The Remarkable Honey Bee

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INTEGRATED PEST MANAGEMENT OF VARROA IN NORTH AMERICA

Last month we reviewed some of the history of *Varroa destructor* in the United States, as well as some of the mite-tolerant stocks available within the country. In this article we will review some of the integrated pest management (IPM) concepts in current use in the Americas. IPM is not a new concept, since it became widely accepted in the early 1970s in general agriculture, but the use of IPM is relatively new for beekeeping since the introduction of trachael and varroa mites into the Americas.

IPM is often offered as a alternative or replacement to the pre-IPM chemical recommendations that governments and the extension services generated using chemical controls. My father routinely used the Michigan State University spray calendar to apply many, many applications of insecticides, miticides and fungicides to our apple trees. The calendar was often based on the plant and flower cycle. Applications were timed to plant growth, which roughly approximated pest growth. It was not an easy schedule to follow, but it did essentially turn pest control into a cook-book operation and he would rush home from the machine shop to apply a fungicide within a certain time period to prevent scab on the apples. He would also listen to the 5:30 a.m. farm show on the local radio station to find out about new pests—and there were always new pests—as county and state specialists were interviewed.

IPM was a result to the strong reaction to over-treatment of crops, which is often considered to have started with the publication of Rachael Carson's Silent Spring, and by 1970 was met with a strong natural food movement much like we are experiencing now. Entomology departments, like the one at MSU where I was a student, took great effort to change the way they operated and made pest control recommendations. This also mirrored the Federal movement, the formation of the Environmental Protection Agency, and a growing political distaste for excessive pesticide usage.

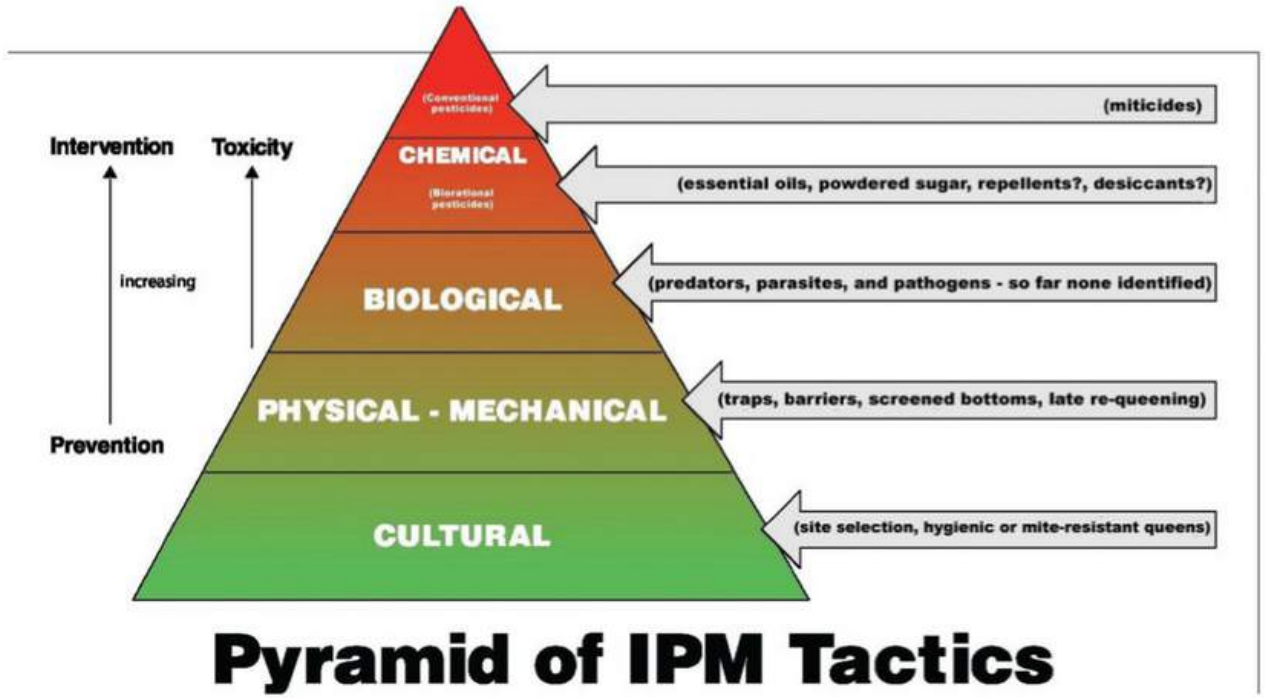
IPM programs are often represented by a triangular image showing four or more components of pest control. These were Cultural (the base), with Physical-Mechanical second, Biological Control third and Chemical Control fourth. The true brilliance of IPM methodology was the insistence that growers actually determine the pest level in a crop or animal population PRIOR TO chemical treatment. This led to the entire survey-sampling methodology widely used by many growers. The logic was simple and worked—only treat for pests when they are present and in numbers that are large enough to cause economic harm to the crop. One apple maggot in a large bin of apples was acceptable, but a maggot in each apple generally was not suitable for the marketplace.

When we look at these parts of a pyramid, we start with Cultural Control in the bee colony. Two of the biggest cultural control methods for mite management include apiary location and genetic stock. Both of these methods focus on prevention of mite buildup at zero or nearly zero toxicity to the bees.

Apiary location impacts the temperature and ventilation of a hive. When I started keeping bees we routinely put colonies in a line along a shady fence line facing south or east. Of course, the cool location kept the beekeeper cooler, and it was widely thought the bee colonies did best in the shade. With the appearance of varroa mites, it was discovered that colonies in full sun generally had a lower varroa mite population growth, apparently because the mites themselves were more sensitive to very warm temperatures. Today many beekeepers now keep their colonies in the full sun, without shade. Where Small Hive Beetles (SHB) are a problem, it has been shown that the beetles also do not reproduce as quickly in hot, dry conditions. Small-scale beekeepers often put water into entrance feeders (no sugar syrup) or put bright children's wading pools filled with large stones and water, to provide a water source.

Mite tolerant Genetic Stock in a hive will help determine the colony's ability to counter the high reproductive rate of the mites. As we discussed in last month's article, there has been a widespread effort to develop tolerance against the mites. Unfortunately, the multiple mating behavior of honey bee queens makes it extremely difficult to keep the stock concentrated enough in open mating systems so that the genetic stock is sustainable. Only when a stock is propagated in an isolated mating area or via instrumental insemination is sustainable stock maintenance successful. In areas of the world where all beekeepers use mite-tolerant stock, beekeepers experience a lower colony loss due to mites. There are few places like that in the United States because of migratory beekeepers and the widespread practice of purchasing package bees.

The second slice of the Pyramid of Control is the Physical and Mechanical methodology many beekeepers employ. I am not aware of any successful varroa traps, functioning like the many small hive beetle traps, that have been shown to be successful in reducing mite numbers by drawing the mites into them. But the growing use of screened-bottom boards has been useful in all sized beekeeping operations. These screens work in several ways, but the most obvious is the elimination of mites as they fall or are groomed from the worker bees and fall to the bottom of the hive and through



Penn State University/M.A.R.E.C IPM pyramid for varroa control.

the hardware cloth screen. Many beekeepers leave their screened bottom boards open year-around, while others insert a tray on the bottom during the fall and leave them there for winter. I think the most useful aspect of the tray in the screened bottom board is to give the beekeeper the ability to sample mite numbers, as well as initiate a low-level chemical control of the mites via repeated powdered sugar treatments.

Calendar-related events are put into this category as well, especially with the production of increase colonies after the summer solstice and requeening colonies during the late summer. Many commercial pollinators routinely make up new colonies from existing colonies returned to their southern base in August and September by reconstituting colonies into new colonies or nucleus units, installing a queen cell, virgin queen or mated queen, removing some of the oldest combs and any residues of pesticides or pathogens, and providing a significant break in the brood cycle to reduce varroa mite population numbers.

Physical and Mechanical control systems in IPM do not use chemicals and pose no toxic impact on bee colonies. They may add stress to weak colonies, such as a small colony in a large hive body with an open screened bottom board, causing the colony to use more of its stores to regulate hive temperature and humidity. There is a great deal of invention to be encouraged within the bee industry to examine other hive designs and arrangements that promote the warm and dry conditions that reduce mite buildup, as well as efficient insulation systems that optimize colony stored food utilization.

The third slice of the IPM triangle is the use of biological control agents to control pests. There we have a long way to go before we have a bio-control agent that controls varroa mite numbers and does not increase the mortality of the bees themselves. As Dr. Dewey Caron states in the revised edition of *Honey Bee Biology and Beekeeping*, beekeepers lack a Lady Beetle-type organism for bio-control of varroa mites in the bee hive. Attempts to find control agents have focused on fungi and other microbes that must kill mites and not negatively impact bees.

The fourth slice is for Chemical control of mites. We will divide these into two groups, the miticides and a general group of lower-risk materials that includes the essential oils, powdered sugar, repellents and desiccants. Here there is a trade-off between prevention and various levels of toxicity. The miticides are often considered the most toxic, but this does not necessarily follow true with all chemicals. Theoretically, there could be a chemical miticide that controls only varroa mites, but does not have a negative impact on the bees or leave residues inside the hive, the honey, beeswax or propolis. Unfortunately, that miticide has not been found.

Resistance develops against many chemicals when the mites are subjected to the molecules for a long period of treatment. Eventually, the small percentage of mites that are not controlled by the chemical reproduce and grow in numbers, leading to the eventual replacement of susceptible mites with chemically resistant ones. Certain miticides have had high levels of resistance develop to them. One solution is to use these chemicals in rotation so that different molecules are used in alternative treatments. As long as the miticides are not closely related chemically, different populations of mites are controlled and die with each treatment, prolonging the use of the chemical in an operation.

Certain miticides have been shown to contaminate combs, pollen, propolis and even honey. This has lead to the routine replacement of comb by many beekeepers. Recent studies have shown that miticides in combination with other agricultural chemicals, like fungicides, increase the risk to colony health through a synergistic reaction, where 1 plus 1 produces a result greater than 2. The same has been shown with miticides and various organisms, such as Nosema and chalkbrood. It seems clear that we are just starting to understand the impact of these synergistic effects on bee colonies.

The key to any IPM methodology is the acceptance of a sampling method to evaluate the mite levels and develop enough of a relationship with the pest to understand what certain mite levels really mean. A sampling method may show you a certain level or number of mites in May, but the colony still dies over the following winter. What do those numbers mean? How do you employ the IPM methodology to manage these parasites. Unless the numbers are put into the context of other control methods (cultural, physical and mechanical), along with chemical treatments (time of year, material selected, miticides in rotation and dosage), mite numbers will be difficult to assess. As we discussed in last month's article, some mite strains demonstrate a combination of higher mite numbers combined with productive colonies. Have these mites and this strain of bees worked

something out that allows for less feedings, but more alive mites, as varroa did on its native host, *Apis cerana*? It so quickly becomes enormously complicated.

Most beekeepers who actually do sample seem to prefer the use of powdered sugar in a shaker jar as a means of sampling mites without killing the bees. Systems using ether, windshield fluid or alcohol, and other methods kill the bees. The lethal methods are great for collecting a sample of bees—about 1/2 cup or 300 worker bees from brood combs—so that the bees may be further sampled to see how effective the sampling technique really is. But this is a research focus.

For most beekeepers a sample of 300 bees from the brood nest bees (where the feeding or phoretic mites accumulate when they emerge from the cells) shaken with a few tablespoons of confectionary (powdered) sugar following a standard technique, should provide a successful comparison of mite population trends for that one colony, the trend for the entire apiary or operation, and the response to the mite level following any of a number of management manipulations: Replacing the queen; removing three frames of bees and two frames of brood to make a new nucleus or increase colony; a biological pesticide treatment such as powdered sugar dusting (entire colony); or an essential oil application (entire colony) or other manipulation.

For any IPM process to work, sampling is advised. The sole use of one component, such as screened bottom boards or resistant bee stock, may provide benefits to the colony and the entire operation, but without data, how do you really know?

October will put Dr. Connor in Kansas for the Kansas Beekeepers meeting (Oct 18-19), and the British Columbia Beekeepers (Oct 25-27). In November he will be at the Joint Wisconsin-Illinois meeting (November 1 and 2), the Texas Beekeepers Nov. 7, the Massachusetts Beekeeping Federation (November 18) and the Southern New England Beekeepers Assembly on November 23. In December Dr. Connor hopes to be recovering under a palm tree somewhere. For the latest, check in at the newly redesigned website www.wicwas.com.