Fifty Shades of Green: Whipping Fungus Gnats in to Submission Using Biological Control©

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Many growers are incorporating some aspect of biological control in to their crop management programs. Reasons include better pest control, resistance management, and operational efficiency as well as marketing and customer-driven preferences. Several suppliers have been active in the nursery/greenhouse biological control realm for many years, and their websites are a great source of technical information. Syngenta Bioline <http://www3.syngenta.com/global/bioline/en/Pages/home.aspx>, Koppert <http://www.koppert.com/>, and Biobest <http://www.biobest.be/home/> are some of most well-known in our industry, and have field technical staff for grower support.

Most successful initial biological control programs are integrated in to existing pest management protocols, with realistic expectations and a single target pest. Fungus gnat control in propagation is a good starting point, since their biological control agents are easy to use, relatively inexpensive, and the odds of success are good if the program is properly executed.

Fungus gnat larvae are the #1 insect problem in propagation. Their feeding reduces callus formation, destroys tender new roots, and girdles stems. Fungus gnat damage also increases plant infections from fungal and bacterial pathogens. Economic impacts include reduced seedling and cutting survival, increased rooting time for cuttings, and increased fungicide costs and plant losses to secondary diseases.

Adult fungus gnats are nuisance pests and can annoy workers and customers, as well as vectoring fungal spores. Adults do not damage plants, their primary objectives are dispersal and procreation. However, the presence of mature fungus gnat indicates an existing problem with larvae. Sticky cards can be used to monitor adult populations. Place one yellow sticky card per 93 m^2 (1000 ft^2), and monitor weekly. Counts of >20 gnats per card is considered to be the economic threshold for treatment.

Fungus gnat larvae are slender, pale, dark-headed maggots, 5 mm or less in length. They feed on organic matter, with a preference for living plant tissue like roots, and are a major problem in many aspects of ornamental production. The addition of vermiculite or perlite to media reduces fungus gnat larval activity; they favor plant-based materials like compost, peat, bark, and coir. High soil moisture and warm temperatures are also conducive to fungus gnat reproduction.

Evidence of fungus gnat larval damage in propagation includes poor rooting and establishment, wilting, and nutritional deficiencies due to root damage. To find larvae, look in the top 1.3 cm (0.5 in.) of media and in the root zone. Potato slices are a good survey tool. Place small pieces of peeled potato on the media surface, and leave overnight. These will attract the maggots, which can be seen when the pieces are moved. If the potato slices disappear, rodents or other vertebrates may be present in the greenhouse. Fungus gnat hot spots can be determined by placing suspect pots in plastic bags for a couple of days and monitoring adult emergence.

If a control program is warranted, taking some initial steps will increase your success rate. Communicate with your employees. Everyone involved with the crop should have a basic understanding of what your integrated crop management program entails. This helps reduce errors in irrigation, chemical applications and other inputs that could jeopardize program results.

Sanitation is critical to long-term fungus gnat control. Clean up algae, plant waste, weeds, and pooling water that can harbor fungus gnats. Also check stock and pet plants for fungus gnat presence. If you plan to utilize biological control agents, avoid pyrethroids (Scimitar®, Talstar™, Decathalon®) or organophosphates (DuraGuard®,

Orthene®) for 4 to 6 weeks prior to releases. These products can damage some biological control agents (BCAs), but will not affect nematodes or bacteria. Some fungicides (Cleary™ 3336, Banner® Maxx®) can impact BCAs as well; check the company websites mentioned earlier for compatibility charts for most commonly used chemicals and fertilizers.

To start your fungus gnat control program, consider conventional treatment if populations are high. Insect growth regulators like Citation®, Distance®, and Adept® are excellent choices to help reduce larval populations in the soil, and can be used in conjunction with nematodes. Drenches with insecticides like Flagship™ or Safari® knock down both larval and adult fungus gnats and can reduce populations to levels that will respond to biological controls.

Once populations are low, or propagation is just beginning, initiate biological control before fungus gnats become a problem. As with most pest and disease control programs preventive treatments are more successful and less expensive than rescue applications.

Biological control agents that work best with soil drenches or through irrigation systems are nematodes and bacteria. Nematodes (*Steinernema feltiae* spp.) are available from several commercial sources (Exhibitline®, Nemasys©, etc.). They seek out fungus gnat larvae, penetrate through anal and oral openings, and release bacteria that kill the maggots. Beneficial nematodes are available year-round, and are easy to use. Nematodes tolerate fairly broad temperature [13 to 29°C (55 to 85°F)] and moisture ranges, and will also attack thrips pupae in the soil.

Bacillus thuringiensis subsp. *israelensis* (Gnatrol®) [B.t.i.] is a bacterium that infects fungus gnat maggots, and works best on 1st instar larvae, the smallest stage. Ingestion of the bacteria disrupts cell function, and efficacy is density dependent since the bacteria are passive and need to be eaten by the maggots. *Bacillus thuringiensis* subsp. *israelensis* is specific to fungus gnat larvae, and won't control other greenhouse pests.

In many cases, regular applications of nematodes alone will prevent or control low level infestations of fungus gnats. *Bacillus thuringiensis* subsp. *israelensis* can be used too in addition to nematode releases as needed. Make sure that propagation medium does not dry out excessively, or is not water-saturated. Both of these conditions will limit the efficacy of beneficial nematodes and B.t.i.

Other BCAs used against fungus gnats include the predatory mite *Hypoaspis miles.* Adult mites live for months, and will establish if conditions are right. These mites are promiscuous feeders, and attack most soil-dwelling creatures, including fungus gnat and shore fly larvae, thrips pupae, root aphids, as well as nematodes (good and bad), and springtails (Collembola). These are typically used by experienced growers, and work best when used along with other controls.

The rove (staphylinid) beetle, *Atheta coriaria*, is another broad spectrum feeder. Adults and immatures favor fungus gnat maggots and pupae and can be used to supplement nematodes in biological control programs. These fast-moving insects are active at dusk, and can be effective against a number of insect pests in propagation. Rove beetles enter diapause, a type of hibernation, in the winter, and are only seasonally available.

There are different approaches to fungus gnat control in propagation based on population size (Table 1) and type of treatment (Table 2). These are general recommendations and can be adjusted based on problem severity, crop type and budget.

Continue to use sticky cards and visual surveys to determine fungus gnat population levels and adjust releases and treatments as needed. Successful biological or integrated control programs require attention to detail and careful tracking. In most cases, they are not easier or less expensive than programs using pesticides exclusively, but do have some advantages. These include no re-entry intervals for treated crops, lower costs on safety equipment, and reduced resistance problems in target pests. Focused projects are best when starting a new approach to pest management, and biological control of fungus gnats in propagation is a great place to begin.

Table 1. Fungus gnat control based on population size.

Fungus gnat control	Low populations <20 flies/week on sticky card	Moderate 20-50/week	High populations >50/week
Option 1 Best for propagation when cover is minimal, and for long-term crops like woodies and perennials. Less labor intensive	Use nematodes at preventative rate prior to potting, follow up with B.t.i. in 2 weeks. Apply nematodes every 2-4 weeks, alternate with B.t.i.	Release nematodes at mid-rate for 3 weeks, monitor and adjust rate and interval. Add B.t.i. once/month if needed	Use nematodes and B.t.i. weekly at high rates, release *Hypoaspis* mites as well. Consider IGR application at 2 week intervals
Option 2 Use when canopy is closed, later in propagation cycle or short-term crops	Release rove beetles at low rates at potting; follow 1 week later with mites. Repeat in 2 weeks	Use rove beetles or mites at moderate rates for 3 weeks	Use rove beetles and mites at high rates for 3 weeks, also nematodes at high rates if soil surface is accessible

B.t.i. = *Bacillus thuringiensis* subsp. *israelensis*, IGR = insect growth regular.

Table 2. Fungal gnat control with an insect growth regulator, nematodes, predatory mites and Staphylinid beetle.

Treatments	Product	Rate	Frequency	Comments
1	Citation® Insect growth regulator	2.66 oz./100 gals drench	Apply as a drench 7 to 14 day interval as needed	Citation® application allows a start with a clean crop
2	Exhibitline™ sf *Steinernema feltiae* (Insect pathogenic nematode)	Apply as a drench using 50,000/ft^2	Preventative: 7-21 day interval Curative: 7-14 days interval	Apply when soil temperatures are between 55-85°F. *S. feltiae* can be tank mixed with Citation
3	Hypoline™ *Hypoaspis miles* (predatory mite)	*H. miles*: 10-25 mites/ft^2 Hot spot: 50 mites/ft^2	Apply 1-2 times per crop, actively reproduce at 50-90°F	Apply evenly on soil and under benches. *H. miles* and *S. feltiae* can be released the same week
4	Staphyline™ *Atheta coriaria* (Staphylinid beetle)	0.5-1.0/ft^2 Hot spot: 2X rate	Make two releases at 7-day intervals to encourage swift establishment	Pest catches will decline over 2-6 weeks

To increase your chances of good results with biological control programs, here are some tips:

- Accurately identify the target pest.
- ID Key people, engage entire staff.
- Start small.
- Start clean.
- Communicate with suppliers about ordering beneficials.
- Maintain good scouting and record keeping.
- Modify spray programs as needed, don't rush to treat if problems break out.
- Watch for secondary pests and diseases.
- Audit scouting data, identify trends and hot spots.
- Celebrate your success!

For more information, go to <www.syngentaflowers.com>.