Fungus Gnat and Shore Fly Control in Greenhouses

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Fungus gnats are a major pest of greenhouse crops, but don't often get the attention they deserve. As immature larvae, they feed on and damage roots and stems. For young seedlings and cuttings in propagation, the damage is often fatal. Equally problematic, adult fungus gnats transport root and crown rot disease organisms from pot to pot in their travels – sort of like cockroaches in human dwellings. Shore flies are often misidentified as fungus gnats. While adults are able to spread pathogens, unlike fungus gnats the larvae are not damaging. High adult populations often deposit tiny black fecal deposits on foliage and detract from aesthetic appeal.

Fungus gnat larvae are clear to white with well developed, black head capsules.

Fungus gnat larva feeding damage shown here on young flowering vinca plants.

Shore fly adult (left) and fungus gnat adult. Photo: Richard Lindquist, OHP Solutions, Inc.

The foundation for good management is habitat modification and sanitation, but integrated control also includes chemical and biological tactics. The following summarizes effective fungus gnat and shore fly management.

Habitat Modification and Sanitation is the first line of defense against fungus gnats. Details for cleaning and sanitizing are given in the bulletin *"Greenhouse Sanitation between Crops"*. In summary, take steps to:

Improve drainage: fungus gnats (prefer moist areas where they feed on fungi, plant roots and decaying matter. Shoreflies are semi-aquatic and breed in areas of standing water.

Remove weeds to reduce a source of food for larvae and pathogens that can spread to crops.

Clean up excess accumulations of potting media and other debris where practical. Eliminate algae by chemical cleaning surfaces with Strip-It followed by power washing and an application of a disinfesting product such as KleenGrow, ZeroTol, XeroTon-3 or Greenshield.

Chemical Control:

******Read and follow all label directions******

Chemical control of fungus gnats and shore flies should target the larval stage. The list below is not intended to be exhaustive; products other than those listed may be safe and effective.

Pesticides for controlling larval stages

Adept WSP - (EPA Reg. # 400-477), Active Ingredient: Diflubenzuron
One 1 oz water-soluble packet per 2 gallons of water through a 1:100 injector used as a top water soil drench. Apply only enough to wet up the top inch or two of soil. The label contains specific ounces per pot recommendations that must be followed to insure safe and effective use. Treat crops and under benches. Insect growth regulator. 30 days of control. Do not use on poinsettias, Reiger begonias, or hibiscus. 12 hr REI. MOA 14. Restricted use pesticide in NH, RI and VT.

Azatin XL - (EPA Reg. # 70051-27-59807), Active Ingredient: Azadirachtin
½ teaspoon per gallon or 8 oz per 100 gallons as a soil drench. Insect growth regulator activity. No visible residue and safe on most open blooms. Certain edible crops are on the label. 4 hr REI. MOA 18 B.

Citation WSP - (EPA Reg. # 100-667), Active Ingredient: Cyromazine
One 2.66-ounce packet per 100 gallons of water as a soil surface spray or drench. It is not labeled for chemigation, (no injectors). Insect growth regulator. May be used through low volume applicators at 1 packet per ½ acre in the appropriate amount of water. Repeat at 14-day intervals to maintain control. 12 hr REI. MOA 17.

Distance EC - (EPA Reg. # 59639-96), Active Ingredient: Pyriproxyfen
Soil surface spray to control the larval stages of fungus gnats and shoreflies. Up to 30 days of control from one application. 1/3 to 1/2 teaspoons per gallon, 6-8 oz per 100 gallons (poinsettias- use rate of 1/3 teas per gallon, or 6 oz per 100 gallons). Supplemental label allows for a soil drench at 2 oz per 100 gallons applied to wet up only the top 1-1.5" of soil. See label for special precautions when treating poinsettias. Can be used on certain fruiting vegetables. Donot use on salvia, Boston fern, schefflera, heuchera, or poinsettia bracts. 12 hr REI. MOA 7C.

Duraguard ME - (EPA Reg. # 499-367), Active Ingredient: Chlorpyrifos
(Restricted Use Pesticide) use as a soil surface spray on crops and under benches at ½ oz per gallon (50 oz per 100 gallons) or as a soil drench at 0.25 oz per gallon (25 oz per 100 gallons). Controls larval stage. No visible residue and safe on most open blooms. 24 hr REI. MOA 1B.

Flagship WG- (EPA Reg # 100-955), Active Ingredient: Thiamethoxam
Label contains directions for soil treatments. Controls larval stage. Not labeled for shoreflies. 12 hr REI. MOA 4A. Not labeled in NY. Restricted use pesticide in MA.

Pylon EC – (EPA Reg. # 241-374-59807), Active Ingredient: Chlorfenapyr
1/3 to 2/3 teaspoons per gallon or 5.2 to 10 oz per 100 gallons applied as a soil surface spray. Maximum of two applications before rotating to another class of chemistry. No visible residue but may burn some open blooms. Read phytotoxicity cautions on the label. Do not add any surfactant. Certain greenhouse fruiting vegetables may be treated. 12 hr REI. MOA 13. Restricted use pesticide in NY.

Safari SG- (EPA Reg # 33657-16-59639), Active Ingredient: Dinotefuran
4-6 week systemic control of larval stage. Drench 1.5 tsp to 1 TBLS per gallon or 12 to 24 oz per 100 gallons (apply 4 oz per 6" pot). Excellent plant and bloom safety. Some edible crops on label. 12 hr REI. MOA 4A. NY Special Local Need (SLN) label, consult label for use restrictions. Restricted use pesticide in MA.

Safari 2G- (EPA Reg # 59639-149), Active Ingredient: Dinotefuran
6+ weeks control from one application. Labeled for containerized or field grown ornamentals in greenhouses, interiorscapes, nurseries and landscapes. The label has rates based on pot diameter. 12 hr REI. MOA 4A. Restricted use pesticide in MA. Not labeled for use in NY.

Controlling the adult stage has been difficult in recent years, as most of the labeled products have not provided adequate control. Conserve SC has been reported by many growers to provide relief from the adult stages of fungus gnats and shoreflies. This use is not on the label, but it is legal to use a product on an unregistered pest as long as the site to which it is applied is registered.

Conserve SC - (EPA Reg. # 62719-291), Active Ingredient: Spinosad
½ teaspoon per gallon or 8 oz per 100 gallons as a foliar spray provides some control of adult fungus gnats and shoreflies. No flower damage or visible residue. (Combining Conserve with Talstar at ½ teaspoon per gallon or 8 oz per 100 gallons may enhance control.) Conserve is labeled for certain edible crops. 4 hr REI. MOA 5.

Biological Control:

Biological control of fungus gnats has been gaining grower acceptance. Many appreciate the 0 hour REI's for biocontrol products, safety to workers and their appeal to customers. To avoid potential pesticide toxicity to biocontrol agents, read the section following the descriptions of each.

Nemasys or Nemashield contains *Steinernema feltiae,* a species of nematodes that attack fungus gnat larvae and thrips. They do not control shoreflies. Nematodes are microscopic roundworms that attack fungus gnat larvae, through their breathing "pores", and introduce a bacterium that produces a toxin that kills the larvae. Applications are made by drenching into media or soil at 14-21 day intervals. Following treatment, numbers of adults will decline after approximately two weeks. Nematodes shipped live from the rearer to the grower at time of use. Follow application suggestions in following table. No re-entry interval is required.

Drenching Technique of Nematodes for control of fungus gnat larvae.

Rate	Application	Viability	Comments
Drench 100 million/ 100 gal	100 gal treats — oz/container Flats:@ 2,000 ft^2 (13.0 oz) 4" pots: 6,400 (2.0 oz) 6" pots: 3,200 (4.0 oz) 8" pots 1,300 (10.0 oz) 10" basket 850 (15.0 oz)	Live nematodes are ½ -1 mm and appear dense – not transparent or clear. They may move if disturbed, but usually remain motionless in a "j" shape. Observation requires magnification	**Drench volumes must be sufficient for uniform distribution through rootzone.** Steinernema is not a highly mobile nematode - it lies in wait to ambush passing fungus gnat larvae. Monitor adult population at 1, 2 and 3 weeks following application. Reapply if adult population does not drop by week 3.

Gnatrol WDG-(EPA Reg. # 73049-56), Active Ingredient: *Bacillus thuringiensis* strain *israelensis* is a biological pesticide specifically for the control of fungus gnat larvae. Drench soil to control larvae by applying 16-32 oz to wet the top inch or so of soil. Can be used on certain vegetables. Three applications at 7-day intervals are needed for heavy infestations. Treat crops and under benches. Does not control shorefly larvae. 4 hr REI. MOA 11A1.

Atheta coriaria – is a generalist predatory beetle that feeds on fungus gnat and shore fly larvae as well as many other soil dwelling pests. There are two products available - Atheta System and Staphyline. Atheta System is packaged as either 100, 250, 500 or 3,000 in peat moss. Staphyline is packaged with 3,000 beetles in coir fiber. To apply, simply divide the contents into piles, with 25 – 50 beetles per pile. Piles are placed on soil surfaces. Make sure they are evenly distributed throughout production areas. The suggested rate is 1 - 2 beetles for every 10f^2. Since Atheta flies and reproduces, populations increase and disperse quickly.

Hypoaspis miles is a predatory mite that lives on and in the top layer of soil. They feed on fungus gnat larvae and may contribute to larval control of shore flies. They are active at temperatures above 50^{o}F and are suggested as a complement to Atheta beetles for fungus gnat control (also thrips larvae that drop to soil surfaces to pupate). Mites work best when introduced while fungus gnat populations are relatively low. There are two products available – Hypoaspis System (10,000, 25,000, 125,000) and Hypoline (25,000 and 125,000). Mites come packaged in a vermiculite/peat carrier with meal mites for food. The suggested application rate, for low populations, is 10 mites per f^2 , but rates up to 30 per f^2 have been suggested for moderate populations. See table below to calculate approximate quantities needed. Mites may be applied to containers or breeding areas on greenhouse floors.

Area and containers treated with 10 Hypoaspis mites per f^2.

Product: # mites/size	**10,000 mites/ 1 liter**	**25,000 mites/1 liter or 125,000/ 5 liters**
# mites/teaspoon	50 mites	125 mites
Area treated	5 f^2	12.5 f^2
# flats treated	3.5	9
# 4 inch pots treated	50	125
# 6 inch pots treated	25	62
# 10 inch baskets treated	9	22
1 liter = 200 teaspoons and 5 liters = 1000 teaspoons		

Pesticide compatibility with fungus gnat biological control agents. Pesticides can be safely used along with biological control agents (BCAs), but they must be carefully chosen to avoid BCA mortality. Selection of incompatible pesticides, and sometimes lingering residues, are a common cause for program failures. For BCAs used against fungus gnats or shore flies, the concern is for pesticide residues on and in media since this is where the BCAs live. Mortality is a function of toxicity and persistence. In other words, a pesticide may be highly toxic, but it doesn't persist. In this case applications can be made before BCAs are released, but not before the time interval necessary for the pesticide to dissipate. On the other hand, a pesticide may only be moderately toxic, but the persistence is long enough to interfere with BCAs even weeks following applications. Considering this, it is important to select compatible pesticides. The following chart provides suggestions.

PESTICIDE	CHEMICAL NAME	*Hypoaspis* spp.	*Atheta* spp.	Steinernema[1]
ADEPT	diflubenzuron		Adults safe	
ATTAIN	bifenthrin	egg safe		
AVID	Abamectin			
AZATIN	Azadirachtin		Adults safe	
BANROT	etridiazole and thiophenate methyl (see individual ingredients)	?	?	
BOTANIGARD	*Beauvaria bassiana* strain GHA	?	?	?
CITATION	Cyromazine			
CLEARY3336	Thiophanate methyl			
COMPASS	trifloxystrobin			
CONSERVE	Spinosad			
DACONIL	chlorothalonil			
DECREE	Fenhexamid			?
DIPEL PRO DF	*Bacillus thuringiensis* subsp. *Kurstaki*			
DISTANCE	pyriproxyfen		Adults safe	?
DURAGUARD	Chlorpyrifos			
ENDEAVOR	pymetrozine		?	
ENSTAR II	s-Kinoprene			?
FLAGSHIP	thiamethoxam spray			?
FLORAMITE	Bifenazate			
FUNGO FLO	Thiophanate methyl			
GNATROL	Bacillus thuringiensis subsp.*israelensis*			
HERITAGE	azoxystrobin			
JUDO	Spriomesifen			
KONTOS	Spirotetramat			?

LEGEND

?	Toxicity unknown
	Safe to listed beneficials
	Slightly toxic to beneficial listed
	Moderately toxic to beneficials listed
	Toxic to beneficials listed

[1] **Do not mix nemtodes with concentrated pesticides in stock tank solutions. Chart indicates safety to diluted pesticide concentrations only**.

PESTICIDE	CHEMICAL NAME	*Hypoaspis* spp.	*Atheta* spp.	Steinernema[1]
MARATHON II	Imidacloprid spray			
MARATHON II	Imidacloprid drench		Adults safe	
MEDALLION	fludioxonil	?	?	
MESUROL	methiocarb			
ORTHENE	Acephate			?
OVATION	chlofentezine			?
SAFARI	Dinotefuran	?	?	?
SANMITE	Pyridaben			
SUBDUE MAXX	mefenoxam	?	?	
TALSTAR	bifenthrin			
THIODAN	Endosulfan			?
TRUBAN	etridiazole		?	