Grower Summary

SF 139

Semiochemical control of raspberry cane midge

Annual 2014

Disclaimer

The results and conclusions in this report may be based on an investigation conducted over one year. Therefore, care must be taken with the interpretation of the results.

Use of pesticides

Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.

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

Read the label before use: use pesticides safely.

HDC is a division of the Agriculture and Horticulture Development Board.

Project Number:	Semiochemical control of raspberry cane midge
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Further information

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GROWER SUMMARY

Headline

- The female raspberry cane midge pheromone has been synthesised and is being used in developing novel attract and kill technology for this raspberry pest.

Background and expected deliverables

The use of pheromones and other semiochemicals to lure pests such as midges to traps that can then be routinely checked has gone a long way to helping growers time the application of crop protection sprays more precisely. The female sex pheromone of raspberry cane midge was identified in a Defra Horticulture LINK project several years ago and is now available to use to monitor the emergence and numbers of male cane midges.

This project, again funded by Defra and HDC, wants to take the approach one step further by designing a means of attracting and then killing male cane midges. Using semiochemicals in the way, not just to lure the pest but to control it, will involve registering any commercial formulation developed as a result with the Chemicals Regulation Directorate.

Volatile chemicals generated by raspberry canes after they have split will attract female midges looking for sites where they can lay eggs. Some of these chemicals have been identified in an HDC studentship project. The project team will see whether releasing such chemicals artificially in plantations could disrupt the female midges' search. If it does, East Malling Research and the Natural Resources Institute will find which blend of chemicals is most attractive to the females and a practical way of using it in the field. They will also explore whether it could be used alongside the attract-and-kill methods for male midges.

A new experimental facility consisting of 12 large field cages have been consttructed at East Malling Research for the purposes of this project so different control methods can be tested in replicated experiments at different pest population densities.

The specific objectives of this project are to:

1. Develop a suitable formulation for sustained and adequate release of the raspberry cane midge pheromone for competitive mating disruption (MD) or attract and kill (A&K).
2. Investigate inclusion of an insecticide for enhancing efficacy through kill of male

midges when they contact the dispensing formulation or a target device, i.e. determine whether an A&K formulation can be developed which is likely to give better results than MD.

3. Determine the optimum number and release rate of MD or A&K sources/ha and how efficacy is affected by population size.
4. Determine whether cane split finding by female raspberry cane midge can be disrupted by artificially provided host volatiles and optimise the blend for doing so.
5. Determine the optimum number and release rate of host volatile sources/ha for disrupting and how efficacy is affected by population size.
6. Develop a host volatile dispensing formulation for practical use.
7. Evaluate the efficacy of the sex pheromone and/or host volatile formulations in the field, alone versus in combination, in comparison with untreated and standard grower insecticide controls.

Summary of the project and main conclusions

In the first year of the project, progress was made in Objectives 1 to 4 as follows:

Objective 1 - Develop a suitable formulation for sustained and adequate release of the raspberry cane midge pheromone for competitive mating disruption (MD) or attract and kill (A&K).

The female sex pheromone of the raspberry cane midge was synthesized at the Natural Resource Institute (NRI) and release rates of the pheromone from the commercially-available wax emulsion (SPLAT, ISCA Technologies, USA) formulation were measured under laboratory and field conditions. Release continued for at least two months and three months respectively, indicating the formulation was very suitable for use with this pheromone.

Formulations containing the raspberry cane midge pheromone at various loadings combined with deltamethrin or abamectin insecticides were made up and provided to EMR for testing. The pheromones of the blackberry midge and of the predatory midge *Aphidoletes aphidimyza* were also synthesized and provided in similar formulations. The formulation for the apple leaf midge was also available.

Objective 2 - Investigate inclusion of an insecticide for enhancing efficacy through kill of male midges when they contact the dispensing formulation or a target device, i.e. determine whether an A&K formulation can be developed which is likely to give better results than MD.

A range of experiments were conducted including behavioural bioassays, laboratory pesticide bioassays and field trials in order to develop suitable formulations for MD and A&K.

Wind tunnel bioassays were done to investigate the behaviour of midges to different pesticide formulations associated with a pheromone. As raspberry cane midge cannot be reared in the laboratory and to ensure a continuous supply of midges, the predatory midge *Aphidoletes aphidimyza*, which is readily available year round from biocontrol suppliers, was used as a model species as it can be commercially supplied as pupae.

The pheromone of *Aphidoletes aphidimyza*, (2R, 7S)-diacetoxytridecane, was synthesised stereospecifically in six steps at NRI. Attempts were made to develop a still air and a wind tunnel bioassay method for testing formulations using this midge and its pheromone but though the midge sometimes responded to a 10 ug pheromone lure, the bioassays were very time consuming and gave inconsistent and inconclusive results.

Deltamethrin, a synthetic pyrethroid (SP), was chosen as the attract and kill insecticide because SPs have rapid knockdown and the parent company, Bayer agreed to support the project. Their Decis formulation containing deltamethrin as an active ingredient (25 g/l EC) is approved and used in raspberry in the UK. Decis is also used as a coating inside the lid of a trap (the Decis trap) for the Mediterranean fruit fly in S. Europe.

Field experiments were done in two commercial raspberry plantings to test different pesticides and formulations in a standard trapping vessel (Droso trap). Discs of plastic (2 cm) from the roof of a Decis trap (Bayer, UK) coated on one side with the pyrethroid insecticide deltamethrin, were attached to rubber septa lures loaded with either raspberry cane midge or blackberry leaf midge pheromone and these were attached inside the trap which was hung at a low height in the planting. Midges were observed throughout the day, with following assessments. Whilst midges were significantly attracted to the traps containing pheromone, there was no significant mortality. This may have been because the midges were able to fly out of the trap and were then subsequently affected.

Further experiments investigated deltamethrin and abamectin in a wax emulsion formulation (SPLAT, ISCA, CA). This type of formulation provides long-term rain and UV protection for the pheromone and active ingredient. It is biologically inert and bio-degradable. Release rates can be varied by changing the size of the dollop. It can also be applied by a number of methods and it is feasible for a grower to apply as a high number of point sources. Tests of 0.4 g dollops of the formulation loaded with 0.1% deltamethrin (exp. 1) or with either 1% deltamethrin or 1% abamectin (exp. 2). In both replicated field experiments two midge species were tested; raspberry cane midge and blackberry leaf midge pheromone in field. Again, the midges were attracted to the traps containing pheromone, but no additional significant mortality was seen in traps containing pesticide.

To ensure that there was no repellent effect of the wax emulsion formulation with a pesticide incorporated, videos were taken of wax emulsion dollops in the field which had a species specific pheromone and with and without a pesticide. This was done for the blackberry leaf midge, the raspberry cane midge and the apple leaf midge. Midges were seen to walk on and around the wax emulsion when it had dried (1+ days), in some cases for at least a minute. Midges only momentarily touched the formulation when it had been freshly extruded and was still wet.

Laboratory bioassays showed that a long exposure (5 minutes) to 1% deltamethrin in the wax emulsion formulation significantly increased the percentage of *A. aphidimyza* affected (with twitching or mortality) reaching 100% after an hour. However shorter exposure times (60 secs & 5 secs) typical of those that may be seen in a field situation affected less than 50% of individuals. SPLAT technology therefore has a good potential for mating disruption but is not suitable for A&K with 1% deltamethrin in the current formulation. Further bioassays showed that the deltamethrin formulation as used in the Decis traps affected 100% of the midges within one hour of a five second exposure, with 50% of those individuals developing symptoms 20 minutes after exposure. This could have a good potential for A&K midges.

Objective 3 – Determine the optimum number and release rate of MD or A&K sources/ha and how efficacy is affected by population size.

An initial experiment was done in the new cage facility to look at blackcurrant leaf curling midge. Twelve cages were constructed, each 12 m x 1.5 m x 2 m (LxWxH) in size. These were separated by 24 m. Each cage contained ten potted blackcurrants (cv. Ben Dorain) placed in a zig-zag linear formation. Plants were placed into the cages on 11 June 2013 and were watered by drip irrigation to each pot. The experiment was set up in randomised block design with three replicates of four treatments. Treatments were:

1. Yellow stick card (8 cm x 10 cm) + lure with 20 ug pheromone recemate
2. Yellow sticky card (8 cm x 10 cm) + lure with 5 ug pheromone enantiomer
3. Yellow sticky card (8 cm x 10 cm)
4. Untreated control

The double-sided yellow sticky cards were attached to the outer edge of each pot with the lure placed into a hole made by a single hole punch in the centre top of the card. Treatments were deployed as soon as plants were introduced to the cages. The number of curled shoots per plant was counted on 29 June and 9-11 July 2013. The numbers of leaf midges on the inside and outside of the sticky traps were counted per pot, in each cage for each generation of midge on 2 and 16 July 2013. Data were analysed using ANOVA.

There was no significant effect of either pheromone blends or yellow sticky traps on resultant damage by the blackcurrant leaf midge (Table 1). There were low midge numbers caught on the sticky traps, 2-5 per cage on 2 July and 0-3 per cage on 16 July, although this may have been due to effectiveness of the trap glue.

Table 1 Effect of pheromone blends and sticky traps on damage by blackcurrant leaf midge

Treatment	Mean curled leaves per plant 29 June	Mean curled leaves per plant 11 July	Mean
Sticky trap + racemate	2.0	6.2	3.7
Sticky trap + enantiomer	3.9	8.2	5.2
Sticky trap	3.5	6.8	4.0
Control	2.4	6.4	4.0

Studies in 2014 on the raspberry cane midge will compare MD with 5,000 0.4 g dollops containing 0.5% pheromone per ha, A&K with 5,000 Decis trap formulation + pheromone per hectare, MD with 1,000 2.0g WE dollops with 0.5% pheromone per hectare and an untreated control.

Objective 4 - Determine whether cane split finding by female raspberry cane midge can be disrupted by artificially provided host volatiles and optimise the blend for doing so.

The experimental planting was established with three raspberry varieties, Glen Moy, Autumn Bliss and Glen Clova, to enable this work to be done in Year 2. Potted plants were also established for Year 2 work in the cage facility.

Fourteen compounds have been shown to be released by raspberry canes on splitting and are anticipated to be involved in attracting the female raspberry cane midge to suitable sites for oviposition. These have been identified and slow-release formulations have been developed for all or sub-sets of these compounds to test in the field.

Work in 2014 will compare the effect of sachets containing these compounds at high and low rates (either one or three sachets per plant) in sachets containing the best 3-5 compounds and an untreated control on female disruption.

Financial benefits

The development of A&K technology and host volatile disruption techniques, would allow growers to reduce reliance upon the use of traditional crop protection products applied as an overall spray to raspberry crops. This would help to avoid the risk of chemical residues appearing in harvested fruit and reduce the cost of labour required to make such spray applications.

Action points for growers

- At this early stage in the project, there are no action points for growers.