

SELECTED TOPICS IN CRANBERRY ENTOMOLOGY

Dan Mahr
Dept. of Entomology, University of Wisconsin – Madison

This year, the Education Committee asked that I cover the following three topics.

1. What Integrated Pest Management Isn't

I think it is more understandable to first cover what Integrated Pest Management (IPM) is, so I'll do that first, and then return to the question at hand.

IPM is nothing new; the concept was developed in the 1950s in response to serious problems that were arising from overuse of broad spectrum pesticides. IPM is a knowledge-based approach to pest control; IPM practitioners must have a good working knowledge of the biology of the pest insects, their natural enemies, pest scouting practices, economic thresholds (action levels), and the crop environment, as well as an understanding of the strengths and drawbacks of the various types of control practices. As new techniques and tools are developed, education must be an on-going process. A couple other characteristics of IPM are (1) that it is a preventative rather than curative approach for reducing pest problems, and (2) that it aims to reduce the harmful effects of pesticides.

Historically, and continuing to the present time, most insecticides have a broad spectrum of activity, meaning that they are not very selective as to the types of insects that are killed. Under certain situations, some of the unanticipated things that insecticides can do include

- change plant chemistry to be more nutritious to certain pests,
- actually directly increase pest reproduction,
- kill the natural enemies of pests, and
- have a loss in effectiveness through the development of resistance.

All of these things can result in an increase in pest populations rather than pest control. IPM uses techniques to reduce these problems.

When IPM was first developed, it was the integration of pesticides and beneficial “natural enemies” to manage pest populations so that they do not cause economic injury. The concept has expanded over the past 50 years and now includes the usage of all appropriate techniques, not just chemical and biological controls. It also integrates insect, plant disease, and weed management, recognizing that in many cases these can interact. And it also integrates pest management with crop production and marketing practices into what is known as Integrated Crop Management (ICM).

The Knowledge Base. The greater knowledge about pests and their control, the better position you will be in to make effective and economical management decisions. This will be increasingly true as broad spectrum insecticides are gradually replaced by more selective ones. An understanding of the following areas will be useful in structuring your IPM program.

Pests. Knowledge of individual pests should include 1) familiarity with their seasonal life cycles, 2) an ability to recognize damage, identify the likely cause, and understand the potential economic loss, 3) an understanding of the existence of natural enemies and their potential impact, and 4) appropriate monitoring methods.

Natural enemies. Dearness scale has highly effective natural enemies that can be disrupted by broad spectrum insecticides. Tipworm has modestly effective natural enemies. Blackheaded fireworm and cranberry fruitworm do not have highly effective natural enemies, but the use of broad spectrum insecticides against these can impact the natural enemies of other pests.

Insecticides. When possible, use more selective insecticides, such as insect growth regulators and spinosads to protect beneficial insects. However, use of these may require more specific application timing than traditional broad spectrum materials.

Other controls. Flooding, sanding, mating disruption, and biological controls have all been proven effective for controlling certain pests and fit harmoniously into IPM programs.

Pest scouting. Pheromone traps are available for blackheaded fireworm, cranberry fruitworm, sparganthis, and cranberry girdler. Sweep sampling is important for various “worms” (Lepidoptera larvae) and cranberry flea beetle. Visual observation is important for identifying dearness scale, and soil feeders such as girdler, flea beetle larvae, and June beetle grubs. Degree day information is available for forecasting pest activity periods. Remember that monitoring must be done routinely or else problems can be missed.

Action levels. It is not economically practical to attempt to kill every insect pest on the marsh; if pest populations are very low, the cost of applying a pesticide will likely be more than the savings from the added protection. Action levels, also known as economic thresholds, have been developed for several pests. The economic threshold (ET) is simply the pest population level where it is economically justifiable to spend money on controls. The factors that determine the ET include the crop market value, the cost of applying controls, and the amount of yield reduction caused by an individual pest. Action levels are highly important for successful IPM because they help us decide when pesticides are not necessary, and therefore help preserve natural enemies.

Cranberry IPM Today. Universities began working with the cranberry industry and private consultants well over 20 years ago to develop IPM programs. Many tools have been developed and refined during this period, such as pheromone traps, degree day models, action thresholds, selective pesticides, and cultural controls. IPM has become widely adopted by the industry, but IPM will continue to evolve as new information is learned and new tools are developed.

What IPM Is:

- Pest management decisions based on economics.
- Routine use of pest scouting and monitoring to determine pest population levels.
- Knowledge of pest biology and damage.
- Awareness of the benefits of natural enemies.
- Thoughtful integration of multiple control methods.
- A process that will continue to be constantly evolving.

What IPM Is Not:

- Avoidance of sound economic principles in pest management decision making.
- Unwillingness to do pest scouting and monitoring.
- Failure to incorporate knowledge of pest biology into management decisions.
- Disregard of natural enemies.
- Unthinking reliance on a single pest management tactic.
- A rigid, unchanging practice.

2. ECONOMIC ENTOMOLOGY 101: Insects as Plant Pests

“The struggle between man and insects began long before the dawn of civilization and has continued without cessation to the present time, and will continue no doubt, as long as the human race endures. It is due to the fact that both men and certain insect species constantly want the same things at the same time.”

-- From *The Insect, the Farmer, the Teacher, the Citizen, and the State*, Bulletin of the Illinois State Laboratory of Natural History, 1915.

A “pest” is an organism that interferes with human activities; it is purely a human concept – without us there would be no pests, only competitors for Earth’s finite resources.

Sometimes it is hard to pigeon-hole a particular species as to whether or not it is a pest. That pretty white butterfly brightens up the day; but did you notice it laying eggs on the cabbage plants in the garden? Bumble bees are wonderful pollinators, but have you ever gotten too close to the entrance of their colony? Cranberry tipworm reduces yield in the northern part of the state, but may actually increase the number of blooming uprights further south.

And “pest” status is often a numbers game: a couple of mosquitoes are tolerable, a swarm becomes outright pestiferous.

How insects become pests. The following is a general discussion of how insects become plant pests. Where appropriate, reference is made to the cranberry crop.

New introductions. Many of the most serious agricultural pests in the United States were accidentally introduced through the movement of humans and their possessions, and through commerce. A study commissioned by the U.S. Congress reported in 1993 that over 2000 non-native species of insects and arachnids have become permanently established in the United States. A few common examples important to Wisconsin crops include alfalfa weevil, European corn borer, Japanese beetle, Hessian fly, German yellowjacket, and codling moth. Invasive species introductions are not a thing of the past; they continue today, with recent introductions into the U.S. such as Asian longhorned beetle, emerald ash borer, and soybean aphid, the first North American report of which was from Wisconsin in 2000. New introductions have not yet been a pest to Wisconsin cranberries, but that may change. The permanently-colonized area of gypsy moth is still spreading from east to west in the state, and we are uncertain of its ultimate pest potential in this part of the country. Although generally considered a tree pest, during outbreak periods larvae will feed on most types of plants, and it has caused economic losses to cranberry production in Massachusetts.

Native insects attack new hosts. Cranberry, along with blueberry, sunflower, and pecan, is one of North America’s few native crops. Therefore, the insects that feed on it here evolved with it here. Most of our crop plants are introduced and in some cases, native insects have willingly developed a fondness for them. Examples include the Colorado potato beetle, the alfalfa butterfly, and apple maggot, all of which fed on wild native plants prior to the introduction of their now-favored crops.

An abundance of food. In natural landscapes, many plant species are scattered here and there and are not particularly abundant. The insects that feed on them spend considerable time and energy finding their food, time that could otherwise be used in reproducing. Along comes modern agriculture and monocultures – vast expanses of nothing but the cultivated crop. This allows insects to eat lots, grow quickly, and reproduce

abundantly. Although cranberry cultivation does not compare with corn in the Corn Belt, Wheat in the Wheat Belt, or cotton in the southern Cotton Belt, our fields do provide a much greater abundance of plants than the normal native habitat along the edges of wetlands. We grow cranberries, but we also grow cranberry pests.

Upset pests. In some cases, farming activities actually stimulate pest outbreaks; these pests are called upset pests because we have upset the balance of nature in favor of the pest species. The most common cause of pest upsets is when the use of broad spectrum pesticides for control of major pests kills the natural enemies of minor pests. Without natural predation, these minor pests can explode to damaging levels. The practices of Integrated Pest Management (IPM – outlined above) are specifically intended to reduce the likelihood of creating upset pests. Many cranberry insects have natural enemies that provide some benefit in pest management. Dearness scale is probably the best example of an upset pest in Wisconsin cranberry production. It has an abundance of highly effective natural enemies, but these can occasionally be eliminated by the use of broad spectrum insecticides, allowing for a scale outbreak.

Native crop, native pests. There are relatively few native North American crops, but each of these crops has several insects that have evolved to feed on it. Examples include sunflower moth, pecan weevil, and blueberry maggot. Virtually all of our cranberry pests are native to North America, though there is some evidence that they have been spread from region to region with vines.

Insect Biology – A Quick Refresher. Understanding the basics of insect biology is important for making pest management decisions. The following is a brief summary of insect growth and development and the types of plant damaged based upon mouthpart types.

Insect growth. Most insects start life in the egg stage. The egg hatches into an immature form. As the immature insect feeds, it must periodically shed its hard, inflexible skin (exoskeleton) in a process known as **molting** or **ecdysis**. The stage of the immature insect between molts is called an **instar**. Most insects have between 3 and 8 immature instars, meaning that they must shed their skins 3 to 8 times before reaching adulthood. Some of our modern Insect Growth Regulator (IGR) insecticides specifically interfere with this molting process. All growth is in the immature instars; once reaching adulthood, which is characterized by reproductive maturity and, in most insects, by the presence of fully developed functional wings, the insect no longer grows and no longer sheds its exoskeleton.

In the maturation process from immature to adult, the insect changes in form; this change is called **metamorphosis**. In more primitive insects, the change in form is relatively minor and the immatures look like small, wingless versions of the adult. The main changes between the last immature instar and the adult include the growth of full-size functional wings and the addition of reproductive structures. The term used for these types of immature insects is **nymph**. This rather direct type of growth is called **simple metamorphosis**. Insects with simple metamorphosis include such things as grasshoppers, katydids, cockroaches, plant bugs, leafhoppers, aphids, earwigs, and lice. Cranberry insects with simple metamorphosis include dearness scale and blunt-nosed leafhopper.

In all higher forms of insects the immatures look drastically different than the adults. In these insects, the immature stages are things like caterpillars, grubs, and maggots, with the corresponding adult stages being moths, beetles, and flies. Collectively, these immature forms are known as **larvae** (singular – **larva**). Because larvae and adults

are so different from each other, these insects have a transitional stage called the **pupa**. This type of growth, from egg to larva (multiple instars) to pupa to adult is much more complicated than simple metamorphosis and is called **complete metamorphosis**. Common insects with complete metamorphosis include beetles and weevils, butterflies and moths, bees, wasps, and ants, flies, gnats, and midges, and fleas. Cranberry insects with complete metamorphosis include the following moths: blackheaded fireworm, sparganothis fruitworm, cranberry fruitworm, spanworms, cranberry girdler, cutworms and armyworms, and blossomworm. Also with complete metamorphosis include the beetles cranberry weevil, cranberry flea beetle, and June beetles (white grubs), and the flies cranberry tipworm, mosquitoes, and deer flies. Metamorphosis is under hormonal control in the insect, and certain modern IGR insecticides cause death by interfering with normal hormonal activity.

Type of plant damage relates to feeding method. Although there are some rather peculiar exceptions, the mouthparts of plant feeding insects are basically of two forms: the more primitive **chewing mouthparts** and the more specialized **piercing-sucking mouthparts**. Insects with chewing mouthparts have two pairs of opposing jaws (mandibles) which grip the food, tear it, and chew it into small pieces before swallowing. Examples include grasshoppers, crickets, katydids, caterpillars, grubs, adult beetles, bees, and ants. Cranberry insects include flea beetle and its larval stage, June beetle and its grub, and the various types of caterpillars such as fireworms, fruitworms, spanworms, and girdler.

Chewing insects cause many types of plant damage. Leaf feeding (defoliation) results in loss of chlorophyll and nutrients resulting in overall plant stress and a loss in productivity and fruit quality. Cranberry insects that cause this type of foliar damage include fireworms, sparganothis, spanworms, armyworms, and flea beetle adults. Chewing insects can also cause damage to fruit, either by feeding on the surface or tunneling within. Examples are fruitworms and fireworms. Chewing insects can kill or damage stems and roots, restricting the movement of moisture and nutrients within the plant, resulting in plant stress and even death. Examples are the larvae of cranberry girdler and cranberry flea beetle.

Piercing-sucking mouthparts have developed numerous times in the evolutionary history of insects. Probably the most notorious group of insects with this type of feeding are the mosquitoes. Amongst plant pests, all members of the order Hemiptera have this type of mouthpart. The mandibles have evolved into very thin stylets that are hypodermic needle-like. The stylets are inserted into the plant and the insect then injects salivary fluids which help “pre-digest” the plant cell contents, allowing the insects to suck up nutrients along with plant sap. This typically results in loss of chlorophyll, plant moisture, and nutrients, which stresses the plant, resulting in poor growth and reduced yields. Certain insects with piercing-sucking mouthparts, notoriously leafhoppers and aphids, are known for transmitting certain plant pathogens, especially viruses and phytoplasmas. Examples of this group of insects include the plant bugs, aphids, leafhoppers, cicadas, and spittlebugs. The only significant Wisconsin cranberry pests that have piercing-sucking mouthparts are dearness scale and blunt-nosed leafhopper.

3. Overview of Cranberry Insecticides

The following is a brief summary of the more commonly used cranberry insecticides. The table lists the various materials by insecticide class. When rotating insecticides to avoid insecticide resistance, it is best to rotate between classes. Note that this information does not imply an endorsement by the University of Wisconsin of these products over other products.

Chemical Group	Product common name	Example brand name	IPM fit	Mammalian toxicity (oral)
Organophosphates	acephate	Orthene	poor	slight
	chlorpyrifos	Lorsban	poor	moderate
	diazinon	diazinon	poor	slight
	phosmet	Imidan	poor	moderate
Carbamates	carbaryl	Sevin	poor	slight
Neonicotinoids	thiamethoxam	Actara	ok ?	low
Insect Growth Regulators	tebufenozide	Confirm	good	low
Bacillus thuringiensis	Bt	DiPel	good	essentially non-toxic
Spinosyns (Naturalytes)	spinosad	SpinTor, Entrust	good	low

The following products are listed by common name; commonly-used or original brand names are also listed.

acephate (Orthene™)

Target insects: fireworm, fruitworm, spanworms, sparganothis.

Restricted Entry Interval (REI): 24 hr.

Preharvest Interval (PHI): 75 days.

Comments. Water soluble. Maximum of 1 application per year. Broad spectrum.

chlorpyrifos (Lorsban™)

Target insects: fireworm, fruitworm, spanworms, sparganothis, cranberry weevil, dearness scale (effective but not listed on label).

Restricted Entry Interval (REI): 24 hr.

Preharvest Interval (PHI): 60 days.

Comments. Maximum of 2 applications per year. Broad spectrum.

diazinon

Target insects: fireworm, fruitworm, tipworm, cranberry girdler (14G formulation)

Restricted Entry Interval (REI): 12-24 hr.

Preharvest Interval (PHI): 7 days.

Comments. Maximum of 6 applications per year of foliar formulations. Broad spectrum.

phosmet (Imidan™)

Target insects: fireworm, fruitworm, spanworms, sparganthis, cranberry weevil, blossomworm, tipworm, armyworm, cutworm.

Restricted Entry Interval (REI): 24 hr.

Preharvest Interval (PHI): 14 days.

Comments. Maximum of 15.6 lbs per year. Broad spectrum. Spray waters must be buffered.

carbaryl (Sevin™)

Target insects: fireworm, fruitworm, sparganthis, cranberry weevil.

Restricted Entry Interval (REI): 12 hr.

Preharvest Interval (PHI): 7 days.

Comments. Maximum of 5 applications per year. Broad spectrum.

thiamethoxam (Actara™)

Target insects: flea beetle, cranberry weevil

Restricted Entry Interval (REI): 12 hr.

Preharvest Interval (PHI): 30 days.

Comments. Maximum of 8 oz/acre per year. Narrow spectrum.

tebufenozide (Confirm™)

Target insects: fireworm, fruitworm, spanworms, sparganthis, blossomworm, false armyworm, gypsy moth

Restricted Entry Interval (REI): 4 hr.

Preharvest Interval (PHI): 30 days.

Comments. Maximum of 4 applications per year. Very narrow spectrum – just Lepidoptera. Does not kill instantly. Timing of application is critical – refer to label.

Bacillus thuringiensis (DiPel™, etc.)

Target insects: spanworms.

Restricted Entry Interval (REI): none listed.

Preharvest Interval (PHI): 0 days.

Comments. Use with spreader-sticker. Does not kill instantly. Works best on small larvae. Very narrow spectrum.

spinosad (SpinTor™, Entrust™)

Target insects: fireworm, fruitworm, spanworms (loopers), sparganthis, blossomworm, armyworm.

Restricted Entry Interval (REI): 4 hr.

Preharvest Interval (PHI): 21 days.

Comments. Entrust™ for certified organic. Very narrow spectrum.