The IPM Practitioner
Monitoring the Field of Pest Management
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Mainstream Pest Management and IPM (Green) Certification

By William Quarles

Sooner or later, everyone encounters structural pests such as termites, cockroaches, ants, clothes moths, carpet beetles, rats, mice, or other critters. Some people try to take care of the problem themselves, others seek professional help. Some customers do not care how the problem is solved. Others want to make sure that they and their families are not exposed to toxic pesticide residues. The problem often becomes, who do you call?

Progressive consumers and organizations such as the Bio-Integral Resource Center (BIRC) have tried for years to find pest control companies providing IPM methods that reduce pesticide exposures. These companies exist, but they have been hard to find, because they are usually small and have limited marketing resources. Until recently, the only easy access customers had to reduced-risk companies was through referral lists developed by BIRC, Beyond Pesticides, and other environmental organizations (see Resources). Companies were identified through labor-intensive surveys, and few resources were available for field audits to verify pest management procedures. For a number of reasons, this situation is changing. Some mainstream companies have adopted green, or reduced-risk pest management as part of their business plan.

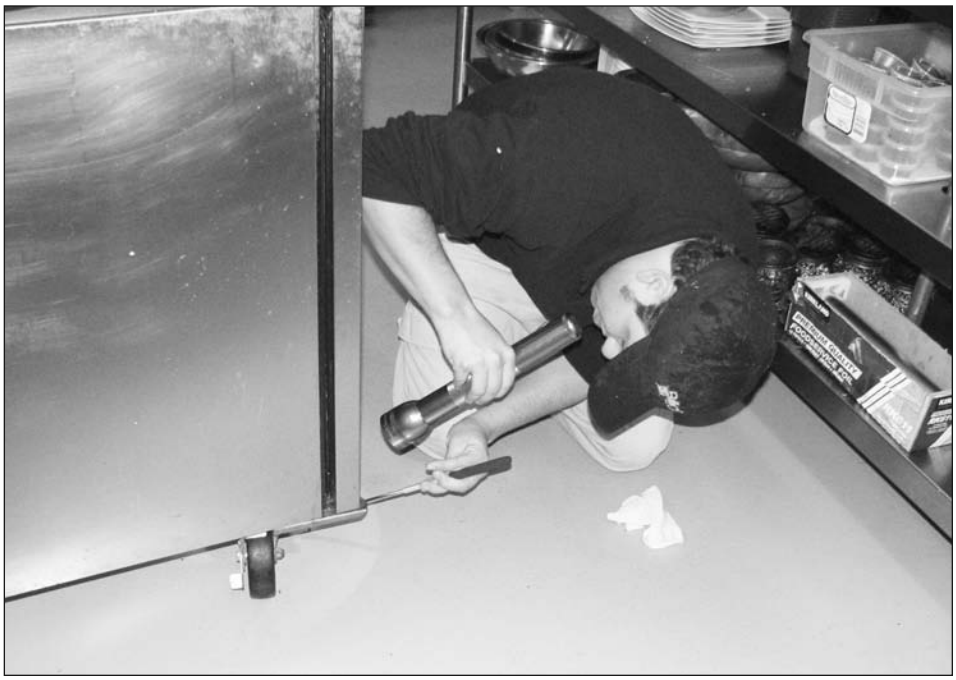

Photo courtesy of Pestec and Finger Design

Carlos Agurto of Pestec is inspecting for cockroaches. Pestec has been approved by both EcoWise Certified and Green Shield. IPM certification programs emphasize monitoring, prevention, and non-chemical controls. Pesticides are used as a last resort.

Reasons for Change

There are a number of reasons why some pest control companies are now moving toward IPM or green pest management methods. One reason is the market created by water quality problems in California and elsewhere. Monitoring studies have shown that pesticides, and especially diazinon, have caused toxicity problems in urban creeks. Diazinon has been phased out, but pyrethroids, which are the emerging replacement, are also causing problems (Johnson 2004; Moran 2005; Amweg et al. 2005; Weston et al. 2004). Part of the remediation strategy for creeks and surface waters impaired by pesticides is encouragement of IPM methods that lead to less surface water contamination

In This Issue

The IPM Practitioner
Monitoring the Field of Pest Management

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

Update

(Johnson 2004). Some public agencies in California now require that their pest management companies provide IPM methods.

IPM methods are inherently green because less pesticide is used and less environmental contamination occurs. Since IPM methods can lead to fewer pesticide applications or reductions in amounts used both in structures (Greene and Breisch 2002) and landscapes (Raupp et al. 1994; Stewart et al. 2002; Sellmer et al. 2004), a number of cities and counties in California and elsewhere require the use of IPM on public property (SF 1997; Santa Clara 2002; Levitan 2004). These IPM contracts can be quite lucrative, and companies with a "green" or reduced-risk reputation and experience as an IPM provider are well positioned to obtain these jobs (BIRC 2008).

Green Buildings

Another reason that mainstream companies are adopting green pest management is the widespread implementation of green building standards. LEED (Leadership in Energy and Environmental Design) standards developed by the US Green Building Council can reduce energy use and improve the environmental profile of buildings that adhere to the standards. Buildings receiving a large number of rating points in the LEED system are often easier to sell, and can bring higher prices.

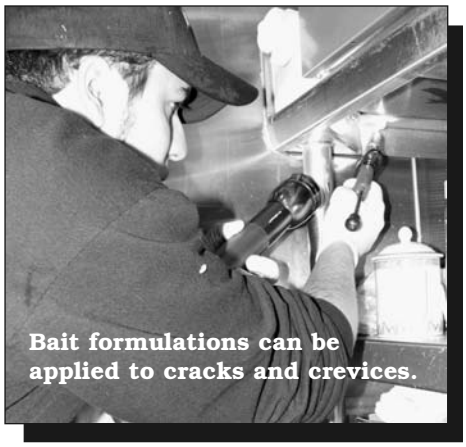
Government agencies are now requiring that their buildings conform to green standards. For instance, all existing State of California buildings larger than 50,000 ft^2 must meet LEED standards "to the maximum extent that is cost effective by no later than 2015" (Green Building 2009). Interior and exterior pest management plans are part of the evaluation system, and IPM methods or green pest management can help a building meet LEED standards.

IPM Certification

Customer pressure for reduced-risk pest management, and the need for companies validated as IPM service providers has driven the establishment of Structural IPM Certification programs. Programs created over the past three years include EcoWise Certified, Green Shield Certified, and QualityPro Green. QualityPro Green has been recently improved and rebranded as GreenPro Certified (see below). These programs define pest management approaches and provide certification standards with formal methods of validation. Once certified, customer access is facilitated through listing of companies on certification websites (see Resources).

Certification Standards

Certification programs provide validity for companies offering reduced-risk services. To be useful, these programs must insure that reduced-risk services are actually being provided. At all costs, they must avoid accusations of "green washing." Green washing means that certification standards are weak, and have so many loopholes that unsatisfactory pest management practices can be used, and yet the company can



Bait formulations can be applied to cracks and crevices.

Photo courtesy of Pestec and Finger Design

still maintain the advantage of being perceived as "green."

The best insurance against green washing is transparent, rigorous, and detailed certification standards so that everyone understands exactly what services are being provided. Especially important are the pesticide application standards and the pesticide evaluation criteria. The application standards explain exactly how and when pesticides will be used, and the pesticide evaluation criteria determine which pesticides will be allowed. Also important is whether or not audits are performed to insure compliance with the standards.

Pesticide Application Standards

EcoWise, Green Shield, and GreenPro all have reasonably satisfactory pesticide application standards. All emphasize prevention and non-chemical methods as being most desirable. Because EcoWise has its origins in water quality problems, it does not allow exterior perimeter sprays. GreenPro providers also cannot use these sprays. Spot treatments outside are permitted by GreenPro and by EcoWise, especially for nests of stinging insects. GreenPro does not allow application to impervious surfaces, such as concrete. Research has shown that these kinds of applications can lead to surface water contamination (GreenPro 2009ab; EcoWise 2006; Green Shield 2007; Moran 2005).

None of the three programs allow foggers where people live and work. All emphasize baits and crack-and-crevice treatments. Inside structures, EcoWise permits directed sprays to wall voids, or other inaccessible areas, crack-and-crevice treatments, and baits. GreenPro allows spot treatments to surfaces indoors with insect growth regulators (IGRs), 25b exempt materials, or pyrethrins. If pyrethrins are used, the customer

Box A. EcoWise Pesticide Evaluation Criteria

EcoWise Certified uses the criteria listed below to screen pesticides for use in an EcoWise Certified service. Only active ingredients are screened for most risk categories because the identities of inert ingredients in the formulation are often not available. The exception is acute toxicity, where the EPA requires that the full formulation be tested for lethal effects in animals, usually rats. The testing determines the single dose required to cause death in test animals via ingestion, inhalation, and skin absorption. The testing also evaluates the degree of skin and eye irritation or damage. Results are then classified as Category I - Danger, Category II - Warning, and Category III - Caution. The highest hazard and greatest mammalian toxicity is associated with Category I.

I.Products Applied Inside Structures

Restrictions:

1.No US EPA Acute Toxicity Categories I and II

No EPA Category I (Danger) or Category II (Warning) pesticides are allowed. If a pesticide is used that is exempt from registration by EPA, it must not exceed criteria for Category I or II for acute oral, dermal, or inhalation toxicity and skin or eye sensitivity.

2.No Carcinogens

No pesticides with active ingredients classified as known, probable, likely, or possible carcinogens by:

(a) US EPA, http://www.epa.gov/pesticides/carlist/

(b) The International Agency for Research on Cancer (IARC), http://www.iarc.fr/

(c) The National Toxicology Program (NTP), http://ntp.niehs.nih.gov/

(d) The California Proposition 65 List, http://www.oehha.ca.gov/prop65/prop65_list/Newlist.html

3.No Reproductive or Developmental Toxins

No pesticides with active ingredients classified as reproductive or developmental toxins by:

(a) US EPA, http://www.epa.gov/

(b) The California Proposition 65 List, http://www.oehha.ca.gov/prop65/prop65_list/Newlist.html

4.No endocrine disruptors

No pesticides with active ingredients classified as known, probable, or suspected endocrine disruptors by:

(a) US EPA, http://www.epa.gov/

(b) The European Union, http://europa.eu.int/comm/environment/endocrine/strategy/substances_en.htm

5.No Pesticides Containing Cholinesterase Inhibitors

II.Products Applied Outside

Products used outside must meet these additional criteria:

6.No active ingredients listed in:

(a) Section 303(d) of the Clean Water Act, http://www.swrcb.ca.gov/ html/

(b) California's Groundwater Protection List, http://www.cdpr.ca.gov/docs/legbills/calcode/040101.htm#a6800

7.No active ingredients that are considered to be extremely toxic to birds, fish, bees, and wildlife as indicated by the label, MSDS, or EPA data.

8.No active ingredients with an average soil half life greater than 99 days as determined by the Oregon State University (OSU) Pesticide Properties Database (http://ace.orst.edu/info/nptn/ppdmove.htm) or other reliable source.

9.No products likely to contaminate groundwater as indicated by the label.

10.No active ingredients with high soil mobility (i.e., a GUS score greater than 3 as determined by the OSU Pesticide Properties Database or other reliable source. The GUS score is calculated in the following way: GUS = log (average half life in days) multiplied by [4 – log (Koc)] where Koc is a measure of the tendency to bind to soil. [http://ace.orst.edu/info/nptn/ppdmove.htm])

11.No active ingredient that is a persistent, bioaccumulative, toxic substance on the US EPA Waste Minimization Priority list: http://www.epa.gov/epaoswer/hazwaste/minimize/chemlist.htm

must be notified in writing to avoid contact with the treated surfaces. Green Shield does not allow toxic residual surface sprays to be applied to floors, baseboards, walls, or foundations (GreenPro 2009ab; EcoWise 2006; Green Shield 2007).

Pesticide Evaluation Criteria

The spirit of all the pesticide application standards is that "a pesticide application shall be made in a precise manner, in the smallest area to be effective, using the minimum quantity of pesticide necessary to achieve control" (GreenPro 2009a). In addition, pesticides used ideally should be least-toxic and present the lowest health and environmental risks.

The San Francisco Department of the Environment pioneered pesticide evaluation criteria as the cornerstone of reduced-risk pest management (SF 1997). Criteria include acute toxicity, and whether or not a pesticide is a carcinogen, endocrine disruptor, reproductive toxicant, or environmental hazard (Hom 1999; SF 2009).

EcoWise and Green Shield have strict pesticide evaluation criteria. The idea is to eliminate the most toxic pesticides (Box A), but maintain flexibility through exemptions based on how the pesticide is used. Both EcoWise and Green Shield require that companies seeking certification provide a field auditor with a list of pesticides that will be used for IPM service accounts. Both EcoWise and Green Shield will allow some products that fail toxicity screening if the risk of human exposure is low. For instance, an active ingredient that fails screening might be allowed when contained within a bait station (EcoWise 2006; Green Shield 2007).

GreenPro Criteria

GreenPro is designed to reduce risk by eliminating or minimizing exposure to pesticides, but does not approve products, so reduced risk products are not required by the certification standards. GreenPro Standards suggest that companies must evaluate pesticide toxicity, potential environmental impact, potential for exposure, and sensitivity of the site. The standards state that "whenever possible, choose products that do not contain chemicals that are known or suspected of causing delayed or toxic effects" [such as cancer, birth defects, organ damage, or endocrine disruption.] (GreenPro 2009a). GreenPro standards basically shift pesticide screening responsibility from the certification program to the company.

Sticky traps are used to monitor for cockroaches.

Photo courtesy of Pestec and Finger Design

Companies that apply for GreenPro certification will probably not exploit this loophole. If they do, their business reputations could suffer, and the considerable effort required for certification could be negated. Also, GreenPro field auditors will probably flag a pattern of pesticide choices made without attention to reduced-risk properties. GreenPro application standards partially mitigate the problem, as only insect growth regulators, 25b exempt materials, and pyrethrins can be used for spot treatments indoors. Spot treatments indoors have a high risk for exposure to residues.

EcoWise and Green Shield do not allow acutely toxic Category I and Category II pesticides. GreenPro standards state "all things being equal, PMPs should choose products with caution labels (Category III) over those with Warning (Category II) labels, and Warning labels over those with Danger or Danger-Poison (Category I) labels" (GreenPro 2009a).

Field Audits

All of the certification systems require field audits to insure that certification standards are met. EcoWise and Green Shield require field audits before a company can be certified. GreenPro requires a paper audit within the first year, and conducts random field audits each year. A minimum of 20% of the certified companies are randomly audited each year under the GreenPro system. Furthermore, additional companies may be audited on a complaint triggered basis (GreenPro 2009b).

Costs

EcoWise is the best bargain, since certification is free. Free certification is possible because EcoWise is funded by a grant. When grant funding expires, fees will probably be required. The other certification systems have a sliding fee scale, and costs are determined by annual company income. Minimum fees are $500 each year. There are additional costs to pay for field auditors (GreenPro 2009b).

EcoWise Certified

EcoWise Certified was created by the Bio-Integral Resource Center (BIRC), the Association of Bay Area Governments (ABAG), the Natural Resources Defense Council (NRDC), and the Stormwater Quality Programs of Sacramento County and the City of Sacramento. Most of the certified practitioners and companies are in the San Francisco Bay Area, in Southern California or in

the Sacramento area. EcoWise has provided a detailed model for the other certification systems. So far, 7 companies and 90 practitioners have been certified. Customers wanting to hire companies can find them on the EcoWise Certified website (see Resources)

EcoWise has strong pesticide application standards and rigorous pesticide evaluation criteria based on those developed by the San Francisco Department of Environment (see Box A). Individual practitioners are certified through an in-person exam, and companies must pass a field audit to confirm their adherence to the standards (EcoWise 2006). The innovative nature of the program, and its potential to reduce pesticide exposures, resulted in an IPM Innovator Award from the State of California Department of Pesticide Regulation in 2008.

Ted Shapas is the Director of the EcoWise Certified Program. He is an experienced researcher who helped develop many of the commercially successful cockroach and ant baits. Shapas believes that "IPM Certification Standards can reassure customers about what kind of service they will get. For a company, EcoWise certification can lead to new business opportunities, and can help with employee recognition and advancement."

EcoWise Certified is not a one dimensional program created by special interest groups from industry or environmental organizations. EcoWise Certified has many diverse stakeholders. Pest Management Professionals (PMPs), IPM experts, state agencies, regulators, and water quality experts all contributed to developing the program.

According to Shapas, Ecowise Certified can help establish PMPs as IPM professionals and provide them with new markets. Consumers will be able to confidently hire professionals to provide effective pest management, while minimizing pesticide use.

Green Shield Certified

The Green Shield program was developed by the IPM Institute, which is a non-profit based in Madison, Wisconsin (see Resources). Green Shield evolved from the IPM Star certification program that the Institute had developed for school IPM. Green Shield has a good reputation with IPM professionals, and it received the IPM Excellence Award at the 6th International IPM Symposium in March 2009. Companies can be certified by passing a field audit based on a checklist of requirements. Some of the requirements are pass-fail. For instance, companies that apply pesticides before a pest is identified cannot be certified (Green Shield 2007).

A major focus of Green Shield is prohibition of the most toxic pesticides. For example, companies that propose to use pesticides with high acute toxicities (Category I) in a Green Shield account cannot be certified. Green Shield has certified about 28 companies in 17 states. Customers wanting to hire these companies can find them on the Green Shield website (see Resources). Green Shield will also certify buildings (Greenshield 2009).

GreenPro Certified

GreenPro Certified was developed by the National Pest Management Association (NPMA), an organization funded by the pest management industry. Individual practitioners can be certified by taking an exam. Before a company can be certified, it must first meet QualityPro criteria, including good business practices and high professional standards (GreenPro 2009a).

The first IPM certification program offered by the NPMA was QualityPro Green (QPG). About 64 companies, including large, mainstream organizations, have been certified by QPG. A weakness of QPG was a lack of independent audits to monitor compliance with standards. QPG was replaced in June 2009 by the GreenPro Certified program.

GreenPro pesticide application standards are similar to those developed by BIRC for the EcoWise Certified program. Probably because of the rigorous pesticide application standards, and the requirement of a third party audit during the first year of certification, GreenPro has been endorsed

Resources

Beyond Pesticides, 701 E. Street SE, No. 200, Washington, DC 20003; 202/543-5450, Fax 202/543-4791; www.beyondpesticides.org

Bio-Integral Resource Center, PO Box 7414, Berkeley, CA 94707; 510/524-2567, 510/524-1758; www.birc.org; email birc@igc.org

EcoWise Certified, 510/464-7960, 866/858-6386; www.ecowisecertified.org

Green Shield Certified, 4510 Regent Street, Madison, WI 53705; 888/476-7453; Fax 608/232-1440; www.greenshieldcertified.org

GreenPro Certified, www.certifiedgreenpro.org; www.npmagreenpro.com

IPM Institute of North America, Inc., 4510 Regent Street, Madison, WI 53705; 608/232-1410; Fax 608/232-1440; www.ipminstitute.org

National Pest Management Association, 10460 North St., Fairfax, VA 22031; 800/678-6722, 703/352-6762, Fax 703/352-3031; www.pestworld.org

Natural Resources Defense Council (NRDC), 111 Sutter Street, 20th Fl, San Francisco, CA 94104; 415/875-6100; Fax 415/989-0062; www.nrdc.org

San Francisco Department of Environment, 11 Grove Street, San Francisco, CA 94102; 415/355-3700; www.sfenvironment.org

by the Natural Resources Defense Council (NRDC) (GreenPro 2009ab). QPG companies have until January 1, 2010 to make the transition to GreenPro. According to Andrew Architect of GreenPro, about 6 companies have been certified so far, and they expect between 100 and 150 companies to be certified before January.

Green Buildings

Part of the standards for LEED certified green buildings are interior and exterior pest management plans. One way to insure that IPM plans conform to green building standards is to hire an IPM certified company. But large institutions such as the University of California, Berkeley have their own pest management staff. Although UC Berkeley has always preferred least-toxic methods, it is now making the transition to LEED green building pest management standards.

According to Margaret Hurlbert, pest management director of UC Berkeley, LEED standards emphasize prevention and IPM methods. If reduced-risk products (Tier 3) listed by the San Francisco Department of Environment are not used, then pesticide applicators must post 72-hour notices (SF 2009).

Conclusion

IPM certification and green pest management is good for consumers and good for the structural pest management industry. Consumers can buy pest services based on prevention and reduced-risk methods. IPM providers and green companies can be easily found on IPM certification websites. Industry now has another way of marketing services, and creation of a green pest management industry can potentially provide prestigious jobs for highly trained professionals.

Acknowledgement

The author would like to thank Ted Shapas, Ph.D., of EcoWise Certified, Jonathan Kaplan of the Natural Resources Defense Council, and Margaret Hurlbert of UC Berkeley for reading the manuscript and making suggestions for improvement.

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

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US EPA, Chemicals Evaluated for Carcinogenic Potential, Science Information Management Branch, Health Effects Division, Office of Pesticide Programs, US EPA, December, 2005. Telephone: (703) 305-5017; http://www.epa.gov/pesticides/carlist/

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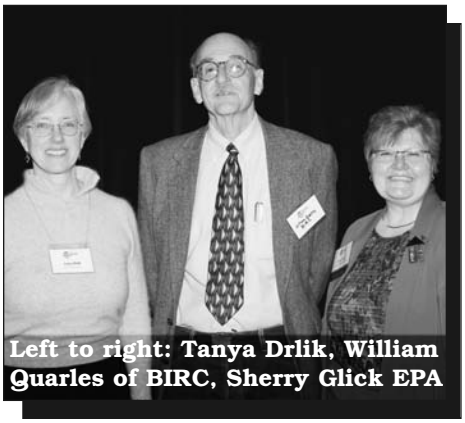
BIRC Receives Lifetime International IPM Achievement Award

More than 700 IPM Professionals from 29 countries, representing industry, government, universities, and non-profits attended the 6th International IPM Symposium, held March 24-26, 2009 in Portland, OR. There were presentations covering a wide range of topics such as green buildings, school IPM, ecolabeling, invasive species, ants, termites, bed bugs, biopesticides, IPM policy, and IPM Certification programs. There were 67 regular sessions, 194 posters, and a considerable number of side meetings. Abstracts and presentations are now online at www.ipminstitute.org.

Several organizations received awards. Award recipients were chosen because they "displayed notable contributions to 1) improving economic benefits related to IPM adoption, 2) reducing potential human health risks, and/or 3) minimizing adverse environmental effects" [of pesticides]. The Bio-Integral Resource Center (BIRC) was awarded the Lifetime International IPM Achievement Award. The award was based on "years of accomplishments with IPM and reflected many publications, demonstrations and real valued outcomes."

BIRC was founded in 1979 by William Olkowski, Helga Olkowski, and Sheila Daar, whose previous work was instrumental in creating the field of urban IPM. BIRC has provided 30 years of leadership, insight, and innovation in the development and implementation of IPM methods from the local to the international level. It has a long history of "firsts": first to design and implement municipal and school IPM programs, first to publish a school IPM manual, first to design an IPM program for a national park service, first to publish an international journal dedicated to the dissemination and advancement of IPM information, first to produce an international directory of IPM products and services, and the first to design an IPM certification program for structural pest control.



Left to right: Tanya Drlik, William Quarles of BIRC, Sherry Glick EPA

For 30 years, BIRC's publications, *The IPM Practitioner* and *Common Sense Pest Control Quarterly*, have reported on new research and ideas in the field of IPM. Over the years, BIRC staff have been an international resource, answering tens of thousands of pest management questions from professionals and homeowners alike. According to the Awards Committee, "without BIRC's pioneering efforts, urban IPM and "green" pest management could not have achieved the prominence they enjoy today."

Thank You, BIRC Members!

This award is a great honor, and we would like to thank all the BIRC members who have made it possible. Without your support, we would not have been able to implement the programs and publications that led to this award. We also want to thank everyone who has worked for BIRC especially Bill and Helga Olkowski, Sheila Daar, William Quarles, Tanya Drlik, Joel Grossman, Bart Brandenburg, Laurie Swiadon, Diane Kuhn, Kathy Spalding, and Jennifer Bates.

William Quarles accepts the award for BIRC

Recognition of the IPM Community

BIRC would also like to thank the Pest Management Professionals (PMPs), IPM Coordinators, policy experts, IPM Specialists, and government regulators who have been working to make changes. When we started back in 1979, urban pest management was one dimensional, relying totally on pesticide applications. Then the urban IPM concept was developed. We have now turned to pest prevention, and the use of pesticides as a last resort.

Due to the efforts of the IPM community, we have seen the development of school IPM programs; we have seen many cities and counties implement urban IPM programs. And we have seen the development of structural IPM certification programs such as Green Shield, EcoWise, and GreenPro. The IPM community as a whole deserves an award, since those working tirelessly as IPM professionals have made it possible for healthier schools, homes, and workplaces.

ESA 2008 Annual Meeting Highlights

By Joel Grossman

These Conference Highlights are from the November 16-19, 2008, Entomological Society of America (ESA) annual meeting in Reno, Nevada. ESA's next annual meeting is December 13-16, 2009, in Indianapolis, Indiana. For more information contact the ESA (10001 Derekwood Lane, Suite 100, Lanham, MD 20706; 301/731-4535; http://www.entsoc.org

Methyl salicylate (MeSA), an induced resistance plant volatile, "can potentially prevent aphid and spider mite outbreaks in strawberry fields since MeSA attracts a variety of foliar predators," said Jana Lee (USDA-ARS, 3420 NW Orchard Ave, Corvallis, OR 97330; jana.lee@ars.usda.gov). In grape and hop fields, application of MeSA increases the abundance of predators and parasitoids.

MeSA 30-day Predalure® (AgBio Inc) dispensers at ground level and 1.5 ft (0.46 m) were tested in a large strawberry field monitored with pitfall and white sticky traps, as well as visually and through leaf samples. Pitfall trap captures of ground beetles, spiders and daddy long legs were similar with and without MeSA. Leaf samples in MeSA plots had 200-400% more natural enemies within 3-24 days. Green lacewing numbers were doubled; lady beetle numbers were marginally higher. White sticky traps in treated plots caught 45% more Chalcidoidea parasitoids.

Sticky Circles

Originally developed to attract western flower thrips, *Frankliniella occidentalis*, a sticky card with a yellow circle on a black background also attracts whiteflies, said Sangwon Kim (Andong National Univ, Songchun, Andong 760-749, Gyeongbuk, South Korea; blueguy813@naver.com). In oriental melon greenhouse tests, 24-39 cm (9.4x15 inch) doublesided, sticky traps with either two 18-cm (7-in) or two 13-cm (5-in) diameter yellow circles on a black background were compared to standard rectangular yellow sticky cards.

Black sticky cards with small yellow circles caught 180% more sweetpotato whitefly, *Bemisia tabaci*, than cards with larger circles. However, the sticky cards with larger circles caught 70% of the whiteflies taking off from the plant canopy; versus 49% for the card with smaller circles, and 32% for rectangular yellow sticky traps.

In laboratory behavioral studies yellow sticky cards with black backgrounds were 1.8 times more attractive than sticky cards without backgrounds. Yellow triangles attracted 1.5 times more *B. tabaci* than squares. Yellow sticky cards with black backgrounds attract more *B. tabaci* per unit area than conventional yellow sticky cards and could be a good addition to management or monitoring programs.

Botanical Cockroach Repellent

BioUD (HOMS LLC, Clayton, NC), which was isolated from wild tomatoes, was registered by the U.S. EPA in 2007 as a botanical alternative to DEET for repelling mosquitoes and ticks. According to Christof Stumpf (Louisiana State Univ, 8100 Hwy 71 South, Alexandria, LA 71302; cstumpf@lsua.edu), the active ingredient, 2-undecanone, also kills German cockroaches, *Blattella germanica*, faster than the commercial household insecticide Raid®. Suspensions of about 1% in alcohol or water were 100% repellent in 90-120 minutes after application.

Drywood Termite Night Lights

The West Indian drywood termite, *Cryptotermes brevis*, is attracted to light, and this information can be used to reduce infestations. According to Maria Ferreira (Univ of Florida, 3205 College Ave, Fort Lauderdale, FL 33314; mteresaf@ufl.edu), an attic with a light on during the night has a higher probability of being infested than one with with no lights on.

In light intensity experiments with light emitting diodes (LEDs), winged termite attraction increases with light intensity, which is "useful information for creating better light traps for this species," said Ferreira. Alates lose their wings after flying to lights, becoming dealates. "Dealates display negative phototactic behavior, colonizing more in darker areas or near dark areas." Even "cracks and holes in wood in darker areas were more susceptible to colonization."

Apartment IPM Bedbug Traps

IPM is needed for bed bugs, because cryptic behaviors and pesticide resistance make effective control with chemicals alone impossible, said Changlu Wang (Rutgers Univ, 901 West State St, West Lafayette, IN 47907; changluw@yahoo.com). Spray and dust based IPM programs were compared in an infested Indiana building with 225 one bedroom apartments, each containing from 10 to more than 3,000 bed bugs. Liquid chlorfenapyr (Phantom®) sprays or diatomaceous earth (DE) dusts were the pesticide treatments. IPM tools included encasements, washing, hot steam, traps and decluttering.

Bed bugs detected in visual inspections were crushed, steamed, or otherwise removed. Apartment residents were asked to bag and wash infested belongings. Mattresses and box springs were installed with encasements. Sofas, floors and curtains were treated with hot steam. Since clutter and secondhand furniture often contribute to the problem, residents were asked to remove clutter. Trapping was done with bed bug interceptors, small containers con-

taining 20 ml of antifreeze placed inside a larger container of diatomaceous earth surrounding the bedpost legs.

Each bed bug interceptor (Climbup™ Susan McKnight, Inc.) trapped from 8 to 1,103 bed bugs in 10 weeks, an indication that inspections underestimated bed bug populations. DE in the large outer bowl of the traps trapped 94% of the bed bugs, which were moving from the furniture towards the bed. Effective DE trapping made the dust based IPM program significantly more reliable than the spray based IPM program. In 10 weeks, 50% of the bed bug population was killed. The spray based program for a small one bedroom apartment cost $463, of which $1 was the cost of pesticide. The dust treatment cost $482, and $1.40 was the cost of dust.

Mobility Increases with Hunger

Night feeding, followed by hiding in daytime harborages is a bed bug survival strategy governed in large measure by circadian rhythms, said Alvaro Romero (Univ of Kentucky, S-225 Ag Sci Center North, Lexington, KY 40546; alvromero@uky.edu). Young adult bed bugs (1-2 weeks old) move around more frequently when unfed and less after feeding. However, when blood resources are less, bed bugs conserve energy after 5 weeks by moving around less and can survive for a year without feeding. Future research will test the hypothesis that after prolonged starvation bed bugs switch from random searches to dependence on host cues.

Bedbug Pheromones and Pesticide Resistance

According to Daniel Suiter (Univ of Georgia, 1109 Experiment St, Griffin, GA 30223; dsuiter@griffin.uga.edu), bed bug research highlights of 2008 included the identification by Siljander et al. of an airborne aggregation pheromone. In bioassays, the pheromone proved to be a complex mixture of nonanal, decanal, (E)-2-hexenal, (E)-2-octenal, (2E,4E)-octadienal, benzaldehyde, (+)-limonene, (-)-limonene, sulcatone and benzyl alcohol. In 2007, Siljander et al. also identified contact pheromones of the common bed bug, *Cimex lectularius*.

Alvaro Romero et al. (2008) randomly sampled bed bug colonies in the U.S. and found pesticide resistance ratios of over 12,000. In other words, there was 0% mortality using many insecticides at 1,000% greater concentrations than the label rate. Also, unless harborage is soiled with bed bug feces and eggs, bed bugs respond to deposits of pyrethroids by dispersing. The implication and concern, said Suiter, is that "the application of pyrethroid insecticides to clean surfaces will wind up dispersing incredibly resistant populations of bed bugs." Hence, "a number of folks are out working on alternative methods for bed bug control such as heat treatments."

Heat Kills Bed Bugs

Hot air (heat fumigation) applied either to furnishings in insulated chambers or to whole rooms or whole structures is an IPM tool for combating bed bugs, said Roberto Pereira (Univ of Florida, Bldg 970, Natural Area Dr, Gainesville, FL 32611; rpereira@ufl.edu). Temperatures and durations needed for field use were calculated from exposure of test tubes containing two bed bugs to heat in hot tubs. Two hours at 39°C (102°F) killed no bed bugs. Bed bugs were killed by 44-45°C (111-113°F) heat applied for 2-6 hours.

Low Profile Treatment

The hotel industry is sensitive to treatment visibility, fearing negative guest reactions to visible evidence of heat fumigation such as heaters and fans. Heat chambers (insulated boxes) for hot air fumigation of room contents are a less conspicuous alternative, though oil heaters and fans outside the boxes circulate the air. Styrofoam boards sealed around the treatment area can create inexpensive heat chambers. Treatment times can be determined from thermocouples linked to computers (see IPMP May/June 2006). The equipment costs less than $400, and the low profile treatment can be completed in 30 minutes to 6 hours. More time is needed for rooms with carpeted floors, versus tile floors.

Nematodes and Sustainable Turf Biocontrol

The entomopathogenic nematode *Steinernema scarabaei*, is highly virulent and has great short-term efficacy, killing most white grub species except masked chafers, said Albrecht Koppenhöfer (Rutgers Univ, Blake Hall, 93 Lipman Dr, New Brunswick, NJ 08901; koppenhofer@aesop.rutgers.edu). September applications of *S. scarabaei* to Kentucky bluegrass microplots infested with Oriental beetle, *Anomala orientalis*, worked so well that no white grubs survived into the spring. Even with natural white grub reinvasion, there was still significant white grub suppression a year later despite no increase in *S. scarabaei*. Two years later *S. scarabaei* had spread to untreated control plots, probably via equipment.

It is difficult to mass rear *S. scarabaei*. So Koppenhöfer reduced the *S. scarabaei* release rate by 40% in hopes of creating a sustainable system in the field. Fewer applied nematodes left some Oriental beetles as hosts for population growth in the spring. The reduced release rate led to reduced white grub populations 1-2 years later. In some plots the nematodes persisted 3-4 years. White grub control was 63-100% after 2-3 years; and varied from 0% to 88% after 4 years. White grubs survived best in sandy soils; nematodes did worst in acidic sandy soils, such as those used to grow blueberries.

Interaction with Endophytes

Endophytes can indirectly interact with nematodes and other natural enemies by altering insect behavior, said Douglas Richmond (Purdue Univ, 901 West State St, West Lafayette, IN 47907; drichmond@purdue.edu). Turf pests vary in susceptibility to endophytes. For example, black cutworms, *Agrotis ipsilon*, are killed by eating grass endophytes that have little effect on fall

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armyworms, *Spodoptera frugiperda*. Endophytes can reduce fall armyworm susceptiblity to beneficial nematodes by inhibiting growth of the *Xenorhabdus* bacteria carried by the nematodes.

Endophytes and Webworms

Three webworm species were bioassayed in choice and no-choice tests. Two webworm species accepted and fed on grass with endophytes. One species, the bluegrass webworm, *Paraediusia teterella*, avoided endophytic tall fescue. However, as bluegrass webworms were exposed to more endophytic grasses, their rate of infection by the entomopathogenic nematode *Steinernema carpocapsae* increased because more time was spent foraging in search of suitable host plants.

The combination of high aesthetic standards and inexpensive pesticides makes it hard to convince turfgrass managers that other approaches are viable, said Richmond. An ecological approach recognizes that no one factor operates by itself. Combinations of natural enemies and cultural factors such as host plant resistance work together to produce pest suppression. More research is needed on interactions of cultural tools such as host plant resistance and biological controls.

Lawn Care IPM

According to Parwinder Grewal (Ohio State Univ, 1680 Madison Ave, Wooster, OH 44691; grewal.4@osu.edu), "turfgrass is now the dominant feature in the urban landscape," and at 163,800 km^2 (63,243 mi^2) occupies three times the area of the largest irrigated U.S. crop. Grewal compared five different campus lawn care programs called organic, IPM, commercial, consumer, and controls. [Contact Grewal for details of each program.] The organic program used corn gluten for weed control and Ringer® Lawn Restore® for fertility; 20 Mule Team® Borax was used for ivy control. Labor costs were estimated at $10 per hour, and $30 per hour for monitoring.

Both the commercial and IPM programs did a good job of managing weed cover and dandelions. White grub numbers were very low, so none of the programs needed much treatment. Over a 3-year period, consumers rated quality best in the commercial program, with IPM and organic also getting good ratings.

For 5,000 ft^2 (465 m^2) of lawn, the commercial program was most expensive at $382, versus $304 for organic, $252 for IPM, $127 for the consumer program and $0 for the untreated control. When it comes to the percentage of lawn covered with weeds, "you get what you pay for," said Grewal. Lawn weed cover was 55% with no treatment; 45% with the consumer program; 20% with organic; 10% with IPM; and 5% with commercial. Lawn care quality was rated best for commercial because of fewest weeds; organic was slightly better than IPM because the high nitrogen in the corn gluten herbicide made for greener grass.

Commercial Comparison

Two commercial lawn care programs implemented by Buckeye Ecocare in Dayton, Ohio, were compared in the next phase of research in 2005. The standard program had no treatment thresholds; sprays were applied on a fixed calendar schedule. The IPM program had monitoring (3x/yr by grad students), and treatments were applied only if insect damage or weed cover exceeded a 5% threshold level. About 40% (12/29) of the IPM customers continued with the program in 2006; since nothing was applied preventively, IPM lawns had more weeds, and some customers demanded zero weeds. Even less than 5% weed cover was too much for some customers to tolerate.

Very few IPM lawns needed treatment for insects. Both standard and IPM lawns were rated 8-8.5 out of 10 for lawn quality. However, IPM cost half as much as the standard program. Even though the lawn care company could save a lot of money doing IPM instead of calendar sprays, when the students quit doing "free" monitoring, the lawn care company went back to calendar sprays.

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What You See is What You Get

Cultural or social perceptions play a role in weed tolerance. For example, in Europe people treat white clover as a companion crop in lawns, and eventually grasses outcompete the clover. In contrast, in the U.S. people treat clover as a weed to be eradicated rather than as a beneficial legume that fixes nitrogen.

In an Ohio telephone survey of 900 people, the majority said they would continue to use chemicals even if they knew they were bad for the environment and caused water pollution, in order to better fit into the community. "Sometimes lawn care companies get fired if the homeowner sees a single dandelion on their lawn," said Grewal, which makes it hard to implement IPM programs with 5% thresholds.

Nematodes Stop Plum Curculio

Plum curculio, *Conotrachelus nenuphar*, a native eastern North America fruit tree pest, has one generation per year in Michigan. Its egg-laying scars make freshmarket apples unsaleable, said Renee Pereault (Michigan State Univ, B-11 CIPS, East Lansing, MI 48824; pereault@msu.edu). Processed cherries have a zero tolerance for plum curculio larvae.

Adult plum curculio populations are typically sprayed with organophosphates to stop fruit damage. Some organic remedies include repeated kaolin clay coverage, Pyganic 'push-pull' strategies, and integration of livestock grazing into fruit tree production systems.

Larval emergence (3rd instar leaves fruit; 4th instar pupates in soil) has been correlated with calendar date and fruit stage in West Virginia tree fruits and New Jersey blueberries. Nematodes and fungi such as *Metarhizium anisopliae* and *Beauveria bassiana* applied late in the season to 4th instar larvae in soil can reduce adult emergence and numbers the following year.

Pereault tested *B. bassiana* fungi and both *Heterorhabditis* and *Steinernema* nematodes. *B. bassiana* GHA (Mycotrol-O) was applied at $5x10^{13}$ conidia per ha (0.4 acres). Infective juveniles of the nematodes *Heterorhabditis bacteriophora* (Utah; unformulated) and *Steinernema riobrave* 355 (Biovector® gel) were applied at $1x10^9$ and $4x10^9$ per ha. Timing was 10 days before to 20 days after plum curculio 4th instar larvae were introduced to soils.

Effectiveness Depends on Timing

High rates of *S. riobrave* were significantly better than the other treatments. Effectiveness depended on timing of applications. There was 66% larval mortality (66% less adult plum curculio emergence) when nematodes were applied 5 days prior to introduction of curculio larvae to the soil. There was 50% less adult emergence when nematodes were applied simultaneously with larvae; 27% less when applied 5 days after larvae were introduced to soil; 36% less adult emergence when applied 10 days after larvae were in soil.

The previous year, there was 80-90% nematode efficacy when applied either simultaneously or 5 days before plum curculio larvae were added to the soil. When orchard data analyzed by soil type, plum curculio mortality was as high as 89% in sandy loams, which may favor nematodes by having more soil pore space than clay soils.

Plum Curculio Bait Trees

Baited perimeter trees can protect apple orchards against plum curculio, *Conotrachelus nenuphar*, said Barbara Lewis (Univ of Arkansas, AGRI 319, Fayetteville, AR 72701; balewis@uark.edu). Between early April and late May 2004/5 and 2008, every 4th or 5th tree in the outer perimeter of an apple orchard were baited with lures containing grandisoic acid (APTIV, Inc), benzaldehyde and plum essence (Great Lakes IPM) to protect interior orchard trees from plum curculio fruit damage.

Baited perimeter trap trees proved an effective IPM tool, reducing adult plum curculio fruit damage in interior orchard trees; and might be com-

Calendar

August 1-5, 2009. Annual Meeting American Phytopathological Association. Portland, OR. Contact: APS, 3340 Pilot Knob Rd., St. Paul, MN 55121; 651/454-7250; www.apsnet.org

August 2, 2009. 94th Annual Meeting, Ecological Society of America. Albuquerque, NM. Contact: www.esa.org

August 7-9, 2009. NOFA Summer Conference, Amherst, MA. Contact: www.nofasummerconference.org

August 11-12, 2009. 5th Mid-Atlantic Exotic Pest Plant Council Conference. Johnstown, PA. Contact: S. Young, MA-EPPC, 5617 5th St., South Arlington, VA; www.ma-eppc.org

August 18, 2009. Midwestern Bio-Ag Field Day. Clyde, WI. Contact: www.midwesternbioag.com

August 25-28, 2009. IFOAM Conference on Organic Animal and Plant Breeding. Santa Fe, NM. Contact: www.ifoam.org

October 3, 2009. Hoes Down Festival, Full Belly Farm, Capay Valley, CA. Contact: www.hoesdown.org

October 7-9, 2009. 33rd Annual Provender Alliance Conference. Bellingham, WA. Contact: www.provender.org

October 16-18, 2009. 20th Annual Bioneers Conference. San Rafael, CA. Contact: www.bioneers.org

October 19-20, 2009. 4th Annual Biocontrol Industry Meeting. Lucerne, Switzerland. Contact: www.abim-lucerene.ch

October 26-29, 2009. Annual Meeting National Pest Management Association (NPMA). Las Vegas, NV. Contact: NPMA, 10460 North St., Fairfax, VA 22031; 800/678-6722, 703/352-6762, Fax 703/352-3031; www.npmapestworld.org

October 28-29, 2009. WSU IPM Plant Workshop. Chehalis, WA. Contact: http://pep.wsu.edu

December 13-17, 2009. Entomological Society of America Annual Meeting. Indianapolis, IN. Contact: ESA, 9301 Annapolis Road, Lanham, MD 20706; Fax 301/731-4538; www.entsoc.org

January 31-February 3, 2010. Annual Meeting Association Applied IPM Ecologists. Napa, CA. Contact: www.aaie.net

February 7-11, 2010. Annual Meeting Weed Science Society of America. Denver, CO. Contact: www.wssa.net

February 25-27, 2010. 21st Annual Moses Organic Farm Conference. La Crosse, WI. Contact: Moses, PO Box 339, Spring Valley, WI 54767; 715/778-5775; www.mosesorganic.org

February 28-March 2, 2010. California Small Farm Conference. San Diego, CA. Contact: www.californiafarmconference.com

July 1-3, 2010. 67th Annual Convention, Pest Control Operators of CA. Monterey, CA. Contact: www.pcoc.org

bined with other IPM tactics. "Plum curculio adult feeding damage was significantly greater in perimeter apple trees baited with varying combinations of dispensers of benzaldehyde, grandisoic acid or plum essence than in adjacent or interior unbaited trees," said Lewis. "Baited trees or Japanese plums coupled with soil drench of nematodes under bait or plum trees to kill plum curculio larvae may prove to be an effective tactic against 1st generation larvae."

Centipede Grass Stops Plum Curculio

Peach farmers in the Southeast are trying cultural practices to reduce plum curculio damage. According to Clement Akotsen-Mensah (Auburn Univ, 301 Funchess Hall, Auburn, AL 36849; akotscl@auburn.edu), since plum curculio larvae pupate in soil, soil and weed management tactics can be IPM tools. In field trials in 2007 and 2008, "significantly fewer adult plum curculios emerged from soil covered with centipede grass than from all other treatments," said Akotsen-Mensah. However, in screenhouse studies, there were no significant differences between understories of centipede grass, weeds, pine bark and bare ground, "which suggests that other factors could have contributed to the mortality recorded in field plots." The effect may be due to increased numbers of predators in centipede grass.

Mosquito Lures

Lures with a synthetic blend of skin chemicals could be easier for field use than carbon dioxide (CO_2) in mosquito traps, said Uli Bernier (USDA-ARS, 1600 SW 23rd Dr, Gainesville, FL 32608; uli.bernier@ars.usda.gov). Among more than 300 compounds collected from human skin by glass beads are C12-C18 organic acids; some of these attract mosquitoes and others act as repellents. Other methodologies can collect the more volatile C6-C9 aldehydes and acetone, ethanol, methanol, hexanol and 2-methylbutanol from human skin.

In olfactometer test cages, lactic acid and CO_2 are synergistic mosquito attractants; 1-octen-3-ol [octenol] also works well with CO_2, but the 3-component blend is even better than the 2-component blend. Good mosquito attraction is also provided by C6-C9 ketones and alcohols from chickens and nonanal and undecanal from horses.

Giraffes produce ketones which may account for reports that these animals repel ectoparasites. Geranyl acetone, present in traces, and linalool and geraniol could account for some of the repellency. A push-pull mosquito trapping system could be created by combining these types of repellents with human skin attractants. Current research is evaluating 10 compounds that can last 40 days or longer, and techniques such as application to cloth that increase longevity.

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