Grower Summary

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

PC 283

Annual report 2010

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Project leader:	Dr Dave Chandler, Warwick HRI University of Warwick
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Key staff:	Dave Chandler, Warwick HRI Gill Prince, Warwick HRI Jude Bennison, ADAS John Buxton, ADAS Kerry Maulden, ADAS
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Project coordinator:	
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The following are members of the Consortium for LINK project no HL0193

Bulrush Horticulture Ltd
and
Bordon Hill Nurseries
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Double H Nurseries
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Brosters Nurseries
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Koppert UK
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Humber VHB
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Fargro Ltd
and
Swedeponic Ltd (re-named Lincolnshire Herbs in 2009)

GROWER SUMMARY

Headline

- Incorporating composted green waste into peat based substrates can result in significantly higher infestations of sciarid and shore flies.
- Sciarid fly populations develop faster as temperatures increase. The optimum temperature tested for the development from egg stage to adult is 30°C. Larvae will not develop at 10°C, and development is very slow at 15°C.
- Natural fungal infections of sciarid fly larvae and shore fly adults could provide 'free' biological control and spread of the fungus between flies is probably more effective at lower temperatures.
- Two commercial fungal bio-pesticides tested could be used to give partial control of sciarid fly larvae if approval was sought and obtained for their use in a substrate drench.

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. Some 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 group of IPM tools do not always give sufficiently reliable control of sciarid flies or shore flies. Therefore additional measures are needed.

At present, most of herb and ornamental bedding and pot plant crops are grown in peat based substrates. However, the industry is under pressure to reduce the use of peat and to find alternative, sustainable alternatives. Potential ‘green’ candidate materials for incorporating into substrates include composted green waste, bark, wood fibre and 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 bio-control.

The project has two aims:

- Develop novel methods of bio-control for sciarid and shore fly pests on pot herbs and ornamental bedding and pot plants.
- Investigate their interaction with substrates containing composted green waste.

The expected deliverables from the project include the following:

- 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.
- New understanding of the role of naturally occurring insect pathogenic fungi in the population dynamics of pest insects that have adverse effects in a complex, integrated plant production system.
- New insights into the methods needed to enhance the effects of the fungi.

Summary of the project and main conclusions

Sciarid fly infections on nurseries

In Year 2, the work focused on fungal infections of sciarid flies, as the fungus infecting shore flies was only found on one nursery at very low levels. Two experiments were set up on nurseries to gain information about outbreaks of the insect pathogenic fungus *Furia sciarae* on populations of sciarid flies. One experiment was done on cyclamen and one on mint, on nurseries with a history of sciarid fly infection with *Furia* and they were set up where infected larvae had very recently been observed by the host growers.

Cyclamen and mint plants were grown in pots of standard peat based substrate and a mixture of peat and composted green waste or wood fibre, and the development of sciarid populations and the amount of *Furia* infection were monitored over time. On cyclamen, the sciarid population was monitored over three months. There was a peak in the sciarid population after one month, after which it declined to very low levels and *Furia* infections could not be detected. On mint, no sciarid fly larvae infected with *Furia* were seen, and it is possible that *Furia* had reduced the sciarid fly population to such low numbers that the infection died out just before the experiment was set up. Information on the timing of the onset of *Furia* infection in sequential batches of mint was gained from assessing infected larvae in the grower's crop in mid-December before the experiment was set up. These observations indicated that the onset of visible *Furia* infection was two weeks after the first

larvae were available for infection. At four weeks after the first larvae were available for infection, all the larvae that were visible on the substrate surface were infected with the fungus.

Isolating Furia from naturally infected sciarid flies

Isolating *Furia* from naturally infected sciarid fly larvae is very difficult. Infected larvae migrate to the surface of the substrate, the fungus then kills the larvae and grows out through the cuticle and produces 'ballistospores' that are discharged into the air. This process can occur over the course of a single night, after which the fungus dies. The fungus can only be cultured using ballistospores that are caught from infected larvae, but often these are contaminated with bacteria or other fungi which prevent a 'clean' culture of *Furia* being established. The medium used to grow *Furia* is difficult to prepare and becomes easily contaminated. However, it was found that *Furia* will grow in two liquid media that are used for growing insect cells and which are available from commercial suppliers in pre-sterilized form. The fungus grows as mycelium in these media, and when the mycelium is harvested and washed it goes on to produce ballistospores. The next stage is to quantify the rate of spore production and to see if these will infect sciarid larvae.

Susceptibility of sciarid flies to entomopathogenic fungi

A laboratory experiment was done to investigate whether sciarid larvae were susceptible to three different types of insect pathogenic fungi that are used as 'bio-pesticides' of glasshouse pests: Metarhizium (from Met52, a commercial product undergoing UK registration), Beauveria (from Naturalis, which is registered in the UK) and Lecanicillium (using a fungal strain isolated from a naturally infected sciarid fly, although other strains of this fungus are used in the commercial products Mycotal and Vertalec).

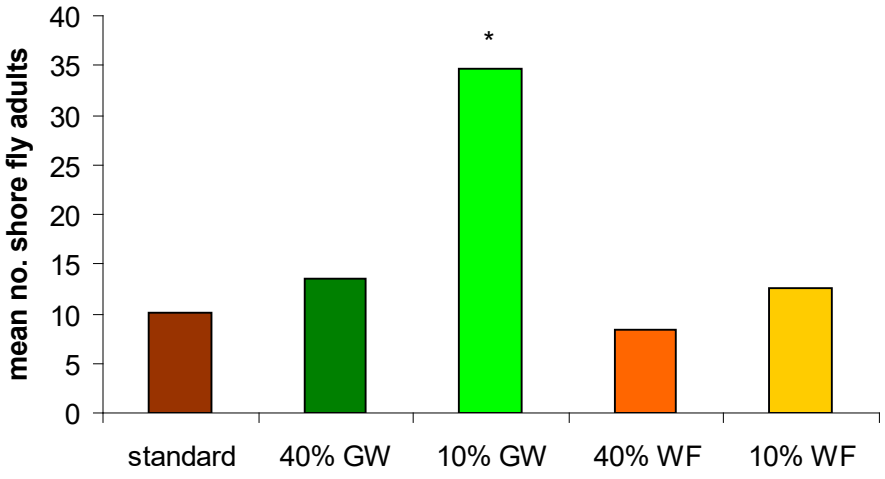
These types of fungi are not normally associated with fly infections, and unlike *Furia* they do not cause 'outbreaks' that have the ability to reproduce on insects and spread rapidly through an insect population. Instead, they are used in a similar way to a chemical insecticide. In the laboratory experiment, spores of these fungi were applied as a drench to the surface of the substrate containing sciarid fly eggs. The spores were applied at three different times, namely (1) before sciarid fly egg hatch; (2) when first and second instar larvae were present; (3) when second and third instar larvae were present. All the fungi reduced the sciarid fly populations although the overall level of control was low. As a general rule, the level of control increased with the age of the larvae. Insect pathogenic fungi infect insects using spores that grow through the insect cuticle, and therefore larvae that moult before the spores have grown sufficiently may be able to rid themselves of infection. Hence applications to early stage larvae present more opportunities for larvae to

escape infection. From previous studies it was found that spores applied to substrates tend to be concentrated in a band in the top few cm of the substrate. It may be that the later stage larvae are migrating more often to the top of the substrate surface and hence exposing themselves to more fungal inoculum.

Attractiveness of growing media to sciarid and shore flies

An experiment was done on a commercial nursery to measure the attractiveness to shore flies of five different kinds of substrate: (1) A standard peat-based substrate suitable for growing bedding plants or pot herbs; (2) a mixture of 40% composted green waste and 60% peat (3) a mixture of 10% composted green waste and 90% peat; (4) a mixture of 40% wood fibre, 60% peat and (5) a mixture of 10% wood fibre and 90% peat.

Significantly more shore fly adults emerged from the substrate with 10% composted green waste than from the other substrates tested. The results indicate that either shore fly females were more attracted to the 10% composted green waste than the other substrates for egg laying, and/or this substrate was more suitable for shore fly larval development.



Mean number of shore fly adults emerging per pot. GW = composted green waste, WF = wood fibre. * Significantly more in composted green waste than other substrates, $P<0.05$.

The substrates containing composted green waste had consistently higher moisture readings than the other substrates, with the 40% composted green waste substrate having a higher moisture volume than the 10% composted green waste substrate on some assessment dates which may have been more conducive to sciarid fly development?. The two wood fibre substrates and the standard peat based substrate had similar readings throughout.

Olfactometer studies indicated that sciarid fly adults are attracted to the smell of 40% composted green waste. This result is consistent with those of glasshouse experiments in Year 1 and with grower observations that substrates based on composted green waste lead to greater problems with sciarid flies. Olfactometer studies with shore flies were less conclusive, possibly because of the absence of algae from the fresh substrates tested; this will be further investigated in future work.

Effect of temperature on the development rate of sciarid flies

Research was done to measure the rate of development of sciarid fly, *Bradysia difformis*, from egg to adulthood in peat-based substrate at different temperatures from 10°C to 30°C. The effect of temperature on the rate of development of *B. difformis* has not been measured before, although some information is available for other *Bradysia* species. Total development time was inversely proportional to temperature, with the shortest development time being at temperatures above 30°C. At the lowest temperature studied, 10°C, eggs hatched slowly and did not develop to complete the larval stage. There was no emergence of adults at 10°C even after 70 days of incubation. At all the temperatures used, larvae were seen moving close to the substrate surface prior to pupation. At lower temperatures (less than 20°C) larvae were observed on the substrate surface for greater periods than at the higher temperatures. This may indicate a mismatch between the optimum temperature for sciarid development and the best conditions for the transmission of *Furia* infections: the fungus is likely to be transmitted more effectively at lower temperatures because transmission occurs on the substrate surface. Thus, the longer a larva remains at the surface, the more likely it is to contact *Furia*.

Effect of substrate type on the development rate of sciarid flies

An experiment is being run to measure the effect of different types of substrate (standard bedding peat, composted green waste and wood fibre, obtained from Bulrush Horticulture) on the development of sciarid fly populations. This is ongoing at the time of writing. The substrates are maintained at the same total wet weight via manipulation of the irrigation regime and infested with batches of sciarid fly eggs. The production of adult flies that emerge from these eggs is being recorded over time.

Financial benefits

- Natural fungal infections of sciarid fly larvae and shore fly adults occur ‘free of charge’ to 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 *Furia* infections of sciarid fly larvae when monitoring for pests, particularly from autumn to spring. Infected sciarid fly larvae are opaque white, visible on the substrate surface and are relatively easy to spot.

Sciarid fly larva infected with *Furia sciariae* © ADAS. The shiny black head capsule is still visible at one end and the body is opaque white and covered with tiny spores

- Leave infected dead sciarid fly larvae on the surface of the substrate so that the fungal infection can spread.
- As the infection probably spreads better at lower temperatures (20°C), adjust the environmental growing conditions, if possible, to both favour development of the insect pathogenic fungi and delay development of any sciarid fly.
- If you need help recognising healthy or infected infected flies, contact Jude Bennison, ADAS Boxworth (tel. 01954 268225, email jude.bennison@adas.co.uk) who can send you more photographs and discuss them with you.
- If you have seen infected flies and we have not already contacted you about the project, please contact any of us below:

  Jude Bennison, ADAS, tel. 01954 268225, email jude.bennison@adas.co.uk
  John Buxton, ADAS, tel. 01886 822106, email john.buxton@adas.co.uk
  Gill Prince, Warwick HRI, tel. 024 7657 5040, email Gillian.Prince@warwick.ac.uk