Information for pest management professionals and pesticide applicators

UC IPM

Green Bulletin

University of California
Agriculture and Natural Resources

Vol. 1 • No. 7a • March 2011

Don't Let Your Pesticides Go Down the Drain

Landscape drains and drainage that ensure excess water in the landscape is removed are a key feature of urban landscapes, especially near building foundations. Drainage often is required to prevent damage to structures or damage to plants by root diseases or other disorders favored by waterlogged conditions. Excess water in the landscape most commonly occurs as a result of rain. It also can occur when site conditions (e.g., poor infiltration and percolation of water in and down through the soil caused by soil compaction, a lack of regular irrigation maintenance, and overall poor landscape design) cause water to pool on a regular basis.

The number of drains, the size of drainage pipes, and number of discharge locations necessary vary considerably among sites, because surface runoff volumes are affected by many factors such as overall site topography, soil type and infiltration rate, and rainfall intensity and amounts. Regardless of drainage design differences, one common feature is that drainage is directly connected to the street gutter and storm drain. Although this design feature does its job by quickly and effectively carrying excess water from the landscape, it also can carry fertilizers and pesticides that have inadvertently entered the landscape drainage system directly or indirectly into the storm drain (Fig. 1).

Figure 1. Patio landscape drain located at the base of a roof downspout.

Figure 2. Landscape drain located in the center of a large park turfgrass area.

Figure 3. Downspout draining directly into a landscape drain.

Figure 4. This exposed landscape drain, which is located adjacent to a large sports field, can easily carry pesticides to storm drains and local bodies of water.

Photos by D. L. Haver, UC Davis

The July 2010 issue of this newsletter highlighted studies demonstrating the ability of various pesticides to be transported from urban landscapes to storm water outfalls. Drains located near structures or on driveways, patios, and sidewalks as well as drains located in the landscape itself provide an ideal conduit for pesticides and fertilizers to travel from the application site to storm drains where they ultimately reach local water bodies such as creeks and rivers (Figs. 2 and 3).

Prior to applying pesticides and fertilizers, the applicator should identify both landscape and hardscape drains to ensure chemicals aren't directly applied over the drain (Fig. 4). In addition the applicator might want to designate a "no-spray zone" around the drain to minimize both granules and sprayed chemicals from entering the landscape drainage system at the next irrigation. Another option is to cover drains with an impervious

... continued on Page 6

WHAT'S INSIDE ...

Pesticides on Concrete Surfaces

Monitoring consistently has shown that pesticides applied around houses can move in surface runoff and eventually contaminate downstream water bodies. Concrete is believed to be a major contributor to this problem, because it is impermeable and a common component of urban landscapes. Pesticides can be applied directly onto concrete surfaces, or water or wind can transfer pesticide residues onto concrete following pesticide application. However, even though pesticides have long been used in urban settings, very little actually is known about pesticide fate and transport on concrete surfaces.

With support from the California Department of Pesticide Regulation (CDPR), researchers at UC Davis and UC Riverside have started to look into the underlying processes and mechanisms controlling pesticide behavior on concrete and hence the potential for pesticide residues to contaminate runoff water. This article provides a simple synopsis of what has been discovered so far and summarizes the main findings from three new research publications (Jiang *et al.* 2010, 2011; Jorgenson and Young 2010).

In the first study of its kind (Jiang *et al.* 2010), small concrete disks were treated with different insecticides, and the treated concrete disks then were exposed to the summer sun of Riverside. The concrete disks were periodically removed and brought back to the laboratory to measure the "washable" pesticide residue by simply mixing the concrete in water for 10 minutes and analyzing the amount of pesticide transferred into the water.

The results show that following pesticide treatment, the wash-off potential quickly decreased over time. However, it also is evident that a small fraction of the pesticide somehow became "shielded" and continued to be available for release back into

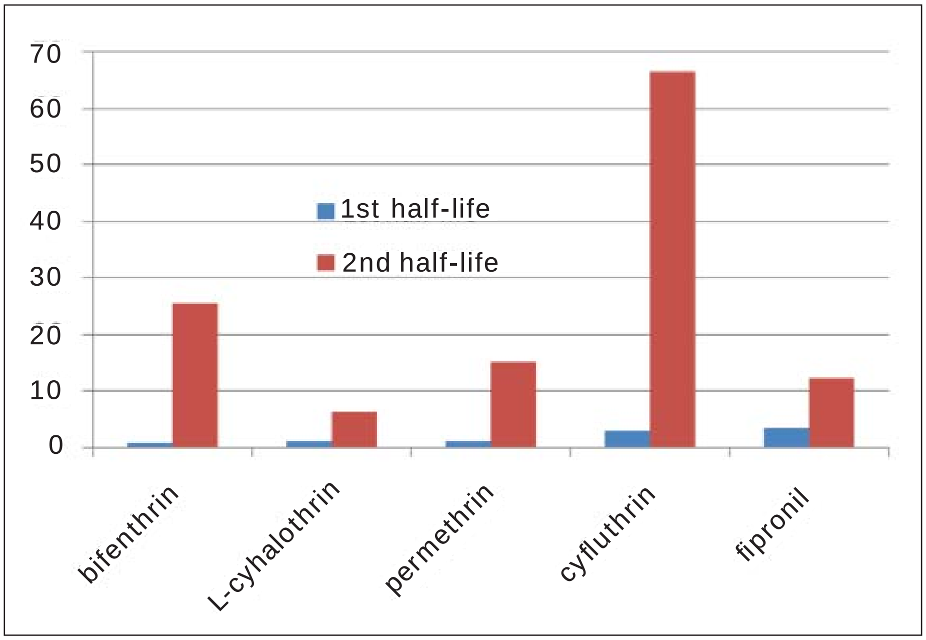


Figure 1. Half-life values (in days) of pesticides on concrete as a function of time. Short first phase half-lives represent rapid decreases of washable residues right after pesticide application. Long second phase half-lives suggest continued availability of pesticide residues long after pesticide treatment.

the water over an extended period of time. Subsequently, as shown in Figure 1, there are two stages describing the decline of washable pesticide residues from concrete.

The first phase has a very short half-life, suggesting that the wash-off potential of pesticides quickly decreased with time at the beginning. This is in contrast with the second phase showing a much longer half-life, implying that pesticide residues continued to be available for contaminating the sweeping runoff water long after the treatment.

In fact, detectable levels of pesticides were found in the wash-off water even after 4 months of exposure to the harsh Riverside summer conditions. This finding highlights that small pores of concrete might protect some pesticide residues from degradation and that pesticide residues left from applications early in the year still might be able to contaminate storm runoff many months later.

In a follow-up study, Jiang *et al.* (2011) employed a radioisotope tracing technique to explore how pesticides adsorb and desorb from concrete (Fig. 2). In that study, ^{14}C-labeled permethrin was used as a model pyrethroid compound. Small concrete cubes were treated with ^{14}C-permethrin, and desorption into water was measured at 0 days (immediately), 1 day, and 7 days after pesticide treatment.

The results validated that desorption of permethrin initially was fast but became gradually slower over time. As the contact time between the pesticide and concrete increased, the desorption potential also quickly decreased, implying that the longer the time interval is between pesticide application and the onset of a runoff event, the less would be residue available for contaminating the runoff water.

For example, while 56% of permethrin was desorbed into water for freshly treated cubes, only 24% was desorbed when the concrete cubes were tested 7 days after the treatment. The

... *continued on the next page*

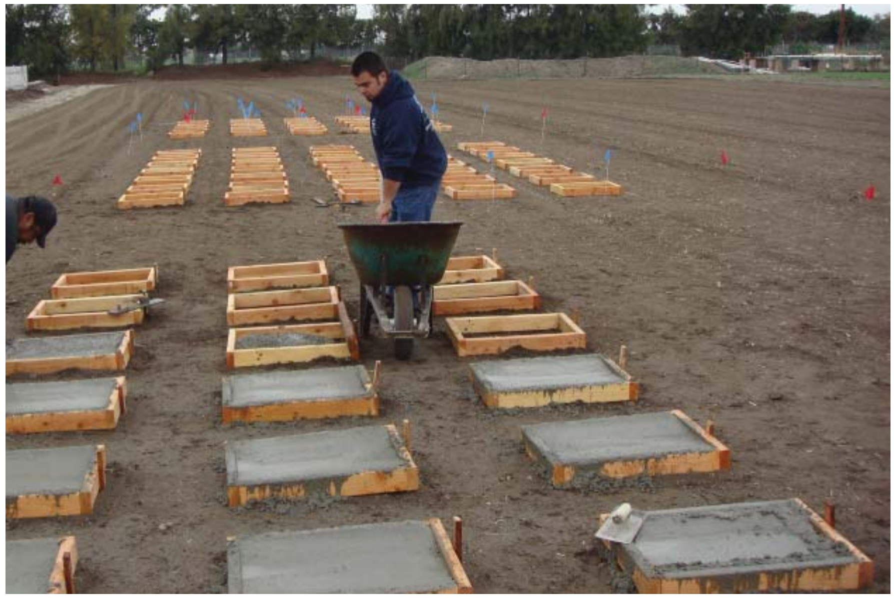
... continued from the previous page
results also showed that permethrin decomposed substantially on concrete and the decomposition likely was due to the concrete matrix's high pH. The degree of decomposition increased quickly with the pesticide residence time on concrete.

Together, these studies clearly suggest that when pesticide-contaminated concrete surfaces come into contact with runoff water, high levels of contamination can be expected initially, but sustained contamination also is possible due to the extended slow desorption.

Jorgenson and Young (2010) at UC Davis evaluated pesticide runoff from small concrete slabs using simulated rainfall. A number of factors were considered in their studies, including runoff onset time (i.e., time after application), rainfall intensity, and formulation types.

Runoff loss of pesticides was rapid initially followed by a more gradual trend, confirming similar observations made in the Jiang *et al*. studies. Rainfall intensity did not show any discernable effect. Pesticide runoff decreased as the runoff onset time was delayed. For instance, mass runoff loss of β-cyfluthrin from slabs 7 days after treatment was 9 times smaller than that from surfaces 1 1/2 hours after pesticide treatment.

However, among all the factors considered, the type of formulation appeared to be the most important factor, causing up to orders of magnitude differences in pesticide runoff losses. Surfactants in the liquid formulations were found to generally enhance pesticide runoff from concrete surfaces. The effect of surfactants was validated by evaluating the effect of the addition of linear alkylbenzene sulfonate (LAS), a common surfactant, to technical pesticides. The influence of surfactants was further confounded by other factors including types of surfactants and other inert additives in formulations.



T. Jiang, UC Riverside

Figure 2. Small concrete slabs with different surface finishes have been constructed at the South Coast Research and Extension Center for studying pesticide runoff.

Types of surfactants and other additives often are considered as proprietary information, and such information is not readily available to researchers. This complexity might prevent a more comprehensive investigation of the role of surfactants in commercial formulations.

Both UC Riverside and UC Davis research groups currently are carrying out new studies to further improve our understanding of pesticide runoff potential from concrete under different conditions. Factors being considered include types and properties of surfactants, hard surface types, relationships between pesticide runoff potential and pest control efficacy (e.g., ant toxicity), and pesticide decomposition.

Looking forward, a critical information gap is to characterize the contribution of urban hard surfaces to pesticide runoff in relation to other landscape components such as soil and grass. Another critical need is to develop simple tools for predicting pesticide runoff potentials from landscapes of different compositions.

References

Jiang, W., K. Lin, D. Haver, S. Qin, F. Spurlock, and J. Gan. 2010. Wash-off potential of urban use insecticides on concrete surfaces. *Environ. Tox. and Chem.* 29:1203–1208.

Jorgenson, B. C., and T. Young. 2010. Formulation effects and the off-target transport of pyrethroid insecticides from urban hard surfaces. *Environ. Sci. and Tech.* 44:4951–4957.

Jiang, W., J. Gan, and D. Haver. 2011. Sorption and desorption of pyrethroid insecticide permethrin on concrete. *Environ. Sci. and Tech.* 45:602–607.

—Jay Gan, Professor of Soil Science and UC Cooperative Extension Specialist, Environmental Sciences, UC Riverside, jgan@ucr.edu;

—Tim Jiang, PhD student, Environmental Sciences, UC Riverside, weiying.jiang@email.ucr.edu; and

—Darren Haver, Water Resources/Water Quality Advisor, UC Cooperative Extension Orange and Riverside counties and Director, South Coast Research and Extension Center, dlhaver@ucdavis.edu

New at UC IPM!

Pest Note on Olive Knot has been released on the UC IPM Web Site, http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74156.html.

See the new, narrated presentation about biological control on the Natural Enemies Gallery page of the UC IPM Web site, http://www.ipm.ucdavis.edu/PMG/NE/index.html.

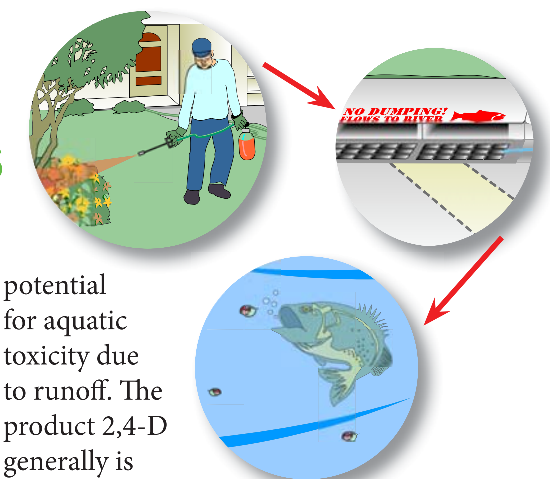
The educational course *Urban Pesticide Runoff* and Mitigation for Pest Management Professionals is now available online for CE units! See http://www.ipm.ucdavis.edu/training/upr-mitigation.html for more details.

New Pesticide Database

To help consumers make safe pesticide choices, UC IPM is building a pesticide hazards database for pesticides included in UC IPM Pest Notes. A new page for each pesticide gives information about pesticide type, hazards to people, water quality, honeybees and natural enemies, plus other precautions and tips for use. These pages also include example home and garden products that contain each active ingredient. Not all pesticides are included at present, and some hazard information for some pesticides isn't available.

This database has been linked to selected Pest Notes, so you can compare the relative hazard of pesticides that might be used to manage a specific pest. View the database at http://www.ipm.ucdavis.edu/PMG/menu.pesticides.php.

Choosing Pesticides with Fewer Water Quality Risks



The best way to reduce pesticide contamination of our creeks, rivers, and oceans is to avoid pesticides that have high potential for moving into water and adversely affecting aquatic wildlife. For most landscape pests and some structural pests, there are safer alternatives that provide just as effective control. In some cases, nonchemical management methods are the best choice. In other situations, you can choose pesticides that pose minimum risks.

A pesticide's likelihood of causing harm relates first to how toxic it is to aquatic organisms but also to how easily it will move in irrigation or storm water runoff to storm drains or bodies of water.

A good place to start if you need to manage insects and want to reduce water quality risks is with organically acceptable insecticides. (See Table 1 on Page 5.) Almost all available organic insecticides—pyrethrins are the exception—have low toxicity to aquatic organisms. Organic insecticides generally break down in the environment rapidly, thus further reducing their potential for harm. Using these insecticides eliminates the risks associated with problem insecticides such as fipronil and abamectin (Avid) or materials in the pyrethroid group including bifenthrin, cyfluthrin, and permethrin.

Several fungicides pose significant water quality risks, including organically acceptable copper products such as copper sulfate. Other common landscape fungicides with high water quality risks include mancozeb and chlorothalonil (e.g., Daconil). Fungicides with low risk include oil products such as horticultural oils, neem oil, and jojoba oil as well as fungicidal soaps, *Bacillus subtilis* (Serenade), triforine, and fosetyl-al (Aliette).

Many herbicides pose risks to aquatic life, often due to their impact on phytoplankton. Landscape herbicides with high overall runoff risks to aquatic life include oxydiazon (Ronstar), pendimethalin (Pendulum, Pre-M), trifluralin (Treflan), and benefin (Balan).

Common landscape herbicides with low risk to water quality include halosulfuron (Sedgehammer/Manage), glufosinate (Finale), clethodim (Envoy), and mecoprop (MCPP). Glyphosate (Roundup) has a moderate potential for aquatic toxicity due to runoff. The product 2,4-D generally is considered to have low water-quality risk, although some studies have shown negative impacts to fish from ester forms of 2,4-D, primarily when it is applied directly to water. Also the organic oil and acetic acid herbicides have little potential to runoff and cause water contamination problems.

For more information on water quality risks associated with specific pesticides, see UC ANR publication 8161, *Pesticide Choice: Best Management Practice (BMP) for Protecting Surface Water Quality in Agriculture*, available at http://anrcatalog.ucdavis.edu/InOrder/Shop/ItemDetails.asp?ItemNo=8161 and the UC IPM database at http://www.ipm.ucdavis.edu/PMG/menu.pesticides.php.

—Mary Louise Flint, Ph.D.
Associate Director for Urban and Community IPM and Extension Entomologist

Table 1. Common organic insecticides for landscape use. Only pyrethrins have significant toxicity to aquatic organisms.

Common name (examples)	Active ingredient	Pesticide type	Pests effective against	Comments
Bacillus thuringiensis (B.t.) (Caterpillar Killer, Dipel, Green Light BT Worm Killer)	*Bacillus thuringiensis* var. *kurstaki* (var. *israelensis* isn't effective on caterpillars but is used for mosquito larvae)	insecticide	caterpillar larvae of moths and butterflies, especially newly hatched larvae feeding exposed on leaves or buds	Bacteria that kills some caterpillars. Must be consumed by caterpillar within 24 to 48 hours of application. Breaks down rapidly. Not harmful to organisms outside moth and butterfly group. Good coverage essential.
Borate based baits (Gourmet Liquid Ant Bait)	boric acid, disodium octaborate tetrahydrate, borax	insecticide	ants	For use in bait dispensers. Low toxicity to humans and most nontargets but must be 1% or less boric acid to be effective. Baits containing these products are much safer than sprays.
Entomophagous nematodes	*Steinernema* species, *Heterorhabditis* species	biocontrol for certain insects	clearwinged moth larvae, carpenterworm, lawn cutworms, lawn grubs	Usually mail ordered and used right away. Read UC Pest Notes for directions. *Heterorhabditis* used for lawn grubs, *Steinernema* for others.
Insecticidal soap (Safer Insecticidal Soap)	potassium salts of fatty acids	insecticide, miticide	aphids, whiteflies, immature scale insects, spider mites	Good coverage essential, as insect must be completely covered. Provides partial control (70 to 80%) and no residual, but natural enemies will mostly survive to help control the population. Repeat application might be required.
Spinosad (Garden Insect Spray, Entrust)	Spinosad	insecticide	caterpillars, leafminers, thrips, and katydids	Some beneficial insects or bees might be killed in the first 24 hours, but rapidly breaks down. Low toxicity to people. Derived through fermentation of a naturally occurring bacterium.
Pyrethrins or pyrethrum	pyrethrins	insecticide	a range of insects	Derived from the chrysanthemum daisy. Products formulated with Piperonyl butoxide (PBO) aren't organically acceptable. **High toxicity to fish, aquatic organisms, and fish.**
Neem seed extract (Amazin Plus 1.2% ME, Safer Brand Bioneem Multi-purpose Insecticide & Repellent Concentrate)	Azadirachtin	insecticide	beetles, thrips, aphids, white grubs, mole crickets, crane flies	Insect growth regulator. Not effective on adults. Can cause injury to some tender plant tissue.
Horticultural oil, insecticidal oil (Saf-t-Side, Ready-to-Use Year Round Spray Oil, Volk Oil Spray,JMS Stylet)	petroleum oil, superior oil, supreme oil, narrow range oil, paraffinic oil	fungicide, insecticide, miticide	aphids, whiteflies, scale insects, spider mites, mealy bugs, lacebugs, psyllids, thrips, other sucking insects, some insect eggs; also powdery mildew on many plants, black spot on roses	Good coverage is essential. Insect must be smothered. Best activity on insects when temperatures are greater than 45˚F. Some products might cause plant injury if applied when temperatures are above 85°F. Don't apply during periods of drought or when plants exhibit moisture stress. Natural enemies might be killed by contact but not by residue.
Neem oil (Green Light Rose Defense, Garden Safe Fungicide 3, Safer Brand 3-in-1 Garden Spray)	neem oil	fungicide, insecticide, miticide	aphids, whiteflies, scale insects, spider mites, mealy bugs, lacebugs, psyllids, thrips, other sucking insects, some insect eggs; also powdery mildew on many plants, black spot on roses	Good coverage is essential. Insect must be smothered. Best to apply in early morning or late evening to minimize the potential for leaf burn. Might also cause injury to plants with tender tissue. Don't apply during periods of drought or when plants exhibit moisture stress. Natural enemies might be killed by contact but not by residue.
Other plant-based insecticidal oils (many brands and mixtures)	d-Limonene, canola oil, cottonseed oil, rosemary, thyme, clove and sesame oils	insecticide, miticide	soft-bodied insects and mites as described for other oils	These oils work similar to horticultural oils. Good coverage is essential.

Stop Pesticides from Going Down Drains ... continued from Page 1

Figure 5. This dry streambed channels runoff from roof downspouts to vegetated areas a safe distance from the building.

Photos by D. L. Haver, UC Davis

Figure 6. Installating perforated drainage pipe helps reduce waterlogged soil.

material such as a secured plastic sheet prior to application.

Some landscape architects have started to incorporate structural elements that reduce runoff into the overall design such as vegetative filters, swales, and dry streambeds (Fig. 5). These landscape features break the direct connection between landscape drains and storm drains, allowing surface runoff to infiltrate into the landscape at a safe distance from building structures. Water from excess irrigation and small storm events no longer runs off the landscape carrying pesticides and fertilizers to the storm drain. Landscapers also are installing perforated drainage pipe to improve overall drainage and to reduce root diseases common in heavy, waterlogged soils (Fig. 6).

—Darren Haver, Water Resources/Water Quality Advisor, UC Cooperative Extension Orange and Riverside counties and Director, South Coast Research and Extension Center, dlhaver@ucdavis.edu

University of California Statewide IPM Program
One Shields Avenue
Davis, CA 95616-8621

Phone: (530) 752-8350

E-mail: ucipm@ucdavis.edu

Online: www.ipm.ucdavis.edu

Supported by the University of California Statewide IPM Program and the California Department of Pesticide Regulation through the Urban Pesticide Runoff Mitigation and Outreach Project.

Ask the Expert!

Q I like the idea of covering drains located in landscape or turf areas before a pesticide or fertilizer application. Where can I get covers?

A A number of companies make or sell drain covers. There are two general types: flat urethane or polyurethane covers that have a tacky side to stick to smooth surfaces and covers made of PVC or urethane that are filled with water to cover uneven surfaces. Both types come in a variety of sizes, and the flat covers can be round or square to fit over different drain shapes.

The one drawback to these commercially available drain covers is their price; $50 to $80 isn't an uncommon price for small sizes. However, you can make your own covers using a suitable material. The keys to an effective drain cover are that it is heavy enough to stay close to the ground or area surrounding the drain, has at least 6 inches of overage on all sides of the drain, and not be made of any material that is permeable or absorbent. For example, a piece of plywood wouldn't make a good drain cover when applying a sprayable formulation, because it would absorb the pesticide.

Q Do I have to report organic pesticides on my monthly use report that goes to the Agricultural Commissioner?

A A pesticide advertised as organic might still be as toxic or sometimes more toxic than conventional pesticides. For example, there are now herbicides with 20% acetic acid as the active ingredient that have the signal word DANGER, yet are still classified as organic. Any product used for pest management by professionals that has an EPA or California registration number (found on the label) must be reported on your monthly use report.

Pesticides that contain only ingredients that are classified as EXEMPT don't have to be reported in your monthly use report that goes to your Agricultural Commissioner. The ingredients in these pesticides are GRAS (generally regarded as safe) or are otherwise listed by EPA or CDPR as exempt from registration. However, you still are required to keep pesticide records, including applications of exempt materials, on file for two years (California Code of Regulations, Title 3, Section 6624(g)).

Have a question? E-mail it to ucipm@ucdavis.edu.

Biological Control Resources

Want to reduce your reliance on insecticides by encouraging beneficial insects in the landscapes you manage? The UC IPM program has a number of resources to help you do this. At the Natural Enemies Gallery page of the UC IPM Web site, http://www.ipm.ucdavis.edu/PMG/NE/index.html, you'll find photos and information about 40 of the most common predators and parasites in California landscapes. These lists are sortable by pest attacked, common and scientific name, or insect family.

This page also has a link to a new 24-minute narrated presentation about biological control, which can familiarize you with common natural enemies and how to use them. Other resources accessible through this page include the free *Biological Control and Natural Enemies* Pest Note and information about ordering the *Natural Enemies Handbook: The Illustrated Guide to Biological Control.*