nectar sugar content also tended to be higher in VC flowers, but differences were not statistically significant. Even further, *B. impatiens* colonies confined to forage on plants from either treatment for 30 days, lost significantly less weight and had lower pathogen incidence when foraging on plants grown in VC soil. Thus, soil quality enhancement has significant impacts on plant-pollinator interactions and can directly influence pollinator nutrition and thereby, overall performance and health.

## Alyssum Lowers Lettuce Aphids

"We investigated the effects of floral resources on aphid suppression by the hoverfly *Eupeodes fumipennis* (Syrphidae) in California lettuce fields, where hoverfly larvae play a key role in suppression of the lettuce aphid, *Nasonovia ribis-nigri*," said Brian Hogg (Univ of California, 130 Mulford Hall, Berkeley CA 94720; hoggbrian@yahoo.com). "Results link alyssum to reduced crop damage, as aphids are primarily a contaminant of lettuce." There were over 80% fewer lettuce aphids when alyssum was interplanted with lettuce. "Although numbers of hoverfly larvae were low overall, they were far higher in the presence of alyssum (flowering alyssum + water) on day 18 of the experiment," compared to the control (water provided) and nectar provision (water + honey solution) field cages, said Hogg.

"Increases in hoverfly fecundity were primarily responsible for effects on aphids," said Hogg. "Nectar alone may not be sufficient to enhance hoverfly fecundity." Adding floral resources to lettuce fields means hoverflies have more energy for reproduction, as they waste less energy traveling to distant pollen sources.

## Buckwheat Living Mulch for Florida Whiteflies

"Living mulches including buckwheat, *Fagopyrum esculentum*, have been reported to suppress adult whiteflies on zucchini squash plants, as well as attract beneficial insects to the cucurbit crop," said Janine Razze (Univ of Florida, PO

# Calendar

October 17-20, 2012. Pestworld, Annual Meeting National Pest Management Association (NPMA), Boston, MA. Contact: NPMA, 10460 North St., Fairfax, VA 22031; 800/678-6722; 703/352-6762www.npmapestworld.org

November 1, 2012. New Regulations and IPM for Ants. Sponsored by UC Irvine and Santa Clara County IPM. Isaac Newton Center, 70 West Hedding St., San Jose, CA. Contact: Les Greenberg, 951/827-3217

November 4-10, 2012. Biocontrol of Bacterial Plant Diseases. Agadir, Morocco. Contact: www.lavcha.ac.ma/biocontrol2012

November 11-14, 2012. ESA Annual Meeting Knoxville, TN. Contact: ESA, 10001 Derekwood Lane, Suite 100, Lanham, MD 20706; 301/731-4535; http://www.entsoc.org

December 6-8, 2012. Acres USA Conference and Trade Show. Louisville, Kentucky. Contact:800-355-5353; www.acresusa.com

January 7-12, 2013. 25th Advanced Landscape IPM Short Course. University of Maryland, College Park. Contact: Avis Koeiman, Dept. Entomology, 301/405-3913. email akoeiman@umd.edu

January 23-26, 2013. 33rd Annual EcoFarm Conference. Asilomar, Pacific Grove, CA. Contact: Ecological Farming Association, 831/763-2111; info@eco-farm.org

February 4-7, 2013. Annual Meeting Weed Science Society of America. Baltimore, MD. Contact: www.wssa.net

February 14-17, 2013. Annual Meeting Association Applied IPM Ecologists. Hyatt Regency, San Francisco, CA. Contact: www.aaie.org

February 21-23, 2013. 24th Annual Moses Organic Farm Conference. La Crosse, WI. Contact: Moses, PO Box 339, Spring Valley, WI 54767; 715/778-5775; www.mosesorganic.org

March 4-6, 2013. California Small Farm Conference. Fresno, CA. Contact: www.californiafarmconference.com

June 18-23, 2013. 70th Annual Convention, Pest Control Operators of CA. Harrah's, Las Vegas, NV. Contact: www.pcoc.org

August 4-9, 2013. 98th Annual Conference Ecological Society of America. Minneapolis, MN. Contact: www.esa.org

August 10-13, 2013. Annual Conference American Phytopathological Society (APS). Austin, TX. Contact: Betty Ford, bford@scisoc.org or www.apsnet.org

November 17-20, 2013. Annual ESA Meeting. Austin, TX. Contact: ESA, 10001 Derekwood Lane, Suite 100, Lanham, MD 20706; 301/731-4535; http://www.entsoc.org

# Conference Notes

Box 110620, Gainesville, FL 32611; jrazze@ufl.edu). "Zucchini squash, *Cucurbita pepo*, is a high value vegetable crop in Florida. Plant physiological disorders and insect-transmitted diseases associated with the feeding of immature silverleaf whiteflies, *Bemisia tabaci* B biotype, are serious problems for many growers around the state." Biocontrol tactics and the implementation of cultural control techniques such as living mulches have potential to reduce whitefly numbers and whitefly-transmitted viruses on cucurbits.

Exclusion cage experiments evaluated silverleaf whitefly preferential attraction to zucchini versus buckwheat. The study also evaluated the whitefly predator *Delphastus catalinae*. "Our findings suggest that zucchini squash is the preferred host of silverleaf whitefly when compared with buckwheat," said Razze. Silverleaf whitefly headed to zucchini could be intercepted by *Delphastus catalinae*. "*Delphastus catalinae*, when used in conjunction with buckwheat as a living mulch, could aid in the reduction of whiteflies on zucchini squash and the incidence of whitefly-transmitted diseases."

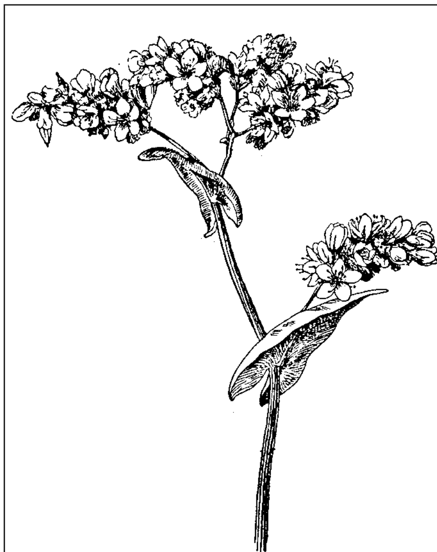
## Whitefly Parasitoid California Success

*Eretmocerus mundus*, an Aphelinidae parasitoid of the whitefly *Bemisia tabaci*, was last released into central California in 2000 along with other parasitoids as part of a multi-agency national program. "Over the course of 9 years, *E. mundus* continues to be the only parasitoid release recovered," said Charles Pickett (CDFA, 3288 Meadowview Rd, Sacramento, CA 95832; cpickett@cdfa.ca.gov). "Today it is the dominant parasitoid attacking *B. tabaci* in cotton in central California. Parasitism levels measured from cotton leaves with high numbers of *B. tabaci* have remained at 20% to 35%, up from less than 1.4% when first measured. The percentage of leaves infested by *B. tabaci* in the southern San Joaquin Valley have dropped from a seasonal average of 36.6% to 13.6%."

## Greenhouse Companion Plants

"Companion plants can provide supplemental resources for natural enemy open rearing in greenhouses and serve as pest monitoring or trapping tools," said Emily Pochubay (Michigan State Univ, 205 CIPS, East Lansing, MI 48824; pochubay@msu.edu). A 4-acre (1.6 ha) certified organic lettuce and herb greenhouse in Michigan was used to test the following companion plants grown in pots: calendula, *Calendula officinalis*; dill, *Anethum graveolens*; alyssum, *Lobularia maritime*; poppy, *Papaver somniferum*; eggplant, *Solanum melongena*; pepper, *Capsicum annuum*; barley, *Hordeum vulgare*; blue hubbard squash, *Cucurbita maxima*; buckwheat, *Fagopyrum esculentum*; castor bean, *Ricinus zanzibarensis*; impatiens, *Impatiens balsamina*; fiddleneck, *Phacelia tanacetifolia*; and Queen Anne's lace, *Daucus carota*.

Green lacewings and minute pirate bugs were released in plots adjacent to the experimental plots. Pests and natural enemies were monitored with yellow sticky cards. Organic pesticides were used as needed. Barley and eggplant were the only plants not flowering throughout the experiment.



**Buckwheat, *Fagopyrum esculentum***

Natural enemies such as lady beetles, minute pirate bugs, and parasitoids were most numerous on sticky cards in plots with pots of dill, fiddleneck, and alyssum. Parasitoid mummies (aphid biocontrol) were highest in eggplant, pepper, poppy, and fiddleneck; these could all be good banker plants for augmentative release of aphid parasitoids. However, fiddleneck is hard to grow and manage.

## Iowa Buffer Strips

Certified organic growers in Iowa are required to have buffer strips to intercept genetically-modified (GM) pollen and pesticide drift, said Kelly Ann Gill (Iowa State Univ, Ames, IA 50011; kaseman@iastate.edu). Buffer strips can also be optimized to increase biodiversity, conserve pollinators and natural enemies, and aid in pest suppression.

The goal is planting locally-adapted, multi-function buffer strips resistant to invasive pests and lasting many years. Six native perennial buffer strips were tested in 2 $m^2$ (21.5 $ft^2$) garden style plots, in part to determine how many plant species were best for buffer strips: 1) switchgrass; 2) CP-IA (14 species of grasses, forbs, and legumes used to restore prairies); 3) 'Best Bet' MSU mix (12 of 43 species; rated for natural enemy attractiveness); 4) MSU 5-species subset; 5) MSU 3-species subset; 6) MSU 2-species subset (bare minimum mixture: cup plant & meadow zizia).

About 1/3 of the midday insect fauna sampled with vacuum devices were beneficial insects (17% minute pirate bugs; 9% parasitoids; 1% pollinators); 63% were herbivores. The MSU (Michigan State Univ) mixes had twice the number of beneficials and more biodiversity than the CP-IA mix optimized for Iowa. 'Best Bet' MSU mix had the most natural enemies, followed by the 3 and 5 species MSU subsets. The plantings cost $15.50 per 75 $ft^2$ (7 $m^2$) of plugs.

# Conference Notes

## Methyl Salicylate for Cranberry IPM

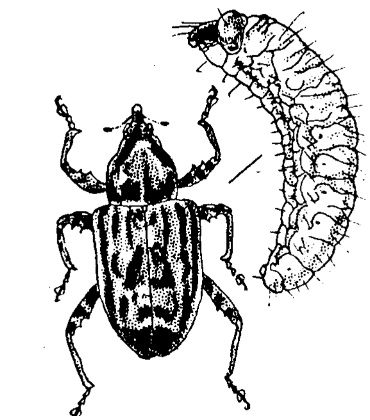
Methyl salicylate (MeSA), commercially formulated as PredaLure®, is an herbivore-induced plant volatile (HIPV) triggering plant release of HIPVs and attracting predators and parasitoids useful in controlling aphids, spider mites, and other pests in agricultural settings as diverse as corn fields and cranberry bogs, said Cesar Rodriguez-Saona (Rutgers Univ, 125a Lake Oswego, Chatsworth, NJ 08019; crodriguez@aesop.rutgers.edu).

Insect predator responses to MeSA lures were monitored for eight weeks in 15 commercial cranberry bogs using paired yellow sticky traps (unbaited control; MeSA lure). Significantly more adult lady beetles and green lacewings were caught on two of eight sampling dates. Significantly more adult syrphid flies, *Toxomerus marginatus*, were caught in traps with MeSA lures on most sampling dates. Syrphid flies showed a point source attraction to the lures, which was a surprise.

Cranberry plants, which normally produce little MeSA, were also exposed to variously aged MeSA lures in greenhouse tests. Fresh and aged MeSA lures resulted in nearby cranberry plants producing more MeSA.

Though European corn borer (ECB), *Ostrinia nubilalis* is not a cranberry pest, commercially-available ECB egg masses were placed different distances from MeSA lures to measure predation. ECB egg mass predation increased by 3% from 8% to 11% with MeSA lures. There were more syrphid flies, green lacewings, and lady beetles.

Numbers of parasitoids and ground predators from the MeSA experiments are also being counted. A predatory mite not captured by the yellow sticky cards was observed eating the ECB egg masses. A larger ecological question still to be answered is: What are the ecological effects on crop fields and surrounding areas when natural enemies are attracted to MeSA lures in the absence of pests? [This might be a moot question, as pests always seem to find a crop.]



**Plum curculio, *C. nenuphar***

## Plum Curculio Trap Trees

Pesticide spraying can be reduced 99% if only perimeter or selected infested trap trees are treated for plum curculio, *Conotrachelus nenuphar*, said Starker Wright (USDA-ARS, 2217 Wiltshire Rd, Kearneysville, WV 25430; Starker.Wright@ars.usda.gov). Perimeter rows of apple trees can act as trap trees when baited with synthetic fruit volatiles such as benzaldehyde or plum curculio aggregation pheromone (grandisoic acid).

Oviposition (egg-laying) scars are evidence of plum curculio aggregation, indicating baited trap trees attract the pest. Baiting trap trees with benzaldehyde and grandisoic acid reduced plum curculio injury to 14.6%. Plum curculio aggregation was evident in baited trap trees, and decreased with increasing distance from the trap trees.

Interestingly, electroantennogram (EAG) activity did always predict plum curculio behavioral responses. For example, there was no EAG response to benzaldehyde, which was a good attractant in the field. Trans-2-hexenal produced an EAG response, but no aggregation.

To prevent trap trees from competing with each other, trap trees were spaced 50 meters (164 ft) apart; the idea being to have 25 meters (82 ft) on either side of the trap tree free from competition (for plum curculio attraction). Baited trap trees can be combined with other IPM techniques. For example, entomogenous nematodes can target plum curculio in dropped fruit.

## Roadside Mowing and Butterfly Strips

Road ecology, a relatively new field (1990s) involved with keeping roadside wildlife intact, has tended to focus more on vehicle collisions with larger animals such as vertebrates rather than invertebrates like butterflies, said Dale Halbritter (Univ of Florida, 970 Natural Area Dr, Gainesville, FL 32611; dhalb001@ufl.edu). But butterflies to some extent are also proxies for pollinators and other flying insects, including beneficials. Loss of habitat to roads, habitat fragmentation, and habitat degradation beyond the roadside are also road ecology concerns.

In Central Florida, roadside margins include butterfly habitats. Thus, roadside butterfly kills and mowing impacts are concerns for these habitats. Along the roadside, test plots were evaluated. The test plots were 600-meter (1,969-ft) lengths divided into 200-m (656-ft) treatment blocks. Treatments included no mowing; mowing every six weeks; and mowing every three weeks (frequent mowing). Killed butterflies were collected within 1 meter (3.3 ft) of either side of the road edge for one flight season (April-Oct). Live butterflies were sampled along linear transects. Floral analysis (species richness & density) utilized 1 $m^2$ (10.8 $ft^2$) quadrants.

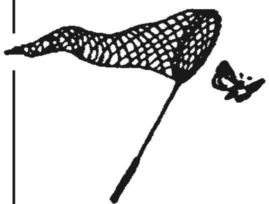
Mowing treatments had an effect on the abundance of live butterflies, particularly Hesperioidea (skippers) and Papilionoidea (other butterflies). Reducing mowing frequency is a cultural technique to increase flowers and butterfly abundance. The least-frequently mowed areas can become "sinks" for butterflies from nearby areas or act as butterfly (i.e. wildlife) corridors between habitats. The long-term goal is designing roadside mowing schedules that conserve butterflies and other pollinators, and at the same time accommodate highway safety.

Bio-Integral Resource Center
B • I • R • C
P.O. Box 7414, Berkeley, California 94707

ADDRESS SERVICE REQUESTED

NON-PROFIT ORG.
U.S. POSTAGE
PAID
Berkeley, CA
Permit #442

Please renew your membership and help support BIRC. THANK YOU!



INKWORKS 147
Printed with vegetable-based inks
On Processed Chlorine-free paper
100% post-Consumer Waste content

# Classified Ads

## PRODUCTS



## PRODUCTS



**CLASSIFIED AD RATES**—1x rate: $1 per word. 2x-3x: 80¢ per word. 4x or more: 80¢ per word. Write ad, calculate the cost. **BUSINESS CARD AD RATES** (2 x 3.5")—1x rate: $55. 2x-3x: $45 each time. 4x or more $40 each time. Business card ads must be camera-ready; or BIRC will typeset your ad for $40. **ALL ADS MUST BE PREPAID**. Send ads and payment to ***IPMP* Classified Ads**, PO Box 7414, Berkeley, CA 94707. Ads must be received five weeks prior to date of issue in which it is to appear. We reserve the right to refuse materials we feel are inappropriate.