Grower Summary

TF 181 (HL 0194)

Exploiting semiochemicals, conservation biocontrol and selective physical controls in integrated management of pear sucker

Final year 2012

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Further information

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Project Leader:	Professor Jerry Cross
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Headline

Growers should conserve nettles, willow and hazel trees in the vicinity of pear orchards to act as early season sources of anthocorids and other important pear sucker natural enemies and consider planting these if they are not present.

Background and expected deliverables

Pear sucker is a devastating pest of pears which cannot currently be effectively and reliably controlled by UK growers. This project aims to combine exploitation of semiochemicals, conservation biocontrol and selective physical controls to develop improved Integrated Pest Management methods for the pest. It was thought that a pear sucker sex pheromone possibly exists and could be identified providing a tool for monitoring pear sucker populations and, more importantly, a possible means of control of the pest by mating disruption, mass trapping or attract-and-kill approaches. Anthocorid bugs are known to be powerful predators of pear sucker and can naturally regulate pear sucker populations but they do not over-winter in pear orchards and their influx in spring is often inadequate or too late. There is an opportunity to improve the species composition of hedgerows/windbreaks and develop management methods for a greater, more-timely influx. Extensive underpinning research in the Netherlands has identified a number of volatile substances produced by foliage infested with pear sucker that attract anthocorid predators. Two of the compounds are inexpensive and readily available and lures containing one of these have been shown to be attractive. It may prove possible to exploit these to enhance further the influx of anthocorid predators. Growers currently use spray programmes of chemicals that are considered to act physically to control pear sucker, including high volume sprays of water and wetters, sulphur and magnesium sulphate. The treatments used are not evidence-based; life stages against which they act, their relative efficacy, optimum concentrations and, crucially, effects on anthocorids have not been determined. Careful experimental investigation through laboratory and field testing should enable the value of these treatments to be determined and selection and optimisation of treatments to avoid disruptive effects on natural enemies.

Summary of the project and main conclusions

Objective 1. Identify and exploit the pear sucker sex pheromone for pest monitoring

The project's first surprising finding was that the species of pear sucker attacking intensively managed pear orchards in the UK is Cacopsylla pyri and not C. pyricola, the species which was dominant when surveys were last done in the 1970s. C. pyri has long been the dominant

species in continental Europe and it may be speculated that resistant strains have spread from Europe, possibly on nursery trees. A mixture of the two species now often occurs with C. pyricola being predominant in less intensively managed orchards. The implications of this finding have not yet been ascertained. The two species have very similar, though not identical, life cycles and attack pears in the same ways. It is possible that C pyri, a slightly larger species, is more resistant to insecticides than C. pyricola. A detailed analysis of the life tables of the two species and their susceptibilities to insecticides is needed to better understand them.

As a consequence of this early project finding, it was decided at the outset to focus effort on identifying the sex pheromone of C. pyri rather than C. pyricola. To attempt to identify the pheromone, numerous collections of body washings of volatiles were made from groups of winter and summer-form males and females alone or feeding on pear foliage. Exhaustive chemical and electrophysiological analyses of numerous samples were done. Despite this, no sex specific compounds that might be components of a sex pheromone could be identified. Work in the USA claimed 13Me-27:H an involatile cuticular hydrocarbon, to be the sex pheromone of C. pyricola. This compound was found in this work to be present on the cuticle of C. pyri but present in similar quantities in both males and females. The fact that it was present in similar quantities in both sexes and that it is involatile indicated to us that it was probably not a sex pheromone and the US claims were erroneous. However, the compound was synthesised, dispensers made and tested in sticky traps (similar to those used in the USA to test attractancy) in pear orchards where both C. pyricola and C. pyri were present. Considerable numbers of both species were caught in traps, but this was by random chance, there being no statistical difference in the numbers of males and females caught. Furthermore, the research was unable to demonstrate attraction of males to females or vice versa. In addition, no consistent EAG responses were observed when males were exposed the proposed pheromone of C. pyricola 13Me-27:H or to hexane washed off C.pyri females. This led us to the conclusions that a sex pheromone is unlikely to exist or if it does exist it is very weak and transitory, and that the identification of 13Me-27:H in the USA is almost certainly erroneous.

Recently, acoustic signalling has been shown to be a means of sexual attraction in various species of planthopper and psyllid so finding ways of using the sounds these pests make, may offer a more fruitful avenue of research.

Objective 2. To develop conservation biocontrol methods to maximise anthocorid populations and other natural enemies of pear sucker

An important aim of this work was to identify trees and herbaceous plants that could be provided round the borders of pear orchards and which could act as sources of the pear sucker's important natural enemies, anthocorid predatory bugs. It was known that these predators did not over-winter in significant numbers in pear orchards and the aim was to identify other plants which were rich sources of them in early spring when pear sucker egg laying commences and throughout the growing season. An important realisation at the outset was that though 2 species of anthocorid (Anthocoris nemoralis and A. nemorum) occur on pear and are both important predators of per sucker, A. nemoralis was adapted and had a preference for feeding on psyllids which occur on certain trees early in the season, whereas A. nemorum has a preference for feeding on aphids which tend to occur slightly later.

At the outset of the project, three new experimental hedgerows over 200 m long and comprising replicate 8 m plots of 12 different native tree species were planted on the farms of three grower consortium members. While these established in the first two years of the project, arthropod faunal surveys were done on a wide range of different tree species and on stinging nettles in three old established hedgerows around existing pear orchards. In the first year, 24 different species were sampled through the season to determine the abundance of anthocorid and other predators, of other psyllids and aphids which might act as food sources for anthocorids and of other specialist predatory bugs that might compete with anthocorids for these sources of food. Grey and pussy willow, hawthorn, hazel and stinging nettle were identified as by far the best sources of anthocorids as well as being rich sources of other important pear sucker natural enemies including ladybirds, earwigs and spiders. Alnus cordata widely used as a windbreak was found to support very few predators. The best subjects were studied in greater detail in the later years of the project, the seasonal population dynamics of the predators and prey being determined on each. Work on the purpose planted hedgerows in the final years of the project confirmed the earlier findings, but indicated that it could probably take 6-10 years for characteristic arthropod fauna to establish after planting, though some dominant species colonised early.

Mark and capture experiments using monoclonal antibody detection methods to study the movement of anthocorid predators from nettles in hedgerows adjacent to pear orchards and within pear orchards showed the predators could disperse over a distance of at least 50 m in a single day.

Observations of predators feeding on pear sucker in orchards, clearly indicated that although anthocorids were highly mobile with a comparatively fast numerical response to pear sucker infestations, they have only a low prey consumption rate as their body size is small compared to pear sucker. Earwigs, though much less mobile and slower to increase, showed much higher consumption rates and it suspected that pear sucker is only a problem where earwig numbers are low or where they are absent, possibly due to inappropriate pesticide use. Spiders, especially Phylodromus sp., and ladybirds, especially the Harlequin ladybird, were also observed to be very important pear sucker predators.

This work as a whole has led to recommendations for pear sucker management with a new emphasis on providing the correct plant species in hedgerows/windbreaks, avoiding large orchards where sources of predators are too distant, and use of only the safest pesticides to important pear sucker predators. These recommendations have been strongly communicated to UK pear growers and recognised as being of the highest importance.

Objective 3. To exploit synomones (of pear foliage fed on by pear sucker) to attract anthocorids into pear orchards in spring

Previous work in The Netherlands had shown that pear sucker infested pear trees are strongly attractive to anthocorid predators. Volatiles were collected from pear foliage infested with pear sucker adults and nymphs both in the laboratory and field. Chemical analysis (GC-MS) and link GC-electroantennagramme analysis was conducted using anthocorid antennae. Analysis of collections from foliage showed no consistent differences with, versus without pear sucker. Volatile compounds identified at the highest concentrations were ocimene, (Z)-3-hexenyl acetate, linalool oxide, copaene, linalool, caryophyllene, δ-cadinene, α-farnesene, methyl salicylate and eugenol. Of these (Z)-3-hexenyl acetate, α-farnesene and methyl salicylate had been identified in the previous Dutch research. GC-EAG analyses of synthetic compounds with Anthocoris nemoralis showed consistent EAG responses to decanal and methyl salicylate and occasional responses to (Z)-3-hexenyl acetate and 2-phenylethanol. GC-EAG analyses of volatiles collected from pear seedlings with Anthocoris nemoralis showed EAG responses to decanal, and methyl salicylate and also to δ-cadinene. Lures containing methyl salicylate, phenyl ethanol or farnesene were not attractive to anthocorids in field trials, though the sex pheromone of the vine mealy bug, lavandulyl senecioate, was weakly attractive to Orius sp.. This latter compound was tested on the advice of Suterra following observation where the vine mealy bug lures had been used in Europe. Methyl salicylate had been shown to be attractive to hoverfly adults in previous experiments. Regrettably no synthetic synomone attractant was identified but the scope for extensive

further work investigating blends and release rates of the compounds identified was highlighted.

Objective 4. To identify the most effective physically-acting spray treatment of those used currently that is safe to anthocorid predators and to determine optimum concentration and spray cover requirements

A series of lab and field experiments were done to investigate the efficacy of magnesium sulphate, sulphur, various adjuvants and kaolin for control of pear sucker. It is common practice for growers to apply sprays of these materials, the former three in admixture, to control serious outbreaks of pear sucker. The work showed that magnesium sulphate and sulphur had little direct insecticidal effect on pear sucker but non-ionic and silicone wetters did, especially when used at high concentrations. Trials also showed that early season sprays of kaolin greatly reduced egg laying by over-wintering adults in early spring having lasting results on the populations well into the summer. Kaolin may also deter egg laying by anthocorids so later applications are not recommended. Further laboratory work showed that the above materials were relatively safe to eggs and nymphs of Orius and Anthocorid bugs. This work identified new safe and effective treatments for pear sucker control which are already being used in the industry.

Objective 5. To transfer the results of the research to UK pear growers in a series of workshops as part of a wider focus on improving and increasing UK pear production

Two one day pear conferences focussing on UK pear growing were organised by English Apples and Pears, Sainsbury's and East Malling Research. At each conference the results of the project were reported.

25 February 2010: 'Pear growing for the future'

Programme: The UK pear market and industry (Adrian Barlow, English Apples and Pears Ltd); Retailer / customer perspective (Theresa Huxley, Sainsbury's Supermarkets Ltd); Improving pear growing at A Scripps Ltd (James Simpson, A. Scripps Ltd); Limiting factors in UK pear growing (Tim Biddlecombe, FAST Ltd); The economics of intensive pear production (Wouter van Teeffelen, WTE Fruitadvies, NL; Visit to concept pear orchard at EMR; The Concept Pear Orchard (Francis Wheatley, Chingford Fruit Ltd, Henk Nooteboom, NL); Pear breeding for the "Alternative Variety"(Jean Paul Reynoird, Pepinieres Georges Delbard, FR); Application of water research at EMR to pear growing (Mark Else, EMR) Pear sucker research (Jerry Cross, EMR); Conclusions: Changing pear industry attitude and investment (Discussion led by Adrian Barlow, English Apples and Pears)

27 February 2012 'Profitable pear production in the UK'

Programme: The UK market and pear industry (Adrian Barlow, English Apples and Pears); Retailer/customer perspective (Theresa Huxley, Sainsbury's Supermarkets Ltd); Experiences of growers (Clive Baxter, Tony Frankum, Michael Bentley, Tom palmer, Oliver Doubleday); The concept pear orchard at EMR (Francis Wheatley, Chingford Fruit); Economics of pear production (David Knight ARC Agriculture); Optimising the performance of Conference (Leon Jahe, Agrovista); Pear sucker management (Jerry Cross, EMR); Application of water research at EMR to pear growing (Mark Else, EMR)

Both of these conferences were very well attended with 80 and > 100 delegates, respectively. Good feedback was received after the conferences indicating that they both had a significant effect on grower's attitudes towards pear growing in the UK. At both conferences, the outcomes of this HortLINK project were strongly communicated, the presentation at the second conference setting out important requirements and changes needed for successful pear sucker management based on the findings of this project, which is vital to the future success of the UK pear industry.

Main conclusions

- Pear sucker is a man-made pest caused by monoculture and inappropriate use of pesticides that are harmful to pear sucker's natural enemies.

- A wide range of generalist predators are important for naturally regulating pear sucker populations including anthocorids, earwigs , ladybirds and spiders.

- Pear sucker is not a problem in orchards where earwigs are sufficiently abundant.

- The paramount importance of avoidance of the use of broad-spectrum pesticides is stressed and adoption of a precautionary approach of only using pesticides which are known with certainty to be safe to anthocorids and earwigs.

- Growers should conserve nettles, willow and hazel trees in the vicinity of pear orchards to act as early season sources of anthocorids and other important pear sucker natural enemies and consider planting these if they are not present. Hawthorn is also an excellent source of predators, though if it is used it should be regularly inspected and managed to avoid the risk of fireblight.

- Large orchards should be avoided. Ideally all parts of a pear orchard should be <50 m from hedgerow/windbreak sources of natural enemies.

Financial benefits

Losses to the UK pear industry due to pear sucker, which vary considerably from season to season depending on weather conditions, have not been quantified but the pest is present in every commercial pear orchard, many orchards suffering regularly. Assuming 10% of the crop is forgone as a result of these infestations, this is equivalent to 2,300 tonnes of pears, worth £2.9 m per annum. Additionally, a substantial number of young trees in newly planted orchards become infected with the pear decline phytoplasma vectored by pear sucker and a number of orchards are so badly attacked by the pest that they have become unviable and have to be grubbed. Loss and replanting of 25 ha of pear orchards per annum, directly or indirectly, as a result of pear sucker, costs the UK industry a further £1.3 m per annum. Additionally, growers typically spend £200 per ha on pesticides to control pear sucker though this amount rises steeply (to up to £500 per ha) if a problem arises. The cost of control of pear sucker to the industry is estimated to be approximately £0.5 m per annum. Thus the grand total costs of the pest to the industry are in the region of £5 m per annum.

The work is highly relevant to the UK pear industry which has suffered grievously from pear sucker which has developed resistance to most pesticides. Growers realise and have learnt from bitter experience that they cannot reliably control pear sucker with pesticides. The UK only produces less than 20% of the pears that it consumes nationally and there is substantial scope for increase in UK production, as was strongly identified and highlighted in both the Pear conferences held as part of this project. Reliable pear sucker management is a key to future investment in the UK pear industry. The findings of this project have provided growers with clear and sound guidelines on how to manage pear sucker.

Action points for growers

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- Large orchards should be avoided. Ideally all parts of a pear orchard should be <50 m from hedgerow/windbreak sources of natural enemies.

- Sprays of dormant season kaolin give good suppression of the first generation of pear sucker nymphs.

- Cacopsylla pyri is now the dominant pear sucker species in intensively managed pear orchards in the UK, whereas C. pyricola was the dominant species when surveys were last done in the 1970s. The implications for this for pear sucker management are not understood but it may be that C. pyri is more resistant to insecticides. A pear sucker species identification guide is available from Jerry Cross or Michelle Fountain at East Malling Research (Email: jerry.cross@emr.ac.uk; michelle.fountain@emr.ac.uk, Office: 01732 523748).

Further publicity of results

The results of this project have been strongly publicised to UK pear growers and especially to the five grower members of the consortium, including at the two specially organised pear conferences. It has been agreed with the HDC that a new HDC factsheet will be produced in 2012 based on the findings of the project.