Editors' Note: This is the third in a seven-part series on research being performed at North Carolina State University in Raleigh, N.C.

Taking the Biocontrol Plunge

Learn the benefits of transitioning to biological controls and which initial pitfalls to avoid

By Steven Frank

Biological control of arthropod pests can be very effective and is used with great success by growers in the United States and abroad. However, many growers who try biological control find it ineffective or unreliable. Some easily avoidable pitfalls can stymie the efforts of growers who want to begin using biological control. In this article, I will discuss some of the benefits of biological control and some initial pitfalls to be aware of when making the transition.

Why should I consider biological control?

There are many high-minded reasons to include biological control as part of your pest management program. However, the primary reasons growers tell me they switch to biological control have more to do with practicality and profit than environmentalism and sustainability. With some pesticide applications there may be logistical challenges. Restricted Entry Intervals (REI) restrict worker access to plants that may need to be cared for or shipped. Some pesticides may be phytotoxic to or leave residue on some plants but not others, which complicates pesticide selection and timing in diverse cropping systems.

The other reason growers want to use biological control is a real or perceived concern that certain chemicals are losing efficacy or may become unavailable. For example, some greenhouse populations of Western Flower thrips have developed resistance to spinosad so a sudden reduction in the efficacy or availability of pesticides to manage thrips could be devastating.

Do I have to go cold turkey?

Successful implementation of a biological control program requires a change in mindset and production practices that cannot happen overnight. Compatible pesticides can ease the transition to biological control and even play a role in a

Green peach aphids give birth to live nymphs, which increases population growth rate. (Photo: J. Baker, NCSU)

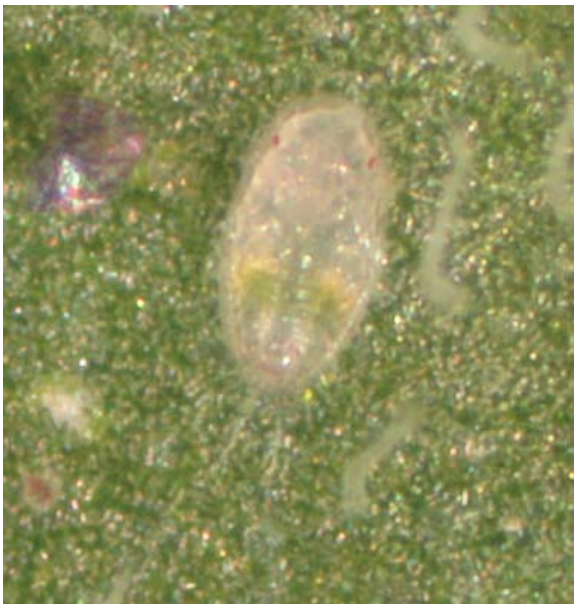
biologically-based pest management. Pesticides may be necessary to get an outbreak under control or to manage an uncommon pest for which biological control agents are not available. Pesticides should be separated from natural enemies by an appropriate amount of time or space. Separating pesticides and natural enemies in time means natural enemies should be released a safe time interval after pesticide applications so they are not killed by pesticide residual. Separating pesticides and natural enemies in space means you apply pesticides to plant parts where natural enemies do not forage. For example, drenching the roots of a plant will have minimal effects on natural enemies foraging in the foliage.

Using pesticides that are toxic to natural enemies will quickly ruin a biological control program. Pyrethroid insecticides remain toxic to natural enemies for several weeks longer than to pests. We conducted experiments with bifenthrin (Talstar) which left a toxic residual that killed minute pirate bugs (*Orius insidiosus*) that walked on leaves for eight weeks. However, aphids and whiteflies recolonized the plants much more quickly. In a similar experiment, residual from one permethrin application killed minute pirate bugs, parasitoid wasps, and predatory mites for ten weeks while spider mites flourished. Therefore, it is best to initiate biological control with a new crop cycle so you start with plants that are free of pests and pesticide residue.

Several available pesticides are considered compatible with natural enemies due to their low toxicity or short residual. Examples include s-kinoprene (e.g. Enstar II), azadiractin (e.g. Azatin XL, Molt X), abamectin (e.g. Avid), flonicamid (e.g. Aria), insecticidal soaps and horticultural oil. The best insecticide option will depend on the target pest and natural enemies present. You can find detailed information at the websites listed on the previous page.

I wish biological were more like pesticides.

There are many biological control agents that you mix and apply like pesticides but are generally compatible with arthropod natural enemies. *Beauveria bassiana*, a fungus that attacks and kills insects, is one such biological control



Healthy whitefly and a darker colored nymph infected with Beauveria bassiana *fungus. (Photo: BioWorks Inc.)*

Resources

Compatible pesticides and other information:
http://cipm.ncsu.edu/ent/biocontrol/pestacides.htm

Thrips management with compatible pesticides:
http://mrec.ifas.ufl.edu/lso/DOCUMENTS/ThripsManagementProgram_100308.pdf

Pesticide side effect databases:
http://side-effects.koppert.nl/
http://www.biobest.be/neveneffecten/3/3/

agent. It is available in products such as BotaniGard, Mycotrol and Naturalis that are applied as foliar sprays or drenches. Fungal spores attach to insect cuticle, grow into the insect body, and kill the insect via depletion of nutrients and release of toxins. The advantages of using entomopathogens like *B. bassiana* are that it has a mode of action unlike traditional insecticides; a very short REI; and minimal impact on plant quality, worker health or beneficial insects.

Entomopathogenic nematodes are another type of natural enemy applied using standard application equipment. Nematodes are dispersed into water and applied as a drench to potting media or sprayed onto plants. Nematodes enter the insect's body through the mouth, anus or spiracles. Once inside, nematodes release bacteria, which proliferate and serve as food for the nematodes. Bacteria and nematode reproduction eventually exceeds the capacity of the insect body cavity, which splits open releasing hundreds of nematodes into the soil that hunt for more insect pests. Many species and strains of nematodes are available that target different pest species or life stages.

Last time I released natural enemies they disappeared.

Biological control is most successful if you release natural enemies in a preventative rather than curative manner. There are two reasons for this. First, pests reproduce faster than natural enemies so predators or parasitoids released after pests are established cannot keep up. We conduct research with the parasitoid wasp *Aphidius colemani* that attacks aphids. Female wasps insert eggs into aphids using a sharp ovipositor. The larval wasp feeds within the aphid until it emerges as an adult seven to 10 days later. Aphids on the other hand produce up to seven nymphs per day. In the time it takes a parasitoid to go from egg to adult in one aphid, a neighboring unparasitized aphid could produce 70 babies! Scale, mites, thrips and other pests also reproduce faster than their natural enemies. To gain the upper hand you need to start with clean stock and release parasitoids continuously so they attack small aphid populations.

The second reason preventative releases are more successful than curative releases is that natural enemies need pests to survive. If you release parasitoids and they do their job, there will be no more aphids for them to use as hosts so parasitoids die or emigrate. If aphids return through a vent, on worker clothes or on a shipment of plants,

Hemispherical scale and other pests reproduce more rapidly than natural enemies. (Photo: S. Frank, NCSU)

there will be no parasitoids to prevent an outbreak. Preventative releases mean you are maintaining a natural enemy community that prevents pest from becoming established.

How do I manage many different pests at the same time?

If you only had one pest, then management with biological control or any other means would be straightforward. Unfortunately, you will have to develop a biological control program to manage many different pests. There is not a biological control recipe that describes exactly which natural enemies to purchase, how many of each and when to release them. These variables will change depending on the crops you produce, time of year and particular pest species. For example, the parasitoid wasp *A. colemani* will attack cotton and green peach aphids but not foxglove aphids. For these you will need a different natural enemy such as the predatory fly *Aphidoletes aphidimyza*. This is why it is essential to know which pest species you are dealing with and why it is impossible to develop a one-size-fits-all program.

How do I pull it all together with IPM?

So how do you put all this together and make a successful transition to biologically based pest management? Take a season or a year to prepare. Monitor during this time to identify the pest species you have, when they occur and in which crops. To assemble an effective natural enemy community you need to keep detailed records and know what you have. During this preparatory season look for cultural or mechanical ways to reduce the abundance and diversity of pests in your greenhouse. Fine-tune watering protocols to reduce fungus gnats and shore flies. Clear out weeds and debris from under benches that serve as food and pupation sites for pests. Anything you can do to reduce pest pressure means your biological control agents will not have to work as hard.

Develop a good relationship with a biological control supplier. They have an interest in helping you use their products correctly and effectively. With your records they should be able to help you establish an initial biological control program and to tweak it as problems occur. This is where your observations and records will be invaluable.

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