

Nematodes for Greenhouse Pest Management

Prepared by:

Cheryl E. Frank Sullivan & Margaret Skinner

University of Vermont, Entomology Research Laboratory, Burlington, VT

What are Beneficial Nematodes?

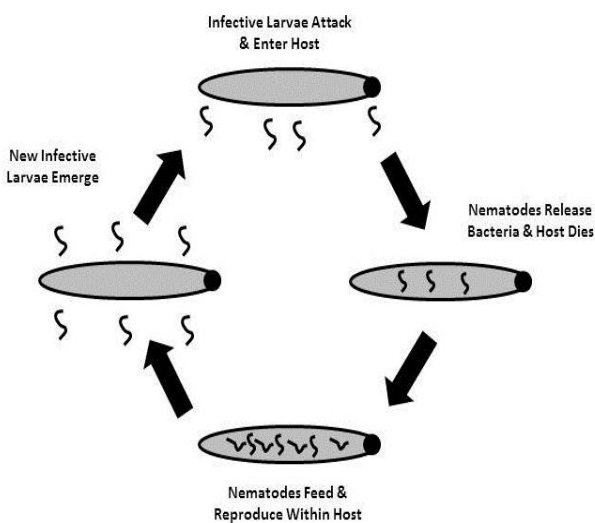
Nematodes (Fig. 1) are small (0.04-0.06 inches long), non-segmented, elongated roundworms. Their use as bio-insecticides to control fungus gnats, shore flies and thrips in greenhouses is increasing. They have several advantages over chemical insecticides. They are safe to applicators, workers, customers and the environment. There is no restricted entry interval after use and no protective equipment is needed during application. They are compatible with several other biological control agents and pest resistance problems are rarely an issue.

Several nematode species and formulations are commercially available. The most common species used in greenhouses are *Steinernema feltiae* for fungus gnat larvae and thrips pre-pupae and pupae; and *Heterorhabditis bacteriophora* and *Steinernema carpocapsae* for shore fly larvae. Some nematodes are fairly host specific, so care must be taken to select the right nematode species for the particular target pest.



Figure 1. Nematodes attacking a fungus gnat larva.

Life Cycle & Mode of Action



The life cycle of nematode includes, the egg, four larval stages and the adult. Nematodes are only infective to insects in their 3rd larval stage, when they do not require food and can survive outside of their host. The infective larvae live in water-filled spaces (pores) of the soil where they actively locate, attack and infect target pests. They enter the insect host through body openings, such as the mouth, anus or breathing holes (Fig. 2). Once inside, nematodes release bacteria from their gut. The bacteria reproduce and spread throughout the body of the host, releasing toxins, that kills the host in 24-48 hours. The bacteria break down host tissues that are then taken up by the nematodes. After the host dies, the nematodes feed and reproduce, then emerge again as infective 3rd stage larvae to seek out new hosts. Development under optimal conditions (soil temperatures of 77-82°F) takes approx. 3-7 days for one life cycle inside a host from egg to egg.

Figure 2. Nematode life cycle within an insect host.

Important Considerations When Applying Nematodes

- Select the right nematode species for the pest species you are targeting. Check with the supplier to be sure.
- Read the directions that come with the product! Most of the information you need should be included. If you have any questions contact the supplier immediately.
- Nematodes have a short shelf life. Storage time depends on species and formulation. Several formulations are available (sponge, gel, vermiculite, powder) and have storage times ranging from one week to 12 months. They must be immediately stored in a refrigerator at 40°F. The longer they are stored, the less infective they are. Do not freeze them, it will kill them! They should be prepared no more than one hour before they are to be applied.

- Be sure to **Check Viability** of the product before applying them to make sure they are alive.
 - When received, immediately open the box and be sure contents do not feel warm or hot and the ice packs are still cool or cold.
 - Open container of nematodes and check the color and odor. Gel formulations should look like a light tan or grey paste. If it looks blotchy, the nematodes may not be alive. Nematodes in the vermiculite or liquid suspension formulations are not distinguishable from the carrier material, so it is not possible to assess their condition visually. The odor should be mild. If it smells like ammonia, the product is likely dead and you should contact your supplier to order new material.
 - Remove a tiny portion of product (a pin drop) and mix with 1 teaspoon of cool water (approx. 60°F) on a piece of glass or clear plastic.
 - After 10-15 minutes, look at the sample using a hand lens or microscope under at least 10xpower. It helps to examine the samples against a dark background because the nematodes are translucent and they do not show up well against white or light colored backgrounds. If the nematodes are moving or appear as an “S” or curly shape, they are alive. If they are not moving and are fairly straight, they are very likely dead.
 - Mortality of approximately 10% typically occurs. If you see little movement on freshly prepared samples, immediately contact your supplier for a replacement/refund.
- Applications should be made at temperatures below 86°F. Dark, cool and wet conditions are favorable for survival. Hot and dry conditions reduce effectiveness. Never apply during the sunniest periods of the day. Apply late in the day or on cloudy cooler days. It is best to water plants prior to application. Potting soil should be moist (not dry) when nematodes are applied and they should not be watered in heavily immediately after application.
- It is essential to mix the nematodes prior to and keep the mixed during application. If not agitated, nematodes will sink to the bottom, which results in uneven distribution, death of the nematode and most importantly poor pest control. Mechanical recirculating pumps or 50-100 gallon fish tank bubblers are commonly used.
- Use clean, cool water that does not contain fertilizers. Some nitrogen-based fertilizers are harmful to nematodes.
- Application rates are on the product label. The application equipment used for conventional insecticides can be used to apply nematodes. **Remember**, if you use the same equipment for both applications, clean it thoroughly to make it as free of chemical residues as possible. Some chemical residues are harmful to beneficial nematodes. Spray pressure should be below 300 psi and the nozzle openings should be larger than 0.5 mm. **Make sure to remove filters and screens of 50-mesh or finer.** The nematode solution may clog them. Always check to be sure you know the compatibility of nematodes with chemical insecticides you use! This information is available from the BioWorks website: (<http://www.bioworksinc.com/products/shared/compatibility-chart.pdf>). When in doubt ask your supplier.

For More Information, Please Visit the Following:

Beneficial Nematode Information - NemaShield (BioWorks):

<http://www.bioworksinc.com/products/nemashield.php>

Biological Control Using Nematodes (UMass Amherst):

<http://extension.umass.edu/floriculture/fact-sheets/biological-control-using-beneficial-nematodes>

Bio-Insecticides - Nematodes (BASF - Becker Underwood):

<http://www.beckerunderwood.com/productsservices/biological-crop-protection/bio-insecticides/>

Nematode News Blog (BASF - Becker Underwood):

<http://www.beckerunderwood.com/solutionsresources/blogs/nematode-news/>

Using Entomopathogenic Nematodes for Crop Insect Pest Control (Pacific Northwest Extension):

<http://cru.cahe.wsu.edu/CEPublications/PNW544/PNW544.pdf>