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FUNGUS GNATS AND SHOREFLIES IN GREENHOUSE CROPS

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INTRODUCTION

Fungus gnats and shoreflies are small black flies often observed in the vicinity of the growing media of greenhouse crops. These flies, often regarded as nuisance pests, can facilitate and transmit root diseases in all greenhouse vegetable and ornamental crops and reduce the aesthetic quality of ornamental crops.

DESCRIPTION AND LIFE HISTORY

Adult fungus gnats are grey to black, about 3–4 mm long with long legs, thread-like antennae, and large compound eyes that meet above the base of the antennae. Adults resemble small mosquitoes (*Figure 1*) and are weak fliers frequently observed resting on the media surface. Each female lives about 10 days and lays about 150 oval, white eggs in the organic matter of the media. Eggs hatch in 2–7 days, depending on the temperature, producing white larvae that are 4–6 mm long. The larvae have 12 abdominal segments and a distinctive shiny black head (*Figure 2*). The larvae feed for 5–14 days before pupating, after which adults emerge in 4–6 days. As with other insects, fungus gnats become more active and reproduce more quickly at warmer temperatures. The life cycle can be completed in 21 days at 24°C, compared with 38 days at 16°C.

Adult shoreflies are similar in size to fungus gnats but resemble small houseflies, having a dark chunky body with short, bristle-like antennae and short legs (*Figure 3*). They are stronger fliers than fungus gnats, and have five clear spots on the wings. Adult shoreflies prefer wetter conditions than fungus gnats and are often found in wet areas under benches and other water-soaked areas. Females lay eggs on algae or moist growing media and larvae hatch in 2–3 days. Shorefly larvae are cream to muddy brown in colour (*Figure 4*), appear headless, and feed on algae and other micro-organisms found in the media for 3–6 days before pupating. After a further 4–5 days, the adults emerge. Shoreflies take approximately 9–14 days to complete a generation at greenhouse temperatures. Generally, adults and larvae feed on algae. However, larvae may feed on roots infected with fungi.

DAMAGE

The immature stages of fungus gnats generally feed on decaying organic matter, soil fungi and algae, and can cause direct damage by feeding on fine roots, root hairs and on tender lower stems. All greenhouse crops can be affected. They also cause indirect damage by creating entry points in the roots for disease-causing organisms. Fungus gnats can themselves transmit such disease-causing organisms. For instance, hardy *Pythium* spores ingested by the larvae can remain in the gut until the larvae have developed into the adult flying stage. Various studies indicate that fungus gnat adults can spread spores of disease-causing fungi such as *Pythium* and *Rhizoctonia* (*Figure 5*) by flying to non-infected plants and excreting the spores. Adult flies can also spread *Fusarium*, *Verticillium* and other fungi by means of spores that are caught on their legs and bodies. Organic media such as peat and cocofibre favour reproduction of fungus gnats.

Immature shoreflies, by contrast, are semi-aquatic, feed principally on algae, and do not normally feed on plant parts. However, they will feed on roots infected with fungi and can therefore spread disease if ingested spores remain viable in the gut until the adult stage is reached. Research indicates that shoreflies can acquire and spread *Pythium* spores in a manner similar to that of fungus gnats. Shoreflies also cause cosmetic damage to ornamental crops by depositing black drops of excrement on leaves and flowers.

FIGURE 1. Adult fungus gnat on sticky card. Note long legs and antennae.

FIGURE 3. Shorefly adult. Note very short antennae, stout body and clear spots on wings.

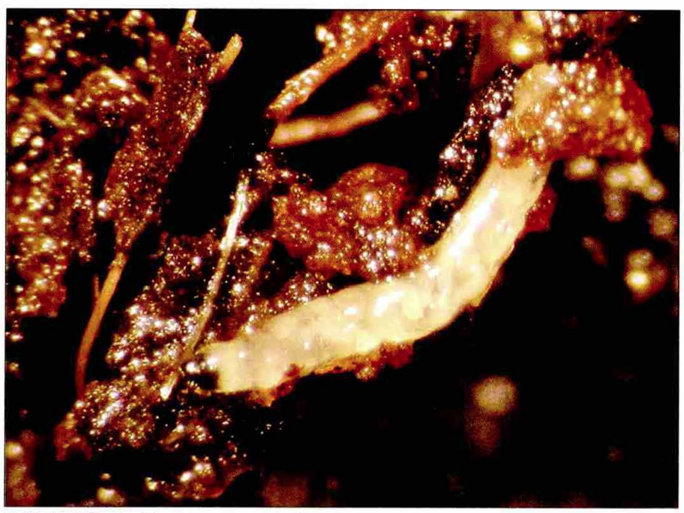

FIGURE 2. Fungus gnat larva.

FIGURE 4. Shorefly larva.

FIGURE 5. Fungus gnats can transmit diseases such as *Rhizoctonia* shown on this poinsettia.

FIGURE 6. Use of potato slices can be very effective in monitoring for fungus gnat larvae and the predatory rove beetle.

MANAGEMENT STRATEGIES

Generally, control of these flies can be difficult because of the above ground stage, continuous overlapping generations and short life cycles. To avoid problems associated with these flies, implement control measures early. Strategies for management of these flies include monitoring and cultural controls. Whereas biological control agents (BCAs) can be effectively used for suppression of fungus gnats, the effectiveness of many of them against shoreflies is uncertain.

Monitoring

Yellow sticky cards at the normal position at the top of the canopy will indicate the presence of these flies. But for earlier detection and greater trapping effectiveness, such cards are best placed horizontally at the base of the plants. For indication of levels of fungus gnat larvae, place slices of raw potato on the media and examine after 24 hours with a magnifying lens (*Figure* 6).

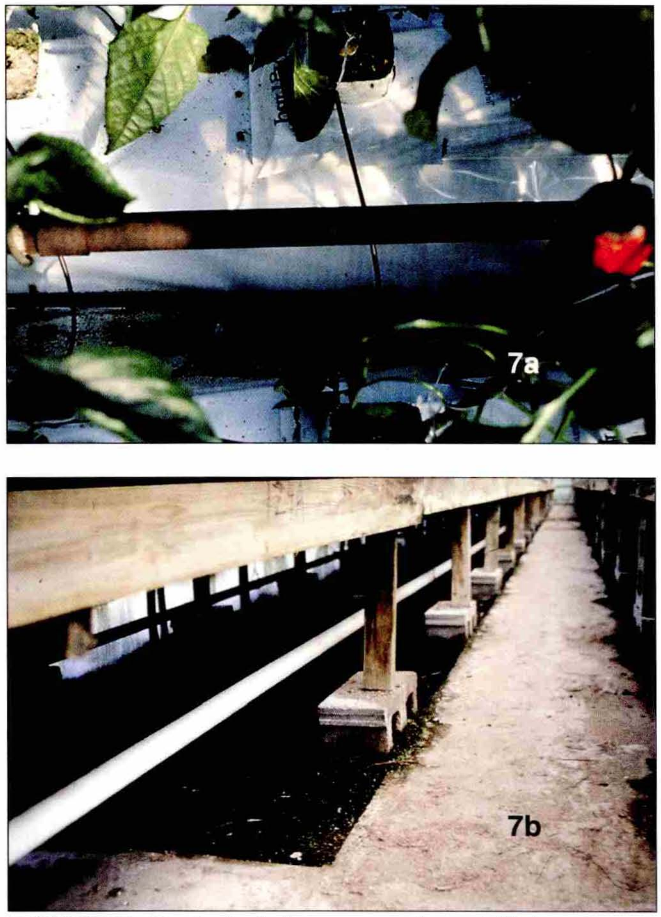

FIGURE 7. Control of algae on rockwool (7a) and under benches (7b) is important in the management of fungus gnats and shoreflies.

General Control Strategies

It is best to prevent establishment of these flies in the greenhouse by implementing good hygiene practices, and having good drainage to eliminate puddles and formation of algae (*Figure 7a, b*). Minimizing exposure of media surfaces will block light and thus help prevent growth of algae.

Biological Control

Several commercially available Biological Control Agents (BCAs) can be used for managing fungus gnat populations. These include a bacterial insecticide, *Bacillus thuringiensis* subsp. *israelensis*; a parasitic nematode, *Steinernema feltiae*; a predatory mite, *Hypoaspis* spp.; and a predatory beetle, *Atheta coriaria*, commonly called the rove beetle. The effectiveness of these agents has been determined mainly for fungus gnat larvae and may not be equally effective against shorefly larvae. There are also several naturally occurring BCAs that are not available commercially, but are often found in greenhouses where pesticide use has been reduced.

Coenosia attenuata is a predatory fly that attacks both fungus gnats and shoreflies, *Synacra* and *Hexacola neoscatellae* are parasitic wasps that attack fungus gnats and shoreflies respectively. Some notes about use of these BCAs follow.

Bacillus thuringiensis subsp. *israelensis* (Bti): Bti consists of two kinds of spores, one is active and the other is a storage spore that includes a toxic protein crystal. Once these spores are ingested by the larva, the alkaline pH in the gut facilitates release of the toxic crystal. This crystal destroys the gut wall of the insect, allowing the active spores to pass into the blood stream. The insect then dies from blood poisoning. Within 24 hours of ingesting Bti, fungus gnat larvae stop feeding and become limp. Death follows 1–7 days after ingestion. This bacterium does not kill by contact and only the larval stage is killed by ingesting Bti. Studies show that the younger larval stages of fungus gnats are more susceptible and therefore multiple applications must be applied to achieve control. Adults do not feed on these spores and are therefore unaffected. When using this bacterium, ensure that the pH of the water used for mixing is neutral or slightly acidic (upper limit is pH = 7.0). Alkaline water, or the addition of any other substance that will raise the pH, will render this organism ineffective.

Steinernema feltiae: These nematodes may provide more rapid control of fungus gnat larvae than the other BCAs. Pupae are not as susceptible to the nematodes as the larval stages. The nematodes search out an insect host and enter it though body openings such as the mouth, anus, and breathing pores called spiracles. Once inside the insect, the nematodes release a bacterium (*Xenorhabdus* spp.) which they carry in their gut. The bacteria develop within the insect, killing it within 48 hr. The nematodes can then theoretically develop by feeding within the larva (*Figure 8*). However, the size of fungus gnat larvae may be too small to accommodate their reproduction. For best results, apply at the end of the day to avoid drying out and exposure to direct sunlight. Applying them at this time also reduces the risk of flushing the nematodes out of the growing media by irrigation of the fertilizer solution over the course of the day, particularly in rockwool. Studies show that these nematodes move very easily through rockwool, and that within two weeks after application the majority of nematodes are found in the lower parts of the rockwool media. Nematodes are most effective when the temperature and pH of the water used for mixing are the same as those required for optimum crop growth. Applications should be made weekly for several weeks, depending on pest populations.

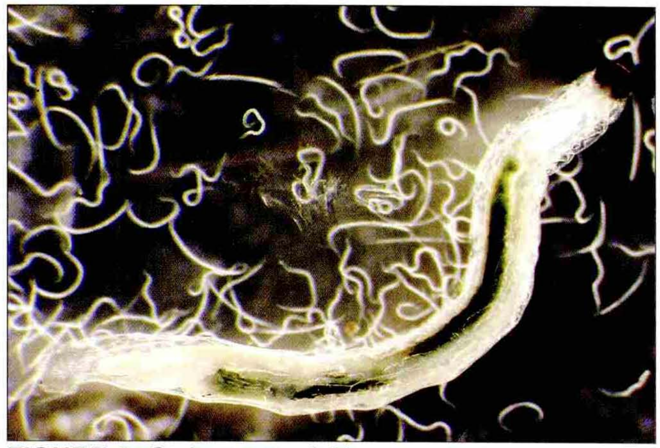

FIGURE 8. *Steinernema feltiae* nematodes can provide effective control of fungus gnats.

Hypoaspis: This predator is a soil-dwelling mite (*Figure 9*) that feeds mainly on the young larvae of the fungus gnat, very little on eggs, and probably not at all on pupae. They do not diapause but will become inactive if media temperatures fall below 15°C. If these predators are released in the seedling stage, make a second release after planting out in the main house when there is increased likelihood of available food to sustain them. It is best to release these predators before fungus gnat populations are established. The advantage of using this predator is that it provides season long suppression, and will also feed on other small insects in the growing media, such as springtails, and thrips pupae.

FIGURE 9. *Hypoaspis* predatory mites feed on soil-dwelling organisms such as fungus gnat larvae, and other pests such as thrips pupae.

Atheta coriaria: This beetle is a relative newcomer to the biological control arsenal for fungus gnats. Laboratory studies indicate that it holds much potential as a control agent for fungus gnats and shoreflies. The adult is a small black beetle, 3–4 mm long (*Figure 10*). There are three larval stages that vary from white in the earlier stages to yellow-brown in the final stage. The adult and all larval stages are predatory. The rove beetle is very active, establishes easily and spreads quickly throughout the greenhouse. It often establishes naturally and resident populations will maintain a permanent presence. Potato slices used to monitor fungus gnat larvae are also very effective in detecting the presence of *Atheta* adults and larvae.

FIGURE 10. The rove beetle *Atheta coriaria* is a soil-dwelling predator that feeds on the eggs and larvae of fungus gnats and shoreflies.

Coenosia attenuata (also called the hunter fly or tiger fly) is a greyish, predatory fly in the same family as the housefly (*Figure 11*). It is larger than the shorefly and the adult preys on other flying insects, catching them in flight. It feeds on fungus gnats and shoreflies, but also on other flying insects such as leafminer and, to a lesser extent, whiteflies. *Coenosia* larvae live in the soil and are generalist predators on other soil-dwelling organisms such as fungus gnat and shorefly larvae.

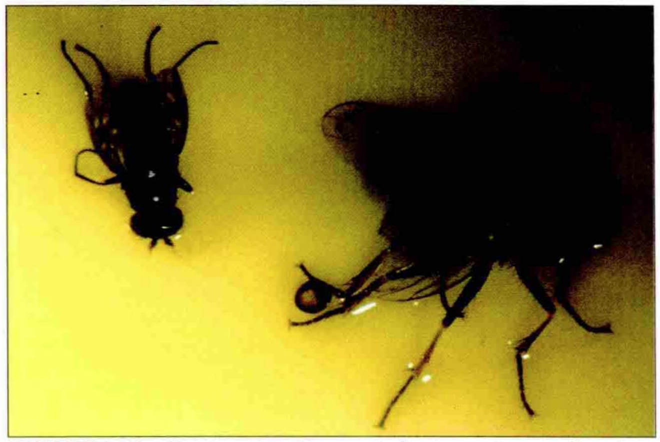

FIGURE 11. *Coenosia attenuata* is a predatory fly, the adult of which feeds on flying insects such as fungus gnats and shoreflies, and whose larva feeds on soil-dwelling organisms. The figure shows the size comparison between a shorefly on the left and *Coenosia* on the right.

Synacra is a parasitic wasp that lays its eggs into fungus gnat larvae. The wasps develop and emerge from the fungus gnat pupae. The adult wasp is similar in size to the fungus gnat but has a typical wasp-like appearance with a pinched "waist" and a long, tapered abdomen (*Figure 12*). Although its effectiveness in controlling fungus gnat populations has not been documented, large numbers of these BCAs are often found on sticky cards in greenhouses.

FIGURE 12. *Synacra* is a parasitic wasp that lays its eggs into fungus gnat larvae.

Hexacola neoscatellae is a parasitic wasp that feeds on shoreflies (*Figure 13*). It is smaller than a shorefly and can be found in large numbers on yellow sticky cards in greenhouses with resident shorefly populations. It is black in colour and has an almost spherical abdomen, in contrast with the more elongated abdomen of *Synacra* (*Figure 14*).

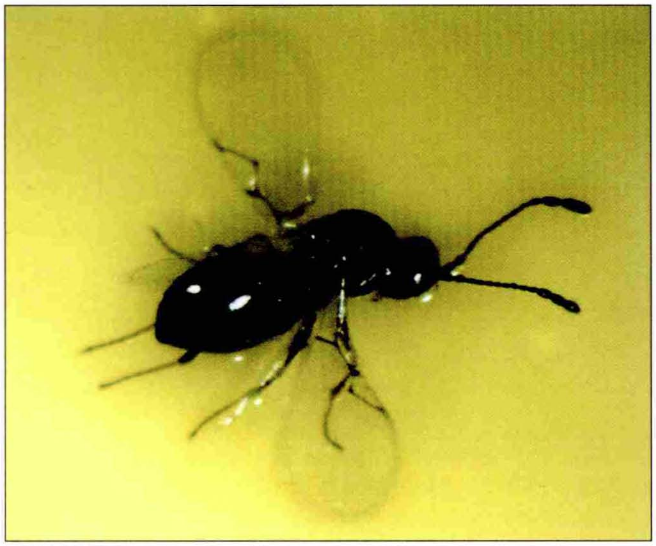

FIGURE 13. *Hexacola neoscatellae* is a parasitic wasp that lays its eggs into shorefly larvae.

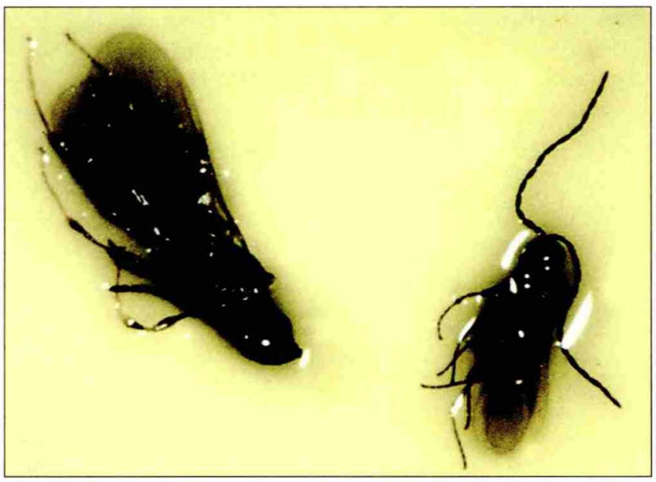

FIGURE 14. Comparison in size between *Synacra* (left) and *Hexacola.* (right).

Chemical Control

Use of pesticides to control fungus gnats is targeted against the larval life stages living in the growing medium. Best results are usually obtained when applied early in the crop production cycle, which is when fungus gnat populations are often at the worst. As the crop matures, the growing medium dries out more quickly and the developing root system is less prone to feeding damage. There are several pesticides registered for control of fungus gnats and shoreflies, some of which are compatible with biological control programs. Please refer to OMAFRA Publication 370, *Production Recommendations for Greenhouse Floriculture*, and Publication 371, *Growing Greenhouse Vegetables*.

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