



Beneficial Nematodes: An Easy Way to Begin Using Biological Controls in the Greenhouse

Growers that are interested in using biological controls are encouraged to begin by using beneficial nematodes. Unlike many traditional pesticides, there is no re-entry interval (REI) or postharvest interval (PHI), and no personal protective equipment is needed during their application. Beneficial nematodes are also compatible with many other biological control agents. There is almost no risk that the target pest will develop resistance to their use. In many different field studies, no adverse effects have been shown against non-target organisms. Beneficial nematodes are living organisms, so there are a number of precautions you need to follow for their successful use.

What are beneficial nematodes?

Nematodes are small, (0.04 to 0.06 inches long), non-segmented, colorless, cylindrical roundworms that occur naturally in soils throughout the world. Nematodes have been primarily used against soil dwelling pests because they are sensitive to ultra violet light and desiccation. The most common species used in greenhouses are *Steinernema feltiae* for fungus gnat larvae and thrips pupae in the growing media and *Steinernema carpocapsae* for shore fly larvae. *Heterorhabditis bacteriophora*, *Steinernema kraussei* (Nemasys L) and *Steinernema carpocapsae* may be used against black vine weevil larvae.

Nematode Life Cycle

The life cycle of nematodes includes an egg stage, four larval stages and adults. The third larval stage is the infective form of the nematode (IJ). The juvenile nematodes enter the insect host through body openings such as the mouth, anus or breathing holes. They multiply within the host and release a symbiotic bacterium whose toxin kills the target pest. The larvae are killed in one to two days by blood poisoning. Nematodes feed and reproduce, emerging as infective juveniles to search for new hosts to infect. Commercially available nematodes can be reared on an insect host (in vivo) or on artificial environments (in vitro).

How to use beneficial nematodes

The beneficial nematode *S. feltiae* (NemaShield, Nemasys, ScanMask and Entonem) is used as a soil drench or sprench against fungus gnat larvae. Preventative applications to moist soils work best. Repeat applications every two weeks. Consult the label and ask your supplier for data on specific rates to use.

- Apply nematodes with a sprayer or injector (remove screens and filters)



Figure 1: Applying nematodes in the greenhouse. Photos by L. Pundt

- If using an injector, set the dilution to 1:100. Remove all filters or screens (50 mesh or finer) in any spray lines so that the nematodes can pass through unimpeded and undamaged.
- If using a sprayer, spray pressure should be kept below 300 psi.
- Remove nematodes from refrigerator and let them warm up for 30 minutes.
- Although nematodes are applied in water, they are not aquatic animals and therefore they need extra care while in stock and tank solutions, so adequate aeration of the nematode suspension during application is important. Use a small battery powered submersible pump to keep the solution agitated. The small pump will also keep them from settling on the bottom. Dramm manufactures an aeration bucket specific for using the nematodes with a fertilizer injector.
- Keep the suspension in the spray tank cool and apply as soon as possible after mixing. This is especially important during the warmer months. Keep water temperatures below 95° F in the summer. The longer they are held before spraying and the warmer the tank water, the more quickly their energy reserves are used up. Weaker nematodes are less robust during and after application, and less able to search for and infect a susceptible host.
- Use clean, cool water that does not contain fertilizers.
- Nematodes can be applied thru an irrigation system, however, there is better distribution with boom sprayers than with drip or sprinkler systems.



Figure 2: Applying nematodes at planting. Photo by L. Pundt

Check their viability before and after application

- Let nematodes come to room temperature for 30 minutes.
- Place a small amount of the product in a small, clear container or petri dish. Add 1 or 2 drops of room temperature water; wait a few minutes and look for actively moving or swimming nematodes. Use a dark black background and a hand lens or field microscope to see the small (0.6 mm or 0.02 inches in length) nematodes. Dead nematodes will be straight and still.
- Collect spray water with an empty nematode tray and check to see what is coming out of the hose, too.



Figure 3: Checking viability of nematodes before and after application. Photos by L. Pundt

- Apply in the early morning, evening or at dusk or on a cloudy, overcast day. (Nematodes are very sensitive to ultra violet light and desiccation).
- Nematodes are compatible with a number of different pesticides. However, they are generally not compatible with organophosphates, carbamates and hydrogen dioxide.

For more detailed information on pesticide compatibility: consult with your supplier or with the following resources on the Internet:

- [Koppert Biological Systems – Side Effects](#)
- [Biobest Side Effects Manual](#)
- [BASF Related Documents for Nemasys](#)

Specific Tips for Use against Fungus Gnat Larvae

- Treat as soon as possible (2 to 3 days) after sticking cuttings, planting plugs or starting seeds. Some growers apply the nematodes to the media directly before sticking cuttings to insure that nematodes reach the media.
- Apply as a media drench or sprench to target the fungus gnat larvae.
- Media temperatures should be above 50° F but avoid applying when soil temperatures are above 80°F. Optimum media temperatures are between 60-70°F. (Use a soil thermometer to monitor temperatures).
- Avoid hot water for mixing the nematodes. Keep water temperatures below 95° F in the summer.
- Water the growing media the day before application. (Nematodes need moisture for movement).
- Apply in the evening or at dusk or on a cloudy, overcast day. (Nematodes are very sensitive to ultra violet light and desiccation).
- Repeated applications are often needed. Make the first application at planting and then repeat every two weeks.
- Recent research at Cornell University seen that nematodes may persist in the growing mix and remain effective for more than four to six weeks after a single drench application, if sub-irrigation is used, so that the nematodes aren't washed or leached out of the containers, as might be the case with overhead watering.

How to tell if they are working against fungus gnats

The symbiotic bacteria breaks down the host insect's cuticle. The infected fungus gnat larvae rapidly disappears, so they may be difficult to locate. Infected fungus gnat larvae are often opaque-white to light yellow in color. Use potato disks to monitor for fungus gnat larvae. Place disks on the surface of the growing medium two days before application in order to determine the population level prior to treatment, and again 3-5 days and 10-12 days after application. Leave the potato disks for two days in each case, before examining them for fungus gnat larval activity.

For use against western flower thrips pupae

In the late 1990s in the U.K., it was reported that cut flower chrysanthemum growers who applied nematodes weekly as a foliar spray, noted a reduction in their thrips populations. More recent research (in Canada, the U.K. and Germany), showed that soil dwelling stages of western flower thrips (especially the pupal stages) were susceptible to several species of nematodes, and particularly to *Steinernema feltiae*. During the weekly sprays, a significant number of nematodes reached the growing media via runoff from the foliar sprays.

Nematodes only live a short time on the plant foliage (there is significant reduction after one hour) but may persist for several weeks in the growing media. Mobile life stages on the plant (adults and larvae) appear to be less susceptible to attack. Thrips control noted in commercial greenhouse crops may have occurred because of overspray and run-off into the growing media after spraying. Take special precautions to help reduce potential desiccation: use of a non-ionic wetting agent, spraying in the late afternoon or evening, and the use of black cloth.

Specific tips for use against western flower thrips

- Nematodes require moist conditions to enhance effectiveness. If plants are dry, provide light overhead irrigation prior to nematode application.
- Ensure good foliar coverage of spray mix to enhance contact with the target pest.
- Use of a wetting agent or surfactant will enhance wettability of the spray mix and encourage nematode movement. Following application, ensure that the crop remains wet for at least two hours. Do not apply in direct sunlight.
- The nematodes will desiccate after about one day, depending upon environmental conditions. Grower feedback has been variable, with some observing excellent results and others less so. Efficacy will be variable depending upon the relative humidity, and temperature in your greenhouse, dose applied, frequency of application, and life stage of the thrips.
- Some growers apply the nematodes with additional water in the summer months to ensure that the foliage stays wet to contact the thrips stages on the foliage. Depending upon the temperature, relative humidity levels and other environmental conditions, up to 2x the amount of water may be needed to keep the foliage wet for two hours.
- Regular monitoring, sanitation, proper spacing and judicious use of fungicides and biological fungicides is needed to discourage foliar diseases.

- Applying the nematodes as a heavy surface spray or "srench" to young, incoming plant material will have an added benefit of targeting any incoming fungus gnats in the media as well as thrips pupae.

Storing nematodes

Several formulations are available and storage time depends upon the species and formulation. If you must store the nematodes, store them in a refrigerator at a constant 40° F. Avoid storing them in a refrigerator that is opened frequently. It is best to purchase a dedicated refrigerator just for storing your nematodes, so you can provide temperatures that are more constant.

Avoid placing them in a small refrigerator where they may freeze and die! Check the expiration date on the package for the length of time they can be stored. Let the nematodes sit at room temperature for about 30 minutes before mixing them in the tank solution to avoid drastic changes in temperature.

As with any biological control measure, beneficial, insect-killing nematodes are most effectively used preventively in conjunction with good cultural practices.

By Leanne Pundt, UConn Extension, 2011. Updated 2019

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