There's only one alternative to insecticide resistance management

Resistance management is up to you

Growing crops today is a world away from cultural practices 30 years ago. Useful tools such as Integrated Pest Management (IPM) techniques, sophisticated crop protection products, and transgenic plants are becoming routine. With all these advances, do we still need to be concerned with pests developing resistance to the tools we use?

Transgenic crops engineered to control insects are the most recent tools growers have adopted to consistently provide low cost, high quality yields. The rapid adoption of transgenic crops in the United States and many areas of the world has exceeded all projections and commercially validated the technology and need for new insect control methods. Transgenics help minimize the use of broad-spectrum pesticides, but also carry a greater potential to foster resistant pests from constant selection than the occasional use of sprayable products. IPM techniques are still a valuable tool toward managing resistance; but growers must continually educate themselves to stay abreast of new technology and make in-season adjustments for these methods to work.

Crop protection products are still the safety net for preserving yields and controlling pests. Several new classes of conventional products have or are being introduced that complement older products, transgenic crops, and IPM practices. With all of these new tools it is natural to become complacent about protecting any one tool. However, with these new tools, resistance management tactics are more numerous and effective. Now is the time to make a difference in controlling long term costs by being proactive with resistance management before resistance becomes serious and little can be done.

An organization of crop protection companies is leading the charge in managing insect resistance. The Insecticide Resistance Action Committee (IRAC) is intensifying efforts with research, fieldwork, consultation, and educational programs to aid growers confronted with resistance issues. The group is addressing problems such as:

- Spider mites. Spider mites have historically demonstrated a propensity for developing resistance particularly in tree and vine crops. Once again, they are becoming tolerant to the latest group of products introduced. The few that remain effective do so because of strict resistance management strategies.
- Diamondback moth (DBM, *Plutella xylostella*) is another renowned bad guy able to shoot down anything thrown its way. Growers in several areas of Asia and most recently in California have considered abandoning cole or crucifer crop production because of resistant DBM.
- Colorado potato beetle. On Long Island, N.Y., when resistance to pyrethroids and other synthetic pesticides raged in 1991, growers were spending up to $400 per acre on pesticides in attempts to control Colorado potato beetles. That same year, some potato growers lost up to 50 percent of their crop to the pest. Growers in this area are now relying on a single class of products, the neonicotinoids. Relying on only one class will almost guarantee a repeat of history.

Catastrophic failures like those described above are not common. However, every major crop — cotton, rice, corn, fruits, vegetables, and ornamentals — has one or more resistant pests. In total, more than 500 species of insects and other arthropods have already shown resistance to at least one class of insecticides.

The price of insecticide resistance in lost yields and higher insect control costs is staggering — in some years more than $1 billion in cotton for the budworm/bollworm complex alone. Once a crop protection product is rendered ineffective by resistance, it could very well be lost from the toolbox forever.

Facing facts. In the past, if one class of chemicals showed resistance, manufacturing companies had a new chemistry to save the day. Today there appear to be more options than ever when transgenic crops, IPM methods, and new and old crop protection products are considered. For most pest and crop complexes however, there are usually no more than one or two viable control tactics. Millions of dollars are spent every year to bring new products to the market but there is no guarantee that industry can continue to meet the increasing hurdles or if discoveries will match the most pressing needs. Likely limits on product introductions mean growers should use products to control insects carefully so the products or tactics that work today will work tomorrow.

Why resistance has developed. Resistance development is simply a consequence of natural selection; a control agent (an insecticide or acaricide) prevents susceptible individual insects and mites from reproducing leaving only those individuals carrying the genes for resistance. A small percentage of the pest population may harbor resistance genes that allow an individual pest to survive. These genes already may exist in a pest population, or they may arise through mutation. As crop protection products keep removing susceptible individuals, the balance of the population changes. Resistant pests continue to multiply and ultimately become predominant.

The rate at which resistance develops is determined by "selection pressure," which depends on three things:

1. Biology of the pest, including reproductive rate, migration and host range;
2. Persistence and specificity of the crop protection product; and
3. Intensity of product use, including dose rate, number and timing of applications.

Resistance management is up to you. Growers hold the key to managing resistance by reducing selection pressure. The key to managing resistance is for growers to reduce selection pressure. Consistent with IPM principles, IRAC recommends the following resistance guidelines to keep valuable protection tools working effectively and help keep grower costs down.

1. **Consult with an agricultural adviser in the area for regional insecticide resistance and IPM strategies**. Consider the pest management options available and map out a season-long plan to avoid unnecessary applications of insecticides. The best plans are those developed by local experts and growers and adopted on a regional basis.

2. **Before planting**. Consider the options for minimizing insecticide use by selecting early maturing varieties or varieties that are insect resistant. Manage the crop for "earliness".

3. **Carefully select crop protection tools**. When selecting crop protection products for use against specific pests, consider more than cost and effectiveness. Think about:

    - **Beneficial insects** — Maintenance of beneficials can keep pest populations below economic thresholds, thereby reducing the need for or the number of applications.
    - **Product class** — Follow label recommendations for rotating or mixing products from different classes based on modes of action, not just different brands. When there are multiple applications per year, alternate products with different classes so that only one generation per year is exposed to a class. When only one application is made, rotate products from different classes from year to year to reduce selection pressure.
    - **Rates and spray intervals** — Use insecticides and acaricides at labeled rates and spray intervals. Do not reduce or increase rates from manufacturer recommendations as this can hasten resistance development. Monitor subsequent pest levels to gauge control.

    - **Coverage** — Calibrate equipment for accurate application. Use recommended spray volumes and pressures.

3. **Watch the pest population during the growing season**. Regularly monitor fields to identify pests and natural enemies, estimate insect populations and track stage of development. Insecticides and miticides generally should be used only if insect counts exceed the local economic threshold or the point where economic losses exceed the costs of insecticide plus application. Time applications against the most susceptible life stages to gain maximum benefit from the product.

4. **End of season**. Remove crop residues, as appropriate, to eliminate food sources and overwintering habitats for pests. Consider next years IPM/Resistance Management Plans while planning and preparing for next year's crops.

If resistance is suspected. Prevention is the best strategy, but if you suspect resistance, first eliminate other possible causes. In many instances, lack of control can be attributed to application error, equipment failure, or less-than-optimal environmental conditions. If these possibilities have been eliminated, work with local agricultural advisers and the manufacturer to confirm actual resistance to the compound applied. In the event of a control failure due to resistance, don't repeat the application with an insecticide of the same chemical class.

What are transgenic crops? Transgenic plants have been engineered to contain genes from other organisms. The most important so far for insect control have been those containing genes from the bacteria *Bacillus thuriengensis* (Bt) that produce a protein that controls lepidopteran (caterpillar) pests. Transgenic crops can reduce the use of broad-spectrum insecticides, but they also are more target-pest specific. This means that populations of beneficial insects can be maintained. Pest control is more easily maintained with transgenic crops because different regions of the plant contain the control agent — even those regions hard to spray with conventional pesticides. However, they put tremendous pressure on pest populations by continually providing selection pressure. There also are very few genes and proteins that are known to be applicable to insect protection today. These last two issues have greatly elevated the amount of research and debate on resistance management. Transgenic crops are bringing value not only to growers but also to the scientists who study resistance management programs.

IRAC recommends the same resistance management guidelines for transgenic crops as previously listed for conventional crops. One additional tactic that should be given consideration is the inclusion of a refugia on each farm. A **refugia** is the designation of a percentage of the crop as nontransgenic with no or reduced control treatments. This maintains some susceptible insects to mate with those surviving treatments and prevents or dilutes resistance in their offspring. Specific guidelines are provided by the seed company to maximize the effectiveness of refugia areas.

Protecting our options and profits. With cooperation among growers, crop protection suppliers, and agricultural advisers, insect and mite resistance management can ensure continued access to valuable crop protection tools. Currently, a small area consistently provides low-cost food and fiber for many, but the loss of just a few crop protection tools could drastically change this. Resistance development can lead to increased treatments, higher cost, lower yields, additional land needs, or even the inability to grow current crops. Follow resistance management strategies and encourage others to do so, or costs to the producer, the environment and the consumer will increase.

About IRAC. The Insecticide Resistance Action Committee was formed in 1984 to provide a coordinated crop protection industry response to the development of resistance in insect and mite pests. The mission of IRAC is to develop resistance management strategies to enable growers to use crop protection products in a way to maintain the efficacy. The organization is implementing comprehensive strategies to confront resistance. They include:

- Identifying the scope of resistance problems through surveys
- Developing methods for detecting and monitoring resistance
- Discovering how resistance occurs
- Devising programs to counter the loss of pest susceptibility
- Developing susceptibility management strategies that incorporate all practical pest management methods into a crop management program

- Disseminating information on management strategies
- Interacting with regulatory authorities responsible for insecticide registration.

IRAC continues to work on new tactics for managing resistance in insects. IRAC is not only trying to prolong the life of industry's products but also the long-term viability of agricultural systems. IRAC appreciates and encourages input from growers, universities and commodity groups in the collection and dissemination of resistance information.