Grower Summary

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

PC 283

Final report 2011

Project title	New approaches to microbial control of insect pests in protected crops and their interaction with waste-based growing media
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The following are members of the Consortium for LINK project no HL0193

Bulrush Horticulture Ltd

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Bordon Hill Nurseries

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Double H Nurseries

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Pinetops Nurseries

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Brosters Nurseries

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Koppert UK

-

Humber VHB (taken over by Vitacress in 2011)

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Fargro Ltd

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Swedeponic Ltd (re-named Lincolnshire Herbs in 2009)

GROWER SUMMARY

Headline

- Incorporating green compost into peat substrates can result in higher infestations of sciarid and shore flies. Incorporating wood fibre into the growing medium can also lead to higher numbers of sciarid flies.
- Sciarid fly populations develop faster as temperature is increased. 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. Spread of the fungus between sciarid flies is probably better at lower temperatures.
- Two commercial fungal biopesticides, Met52 available through an EAMU approval and Naturalis-L approved as a foliar spray for whitefly and thrips control, gave partial control of sciarid fly larvae.

Background

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 the 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 chemical pesticides approved for the control of fly pests on herbs). However, current IPM options do not always give sufficient control of sciarid or shore flies. Therefore additional measures are needed.

Alternatives to peat-based substrate

At present, most herb and ornamental bedding and pot plant crops are grown in peat based substrate. However, the industry is under pressure to reduce the use of peat and to find alternative, more sustainable alternatives. Potential ‘green’ candidate materials for incorporating into substrates are composted green materials, bark, wood fibre or coir. However, during the development this project, anecdotal evidence was received from growers that some of these materials were associated with greater fly problems.

Natural outbreaks of fungal pathogens of fly pests

In recent years, there has been increasing awareness of natural infections of insect pathogenic fungi in sciarid and shore flies. The infections in sciarid flies are caused by the fungal pathogen *Furia* and there was preliminary evidence that it causes “outbreaks” in

sciarid fly larvae that leads to high levels of mortality. This raises the possibility of using these fungal infections to help reduce fly populations as part of an integrated approach to crop management and provide a novel form of biocontrol.

Project aims

The project had two aims: (1) to develop novel methods of biocontrol for sciarid and shore fly pests on pot herbs and ornamental bedding and pot plants; (2) to investigate interaction between these novel methods and substrates containing "green" materials.

Summary of the project and main conclusions

Investigating natural outbreaks of fungal pathogens in sciarid flies and shore flies.

Grower surveys and nursery monitoring

Seventeen growers were interviewed about natural outbreaks of fungal pathogens of sciarid and shore flies on their nurseries. The growers produce either protected bedding and pot plants or protected herbs. In addition, monitoring of fungal infections was done by members of the project consortium at seven nurseries. The key points from this work are as follows:

- Outbreaks of the fungal pathogen *Furia sciarae* on sciarid fly larvae are widespread. Infections were found at 13 sites across the country. However fungal infected shore flies were found at only one site, on pot herbs in southern England. Nine out of 13 growers of ornamentals thought *Furia* was contributing to sciarid fly control.
- Fungal infections occur in larvae on the surface of the plant growing medium. Infections occurred with a wide range of plant species including begonia, cyclamen, poinsettia, primula, chives, mint and parsley. They occurred in a range of commercial growing media including standard peat-based media and peat mixed with other materials including green compost, wood fibre, bark, coir or perlite.
- Most of the growers considered high compost moisture and relative humidities to be key factors in favouring the incidence of *Furia* infections in sciarids. However, wet substrate also favours sciarid fly egg laying and larval development, thus providing more available host insects for the fungus.
- Sciarid fly larvae infected with *Furia* occurred at various times of the year, according to crop production times, e.g. in late summer / early autumn on poinsettia, late autumn to early spring on primula. 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 autumn and winter when the glasshouse was cool and the peat remained very wet. However, the fungus seems to occur at a wide range of temperatures, from very cold conditions in glasshouses with

only frost protection in winter (e.g. on primula), to summer glasshouse temperatures (e.g. on begonia and poinsettia).

- Although many growers commented that infected larvae were not usually seen until 4-6 weeks after potting, on pot herbs they were seen as early as two weeks after potting. The proportion of pots with infected sciarid fly larvae ranged from 1-5% to over 80%. Frequently all visible sciarid fly larvae were infected. Nine of the 13 growers who had seen infected larvae considered that *F. sciarae* had contributed to sciarid fly control.
- The extent of sciarid infection with *F. sciarae* was affected by the biological or chemical control measures being used against the pest. However *Furia* survived fungicide programmes used for disease control on protected ornamentals.
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Isolation of fungus from shore flies

The fungus causing natural outbreaks on shore flies was isolated and grown on a microbiological medium. The genetic code was then obtained from this fungus for a gene that is used widely for fungal taxonomy. This sequence was compared with those from other species of fungi. The analysis showed that the fungus was a species of the genus *Torrubiella*. *Torrubiella* is a sexually reproducing form of the fungal genus *Lecanicillium*, which is used as a commercial biopesticide (Mycotal ®) against other pests. It was an interesting and unexpected finding because this fungus is not normally associated with fly infections. The fungus has not been observed infecting shore flies in any other nursery and it is almost certainly a rare and unusual infection.

Isolation of Furia from infected sciarid fly larvae

Furia is a member of a group of fungi called the Entomophthorales that have evolved specific adaptations to the life cycles of their insect hosts, and which have particular nutrient requirements for growth. *Furia* produces spores ("ballisto-spores") that are discharged into the air from dead, infected sciarid larvae in order to infect other sciarid larvae. We observed that fungus-infected larvae came up to the surface of the substrate at night, died, and then *Furia* ballisto-spores were produced on them and actively discharged during the same night. The fungus was cultured from spores that were captured onto a specialised fungus medium.

Investigating interactions of Furia and sciarid flies

Furia mycelium was grown successfully in two liquid media used to culture insect cells. A laboratory "bioassay" was developed to measure the effect of *Furia* spores against sciarid larvae. The spores caused 11-83% mortality depending on the larval stage. Older larvae (L3-L4) had low mortality while younger ones (L1-L2) had high mortality.

Measuring the effect of other types of fungi against sciarid flies.

Laboratory bioassays were done to measure the effect of other types of fungi against sciarid fly larvae. Three fungi were tested: *Lecanicillium*, *Metarhizium*, and *Beauveria*, all of which are commercially available "biopesticides", used against other pests. These fungi are generally much easier to culture than entomopthoralean fungi but are not normally associated with fly infections, and unlike *Furia* they do not cause 'outbreaks' that can spread rapidly through an insect population. All the fungi reduced sciarid fly populations although the overall level of control was low (c. 25% - 40% for second and third stage larvae). The level of control increased with the age of the larvae, i.e. it was better when the fungus was applied to larvae than when applied prior to egg hatch.

Effect of different growing media on sciarid flies and shore flies

Selection of growing media.

At the start of the project, the consortium chose two different "alternative" media to compare against a standard peat-based medium in the research: green compost and wood fibre. To compare the effects of the two peat alternatives on sciarid and shore flies, it was decided to use 10% and 40% mixes, compared with a standard peat-based substrate suitable for growing ornamental bedding and pot plants and pot herbs. The green compost had a higher conductivity and higher levels of chloride and potassium than the standard substrate and the wood fibre substrate. The green compost also had higher moisture content. However, there were no visible differences in the amount of algae growing on each type of medium.

Measuring the attractiveness of growing media for insect egg laying and the development of insect larvae.

In a pilot experiment, pots of different substrates were placed in a glasshouse containing cyclamen plants naturally infested with shore flies. Significantly more shore fly eggs were found on the green compost than the standard substrate. The green compost had more algal growth on its surface, which may then have attracted shore fly females to lay eggs. A technique was then used that measured both the attractiveness of different substrates to adult sciarid and shore flies for egg laying and the subsequent survival of the eggs through to the adult stage. Experiments were done with five different substrates: Standard peat-based substrate suitable for growing bedding plants or pot herbs; 40% and 10% green compost; 40% and 10% wood fibre. More sciarid fly adults emerged from the 40% green compost than the standard peat-based substrate. More shore fly adults emerged from the 10% green compost than the standard peat-based substrate.

Measuring the attractiveness of the smell of different substrates for adult sciarid and shore flies.

Results of laboratory olfactometer tests indicated that sciarid fly adults were attracted to the smell of damp 40% green compost (but not a 15% green compost mix from a different supplier) and to damp 40% wood fibre mix. Shore fly adults do not seem to respond to olfactory cues from either fresh substrates or those on which algae has been allowed to grow. It is possible they respond to visual rather than olfactory cues.

- Measuring the effect of different substrates on the development of sciarid and shore fly larvae. Known numbers of sciarid or shore fly eggs were placed on three different substrates (standard peat-based substrate, 40% green compost and 40% wood fibre mix) and the percentage survival of the eggs was measured through the larval stage to the emergence of adult flies. Earlier work had shown that green compost had higher moisture content than the wood fibre mix or the standard peat based medium. Therefore, for these experiments, the wet weight was adjusted to be the same for all three substrates. More sciarid flies survived from egg to adulthood on 40% wood fibre mix than on the other two substrates. More shore flies developed from egg to adult on 40% green compost than on the other two substrates at the same moisture content.
- The effect of temperature on the development of sciarid flies. Experiments were done to measure the rate of development of sciarid flies (*Bradysia difformis*) from egg to adult in peat-based medium at different temperatures. Total development time was inversely proportional to temperature, with the shortest development time being at 30°C. At the lowest temperature studied, 10°C, eggs hatched slowly but the larvae did not complete their development. At temperatures of 20°C or below, larvae spent more time on the surface of the medium 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 data obtained in this experiment could be used in a mathematical model in future work to forecast the development of sciarid fly populations. This could be used to help inform the timing of pest control treatments.
- Compatibility of *Furia* with fungicides. An experiment was done to measure the effect of six different fungicides on the growth of *Furia* mycelium on agar-based medium: Rovral (iprodione), Filex (propamocarb hydrochloride), Octave (prochloraz), Fubol Gold (mancozeb + metalaxyl-M), Aliette (fosetyl-aluminium), and Cercobin (thiophanate-methyl). They all inhibited the growth of *Furia* with the exception of Filex which increased growth at 0.1 x and 1 x the recommended application rates.

Main conclusions

- Growing media based on a wood fibre mix are likely to lead to the development of larger sciarid fly populations than a standard peat mix at the same moisture content.

- Substrates based on a green compost are also likely to support increased populations of sciarid flies and shore flies. In the case of sciarid flies this may be as a result of a higher water content in the substrate.
- Sciarid fly adults are attracted to the smell of damp 40% green compost (but not 15% green compost from a different supplier) and to damp 40% wood fibre mix. Shore fly adults do not seem to respond to olfactory cues from either fresh substrates or those on which algae has been allowed to grow. It is possible that shore flies respond to visual rather than olfactory cues.
- Surveys from commercial nurseries show that outbreaks of the fungal pathogen *Furia sciarae* on sciarid fly larvae are widespread and contribute to sciarid control. The amount of natural infection is linked to the size of the sciarid fly population. The outbreaks are affected by the biological or chemical control measures being used against sciarid flies. Although fungicides inhibit the growth of *Furia* in the laboratory, on nurseries the infections seem to survive fungicide programmes commonly used for disease control on protected ornamentals.
- The *Furia* fungus was isolated from infected sciarid fly larvae. A method was developed for producing spores of the fungus. The fungus caused high levels of mortality in sciarid larvae in laboratory experiments.
- A fungus that causes natural infections in shore flies was identified as a species of *Torrubiella*. This is closely related to *Lecanicillium*, a fungus used as a commercial biocontrol agent against other pests (Mycotal ®). Infections by *Torrubiella* were only found on one nursery. The reasons for this are not known.

Financial impacts

- Wider adoption of wood fibre mixes by growers is very likely to result in greater problems with sciarid flies. This will require growers to put more resources into pest management.
- Increased use of green compost is also likely to result in greater problems with sciarid flies and shore flies. In the case of sciarid flies, increased fly numbers are probably linked to the higher water content of green compost. Growers should carefully manage the moisture content of the substrate in order to help prevent fly populations building up, or where this is not practical e.g. in propagation, they should put more resources into preventive or curative treatments. At present there are no chemical pesticides approved for fly pests on herbs or for shore fly control on any protected crop, hence preventive and curative treatments will have to be done using biocontrol methods.
- The fungal pathogen *Furia* causes natural disease outbreaks in sciarid fly populations and hence it gives “free” pest control. We are not yet at a stage where we can recommend methods for increasing the effect of these natural outbreaks or use the fungus as a “biopesticide” by applying it onto the crop. However we have made significant advances towards these goals.

Action points for growers

- If using growing media based on a wood fibre mix or a green waste compost, then expect greater problems with fly pests. Put more resources into pest monitoring and biological control. Carefully monitor the water content of the medium and reduce it if possible to restrict the development of fly larvae. However, do not allow the substrate to dry out as this will also reduce the efficacy of biological control agents.
- Look out for natural fungal infections of *Furia* on sciarid fly larvae when monitoring for pests. Infected sciarid fly larvae are opaque white, and visible on the compost surface. Leave infected dead sciarid fly larvae on the surface of the growing media so that the fungal infection can spread. Infections are more likely to occur in propagation houses or in production areas where the conditions are wetter.