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Management of fungus gnats in nursery production

Fungus gnats (*Bradysia* spp., Sciaridae) are small, mosquito-like flies which are a common problem in production nurseries and propagation greenhouses where seedlings are being grown. Larvae can cause significant damage, substantial economic loss and both adults and larvae can spread fungal diseases such as Chalara, Botrytis, Pythium, Phytophthora, *Chalara*, *Fusarium*, *Rhizoctonia* and *Verticillium*. Management of fungus gnats requires careful and deliberate planning.

Management of fungus gnats in nursery production

This months nursery paper was prepared by Andrew Manners (Senior Entomologist at the Queensland Department of Agriculture, Fisheries and Forestry) in conjunction with the 'Fungus gnat pest management plan for production nurseries' as part of a levy funded project *NY11001 Plant health, biosecurity, risk management and capacity building for the nursery industry.* This nursery paper summarises aspects of the more detailed pest management plan which is also available at www.ngia.com.au.

General biology

Adult fungus gnats are small mosquito-like flies which fly in erratic zig-zag patterns over growing media and around plants. Eggs are laid in the soil or potting media and hatch after about 4 days (depending on temperature). Larval fungus gnats are white maggots with a shiny black head and are 1-8 mm in length (Fig. 1) that tend to inhabit the top 3 cm of growing media. Larvae are primarily fungus feeders and will readily feed on organic matter in the growing media. They will also feed on root hairs and callus, present in the growing media, including leaves touching the soil in the absence of fungus food. Large larvae may feed on the insides of roots and large infestations may see larvae boring into larger roots or stems in the soil. Furthermore, larvae and adults can spread diseases, which can cause significant crop loss. Establishment of disease may also be enhanced from wounds created by larval feeding, particularly at high densities.

Managing fungus gnats

Sole reliance on synthetic pesticides to control fungus gnats will eventually fail. Preventative measures, predators and biopesticides can be used very effectively to the exclusion of all traditional insecticide applications. Taking an integrated approach, using a wide array of options to minimise and manage fungus gnat populations, is very effective for keeping fungus gnats under damaging levels. Populations should be actively monitored and a pest management plan established and updated over time to account for the individual nature of your business and the plant species that you grow.

Fig. 1. Fungus gnat larvae heavily infesting a plant cutting (top) and an adult on a tomato seedling (bottom).

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Monitoring fungus gnats
Plants should be inspected daily with results of monitoring recorded weekly. Frequent monitoring will enable infestations to be spotted while they are still light, and thus easier and cheaper to manage. Different methods can be used for monitoring adults and larvae. For more information on monitoring fungus gnats, refer to the nursery production fungus gnat pest management plan.

Monitoring adults:

1. Yellow sticky traps are essential in cuttings and seedlings (Fig. 2). Position traps about 10 cm above the crop canopy, particularly near susceptible crops. Traps should also be placed near doors, vents and any susceptible crops or areas. At least one trap per 100 m2 for greenhouse crops, more in varieties that are known to be susceptible to fungus gnats. Inspect sticky traps at least weekly and change traps every 2 to 4 weeks. Numbers less than 20 flies per trap/week may be under the economic threshold but will vary with each crop variety. Sticky traps also physically kill adults, precluding their ability to reproduce and further infest the crop.

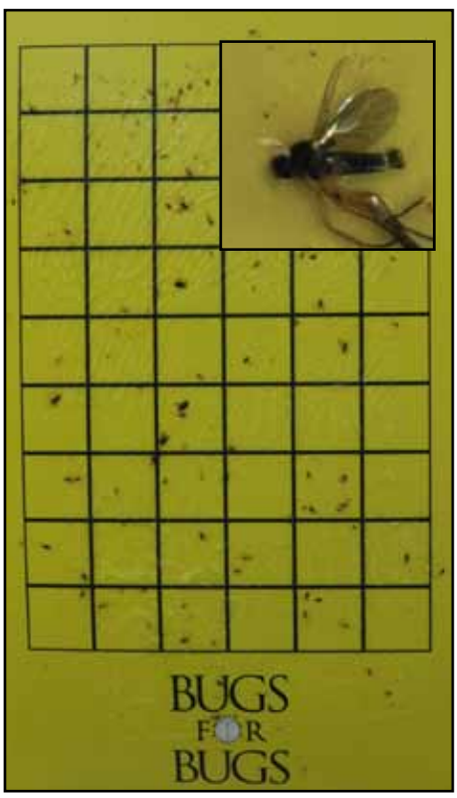


Fig. 2. Yellow sticky trap with fungus gnats and close-up of adult on sticky trap in topright corner.

2. Visual inspection of the crop can also provide valuable qualitative information about the abundance of adult populations. If relatively large numbers are observed when plants are disturbed further investigation should be undertaken.

Monitoring larvae

3. Visual inspection of cuttings and surrounding media can reveal the presence of fungus gnat larvae but is time consuming and may damage cuttings/roots. Small larvae can also be difficult to detect.

Cultural control for fungus gnats

Growing media and storage

- Use growing media low in organic content. High organic content can promote fungus gnats. However, this must be balanced by using a mix that provides beneficial growth properties for the plant species in question.
- Store growing media in a clean, dry area. Storage of media in an unprotected area subject to rain or other sources of moisture may promote fungal growth, which in turn will promote fungus gnat populations. Ideally, cover unused media in a sealable container to prevent further infestations.
- Pasteurise media prior to use to ensure that it is not contaminated.

Protect your growing area

- Prevent entry to the growing area by using an insect proof glasshouse or tunnel.
- Check incoming stock and growing media, either before purchase or on arrival for signs of infestation.
- Quarantine incoming stock as per NIASA Best Practice Guidelines and monitor plants for fungus gnats and other pests prior to incorporation in production areas.
- Grow cultivars that are more resistant to fungus gnats.

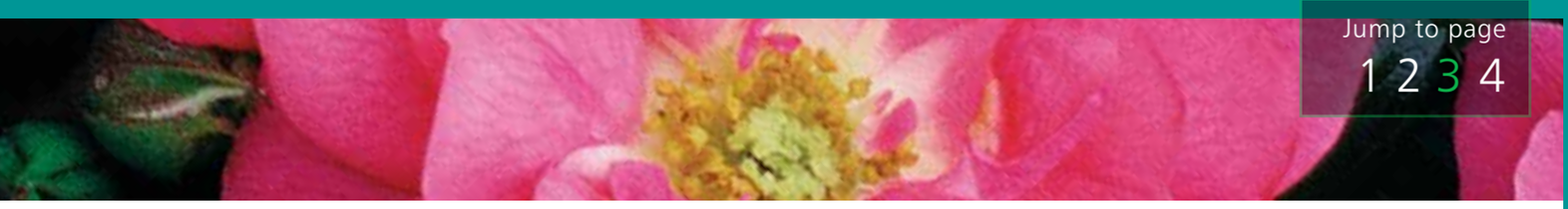
Irrigation and fertilising

- Avoid excess watering. Fungus gnat numbers are lower when moisture levels are relatively low.
- Fertilise using the minimum amount required to maintained required growth. Excess fertiliser will favour the growth of algae in the growing area which will promote fungus gnat populations.

Sanitation and general hygiene

- Reduce fungus growth in the media and growing area.
- Disinfest growing surfaces and paths to remove algae
- Ensure that growing surfaces, below benches, walkways and areas around the growing area are free-draining and free of algal growth.
- Remove weeds and plant waste regularly.
- Modify the growing area so water does not pool in or near the growing area; regrade floors if necessary.
- Remove unsold or unsaleable infested crops from the growing area quickly to reduce populations spread.

Fig. 3. Poor establishment caused by fungus gnats.



4. Potato plugs can be used to lure larvae to the surface. Place a slice of uncooked potato about 3-5 cm in diameter (and about a cm thick) without skin face down on the growing media. Smaller chunks or slices can be used in small plugs/containers. Ensure that most of the surface is in contact with the media so that the potato does not dry out. After 24-48 hours, lift the potato plug and first examine the growing media under the potato, as larvae will rapidly vanish from view on the surface. Then check the potato itself for larvae. It is recommended to mark pots or plugs where potatoes are placed so you can find them more easily. If not removed, potato chunks can rot, sprout, promote fungus gnats and other pests e.g. mice.

Keep long-term records to assist identifying areas and varieties that are more susceptible to fungus gnat infestations. It is also important to continue monitoring following application of biological control agents and other control measures to determine the effectiveness of each treatment. These records can assist with making management decisions in the future. For example, one might modify the composition of growing media to reduce infestations or select varieties that are found to be more resistant to fungus gnat attack. Insect monitoring data sheets are available in the BioSecure *HACCP* protocols. Alternatively, simple spread sheets can be created and modified to suit your farm.

Pesticides and fungus gnats

Pesticides can be used to assist management of fungus gnat larvae. In Australia, there have not been any confirmed cases of pesticide resistance in horticultural or mushroom crops. However, resistance has been reported for certain organophosphates (e.g. diazinon) and permethrin overseas and it is possible that resistance occurs in Australia but has not been reported. It is important to rotate between products from different mode of action groups regularly. Do not to continue using a product that has failed (particularly if it was applied correctly and good control has been achieved in the past). For more information on use of pesticides refer to the nursery production fungus gnat pest management plan.

Biological control of fungus gnats

Biological control is very effective against fungus gnats and is most effective when released in a preventative manner, so that populations of predators are always present in the growing area. If predators are only released after a large infestation has occurred it will take longer to manage the population (regardless of whether predators or pesticides are employed). It is recommended to release predators routinely, particularly after potting-up to reduce the likelihood of populations reaching damaging levels. A brief summary of commercially available predators are provided below with more detail in the nursery production fungus gnat pest management plan.

Predatory mites

There are two species of predatory mites available from Biological Services listed as the products Hypoaspis A and Hypoaspis M. These relatively large, brown to orange coloured mites feed on fungus gnat larvae, thrips pupae and on a variety of other soil organisms, including nematodes, springtails, root aphids and mites. While soil predators may have some protection from foliar sprays of insecticides, run-off from high impact pesticides can still have a severe negative effect on predators, particularly if they have long residual activity.

Case study #1 Propagation Australia, Queensland

In the past, fungus gnats have been a big problem for us, particularly in poinsettias, gerberas, young carnations and all bedding plants. A long time ago, we didn't treat the growing media when it arrived; we used to accept that the media was clean and pot-up. On a couple of occasions we lost entire crops, a large amount of stock. Now, we rarely have such problems because we manage fungus gnats from the beginning of the production cycle. We assume that all potting media is infested with fungus gnats when it arrives at our nursery. We pasteurise media for very sensitive plants that have zero tolerance (e.g. plants in quarantine, plants grown from tissue culture and nuclear stock), however the volume of media used across all crops doesn't allow us to pasteurise everything. Regardless, all stored media is kept covered and dry.

Cultural management practices make a big difference. Fungus gnats love water and we have noticed that areas that remain over-watered for a period of time tend to have larger populations than less watered areas. Therefore, our irrigation is monitored daily and modified to suit climatic conditions on a daily basis. This helps reduce algal growth, which promotes fungus gnats. Much of our growing area is within insect-proof tunnels and this significantly reduces populations of many pests, including fungus gnats. In addition, we use two types of yellow sticky traps. Long rolls of sticky traps are used in the growing areas with susceptible crops and remain in the crop for the entire season; this acts as a mass trapping device. Smaller, more traditional, sticky traps are used for weekly monitoring (both available at Bugs for Bugs).

Unfortunately, we've found fungus gnats to be very persistent and almost impossible to eliminate completely. We use an IPM crop consultant on a weekly basis to make sure that all pests, including fungus gnats, are managed before they reach economically damaging levels. We have a regular regime for management of fungus gnats (described below) but sometimes additional treatments are necessary; our crop consultant informs us when these are needed.

When we first pot-up, we treat the media with entomopathogenic nematodes and we reapply nematodes on a fortnightly basis. On the off week we drench with Vectobac. In addition, for important stock which has very low tolerance we will drench with a imidacloprid on three consecutive weeks. These applications are made after a tunnel has been completely filled. We will also sometimes apply Agri-50 if numbers of adults are relatively high. Agri-50 acts like yellow sticky traps, but can be sprayed on plants, physically trapping adults and killing them; it doesn't damage most plant varieties.

By doing all of these things we now have very few problems with fungus gnats.

Rove beetle

Adults and larvae of the rove beetle, Dalotia coriaria, feed on a range of small insects and mites, feeding heavily on fungus gnat and shorefly eggs and larvae and thrips pupae. Adults have wings and may fly to find food. Adults live about 21 days and lay up to

about 8 eggs per day, and may eat up to about 150 fungus gnat larvae. Adults prefer to eat fungus gnat larvae more than shorefly or western flower thrips pupae, when given a choice. Biological services is the only provider of D. coriaria in Australia.

Insect-killing nematodes (e.g. Steinernema feltiae)
Insect-killing (entomopathogenic) nematodes (ENs) are tiny, very slender, worm-like, soil-dwelling organisms that are a little less than 1 mm in length. The ENs must be drenched into the growing media. Once they come in contact with a host, they enter and kill it. Application of ENs can be completed using a high volume low pressure spray to drench nematodes into the media a short distance or through existing irrigation. In either case, ensure that all filters are removed and speak to your distributor for more specific instructions before applying for the first time. ENs are UV sensitive, so application when the area is in high levels of direct sun is not recommended. There are two suppliers of insect-eating nematodes in Australia, Ecogrow and Becker Underwood. Ecogrow produces nematodes in Australia, Becker Underwood imports their nematodes from the UK.

***Bacillus thuringiensis subsp. israelensis* (Bti)**
Bacilllus thuringiensis subsp. israelensis (Bti) is an entomopathogenic bacteria which causes diseases in insects, e.g. Vectobac or Bactivate. After ingestion by an insect host, the bacteria produce a number of substances which cause cell disruption and other physiological problems which cause the cuticle to disintegrate and the insect to die. There are a large number of Bt subspecies which are specific to certain pest groups, e.g. flies or caterpillars. Bti is specific to various fly larvae, including fungus gnats. Research has shown that Bti is mainly effective against first instar fungus gnat larvae, not larger second or third instars. This is because larger larvae must consume more bacteria to cause mortality than smaller larvae. If using Bti one must apply the product when fungus gnats first appear and may require multiple applications.

Conclusion
Managing fungus gnats without pesticides is feasible but may require modifying the growing environment through cultural management practices. The fungus gnat pest management strategy for production nurseries provides a good basis but may need to be altered to suit your region and growing environment. Be creative and record changes in fungus gnat populations with different management techniques.

Case Study #2 Brocklands Nursery, Tasmania

In the past I used a one application of Crown, Confidor and Azamax over a four week period. At the time, I thought this managed fungus gnats, even though there were adults found commonly on yellow sticky traps. I modified my irrigation system to super-fine foggers which wet the soil but dissipated before reaching the ground. In effect, propagation plants received adequate water, without being too wet, and walkways remain dry. Despite this water saving, relatively dry system, I still had major fungus gnat problems, although it was not recognised at the time. I investigated the use of the product Bactivate primarily for the control of mildews in the propagation house. I now drench Bactivate, which is a combination of five beneficial bacteria active against fungus gnats and pathogens and increasing uptake of certain nutrients, e.g. phosphorous. After the first application, dead fungus gnat larvae appeared everywhere on the surface of the media and resembled a world war battle scene. Now fungus gnats only ever remain at very low levels, plants show higher nutrient uptake and have increased rooting rate.

Fig. 4. Fungus gnats that surfaced and died after application of Bactivate.

Further information

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