Project title:	Screening novel molecules for control of carnation tortrix moth and light brown apple moth caterpillars in hardy nursery stock.
Project number:	HNS 130
Project leader:	John Buxton, ADAS Rosemaund
Report:	Year 1 Annual: August 2005
Previous report:	N/A
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Date project commenced:	1st August 2004
Date project completion:	31st May 2006
Key words:	Integrated pest management, Hardy nursery stock, carnation tortrix moth, light brown apple moth, Insegar, Calypso, Conserve, Runner, Nemasys F, fenoxycarb, thiacloprid, spinosad, methoxyfenozide.

Authentication

I declare that this work was done under my supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

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Headlines

- Natural survival rates of Carnation tortrix moth larvae were too low during trials in 2004 for treatments to be effectively assessed.
- The experimental methods have been reviewed and altered to improve the success of the trials in 2005.

Background and commercial objectives

Carnation tortrix moth and light brown apple moth have increased in incidence and significance over the past 5 years, and can cause serious damage to a wide range of protected nursery stock, especially evergreen species such as Laurel, *Daphne, Choisya, Pyracantha and Ligustrum*. Larvae feed within growing points by tying them up with silk, leading to loss of quality and crop vigour. Over the summer months, there can be several generations of these pests, and insecticide sprays may be needed at regular intervals in order to achieve control. Where IPM programmes are being used, control is especially difficult because compatible insecticides such as Dipel (*Bacillus thuringiensis*) are only persistent for a few hours, or give inadequate control. Broad spectrum insecticides such as deltamethrin (Decis) or cypermethrin (Toppel) give better control, but are not compatible within IPM. Over the last few years, a range of newer, effective, IPM compatible insecticides has become available in the UK.

The commercial objective of this project is to evaluate five new IPM compatible insecticides against carnation tortrix and light brown apple moth in nursery stock.

Summary of the project and main conclusions

A culture of carnation tortrix moth was successfully established at ADAS Rosemaund, and a replicated trial to test five IPM compatible insecticides was carried out during the latter half of 2004. The products chosen were;

1. Spinosad (Conserve), a novel new insecticide with activity against Western flower thrips, and with a label recommendation for use on protected ornamentals. As the product Tracer, it is also labelled for control of several caterpillar pests on top fruit.
2. Thiacloprid (Calypso). This neonicotinoid insecticide has contact and systemic activity and is also labelled for control of top fruit pests, but has an off label (SOLA) for control of a range of pests of protected ornamentals.
3. Fenoxycarb (Insegar). A novel juvenile hormone analogue product labelled specifically for the control of caterpillars on top fruit.
4. Methoxyfenozide (Runner), a moulting accelerator compound which again is labelled for caterpillar control in top fruit.
5. Nemasys F (*Steinernema feltiae*). This nematode has shown activity against Western flower thrips and also leaf miner larvae in protected ornamental crops and may show activity against carnation tortrix larvae in growing points of nursery stock.

All these products were selected because they show good to moderate compatibility within IPM systems.

The work so far has been inconclusive, as larval survival on untreated plants was too low to allow evaluation of treatment effectiveness. The methods used involved artificial inoculation of newly hatched larvae onto the test plants but survival using this method was poor.

However, useful information on the biology of carnation tortrix was obtained, from the experiment particularly the process of hatching of egg masses, and dispersal of the first instar larvae.

Work will continue in 2005, using different experimental methods.

Financial benefits

Successful trials will provide growers with more effective IPM compatible products for tortrix control. There may be potential for reducing the spray interval required, which would help reduce the cost and time of treatments.

Action points for growers

- Use Pheromone traps to monitor numbers of adult moths as they can be very helpful in aiding decisions on spray timing. Growers also need to monitor crops regularly for signs of larval infestation, because early recognition will lead to improved control. Look for larvae inside growing points and leaves tied together with silk.
- If damage increases and the IPM compatible products such as Dipel, or Dimilin are not providing control, then use a Pyrethroid product such as Decis (deltamethrin), or Toppel (cypermethrin). These products are very effective and will provide a high level of control after several sprays, but they are highly persistent and leave toxic residues on the plants, meaning that IPM cannot be used for the rest of the season.
- Newer insecticide products, such as Conserve, Runner, Steward and Calypso may provide improved control, and /or allow the interval between spray applications to be extended, thus saving costs.. However, the results from 2004 trials have been inconclusive due to poor pest survival. Later trials should hopefully allow these new IPM compatible materials to be fully evaluated.

Science Section

Introduction

The carnation tortrix moth (*Cacoecemorpha pronubana*) is a widespread and polyphagous Tortricid pest in all many areas of the UK, especially on protected nursery stock, although it is not an indigenous pest. It is endemic to Mediterranean regions such as the South of France (winter, 1982). However, it has now spread to Northern Europe and survives the winter as caterpillars or pupae in protected structures. In the South West of England, a related tortricid species, the light brown apple moth (*Epiphyas postvittana*) is found, and this has displaced carnation tortrix in these areas. This species is endemic to Australasia, but has been present in the UK for over 30 years (Shaw, 1981). The larvae of these two species are very similar in appearance, but the adults are readily distinguishable. The female of each species produces a specific sex pheromone, which is used as an attractant in monitoring traps.
With the trend towards increasing the area of nursery stock under protection, environmental conditions are suited to a rapid build up and increase in damage from these two species during the summer months. The larvae feed in the growing points of a wide range of evergreen shrubs, such as Laurel, *Choisya, Daphne, Pyracantha*, and *Ligustrum*. Larvae spin up in a silken web and often tie leaves together, making spray penetration difficult. This has caused problems for UK containerised nursery stock growers with control measures, especially where biological control programmes for other pests such as two-spotted spider mite are in place. The most effective insecticides against the tortricids are very harmful to the biological control programme, and so cannot be used.

Native parasites do attack both species, and the Eulophid wasp species *Elachertus artaeus* was identified from carnation tortrix larvae obtained from a nursery in 2004 (Lole, pers comm). Other species of parasite, including *Triclistus* and *Meteorus* have been identified from light brown apple moth (Shaw, 1981). However, these parasites seem unable to regulate the tortrix population and serious plant damage is a regular occurrence in UK nurseries.

Products used currently for control of both tortricids within IPM programmes include *Bacillus thuringiensis* (Dipel), diflubenzuron (Dimilin) and teflubenzuron (Nemolt). Dipel is specific to caterpillars and so safe to most biological control organisms, but has little persistence and is most effective against young caterpillars. Burgess and Jarret (1978) found that higher than label rates of Dipel were needed to obtain effective control of carnation tortrix larvae. Dimilin and Nemolt are chitin synthesis inhibitors and are also fairly safe to biological controls. They act by inhibiting the moulting process, but are less effective against large larvae. By contrast, pyrethroid insecticides such as deltamethrin and cypermethrin are very effective and give excellent control of most larval stages (Vives, 1980). These compounds are very broad spectrum and cause mortality of most biological controls for several months and so are completely incompatible with IPM programmes, which are in use by the majority of UK nursery stock growers.

There is therefore a need for more effective, IPM compatible insecticides which nursery stock growers can use. Several new and novel compounds have been marketed recently in the UK, but not tested against these two species of tortricid. The aim of this project was to test the effectiveness of such materials and also to evaluate the insect parasitic nematode *Steinernema feltiae*

Materials and methods

Experiment 1.

Carnation tortrix larvae were obtained from a nursery in Herefordshire in mid August 2004 (week 33) as larvae spun up in growing points of evergreen *Euonymus fortunei* var Emerald and Gold. Similar plants in 3 litre pots were grown in the glasshouse at ADAS Rosemaund and the larvae were placed on these plants in order to build up a culture. Larvae moved onto the new plants and were allowed to complete development and pupate. Adult moths were first seen in mid September and the plants were examined daily for egg masses. Once located, egg masses on leaves were removed and held in a fridge at 6-8 C for up to 3 weeks until sufficient for the experiment had been amassed. Then they were removed and allowed to hatch at room temperature into first instar larvae.

Unsprayed evergreen Euonymus plants (approx 30 cm high) in 3 litre pots were placed in the polythene tunnel at ADAS Rosemaund, on capillary matting on the floor. Experimental design used groups of 4 plants per replicate, with 5 replicates per treatment arranged in a randomised block design. Five first instar larvae per replicate were placed onto each plant, using a fine camel hairbrush in Week 39. After allowing 7 days for larvae to feed and colonise shoots, treatments were applied to the point of spray run -off, using an Oxford precision sprayer. A repeat treatment was applied 7 days later. Subsequent assessments (14 days after the first spray) checked for live larvae within the growing tips, using a hand lens.

The treatments used in the trial are detailed in Table 1.

Treatment	Active ingredient	Rate (g/100 litres)	Approval status
1. Water only			
2. Insegar	fenoxycarb	40	C
3. Calypso	thiacloprid	45	B
4.Conserve	spinosad	75	A
5. Runner	methoxyfenozide	40	C
6. Nemasys F	Insect parasitic nematode	0.25 million/m2	N/A

Approval status

A: This product has an on –label recommendation for protected ornamentals

B: This product has a specific off label approval (SOLA) for use on protected ornamentals

C: This product has approval for outdoor crops only. A SOLA would need to be applied for use under protection.

Experiment 2.

The culture of carnation tortrix used in Exp. 1 was maintained at a low level overwinter in 2004/05. In spring and summer 2005 as temperatures increased, attempts were made to increase the level of the culture, using fresh plants and also extra larvae collected from infested nurseries. However, the culture did not increase sufficiently despite these efforts, and further experiments could not be done.

Experiment 3.

In June 2005, *Ligustrum* liners naturally infested with carnation tortrix larvae were found on a nursery in Herefordshire. It was decided to use these naturally infested plants in a new trial. Infested plants (where growing points were spun up and might contain a larva) were removed to ADAS Rosemaund and placed on capillary matting in the polythene tunnel. A total of 42 infested plants were used, arranged in a randomised block design with 6 replicates (each plant was a replicate) per treatment. The treatments used were exactly as detailed in Table 1 above.

Treatments were applied in Week 27 in the same manner as Experiment 1 and again 7 days later. Assessments were carried out in Week 29 by examining growing points for live or dead larvae.

Results and discussion

Experiment 1.

Four live larvae in total were found during the assessments from a total of 150 first instar larvae inoculated. The experiment was then terminated as no meaningful data could be collected.

Observations of the culture of carnation tortrix during 2004 showed that, as an egg mass hatched, the larvae dispersed, either by climbing or on silk threads. Therefore, in nature this species seems to disperse rapidly soon after hatching and this presumably ensures that competition between larvae is reduced.

It is thought that the inoculated larvae either moved off the experimental plants in the trial, or died due to handling soon afterwards. This methodology was also time consuming and required constant inspection of the tortrix culture in order to find and remove egg masses.

Experiment 2.

Attempts were made to increase the culture in spring and summer 2005, and new larvae were introduced from nursery collections, but numbers were insufficient to enable further trials to be carried out.

Experiment 3

A total of 8 larvae were recovered from 42 infested plants, insufficient to determine any treatment effects. In untreated plants, only 2 larvae were recovered and these were either dead or moribund.

In these trials, two sprays, 7 days apart were used, and assessments carried out a further 7 days later. This may have allowed some larvae to complete development and hatch out during this 3-week period, thus reducing the effectiveness and accuracy of the assessments. Quaglia (1983) showed that larval development of carnation tortrix was completed in as little as 23 days at 20 degrees C.

Future work

For the remainder of 2005, carnation tortrix infested plants will be sourced from nurseries and these plants will then be used for further trials. The larvae obtained will naturally be of mixed ages and sizes, but this reflects grower conditions and should give a more realistic picture of treatment efficacy.

A separate collection of light brown apple moth will be made from nurseries in the South West, and maintained at a separate location to allow trials to be carried out on this species.

Conclusions

Carnation tortrix remains a difficult and serious pest of protected nursery stock. Some information about its biology has been obtained during the first year of the project, but the survival of larvae on trial plants has been insufficient to provide any data on treatment effectiveness.

The experimental methodology used in Experiment 1 was too labour intensive and did not allow larvae to establish naturally on the trial plants. Also, by using two sprays 7 days apart and assessing 7 days later, some larvae on naturally infested plants in Experiment 3 may have completed development over this 3-week period, and emerged as adults.

In future experiments, naturally infested plants collected from nurseries will be used, and a single spray applied followed by assessments 7 days later. This will reduce the time taken and avoid the possibility of larvae completing development.

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