New Products and How They Work

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For decades, the standard method for managing most of the insect and mite problems on woody ornamentals was heavily reliant on the use of chemical insecticides. Although very useful tools, many of these products raised questions about their long-term effects in the environment, human health, loss of beneficial organisms such as parasites and predators, and the fact that they were "broad-spectrum" products that not only killed the target pest but also were detrimental to most of the incidentals. In the modern era, many of these products were no longer meeting the requirements of a well-educated general public and it has been this evolving attitude that has driven legislation at the state and federal levels for stronger laws to address these issues. As a direct result, many new laws have been enacted in the past decade that have greatly changed the status of pesticide availability and registered uses.

New laws, such as the Food Quality Protection Act of 1996 (FQPA), uses data gathered over many years from national scientific studies, which strongly indicates that children with their developing bodies are at a 10-times greater risk to potential ill-effects that may be generated by pesticide exposure. The law also considers aggregate exposures that children may encounter to specific chemical products, which includes: pesticide residue on foods, exposure from landscape and turf applications, exposures from parks, athletic fields, etc. that have been treated. It is this new criteria for considering residues and potential effects to children's development that has been responsible for many of the well-known compounds disappearing from standard use in recent years. Chlorpyrifos (Dursban®), Diazinon, and Carbaryl (Sevin®), are a few of the products that have been heavily affected by this new legislation.. Many of these are organophosphate and carbamate insecticides that work on the peripheral nervous system as cholinesterase inhibitors.

The loss of so many familiar products initially created a void in the war on insect management. However, "necessity is truly the mother of invention" in this case, and many new products with very unique modes of action (MOA) are now emerging onto the market for professionals in the Green Industry. Also, previous to the FQPA of 1996, the Environmental Protection Agency (EPA), in 1993, defined "Reduced Risk Pesticides" as those that pose a lower risk to the environment and human health. This was coupled with incentives for the development of new products with modes of action to fit these new criteria.

Many of the newer products today tend to be rather "surgical" in their method for reducing the numbers of pest insects. As examples, some of the newer miticides will kill pest spider mites (family: Tetranychidae) but not harm predatory mites (family: Phytosiidae), while some of the new insecticides are only effective on Lepidopteran caterpillars (moth larvae) and not on other orders of insects that are incidental or perhaps beneficial. Also, the potential for these products to harm the environment, human health, or to persist in the environment are for the most part significantly different from the chemicals of years past.

It is not feasible to discuss all of the new products within the limited space of this article. However, the focus here will be to highlight many of the new modes of action, target pests, and the important features that need to be understood before utilizing any of these compounds. A chart is included at the end of this article that organizes a number of these compounds by their chemical classes, active ingredients, certain trade names, and potential uses.

The Neonicotinoids

Neonicotinoid products were the first new major chemical family of insecticides to be introduced within the past 20 years in the USA. Classified as "Nicotine Acetylcholine Receptor Agonists / Antagonists" as their mode of action, they work on very specific nerves areas (nicotine receptors that many insects have in abundance) in the region of the mouth and they paralyze the associated muscles thus causing the insect to starve to death. They also have a rather low mammalian toxicity. The first of these compounds to reach the US market was a chloronicotinyl now well-known as Imidacloprid (e.g. Merit® and Marathon®). This compound has been widely used for many insects that have a piercing-sucking mouth type as well as certain grub pests in turf. Although labeled for certain "chewers" like caterpillars, Imidacloprid has not been nearly as successful at controlling such pests as some of the newer Neonicotinyls that are now becoming available. In the Northeast, Imidacloprid has been used widely for such ornamental pests as aphids, adelgids, whiteflies, certain soft scales, lacebugs, and others. It has been an important weapon in the battle against Hemlock Woolly Adelgid (*Adelges tsugae*). Although labeled for certain foliar applications, ,Imidacloprid achieves it greatest success when applied systemically, which includes both soil and trunk injection methods. Although movement of the product into the vascular system of the plant and then translocation throughout the plant may take anywhere from weeks to several months, Imidacloprid can persist within a tree from six months to perhaps as long as one year in certain cases. Trunk injecting Imidacloprid generally results in quicker systemic action than the soil injection methods, overall.

Recently, what is being referred to as the "second generation of Neonicotinoids", are now becoming available to professionals. These new active ingredients, in addition to Imidacloprid, are: **Clothoinidin** = Celero® 16WSG, **Thiamethoxam** = Flagship® , **Dinotefuran** = Safaria ®20SG), and **Acetamiprid** = TriStar® 70WSG. All of these have the same mode of action as Imidacloprid and are labeled for many of the same pest groups. However, some of these newer products are active as contact sprays, have systemic action within plants and a few have translaminar capabilities, which means that when applied as a foliar spray, the compound moves into the foliage. They do not then become systemic but they do come into contact with those hard to reach pests such as armored scales (Acetamiprid) and those pests that feed within the non-transport cells where systemic products generally do not reach. Some of the new products even have ovicidal (kills eggs) features for certain insect pests.

Although these neonicotinoids are known to mix well with each other, it is strongly recommended that pest managers never rely heavily on any one mode of action for controlling insect pests, which, of course, greatly increases the likelihood of the development of pesticide resistance within a pest population.

Some of the key points for consideration about the Neonicotinoids, in general:

- they work by contact and ingestion
- most have a long residual
- they may act as a contact, systemic and / or translaminar pesticide
- they can be toxic to bees at the time of application and for as long as 5 days after application
- overall, they are relatively non-phytotoxic

- when used repeatedly on evergreens (in particular) there is a risk of developing serious outbreaks of spider mites.

Insect Growth Regulators (IGRs)

Insect Growth Regulators, commonly known as IGRs, have been around for decades but very few products have been available for the Green Industry until recently. These compounds work in specific ways to disrupt the normal developmental processes, often by interfering with the molting process. There are several modes of action for IGRs:

- **Chitin Synthesis Inhibitors**. Chitin is the major building block molecule of an insect's exoskeleton. If an insect cannot process compounds in order to build a new exoskeleton when it is about to molt, then molting becomes lethal. Compounds like Diflubenzuron (Dimilin®) have been utilized for many years against such lepidopteran pests as Gypsy Moth, Browntail Moth, and Spruce Budworm. A new member with this mode of action now is Cyromazine (Citiation®) and is labeled mostly for Dipteran (true flies) pests, such as fungus gnats and certain leaf miners. These compounds, while fairly specific to their labeled target pests, are also very toxic to aquatic invertebrates and great care must be taken to avoid contaminating streams, rivers, ponds and other natural bodies of water.

- **Juvenile Hormone Mimics / Inhibitors**. The developmental and molting process of insects is quite complicated but all of it is strongly driven by specific hormones in their bodies. One such hormone is called "Juvenile Hormone". When high levels of this hormone are present, it informs the insect's brain that the insect is still very immature. As the insect feeds, grows and molts (sheds an old exoskeleton) the concentration of juvenile hormone continually goes down until it reaches an almost non-existent level, which then tells the brain that the insect is now ready to molt for the last time into the adult stage. The IGR products that mimic or inhibit this physiological process trick the insect's brain into "thinking" that the insect is at a different stage of development than it actually is. The IGR compounds that inhibit juvenile hormone usually result in a very immature insect physically trying to molt into the adult stage when it is not physiologically ready, thus resulting in a lethal action for the insect. One such compound available now is **Tebufenozide** (Confirm®) and is labeled for lepidopteran caterpillars. It has become a valuable tool against such serious defoliators as Gypsy Moth, Forest Tent Caterpillar, and the new invasive in Massachusetts and Rhode Island; the Winter Moth caterpillar.

- **Molting Hormone Agonists / Inhibitors**. Ecdysone, commonly known as "the molting hormone", is active in virtually every aspect of the molting process in insects. **Novaluron** (Pedestal®), which is labeled for whiteflies, thrips, armyworms, and others in the Nursery and for containerized plants, works by mimicking or inhibiting this hormone in the insect's body. If an insect experiences a premature molt or can't molt when it needs to, then death of the insect results.

- **S**ome of the overall aspects of IGRs include:

    - Some can be very toxic to aquatic invertebrates and much care during mixing, application, clean-up and disposal need to be taken to avoid contamination of water bodies.
    - IGRs attack the egg stage (ovicidal) and / or the immature stages. They are not effective against the adult stage of insect pests.

- Some may be more phytotoxic than others and pre-testing may be necessary before large-scale applications occur.
- Some have the potential to be leachers and can wind up in ground water.
- Once a pest population is exposed to these products, they usually cease feeding within 24 hours but they may not die for another 2-3 days.
- IGRs, in general, may be currently more expensive than other management options..

Mite Growth Regulators (MGRs)

Many new products are now available for the management of spider mites that are basically classified as "growth regulators" but they have very different modes of action than the ones for insect control. Even though it is known in general what physiological process these compounds interfere with, the exact mechanism may not always be understood. Therefore, we often see such descriptions for their modes of action as "New compounds with modes of action that are not entirely understood but they interfere with normal development". A few of the somewhat recent compounds in this category are:
Etoxazole (TetraSan® 5WDG), **Clofentezine** (Ovation®SC), **Bifenazate** (Floramite®), **Pyridaben** (Sanmite®), and **Hexythiazox** (Hexygon®).

Some of these are very specific to Tetranychids (spider mites) and do not harm the Phytosiids (predatory mites) that may be on the same plant. However, some of these can be more toxic to predators, such as Pyridaben and this issue should be understood before application. The targert stages for mite growth regulators is often the egg stage or the immatures. MGRs are not known to kill adult spider mites but in some cases they may sterilize adult female mites thus preventing them from laying viable eggs. Most of these products work best when spider mite populations are low to moderate in size. Plants that are experiencing a spider mite outbreak probably should not be treated with one of these products until the population has been significantly lowered by other means. A few of these miticides, such as TetraSan, have translaminar attributes that aids in their success. Within this group, there is a wide range of variability in their toxicity to vertebrate organisms.

Unique Modes of Action (MOA):

Insect and mite control is now at a very exciting time given the current wave of development and availability of new compounds. We are now, and will be more so in the near future, controlling pests in ways unimaginable just a few years ago. Frequently, another new MOA gets discovered. In addition to the above described MOAs, we currently have the following compounds either already on the market or they are just coming onto the market, for our battle against the insects and mites:

- **Spiromesifen** (Forbid®4F). This compound is a "Lipid Synthesis Inhibitor". By preventing this necessary biological process in the insect's body, it becomes lethal. Currently, it is labeled for the control of whiteflies (nymphs and "pupae") and mites in all stages.

- **Fermentation Products** (Spinosad(Conserve SC®), and Avermectin). These have been around for a number of years and are now experiencing greater use. These products start out as a bacterium but are then put through a fermentation process to obtain the end compound(s)which has insecticidal and, sometimes, miticidal properties. The EPA has designated this group as Reduced Risk Pesticides. Spinosad works very well on all types of caterpillars including sawfly larvae, leaf beetle larvae, thrips and others. Its MOA "affects

nicotine acetylcholinesterase receptors" and is possibly a "GABA (a neurotransmitter) inhibitor". Products in this group tend to have a low mammalian toxicity rating. However, the label for Spinosad products, in particular, states that it is very toxic to foraging honeybees but this factor diminishes significantly after the spray has dried.

A Note About Plant Disease and Fungicides:

The world of plant disease (pathogen) management has also benefited recently from new products. Many of these fall into the "reduced risk" category. One of the greatest advancements has been with the development of the Strobilurin Fungicides. These commercial compounds were initially derived from the fungus *Strobilurus tenacellus*. The active ingredient is Strobilrin A, which is now available as a synthetic. The presence of Strobilurin inhibits the growth of other fungi. When it is already present on a plant, and a new pathogen arrives, the Stobilurin greatly inhibit that pathogen from successfully colonizing (invading) that plant. Strobilurin fungicides can be applied as a foliar spray as well as a soil drench, in some cases. They also have translaminar capabilities. Strobilurin fungicides are labeled as being protective, curative and systemic, they are deemed to be "reduced risk", and the are active against the major groups of disease-causing fungi, and are labeled for such problems as: powdery mildews, scab, downy mildews, crown and root rots (*Pythium* and *Phytophthera*), *Fusarium*, leaf spots, leaf blights, rusts, and many more. It is even being investigated for possible uses against *Ramorum* Blight (*Phytophthera ramorum* = "Sudden Oak Death").

As with all pesticide products, it is strongly recommended that Strobilurin products not be relied upon exclusively and that rotation with other modes of action be implemented into plant disease management programs in order to avoid the development resistance. A partial list of new Strobilurin products appears in the table at the end of this article.

A very thorough article about the new fungicides, including detailed information about the Strobilurins, was written by Dr. Janna Beckerman from the University of Minnesota and appeared in the June 15, 2005 (Issue 12, Volume 201) issue of American Nurseryman magazine and is highly recommended reading. The article is entitled "Fairly New Fungicides".

Why Products Fail:

In the January 15, 2004 (Issue 2, Vol. 199) issue of American Nurseryman magazine, another plant pathologist, Dr. Jim Chatfield from Ohio State University, wrote an article called "Why Fungicides Fail". His observations and recommendations within that article are highly pertinent when considering disease management. Furthermore, they also have merit for all areas of pest control, insects included, especially when the practitioner is working within the realm of IPM and Plant Health Care. The highlights from that article will be mentioned here.

Why Products Fail:

1) Not implementing continued observations. We all know that regular monitoring is the backbone of any IPM program. If one doesn't know what is happening in the "system" under their management, then that person is not truly practicing IPM.

2) Improper diagnosis. It is absolutely imperative that we know the exact problem before implementing any type of management. This is Step #1 in any pest management program. Incorrect diagnosis generally leads to improper treatments, which often results in greater problems.

3) The use of the incorrect pesticide for the problem at hand. See #2 above and then read the end of this article for obtaining detailed information about the new pesticide products.

4) Over-reliance on pesticide products. Sprays are not always the answer, as we know. This is where our ever-increasing desire for new information plays a strong role. Implementing the use of plant material that is resistant to key pests, culling out infested (infected) plants, watering properly so as not to encourage pathogen growth and to alleviate drought stress, planting the right plant in the right place to begin with, establishing aesthetic injury levels, and then only treating when necessary, etc., is the real long-term solution to successful pest management that meets today's criteria.

How to Stay Current With the New Products:

The influx of new insecticide, miticide, and fungicide products coupled with the newer modes of action is almost overwhelming these days, even for the professional Extension entomologist whose job it is to understand and educate about such things. A couple of sources for information are outlined below and these should continue to offer tremendous benefit for those seeking information about both the older and newer products.

Crop Data Management Systems, Inc

- **www.cdms.net**
- This site lists nearly 100 pesticide companies that produce products for the Turf and Ornamentals (T&O) market (as well as Ag products). The user of this site can obtain specimen labels of specific products along with the Material Safety Data Sheets (MSDS) that accompany the labels.

Greenbook

- **www.greenbook.net**
- This site lists a phenomenal number of products and can be easily searched by company, active ingredient, and trade name products.
- It offers current news related to pesticides
- Along with being able to obtain specimen labels and the MSDS, the user can usually also access a "product summary sheet", Department of Transportation (DOT) information, Mode of Action sheet, state registration information, supplemental label information, as well as other valuable information about each product.

Bear in mind, the pesticide labels that are provided on such sites are almost always the "Specimen Label", which means that it is the federal label as allowed by the EPA. However, within another piece of federal legislation, the Federal Insecticide Fungicide and Rodenticide Act (FIFRA) amendments of 1972, it says that individual states reserve the right to make a pesticide label more strict (but not less). This means that any state has the right to prohibit uses in their state that appear on the specimen label. They can even refuse to register the product for any uses within the state even though the EPA has granted the company a label. Contact your state department of agriculture or access their web site for current state labels.

Some of the Current Pesticide Products for Trees and Shrubs 2005

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Visit: www.greenbook.net & www.cdms.net

TYPE	COMPOUND	MODE OF ACTION	TRADE NAME	COMPANY	TARGETS	NOTES
INSECT GROWTH REGULATORS	Cyromazine	Chitin inhibitor	Citation	Syngenta	mostly diptera	GH, nusery, No landscape
	Pyriproxyfen Tebufenozide	Juvenile hormone mimic	Distance Confirm	Valent Dow AgroSciences	whitefly, mealybug, aphids,etc mostly Lepidoptera	GH, nursery, landscape Landscape and nursery
	Novaluron	Juvenile hormone agonist	Pedestal	Crompton Crop Prot.	Thrips, whitefly, armyworms	GH and outdoor nursery
Lipid Synthesis Inhibitor	Spiromesifen	Lipid synthesis inhibitor	Forbid 4F	Bayer	whitefly, mites, others	Landscape
Miticides	Etoxazole	mite growth regulator	TetraSan 5WDG	Valent	Spider mite eggs & nymphs	Translaminar. GH, .nursery, landscape
	Clofentezine	Ovicide	Ovation SC		Spider mites	Safe for predatory mites.
	Bifenazate	mite growth regulator	Floramite	Crompton Crop Prot.	Spider mites	Safe for predatory mites. GH, Landscape, Nursery
	Pyridaben	mite growth regulator	Sanmite	BASF	Spider mites	Toxic to predatory mites
	Hexythiazox	ovicide / miticide	Hexygon	Gowan	Spider mites	Safe for predatory mites. GH, Landscape, Nursery
Neonicotinoids - Neonicotinyl	Imidacloprid	Nicotine Acetylcholine Receptor agonists / Antagonists	Merit	Bayer	aphids, adelgids, others	Landscape
Neonicotinoids - Thianicotinyl	Clothinidin		Celero 16WSG	Arvesta	aphids, whiteflies, mealybugs	Landscape, nursery
	Thiamethoxam		Flagship 20WG	Syngenta	aphids, whiteflies, scarab grubs	Nursery and GH, NO landscape
Neonicotinoids - Nitroguanidine	Dinotefuran		Safaria 20SG	Valent	aphids, whitefly, scales, Japanese beetle adult, more	Landscape and GH
Neonicotinoids	Acetamiprid		TriStar 70WSP	Cleary	aphids, mealybug, whitefly, armored scales, others	GH, Nursery, Landscape Translaminar
Strobiluron Fungicides	Kresoxim-methyl	mitochondrial respiration inhibitor	Cygnus	BASF		
	Azoxystrobin		Heritage	Syngenta		
	Trifloxystrobin		Compass	Bayer		
	Pyraclostrobin		Insignia	BASF	Currently: turf only	