Starting a Biological Control Program for Greenhouse Insect and Mite Pests

Introduction

Biological control is the using of living organisms (natural enemies) such as insects, mites, fungi, or bacteria to control pests. Natural enemies are living organisms that are most effective when pest populations are low. Use natural enemies **preventatively,** early in the cropping cycle, when plants are small, and when pest numbers are very low. This is a completely different mindset compared to conventional pest control, waiting until you see damage and then treating with insecticides or miticides.

Some of the **advantages** of using biological control agents include:

- less worker exposure to toxic pesticide residues
- less chance of plant damage from sprays
- improved plant quality
- no re-entry intervals (REI) to follow
- part of "sustainability" marketing
- preserving the effective life of pesticides used by removing the selection pressure for development of resistance

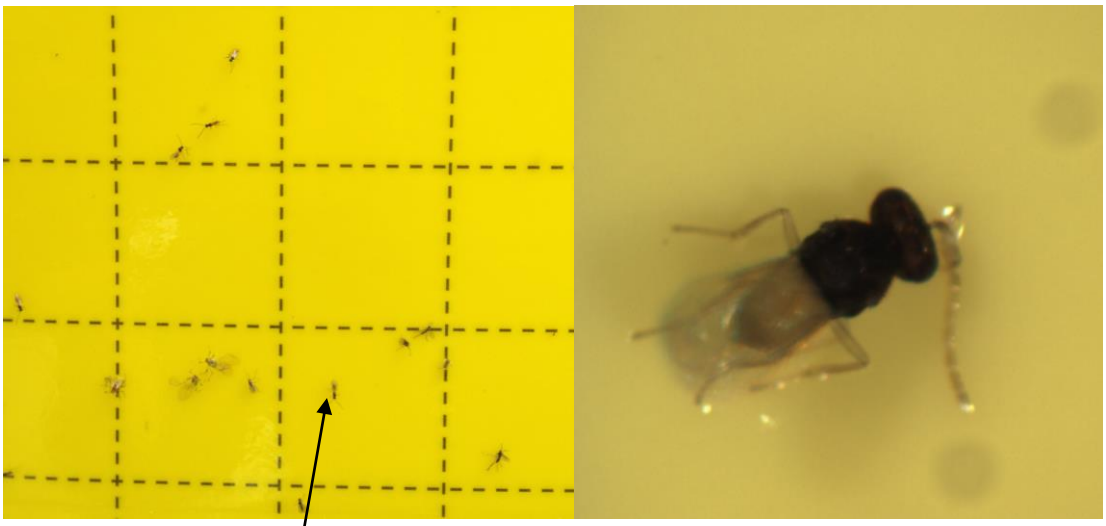
Biological control programs use living organisms – so extra care and effort is needed to make these programs work. Commitment, patience (natural enemies do not work as quickly as pesticides), and a desire to learn about the life history and environmental requirements of pest and its natural enemy are all needed. The commitment of management with a dedicated staff is very important. Sometimes, it may be best to start in an isolated, small area or greenhouse first. Starting in propagation houses is a logical first step.

Types of Natural Enemies

Commercially available natural enemies commercially include parasitic wasps or flies, predators, pathogens and entomopathogenic i.e. (insect-killing) nematodes.

Parasitic wasps lay their eggs inside the host and kill the host as the newly hatched larvae begin to feed. They are very host specific compared to more generalist predators. Parasitic wasps require one host to complete their development as they kill the host in this process. Correct identification of the host prey is needed to determine the specific parasitic wasp to use. Different

species of parasitic wasps are available for use against aphids, whiteflies, leafminers, scale insects and mealybugs. These parasitic wasps do not have a stinger so are **not** harmful to humans.



Figures 1 & 2: Parasitic wasps on sticky cards (on left) and closeup of *Encarsia formosa* (on right). Photos by L. Pundt

Predators tend to be more generalist feeders and are less host specific than parasitic wasps. There are many different species of predatory mites commercially available that feed upon spider mites and thrips.

Figures 3 & 4: *Phytoseiulus persimilis* (on left) and mini sachets containing *Neoseiulus cucumeris* (on right). Photos by L. Pundt

Entomopathogenic (insect-killing) nematodes are microscopic roundworms that enter the insect's body through openings in the exoskeleton. The nematodes multiply inside the host insect and release a bacterium that is toxic to the host. Nematodes complete their life cycle within a few days. *Steinernema*

feltiae is used against fungus gnat larvae and thrips pupae in the growing media. *Steinernema carpocapsae* is used to suppress shore fly larvae.

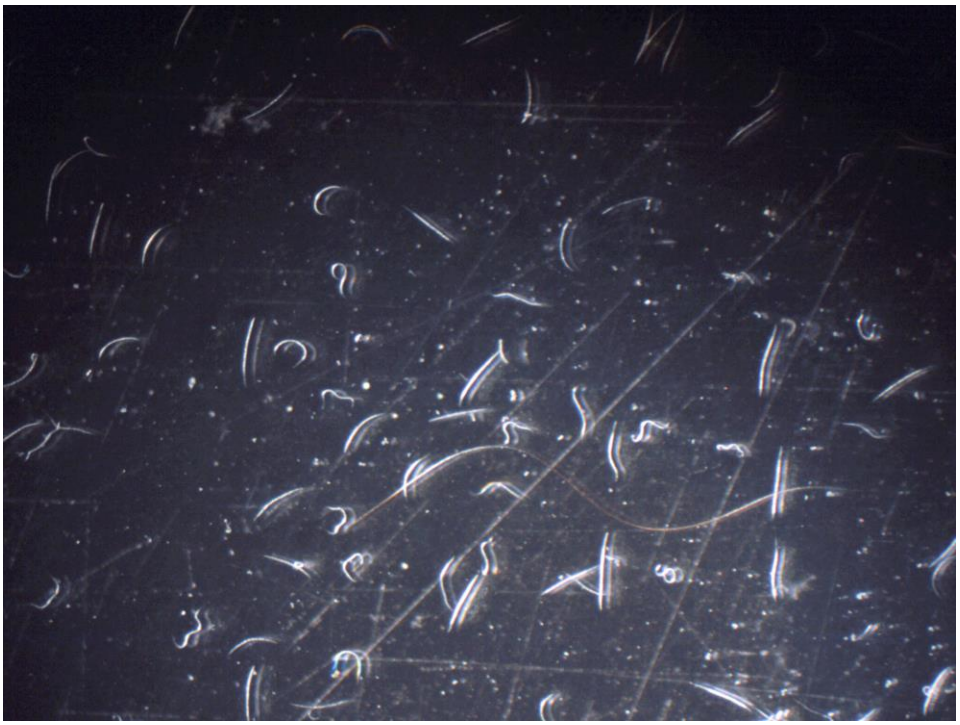


Figure 5: Dead nematodes will be straight and healthy nematodes will have a slight J curl. Check nematodes before and after application. Photo by L. Pundt

Pathogens include insect-killing fungi such as *Beauveria bassiana* and *Isaria fumsoroseus* that use enzymes to dissolve the insect's cuticle using the insect as a food source.

Figure 6: Whitefly nymphs killed by *Beauveria* become discolored. Photo by L. Pundt

Getting Started in Biological Control

1) Gather resources

It takes time and commitment to learn the biology and life cycles of the insect and mite pests and their natural enemies. Become familiar with the optimum environmental requirements (temperature and relative humidity) needed by the different natural enemies. If your greenhouse environment does not provide the appropriate temperatures and humidity levels, it may be difficult for the natural enemies to survive. For example, *Encarsia formosa* (a parasitic wasp used against greenhouse whiteflies), adults rarely fly at temperatures below 64°F. At temperatures above 86°F, their adult life span is reduced. If you are dealing with warmer summer temperatures, *Eretmocerus* sp. may be a better choice. The mealybug destroyer (*Cryptolamus montrouzieri*) prefers warmer temperatures – between 72 to 77°F. Is this compatible with the temperature requirements of the crops being grown? The predatory mite, *Phytoseiulus persmilis*, does best at a humidity range above 60%. Put together a list of resources (some suggestions are at the end of this fact sheet) plus personal contacts (biological control suppliers, other growers, extension educators etc.) that can help you.

2) Review past pest problems

Review your past pest problems. Know the species of pest you are dealing with. This is especially important if you are considering releasing host specific parasitic wasps for aphids, whiteflies, or mealybugs. For example, if you have foxglove aphid, but mistakenly think you have green peach aphid, if you release *Aphidius colemani*, the releases will not be effective. If you are unsure of the aphid species, purchase a mix of different species that work against both the foxglove and green peach aphids.

3) Review pesticide use

Many insecticide residues, such as pyrethrins or organophosphates can adversely affect natural enemies for up to three to four months after their application. Review your pesticide use for the past 3 to 4 months before starting biological control.

Direct contact and pesticide residues on containers, benches, and greenhouse plastic may be directly toxic to natural enemies or effect how well they survive and reproduce. Some of the newer, more selective insecticides and miticides (including some insect growth regulators) are compatible with certain but not necessarily all, natural enemies. For more information on pesticide

compatibility with natural enemies, consult with your supplier, or consult side effect databases. Using pesticides compatible with biological control agents or products with shorter residuals, helps ensure the success of your biological control program.

Consult Pesticide Side Effect Databases

(1) Koppert's online interactive database: https://www.koppertus.com/side-effects-database/

(2) Biobest: https://www.biobestgroup.com/en/side-effect-manual

(3) BASF: https://betterplants.basf.us/

(Nemasys Chemical Compatibility Guide).
https://betterplants.basf.us/content/dam/cxm/agriculture/better-plants/united-states/english/products/nemasys-beneficial-nematodes/nemasys-chemical-compatibility-guide.pdf

(4) Bioworks: for BotaniGard Compatibility information, go to
https://www.bioworksinc.com/wp-content/uploads/20200303_BCA_Compat.pdf

Research is continuing the compatibility of pest control materials with natural enemies so be sure to contact your university-based Extension or research entomologist, biological control supplier, or technical representative of the manufacturer of the chemical.

4) Have a Regular Scouting Program in Place

Before beginning biological control, develop a regular, consistent scouting program. This helps you anticipate when the various pest populations are of concern, so you can plan to release the natural enemies in sufficient time. You will also know where potential hot spots of pest activity are and can evaluate the effectiveness of the natural enemies (just as you evaluate the effectiveness of any method of control). Keep good records.

Yellow sticky cards will attract many parasitic wasps, so reduce the number of sticky cards used or wait a few days after your releases before putting the sticky cards in place. If releasing parasitic wasps, such as *Eretmocerus*, look for parasitism and host feeding of the whitefly immatures on poinsettia indicator plants. If you are releasing parasitic wasps against aphids, the parasitized aphids or aphid mummies can be easily seen. Spider mites fed upon by predatory mites will be dried up and shriveled. Scout banker plants closely as well as susceptible crops.

5) Transition into biological controls
Start in a small, isolated area or separate greenhouse as a trial area to learn how to use natural enemies before releasing in your entire production area. Decide what crops make the most sense for you to use biological controls. If you are propagating, you will want to begin in that growing area.

Because of the "zero tolerance" of pests for ornamentals, cuttings may be treated with long residual pesticides that are not compatible with biological controls. When receiving incoming plant material, always ask your plant supplier for a list of pesticides applied to those plants.

If you are growing edibles such as greenhouse vegetables or herbs that may be a logical starting point for using biological controls. If there are areas, where it is difficult for you to spray (due to re-entry requirements) such as retail houses that may be a logical area to use biological controls. As your experience and comfort level expands, you can expand your use of biological controls.

6) Use with proper cultural controls and sanitation practices
Start clean and stay clean. Remove pet plants and weeds. Discard heavily infested plants. A fallow period (with greenhouses completely empty of plant material) of at least 4 weeks may help reduce pest pressure for the spring growing season.
Biological controls are more likely to be successful if they are integrated with proper cultural controls to discourage insects and diseases and to grow healthy crops. If you are over fertilizing your crops, the tender lush growth is prone to aphids, whiteflies, and other sucking insect pests. It is harder for natural enemies to be successful under those conditions. Restrict entry of pests from outside – keep areas around greenhouse as weed-free as possible and keep cull piles as far as possible from production greenhouses.

7) Plan ahead
Biological control agents, especially parasites, are often specific to a pest or may be shipped in a stage that does not attack the targeted pest. Careful planning is needed before starting a biological control program. Many insecticide residues, such as pyrethrins or organophosphates can adversely affect natural enemies for up to three to four months after their application. Review your pesticide use for the past 3 to 4 months before starting biological control.

Direct contact and pesticide residues on containers, benches, greenhouse plastic may be directly toxic to natural enemies or effect how well they survive and reproduce. Pesticide residues on incoming plants or cuttings will also adversely affect the natural enemies.

Some of the newer, more selective insecticides and miticides (including some insect growth regulators) are compatible with certain natural enemies. For more information on pesticide compatibility with natural enemies, consult with your supplier or refer to the Internet resources mentioned above.

Start planning 6 months to one year in advance. Develop a spreadsheet of dates when cuttings and plugs arrive, your planting schedule and when greenhouses will be open for production to help pre-order biological controls.

8) Establish a Good Relationship with your suppliers

Establishing a good relationship with your suppliers is critical. They want you to succeed, so should be able to supply you with technical information and advice.

9) Ensure quality of natural enemies

Natural enemies are living organisms that must be handled and stored carefully to maximize survival and to sustain their viability. In general, shipments of natural enemies should be received within four days after placing an order. Predatory mites such as *Phytoseiulus persimilis* that are shipped without a food source should be received after an overnight delivery.

The package containing the natural enemies must be shipped in a sturdy container such as a polystyrene box that minimizes exposure to high and low temperatures. Request that the biological control supplier include ice packs and a data logger (if possible). Make sure the container is secured with good packing material during shipment.

Ask your biological control supplier(s) how to best evaluate incoming shipments. They will often send a description of what to look for when receiving the natural enemies. In addition, the following online resources will provide information:

"How to Check the Quality of Biological Control Agents" Brian Spencer, Applied Bio-nomics Ltd (appliedbio-nomics.com/wp-content/uploads/170-quality.pdf)
Grower Guide: Quality Assurance of Biocontrol Products compiled by Dr. Rose Buitenhuis at: https://www.vinelandresearch.com/wp-content/uploads/2020/02/Grower-Guide.pdf.

Figure 7 and 8: A new shipment of biological control agents. Photos by L. Pundt

Check the temperature within the shipping box with an infrared thermometer. If you notice a moldy odor or condensation, that is of concern. Consult with your supplier information on how to best store and what are the maximum storage times for each natural enemy. Most natural enemies should be released immediately upon arrival, especially if they have been shipped without a food source.

10) Release Rates and Timing and Application Delivery Methods
Work with your supplier to determine the appropriate release rates and timing based upon pest activity (determined by regular monitoring), effectiveness of the biological controls and the crops grown. Are the rates for a preventative or curative treatment?

Figure 9, 10 & 11: Applying beneficial predatory mites via a shaker tube, via mini sachets on a stick. Small amounts of aphid mummies or other natural enemies can be placed in the release boxes to keep natural enemies from falling to the ground. Photos by L. Pundt

11) Make use of compatible pesticides, if necessary.
Be ready to use compatible pesticides, if necessary. Multiple pest complexes affecting ornamental crops make it difficult to control all pests – so sometimes-compatible pesticides are needed. However, rarely is a pesticide compatible with all the natural enemies released. Adverse effects can be minimized by using spot treatments (as compared to broadcast, cover sprays) and the application method (drenching compared to spraying). Effects vary depending upon the type of pesticide used and the natural enemies so check the **Pesticide Side Effects Databases** and talk to your supplier. Some natural enemies may be more sensitive to pesticide residues depending upon whether they are a parasitic wasp or predator. Certain species or life stages may be more sensitive, too.

12) Be patient
You need to be able to tolerate some pests for the natural enemies to work. A proactive approach is needed for natural enemies do not work as quickly as pesticides. However, insect and mite pests do not develop resistance to the natural enemies, so biological control is an important part of an overall resistance management program.

Additional Resources

Flint, M.L. and S. H. Dreistadt. 1998. Natural Enemies Handbook: The Illustrated Guide to Biological Pest Control. 154 pp. University of California. Publication # 3386.

Gill, S., and J. Sanderson. 1998. Ball Guide to Identification of Greenhouse Pests and Beneficials. Ball Publishing, Batavia, IL. 244 pp.

Helyer, N., K., N. Cattlin and K. Brown. 2014. Biological Control in Plant Protection: A Color Handbook. 2nd edition. CRC Press. 276 pp.

Greenhouse Scout™ Cornell University (ITunes)
Summarizes information on biocontrol of common greenhouse insect pests and an interactive interface for collecting, organizing, and presentation of scouting data, and product application for insect management.

Grower Guide: Quality Assurance of Biocontrol Products. Compiled by Rose Buitenhuis, Vineland Research and Innovation Centre, 2014.

Pundt, L. 2019. Beneficial Nematodes: An Easy Way to Begin Using Biological Controls in the Greenhouse. UConn Greenhouse IPM Factsheet. 7 pp.

Pundt, L. 2019. Selecting a Supplier of Beneficial Insect and Mites. UConn IPM Fact sheet. 2 pp.

Raudales, R. and L. Pundt (co-editors). 2021 -2022 New England Greenhouse Floriculture Guide. 246 pages. Available online at: http://negfg.uconn.edu/ Available from the Northeast Greenhouse Conference and Expo.

Sanderson, J. S. Wainwright-Evans, and R. Valentin. Best Practices for Biocontrols, Part 1. Grower Talks. 84 (10):40-42. February 2021. https://www.growertalks.com/Article/?articleid=25071

Sanderson, J. S. Wainwright-Evans, and R. Valentin. 2021. Release the Beasts., Part 2. Grower Talks. 84 (11): 64-66. March 2021. https://www.growertalks.com/Article/?srch=1&articleID=25126&highlight=sanderson

Sanderson, J., S. Wainwright Evans, and R. Valentin. 2021. Best Practices for Biocontrols, Part 3. GrowerTalks. 84 (12) 60-64. April 2021. https://www.growertalks.com/Article/?srch=1&articleID=25175&highlight=sanderson

Sanderson, J., S. Wainwright-Evans, and R. Valentin. 2021. Best Practices for Biocontrols, Part 4. GrowerTalks. 85 (1):62-66. May 2021. https://www.growertalks.com/Article/?srch=1&articleID=25217&highlight=sanderson

Sanderson, J., S. Wainwright-Evans, and R. Valentin. 2021. Best Practices for Biocontrols, Part 5. GrowerTalks. June 2021. issue: https://www.growertalks.com/Article/?articleid=25255

Smith, T., and L. Taranot. 2015. Scheduling Biologicals. UMass Extension Factsheet. 2 pp.

Valentin, R. 2017. Successful Biocontrol in Poinsettias. GrowerTalks. May 2017.

Van der Ent, S., M. Knapp, J. Kkapwijk, E. Moerman, J. van Schelt, and S. deWeert. 2017. *Knowing and recognizing the biology of glasshouse pests and their natural enemies.* K Girard and K. Strooback (Eds). Koppert Biological Systems, the Netherlands. 443 pp.

Wollaeger, H., D. Smitley and R. Cloyd. 2015. Commercially Available Biological Control Agents for Common Greenhouse Insect Pests. Michigan State University Extension and Kansas State University. 6 pp.

Some helpful websites:

- Association of Natural Biological Producers
- Biological Control: A Guide to Natural Enemies in North America
- Buglady Consulting – Biological Control Services
- University of Vermont, Entomology Research Laboratory
- Greenhouse IPM (Biocontrol based IPM website): Flowers Canada Growers (FCG), the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA),the Vineland Research and Innovation Centre (Vineland), Agriculture and Agri-Food Canada's (AAFC) Pest Management Center (PMC) http://greenhouseipm.org/

By Leanne Pundt, UConn Extension, November 2007. Updated 2021.