Grower Summary

PC 283

New approaches to microbial control of insect pests in protected crops and their interaction with waste-based growing media

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Before using all pesticides check the approval status and conditions of use.

Read the label before use: use pesticides safely.

Further information

If you would like a copy of the full report, please email the HDC office (hdc@hdc.ahdb.org.uk), quoting your HDC number, alternatively contact the HDC at the address below.

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Headline

- Incorporating composted green waste into peat composts can result in significantly higher infestations of sciarid and shore flies.
- Natural fungal infections of sciarid fly larvae and shore fly adults could provide 'free' biological control.

Background and expected deliverables

Sciarid and shore flies are widespread and important pests and contaminants of containerised herb and ornamental crops. There is a requirement for new forms of control that are compatible with Integrated Pest Management (IPM) programmes that enable growers to reduce their reliance on chemical pesticides. Progressive growers prefer to use IPM based on a combination of cultural control, biological control and IPM-compatible insecticides (the latter on ornamentals only; there are no pesticides approved for the control of fly pests on herbs). However, the current IPM options do not always give sufficiently reliable control of sciarid or shore flies. Additional measures are needed therefore.

At present, most of herb and ornamental bedding and pot plant crops are grown in peat based compost. The UK has a Biodiversity Action Plan (BAP) target of 90% replacement of peat by alternatives by 2010. This would be done by incorporating materials into composts such as composted green waste, bark, wood fibre or coir. However, there is evidence from growers that some of these materials are associated with greater fly problems.

In recent years, there has been increasing awareness of natural infections of insect pathogenic fungi in sciarid and shore flies. These infections can result in high levels of ‘free’ natural pest control. If the naturally occurring fungal infections on sciarid and shore flies could be enhanced through conservation or augmentation, they could help reduce fly populations as part of an integrated approach to crop management and provide a novel form of biocontrol.

The project has two aims:

- Develop novel methods of biocontrol for sciarid and shore fly pests on pot herbs and ornamental bedding and pot plants;
- Investigate their interaction with composts containing recycled green material.

The expected deliverables from the project include the following:

- New understanding of the role of naturally occurring fungi in the population dynamics of insect pests that have adverse effects in a complex, integrated plant production system.
- New insights into the methods needed to enhance the effects of the fungi.
- New information on the effect of alternative growing media on the risk of sciarid and shore fly infestation, and on how to mitigate any adverse effects.

Summary of the project and main conclusions

Survey work on fungal infections with growers

Seventeen growers of protected bedding and pot plants or protected herbs were questioned about natural fungal infections of sciarid and shore flies on the crops produced. Fungal infections of sciarid flies were observed on 13 (=76%) of nurseries and fungal infection of shore fly was observed on just one nursery. 70% of growers who observed fungal infections on sciarid flies thought that they were contributing to sciarid fly control on their nurseries.

Fungal infected sciarid fly larvae were found on many sciarid-susceptible bedding and pot plant species including begonia, cyclamen, geranium, lupin, poinsettia, primula and a wide range of cuttings in propagation. On potted herbs, infected sciarid fly larvae were found particularly on mint but also on chives and parsley. Fungal infected shore fly adults were found particularly on thyme but also on parsley.

Infected sciarid fly larvae were found on a range of growing media from various suppliers, including 100% peat, and peat mixed with other materials i.e. composted green waste, wood fibre, bark, coir, perlite. Typical mixes contained 75-85% peat and 25-15% other materials. Peat was sourced from various countries including Estonia, Finland and Latvia. High substrate moisture and relative humidities were considered by most growers to be key factors favouring the incidence of fungal infection of sciarid flies.

Infections on sciarid flies occurred throughout the year, depending on the times various crops are produced, but were more prevalent in the autumn to spring period. Timing of infections was also affected by temperature and humidity e.g. on a nursery growing mint all year round, infected larvae were only seen in the autumn and winter when the glasshouse was cool and the peat remained very wet.

The extent of fungal infection in fly populations was partly dependent on the extent of sciarid fly infestation. Fungicide applications applied against pathogens within the crop did not appear to impact on fungal infections of sciarid flies on ornamental crops.

On site monitoring of natural fungal infections was then done in the glasshouses of six nurseries by project team members from ADAS, Fargro and the host growers. Results confirmed those of the initial grower survey. Over all the sites, the proportion of pots with infected sciarid fly larvae ranged from 1 to over 80%. Frequently all visible sciarid fly larvae were infected.

Isolation of pathogenic fungi from naturally infected sciarid and shore flies

When the project started, it was known that the natural infections of sciarid and shore flies were caused by two different types of insect pathogenic fungi. These fungi needed to be isolated from infected insects and grown on into a 'pure' culture of each fungus, free from contamination by other microorganisms.

The shore fly fungus was isolated from naturally infected adult shore flies associated with thyme plants. The fungus was grown on an agar based medium in Petri dishes. The fungus grew very slowly having an unusual structure, in which hair like projections emerge from the fungus in a Petri dish or from the shore fly adults in natural infections.

The sciarid fly fungus was difficult to isolate. Natural infection cycles were observed which indicated a complex life cycle. The fungus infects sciarid fly larvae which subsequently come up to the surface of the growing media at night and die. The fungus then produces 'primary' spores on the dead bodies overnight, which are actively discharged in order to spread the infection. If the spores hit a sciarid larva, they germinate on it and grow through the insect cuticle and kill it. If the spores do not contact a living sciarid fly larva, they still germinate but grow to produce a small 'secondary' spore that is actively discharged in search of a sciarid larva. The only way to isolate the fungus and grow it in a culture was by collecting spores discharged onto agar from 'fresh' larval cadavers (= dead insect bodies). . In most cases, they produced secondary spores which then died. However, in some cases they germinated to produce a fungus mycelium which could then be grown on in culture.

Fungal identification

Identification of the two fungal species infecting the sciarid and shore flies was important. Traditionally, the identification of fungi relied on visual characteristics, particularly of the spore bearing structures. However, fungi do not vary much in their appearance, meaning

that species relationships based on visual characters have a low degree of certainty. While visual diagnostic characters are still important tools, fungal identification relies increasingly on information collected at the DNA level, such as gene sequencing.

Isolates of the sciarid fungus were compared with a culture of *Furia sciarae* deposited in a herbarium run by the US Department of Agriculture. The two fungi had the same genetic sequence and hence we can be sure the fungus that kills sciarid flies in the UK is *Furia sciarae*.

The gene sequence for the fungus that infects shore flies, combined with an evaluation of its visual characteristics, indicated that it was not a species from the fungal genus *Hirsutella* as originally thought, but from the genus *Torrubiella*. This was highly unexpected because *Torrubiella* is associated with infections of insects in the tropics and SE Asia in particular. *Torrubiella* is the sexual phase of the fungus *Lecanicillium* (previously known as *Verticillium*). The latter is used as a biopesticide in the products Mycotal and Vertalec (Koppert BV) for the control of glasshouse whitefly and aphids respectively. *Lecanicillium* is naturally widespread in the UK. Although it is genetically the same as its sexual form *Torrubiella*, it looks completely different and we suspect that the two forms have very different natural histories.

Fungal bioassay

Laboratory bioassays are currently being developed to quantify the virulence of *Furia* to sciarid fly. The bioassay protocol, at its current state of development, is based on rearing larvae of a known age, and then treating them with *Furia* spores that are actively discharged from plugs of agar and keeping them under controlled conditions to monitor their survival.

Effect of temperature on sciarid fly development

A series of experiments has commenced to determine the effect of temperature on the development of the sciarid fly species *Bradysia difformis* (the most common sciarid fly species occurring in UK glasshouses). This information can then be used to forecast pest activity as a decision support tool in IPM. The development of sciarid larvae will be determined by collecting eggs from laboratory cultures and keeping them at different temperatures under controlled conditions. The dishes will be observed daily and the development of the larvae will be quantified. The results from these experiments will be used to identify the minimum temperature for development and a simple day degree model of sciarid development will be calculated.

Attractiveness of growing media as egg laying sites for sciarid and shore flies

Experiments to quantify the attractiveness to sciarid and shore flies of growing media containing composted green waste were completed. Two experiments were done, the first was in a research glasshouse at ADAS with sciarid and shore flies, the second was done at a commercial herb nursery with a high population of sciarid flies. In the first experiment, a standard peat based compost was compared with a proprietary compost containing composted green waste and an organic compost. In the second experiment, a standard peat based compost was compared with the same compost supplemented with different amounts of composted green waste or wood fibre. The data from the first experiment indicated that organic compost was more attractive to shore flies for egg laying, while the second experiment indicated that 40% composted green waste was more favourable for the development of sciarid fly populations than the other growing media tested.

Financial benefits

- Natural fungal infections of sciarid fly larvae and shore fly adults can be exploited by growers.
- An additional, effective and reliable biological control solution to sciarid and shore fly problems will give financial benefits to growers and propagators of a wide range of protected crops, including protected ornamentals, herbs, leafy salads, hardy nursery stock; and cucumbers, tomatoes and peppers in propagation.
- The annual values of UK protected herbs and protected pot and bedding plants is estimated at £25 million and £193 million respectively (Defra Basic Horticultural Statistics, 2002/3).
- Crop losses or marketing problems due to sciarid or shore fly damage or contamination respectively probably cause at least 5% losses in herb and pot / bedding plant crop values annually. This represents a combined loss of £11 million per annum, although losses may increase with wider use of potting media based on composted green waste.
- At present there are no pesticides approved for the control of fly pests on herbs, or for shore fly control on any protected crop. Therefore growers will benefit by reducing the proportion of the crop that is unmarketable as a result of better biological pest control.

Action points for growers

- Look out for natural fungal infections of sciarid fly larvae or shore fly adults when monitoring for pests, particularly from autumn to spring. Infected scairid fly larvae are opaque white, and visible on the compost surface. Infected shore flies have long hairs sticking out of the body and can be found clinging to foliage or stems, or on the growing media surface or side of the pot.

- If help is required recognising infected flies, contact Jude Bennison, ADAS Boxworth (tel. 01954 268225, email jude.bennison@adas.co.uk) for further information.

- Leave infected dead sciarid fly larvae on the surface of the growing media so that the fungal infection can spread.

- If infected flies are present on your nursery and you have not already been contacted about the project, please contact any of us below:

  Jude Bennison, ADAS, tel. 01954 268225, email jude.bennison@adas.co.uk
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