Insecticides *a la mode*

The bugs are the same but insecticides' modes of action are changing. Learn how effective they can be

BY DR. PATRICIA J. VITTUM

Most of you are aware that the Food Quality Protection Act (FQPA) passed in 1996, and this law is impacting the availability of pesticides for use in turf and ornamental settings. Based on concerns about cumulative and aggregate exposures to pesticides, the U. S. Environmental Protection Agency determined that the registrations of organophosphate insecticides (OPs) should be reviewed first. This was in part because OPs affect the nervous systems of people and their pets, and so they tend to be more acutely toxic to vertebrates than many other classes of pesticides.

One byproduct of this governmental regulation and other trends has been the proliferation of new insecticides that have strikingly different modes of action against their target insects. While some insecticides, such as fipronil (Chipco Choice) and imidacloprid (Merit), had already been registered, other new chemistry is now under development. In addition, there are insect growth regulators like halofenozide (Mach 2). Meanwhile, several microbial pesticides have been identified and developed, and finally are reaching the market. Let's review what has been happening in each category.

Chemical action for results

1. Case of nerves — Turf and ornamental managers have used organophosphates (OPs) widely for 30 years or more, and some of the more familiar products include acephate (Orthene), chlorpyrifos (Dursban), diazinon, fonofos (Mainstay or Crusade), isofenphos (Oftanol) and trichlorfon (Dylox or Proxol). Each of these is a cholinesterase inhibitor, working on the nervous system.

How do they work? The organophosphates stop (or inhibit) cholinesterase from doing its part to end a neural impulse. The result? Impulses continue to move through the nerve, in effect poisoning the insect and causing tremors and convulsions, difficulty in breathing or loss of bodily functions.

2. Pyrethroid mystery — While the precise mode of action for pyrethroids is not fully understood, they appear to affect the permeability of the membrane in the central region of a cell. Normally when an impulse moves along a cell, the cell membrane gets "leaky" and some sodium ions rush in from the surrounding body fluid, changing the cell's electrical charge. These ions then have to get back to where they started from, but if the cell membrane becomes a little "stiff," it will not allow them to return to their original positions. The cell stays in an active state, sending an impulse that really isn't there. The cell is also unable to recognize when a new impulse should be sent.

Pyrethroids appear to affect both insect and vertebrate nervous systems at this level, and many pyrethroids are toxic to fish in particular. Examples include bifen-

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thrin (Talstar), cyfluthrin (Tempo), deltamethrin (Deltagard) and lambda-cyhalothrin (Battle, Scimitar). Pyrethroids are used most commonly against surface and thatch insects (chinch bugs, webworms, cutworms) in turf or against a variety of insects in landscape plantings.

3. Block that chloride — Fipronil (Chipco Choice) belongs to a class of chemicals called phenyl pyrazoles. Fipronil, which is used against mole crickets in the Southeast, interferes with the passage of chloride ions through a channel in the nerve cell. Insect nerves are more sensitive to this disruption, so fipronil is much more toxic to insects than vertebrates.

4. Bad news for suckers — Thiomethoxam (Meridian) should be released soon by Novartis and will be marketed as Flagship in the ornamentals market. It controls a variety of sucking and chewing insects, following contact or ingestion by the target pest. It is absorbed rapidly into the vascular tissue of the plant, so its systemic qualities will make it a good choice against several common ornamentals pests, including aphids, whiteflies and mealybugs. It is also effective against several species of white grubs. It has a relatively long residue (about 50 days in soil) and is much less toxic to vertebrates than several of the more traditional insecticides that have been used over the past 30 years.

Thiomethoxam is in the thianicotinyl class of insecticides and is considered a nicotinoid. As such, it mimics the action of acetylcholine in the synapse, so it may bind to the receiving cell, tricking it into sensing an impulse to be sent. At low doses, this leads to a stimulation of the cell, but at higher doses, the system shuts down. Insects that come in contact with the material or ingest it demonstrate altered behavior within an hour or two, stopping feeding or no longer using their antennae in a normal manner.

Growth regulators — mixed-up molting

1. Too juvenile — Insects go through a series of molts, during which they absorb the old exoskeleton (a complex structure that serves as the outer "skin" as well as a place for muscles to attach) and produce a new and slightly larger exoskeleton. Molting is an energy-expensive process that is regulated by hormones, some of which send a signal to the insect's body to remain in a juvenile stage — for example, a caterpillar, a grub or a maggot.

As long as that "juvenile" hormone is present, the insect cannot molt to the adult stage and cannot reproduce. Several juvenile hormones have been identified and developed commercially, and are used to reduce mosquito populations (methoprene) or to control whiteflies in greenhouses (kinoprene).

2. Hurry up and molt — Other chemicals interfere with the process of molting itself, usually by interfering with the natural timing of producing the new exoskeleton. One such material, halofenozide (Mach 2), is called a "molt accelerating

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Insecticides in the thianicotinyl class can be used to control grub damage like this.

Damage like this from chinch bugs can be extensive unless treated with the right insecticides.

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compound" because it induces an immature insect to molt before that insect has had an opportunity to store up the energy reserves it will need to complete the process. The insect is doomed to fail — it may begin the process but abort it in the middle, so it may end up with characteristics that are, for example, part first instar and part second instar.

The insect stops feeding shortly after it encounters the material and usually dies within two or three weeks. One advantage of a molt accelerating compound is that vertebrate animals do not have an analogous process — in other words, we don't molt. So Mach 2 is considered much less toxic to people and their pets than most other insecticides currently on the market.

Mach 2 is used in turf settings against several species of white grubs (although the application rate varies with species) and appears to have good activity against several turf caterpillars as well.

Feeding deterrents

Some compounds induce insects to stop feeding shortly after they come in contact with the material. These compounds are called "feeding deterrents," some of which may be distasteful and cause the insect to move on to a more tasty meal. Others may repel an insect from landing on a plant. Still others actually interfere with the physiology of the insect, plugging up its digestive system and making it impossible to feed further. Such insects die quickly after exposure to the compound.

Pymetrozine (Endeavor) is a new product that causes aphids or whiteflies to cease feeding, usually within a few hours of contact. It is believed to affect certain feeding muscles that the insects use to suck up plant juices.

Insects may not die immediately and they may remain on the plant for a few days after contact, but they stop feeding so damage does not worsen. Endeavor is labeled for use as a foliar spray in greenhouses, landscape ornamentals and some nursery settings, among other sites. It has a short residual (will not remain active for a long time on the plant) and has a low level of toxicity to beneficial insects, including honey bees and various predatory insects.

A 'biorational' product

Spinosad (Conserve) is a byproduct of a soil actinomycete (a bacterium), *Saccharopolyspora spinosa*, which has become a popular tool for use in integrated pest management programs. It is effective against several species of caterpillars, but it is relatively specific so it has minimal impact on several beneficial predatory insects.

While it affects acetylcholine receptors on the receiving nerve cells, it appears to do so in a manner that is markedly different than products like organophosphates — and it does *not* appear to interfere with the receptors in vertebrates to the same degree. As a result, it is much less toxic to mammals and other vertebrate nontarget organisms.

When an insect encounters Spinosad, it is incapacitated almost immediately. There are indications that insects are less likely to develop resistance to Spinosad than to some other insecticides.

Making a choice

With the recent addition of several new kinds of insecticides to the turf and ornamentals market, you now have lots of options. Each new product has some strengths, and can be incorporated into an IPM program. Some are selective and have minimal impact on nontarget organisms, while others are much less toxic than some of the older, more traditional materials. Experiment with the new compounds and determine which ones meet your own needs most effectively. **LM**

— The author is associate professor in the Department of Entomology of the University of Massachusetts, Amherst, MA

LM'S TAKE:

Using the *new* insecticides

1. Products will continue to evolve from more naturally occurring substances or processes.
2. Because of this, new products will continue to become more species-specific (targeted).
3. More and more "traditional" products will come under increased scrutiny in the EPA's evaluation of products for the Food Quality Protection Act.
4. This will encourage even more reduced rates of toxicity for products on all species — from humans to beneficial insects.
5. More "targeted" insecticides are becoming much more concentrated and potent at smaller amounts because of their modes of action. What used to require gallons might only require ounces now.
6. Don't expect prices to drop, however. The cost of finding, developing, testing and getting approval for new products is higher than ever.