GROWERTALKS

Pest Management

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Best Practices for Biocontrols, Part 3

John Sanderson, Suzanne Wainwright-Evans & Ronald Valentin

Tiny parasitic wasps can provide effective biocontrol of some of your worst greenhouse pests. These wasps, which will not sting or harm people in any way, will fly or crawl through your plants to search for aphids or whiteflies. Typically, the female wasp will penetrate these pests with her egg-laying ovipositor and lay an egg beneath or inside (depending on the species). The egg will hatch into a wasp larva, eating the aphid or whitefly nymph from the inside out, killing the nymph. They'll pupate inside the host insect and emerge as a wasp that will then search for more hosts.

Because they ultimately cause the death of their hosts, these wasps are called parasitoids. These parasitoids are excellent at finding their pest hosts. They'll find the pests before you will! They're not capable of reducing a significant pest infestation, but are good at keeping a pest population at low levels and should always be released preventatively.

This article will concentrate on the most commonly used parasitoid species, including the aphid parasitoids *Aphidius colemani*, *A. matricariae* and *A. ervi*, and the whitefly parasitoids *Encarsia formosa* and *Eretmocerus eremicus*. All of these are commercially available from suppliers of biological control agents.

Aphid parasitoids

To get the most out of your parasitoids, and get the most bang for your buck, you must know which aphid species you have or are likely to have. This is because the parasitoids differ over which aphid species they're effective against, so you want to be using the correct parasitoid species that will attack your aphids. *Aphidius colemani* and *A. matricariae* are effective against small aphid species, such as green peach aphid (*Myzus persicae*) or melon/cotton aphid (*Aphis gossypii*). *Aphidius ervi* is effective against larger aphid species, such as potato aphid (*Macrosiphum euphorbiae*) or foxglove aphid (*Aulacorthum solani*).

Figure 1. Aphids that have been parasitized by Aphidius wasps become rounded and straw-colored, and are called "mummies." Note the exit hole that indicates that the wasp that grew up inside that mummy has emerged to mate and search for aphids to parasitize. These visible signs of parasitoid activity are useful for monitoring the activity of these wasps. Photo: Suzanne Wainwright-Evans.

Figure 2. The Aphidius parasitoids are shipped as aphid mummies and may be sold in bottles or blister packs, and may be mixed with buckwheat hulls, sawdust or no carrier. Photo: John Sanderson.

Figure 3. For BCAs that arrive in bottles mixed with or without a carrier, a small amount of product can be sprinkled into release boxes (or "bioboxes") that are spaced in spots throughout the crop canopy. Be sure to sprinkle only a small amount of product into each box to avoid burying the mummies and emerging wasps in the carrier. Photo: John Sanderson.

Figure 4. Place blister packs inside the plant canopy in the shade with the transparent blister facing away from the direct sunlight to prevent heating the mummies to death. Be sure to train your staff to open the flap on the back of the blister pack, but don't let the contents fall out though the flap. Keep the flap open enough to allow the wasps to escape, but prevent irrigation water from entering the pack. Photo: John Sanderson.

When an aphid has been parasitized by one of these wasps, it will eventually become rounded and straw-colored, and is called a “mummy” (Figure 1). Once the parasitoid has completed its development inside the aphid and is ready to emerge as an adult, it will chew a round exit hole at the back end of the mummy. These visible signs of parasitoid activity are useful for monitoring the activity of these wasps. Keep in mind that we often see native parasitoids moving in from the outside to help you out, so you can have mummies even if you’ve never released parasitoids.

The parasitoids are shipped as aphid mummies and may be sold in bottles or blister packs, and may be mixed with buckwheat hulls, sawdust or no carrier (Figure 2). Wasps can fly and disperse throughout the crop, so they can be released at various spots. The more release points, the better. Do not scatter the product onto plant foliage, soil surface, benchtop, floor or anywhere else where ants could eat them or they could be washed away.

Bottles that contain wasps that have already emerged upon arrival can be opened when holding the bottle inside the canopy to let some wasps fly out, then carefully recapped (so you don’t crush adults) and moved to another spot to release some more and so on. For products that arrive in bottles as mummies mixed with or without a carrier, a small amount of product can be sprinkled into release boxes (or “bioboxes;” Figure 3) that are spaced in spots throughout the crop canopy.

These are available from all of the biocontrol suppliers. Be sure to sprinkle only a small amount of product into each box to avoid burying the mummies and emerging wasps in the carrier. A single layer of product is best. Release boxes should be kept shaded and placed within the canopy, not above it, so that emerging wasps stay inside the canopy to search for aphids. The location of each box/cup can be marked with a survey flag or equivalent for easy monitoring. Use caution if you’re using overhead irrigation so that you don’t fill the boxes with water. Additional product can be added to the boxes after wasps from the previous release have emerged and remaining debris is emptied.

If using blister packs, place the packs inside the plant canopy in the shade with the transparent blister facing away from the direct sunlight to prevent heating the mummies to death (Figure 4). Be sure to train your staff to open the flap on the back of the blister pack, but don’t let the contents fall out though the flap. Keep the flap open enough to allow the wasps to escape, but prevent irrigation water from entering the pack.

Release rates can be variable depending on crop, pest pressure and where you are in the crop cycle. Sometimes more parasitoids are released at the start of the crop, then reduced, but they should always be released preventatively. This is especially true on crops for which seeing a mummy on the plant could be problematic.

For example, potted herb plants are consumed and people don’t want to see mummies on their food. This doesn’t mean you cannot use the wasps; you just have to be mindful of populations and timing of releases. If used preventatively and with good release rates, the parasitoids are capable of keeping aphid mummies at non-detectable levels.

Figure 5. Greenhouse whiteflies that have been parasitized by Encarsia formosa turn black, so it's very easy to check that these wasps are active in your crop. Photo: Suzanne Wainwright-Evans.

Figure 6. Whitefly nymphs parasitized by Eretmocerus do not turn black. To check for activity, use a hand lens to look for round exit holes on whitefly pupae that indicate that a wasp has killed a nymph and chewed its way out of the pupa. This round exit hole will look very different from the T-shaped slit through which healthy adult whiteflies emerge from their pupal stage. Photo: Suzanne Wainwright-Evans.

Figure 7. Whitefly pupae that have been parasitized by the wasps are shipped glued to cards (or as loose pupae in sawdust carrier in bottles or blister packs). Wasps emerge from the pupae on these cards and fly into the crop to search for whitefly nymphs to parasitize or kill by host-feeding. Photo: John Sanderson.

Figure 8. One way to release parasitoids is from Encarsia/Eretmocerus cards into your crop. Release boxes can also be deployed in a similar way. Be sure to keep the cards or boxes shaded, as dry as possible and inside the crop canopy, not above the canopy. Photo: John Sanderson.

Open rearing systems, also called "banker plants," are an effective way to create a continuous supply of aphid parasitoids in your greenhouse without the need for regular shipments and releases. Banker plants for aphid parasitoids are typically comprised of potted barley plants infested with bird cherry-oat aphids that provide alternate aphid hosts for *A. colemani* parasitoids. This system doesn't work for *A. ervi*. A different aphid is needed for that system. The bird cherry-oat aphids infest monocot cereal crops such as barley, oats and wheat, but don't infest most dicotyledon ornamental crops. But *A. colemani* readily reproduces on these aphids and then disperses throughout the greenhouse to attack their host aphids. Resources about how to use banker plants for *A. colemani* production are available at:

- ipm.uconn.edu/documents/view.php?id=1411 (Leanne Pundt, University of Connecticut Cooperative Extension)
- academic.oup.com/jipm/article/9/1/9/4925476?login=true ("Banker Plants for Aphid Biological Control in Greenhouses"; Tracey Miller and Eric Rebek, Oklahoma State University)

Whitefly parasitoids

Similar to aphids, it's important to identify the whitefly species in order to select the most cost-effective parasitoid species to use. *Encarsia formosa* is an effective parasitoid for greenhouse whitefly (*Trialeurodes vaporariorum*). *Eretmocerus eremicus* is an effective parasitoid for silverleaf/sweetpotato whitefly (*Bemisia tabaci* (=*argentifolii*)). It will also attack greenhouse whitefly, but is more expensive than Encarsia, so it's more cost-effective to use Encarsia for greenhouse whitefly.

Greenhouse whiteflies that have been parasitized by Encarsia turn black, so it's very easy to check that these wasps are active (Figure 5) in whitefly patches on leaves. Color changes are much less obvious for Encarsia on

sweetpotato whitefly or Eretmocerus on either whitefly species. To check for activity, use a hand lens to look for round exit holes on whitefly pupae that indicate that a wasp has killed a nymph and chewed its way out of the pupa (Figure 6). This round exit hole will look very different from the T-shaped slit through which adult whiteflies emerge from their pupal stage.

Whitefly pupae that have been parasitized by the wasps are shipped glued to cards or as loose pupae in sawdust carriers in bottles or blister packs (Figures 7 and 8). Wasps emerge from the pupae on these cards or from the loose pupae in the carrier, and fly into the crop to search for whitefly nymphs to parasitize or kill by host-feeding.

If using cards or blister packs, separate them individually and hang in the plant canopy throughout the greenhouse. As with the aphid parasitoids, it's best if they're placed within the canopy or as close as possible. They should be kept in the shade in the plant canopy. If using blister packs, don't place the blister facing the sun and remember to open the flaps on the backs of the packs.

If using loose pupae, sprinkle the product into the same sort of release boxes used for the aphid mummies, using a very small amount so they aren't buried and the wasps don't have to crawl through the carrier. Place the boxes within the canopy and mark their location with survey flags for easy relocation. Use preventative releases and check with your supplier for release rates and spacing of release points.

Ants

Ants must be controlled when using these parasitoids. Ants will protect honeydew-producing insects, such as aphids, whiteflies and mealybugs, from parasitoids and predators.

Pesticide compatibility

In the biocontrol world, parasitoids tend to be even more sensitive to pesticides than other BCAs. Not so much when they're inside the dead bodies of their host, but more as the adults. Make sure you check the insecticide, miticide, fungicide and plant growth regulator compatibility with the different life stages of the parasitoids to avoid the costly mistake of killing your beneficials. Check with your biocontrol supplier for pesticide compatibility information.

> **Other Parasitoids Available**
> There are a few other parasitoids that are commercially available, but that are less commonly used in the U.S. greenhouse ornamental market. These include *Aphelinus abdominalis*, which is used for aphids; *Diglyphus isaea* and *Dacnusa sibirica*, which are used for Liriomyza leafminers; and *Anagyrus pseudococci* used for citrus mealybug. **GT**

John Sanderson is an Associate Professor at Cornell University in Ithaca, New York, and has worked on research and extension for greenhouse pest management for over 30 years. Suzanne Wainwright-Evans is the owner of Buglady Consulting, now in business 20 years. She specializes in biological control agents and troubleshooting pest issues in ornamentals, cannabis and other specialty crops. Ronald Valentin is Technical Director BCA for BioWorks, Inc. and has been active in Biological Control for over 30 years in Europe, Canada and the U.S.