Resistance Management: A Critical Role for Biopesticides

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BIOPESTICIDES are becoming critical components of resistance management programs. Most biopesticides, particularly microbial products, have multiple modes of action—they don't target a single site or gene. Even if a pest is resistant to a single mode of action, it is highly unlikely it will have cross resistance to a biopesticide that has multiple modes of action or target sites. For this reason, biopesticides are valuable for helping us reduce or eliminate the development of resistance to pesticides.

Resistance Development: A Brief Review

Weeds, insect pests and disease-causing fungi and bacteria are living organisms capable of evolving in response to selection. And one source of selection can be the pesticides used to control them.

Most pest populations include a few individuals with heritable traits that make them more able to survive exposure to certain types of pesticide active ingredients. For example, a genetic mutation resulting in a slight change to an enzyme that is the target of a particular active ingredient (AI) might make individuals expressing the altered enzyme no longer susceptible to that AI. Application of pesticides containing that AI acts as a selective agent favoring those individuals (and their offspring) over individuals lacking the mutant genes for resistance to that mode of action. A resistance trait that was initially very rare in the pest population can become much more prevalent after repeated exposure of the pest population to the same mode of action over multiple generations, leading to control failures in the field. Seemingly different active ingredients may share similar target sites or be sufficiently similar in chemical structure that pests resistant to one AI are already pre-conditioned for resistance to the other, even if they have not yet been exposed to it--a condition known as cross resistance.

Managing Pesticide Resistance

Managing pesticide resistance starts with prevention through adoption of basic IPM tactics. These include field monitoring and use of economic injury levels to guide deployment of multiple control measures, such as chemical and biological pesticides, beneficial insects, cultural practices, host plant resistance and crop rotation.

BENEFITS OF BIOPESTICIDES

Mike Dimock, Ph.D., points out the following benefits to using biopesticides for resistance management:

- Most are exempt from residue tolerance so don't pose an issue with Maximum Residue Limits (MRLs) in export crops.
- Specificity – most biopesticides present lower risks from worker exposure and environmental issues.
- Most have multiple modes of action, rather than attacking a single target site as is more typical of conventional chemical pesticides. This puts them at lower risk of resistance development.
- Many newer conventional pesticides come with use restrictions – for resistance management purposes. Biopesticides have fewer restrictions and different modes of action, so they can fill gaps between chemical pesticide applications.
- There is no known cross resistance between chemical and biological pesticides. In fact, biopesticides can enhance the performance and efficiency of conventional crop protection inputs through complementary, and in some cases, even synergistic modes of action.

But another important component of resistance management is the use of alternatives, rotations or sequences of different modes of action (MoA) to avoid selecting for resistance or cross-resistance by repeated use within the crop cycle—or year after year—of products in the same MoA class.

The Resistance Action Committees (RAC) of CropLife International classify pesticide active ingredients based on MoA as a tool for developing resistance management programs. Many pesticide labels indicate the FRAC (for fungicides) or IRAC (for insecticides) MoA group of the active ingredient. By following RAC guidelines, PCAs can avoid consecutive applications of the products in the same MoA group and rotate between these groups reducing the risk of product failure due to resistance or cross-resistance.

Constant reliance on pesticides having the same modes of action creates more risk of resistance. Using different modes of action means you don't expose the target population to the same "bullet" again and again.

Putting Biopesticides to Use

PCAs have access to multiple biopesticides, including microbial pesticides, botanical extracts, and biochemicals. In a typical California resistance management program, all types might be used. In grapes, for example, PCAs might recommend the use of a copper product to control powdery mildew, a microbial fungicide for control of foliar and soil-borne diseases, a microbial nematicide for plant parasitic nematodes, and a Bt bioinsecticide to control worm pests – in conjunction with conventional chemical applications.

Because they are farmed intensively, grapes and strawberries receive multiple sprays throughout the season for powdery mildew, Botrytis and other diseases. Traditionally growers have had just a few conventional chemistries to control fungal diseases—including DMIs (demethylation inhibitors) and strobilurins. It is not too late to lengthen the lifespan of these products.

A good way to preserve the useful life of conventional pesticides is through tank-mixing or alternating the DMI or strobilurin with biopesticides. Because of their multiple target sites and unique modes of action, biopesticides remain effective against individuals that might otherwise pass resistance to single-site MoA pesticides to their offspring, thereby helping maintain the longevity of these products.

Induced resistance products, a newer category of biopesticides, have an entirely different mode of action. They trigger the plant's own immune system. Plants are capable of fighting disease and infection by producing defensive molecules and metabolites within their cells. Induced resistance (IR) products trick the plant into thinking it is under attack, putting it on alert. When pathogenic fungi or bacteria make an appearance, the plant already has its defenses primed to resist the pathogens' attack.

Spinach Rotation Program

Induced resistance products should be considered as part of a spinach rotation program to control downy mildew. In general, apply the IR product first when disease pressure is low to allow priming of the plant's defenses for fighting the disease. Then rotate with a standard conventional or biological product. Follow with another IR product application and another conventional treatment, if needed. This program will control downy mildew, as well as manage resistance to conventional chemistry.

Alternaria Leaf Spot in Almonds

Relying on single-site chemistry is particularly troublesome for the almond industry. A common fungal disease, Alternaria leaf spot, requires multiple fungicide applications early in the growing season. Left uncontrolled, Alternaria can defoliate a tree, and a defoliated tree doesn't produce the high quality almonds California is known for. If growers continually apply single-target site chemistries without rotating, resistance will develop and endanger the entire industry. As with spinach, grapes and strawberries, early applications of biopesticide products in almonds work best followed by rotation with conventional fungicides in different FRAC mode of action classes.

In the long run, it behooves all PCAs to approach a resistance program with the goal of keeping those resistant mutants rare in pest populations. Continually switching between chemical and biological pesticides with different modes of action can prevent or at least delay the spread of those resistance genes into the wider population.

With the availability of effective biopesticides being more widely available, they are becoming an integral part of resistance management programs and will continue to be an essential component of the future of farming.

BIOPESTICIDE USAGE ADVICE

Scott Ockey suggests the following guidelines for using biopesticides for resistance management:

- Follow the label – make sure you are using effective label rates.
- Talk to the manufacturer's reps – they know their products inside-out. They can tell you how they performed in research trials and how they work best in certain scenarios.
- Talk to your extension agents – they know your area, your crops and your pest issues.
- PCAs – make sure you are as well-trained and expert about biopesticides as you are with the other materials you use.