Project title:	Managing ornamental plants sustainably (MOPS)
Project number:	CP 124
Work package title:	Efficacy of plant protection products against chewing insects – carnation tortrix / hardy nursery stock
Work package leader:	Jude Bennison, ADAS
Report:	Annual report, January 2016
Previous report:	None
Key staff:	Jude Bennison, ADAS Gemma Hough, ADAS until October 2015 Kerry Maulden, ADAS
Location of work:	ADAS Boxworth, Cambs
Date work commenced:	April 2015
Date work completed (or expected completion date):	December 2015

The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

AUTHENTICATION

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

Jude Bennison
Senior Research Entomologist
ADAS

Signature ....Date 14 December 2015

Report authorised by:

John Atwood
Project Leader
ADAS

Signature Date 28 January 2016

CONTENTS

GROWERS SUMMARY

Headline

- No significant treatment-related effects on carnation tortrix caterpillar numbers or leaf damage were observed in the trial. This was most likely to be due to low numbers of surviving caterpillars even on the untreated control plants.

Background and expected deliverables

Carnation tortrix moth, *Cacoecimorpha pronubana* and the light brown apple moth (LBAM), *Epiphyas postvittana* have become common leaf-rolling caterpillar pests of many HNS species grown under protection. Female moths lay egg masses on upper leaf surfaces. The larvae of both species roll up the leaves in the tips of growing points, spinning them together with silk to form a shelter in which they feed, causing irregular leaf holing. Damage can render the host plants unmarketable. Both species have a wide HNS host plant range including *Choisya*, *Chaenomeles* and *Photinia* and carnation tortrix can also damage carnations and pinks. Adult moths are first active in April/May and can be detected using pheromone traps in order to aid pesticide spray timings. As the caterpillars are protected by webbing and rolled leaves they are a difficult target for contact-acting pesticides. Most growers using IPM programmes use *Bacillus thuringiensis* (Dipel DF) for control but this must be timed carefully as it is only effective against young caterpillars. As Dipel DF acts by ingestion, the caterpillars die after eating sprayed leaf material. Diflubenzuron (e.g. Dimilin Flo) is also used within IPM but as this is an insect growth regulator, like Dipel DF it is effective mainly against young caterpillars so must be timed carefully for optimum control. Other pesticide options within IPM include spinosad (Conserve) and indoxacarb (Steward). As repeated pesticide sprays are needed from late spring to autumn, a few growers have started to use the egg parasitoid *Trichogramma brassicae* within an IPM programme as a result of HDC-funded research that showed that this can reduce the number of Dipel DF sprays needed.

The purpose of this experiment was to test the efficacy of products against carnation tortrix or light brown apple moth on a selected susceptible hardy nursery stock species under protection.

Summary of the work and main conclusions

Materials and methods

Seven plant protection products (Table 1) were tested against carnation tortrix caterpillars, *Cacoecimorpha pronubana* on *Choisya ternata* plants grown in a poly tunnel between April and September 2015 at ADAS Boxworth. Each experimental plot consisted of six *Choisya* plants. There were six replicate plots per treatment. Temperature was regulated in the poly tunnel during the summer by rolling up the polythene covering the mesh lower sides of the tunnel and by opening the tunnel doors.

Plants were obtained as liners and potted on into 1 L pots on 29 April. On 26 June, plants for the experiment were selected, choosing plants uniform in size and vigour. Six plants were arranged in two rows of three plants in each plot. The pots were stood on capillary matting and watered using sub-irrigation as overhead watering could lead to young caterpillars being washed from the leaves.

Each plot was infested with light brown apple moth (LBAM) egg batches of synchronized age on 26 June. This was done by collecting individual *Choisya* leaves with egg batches from the glasshouse culture during June, refrigerating them until sufficient batches had been collected, then incubating them at 21°C until they were almost ready to hatch. Each detached leaf had a mean of 26 eggs per batch and one detached leaf per plot was attached to a leaf on a central *Choisya* plant in each plot. The plants were touching to allow the caterpillars to spread between the six plants per plot after egg hatch. Due to exceptionally hot weather during the following few days, most of the eggs had died by 8 July and did not successfully hatch. Therefore, the detached leaves were removed and a further infestation was made between 10 and 12 August. In order to avoid the risk of egg death, the second infestation was done with newly hatched caterpillars, this time using carnation tortrix rather than LBAM. Egg batches were reared as before with LBAM, but incubated until egg hatch. Ten newly emerged caterpillars were carefully transferred to the plants in each plot using a fine paintbrush, after checking all the plants for older caterpillars surviving from the first infestation with LBAM eggs and removing any caterpillars and damaged leaves.

Table 1. Products tested

MOPS code number	Authorisation status	Biopesticide or conventional pesticide
Untreated control	-	-
Water control	-	-
Steward (indoxacarb)	Approved on protected ornamentals	conventional
200	unauthorised	conventional
48	unauthorised	conventional
198	unauthorised	conventional
130	unauthorised	biopesticide
Nemasys C (*Steinernema carpocapsae*)	No approval required, recommended on ornamentals and other crops for other caterpillar species	entomopathogenic nematode
199	unauthorised	conventional

All treatments were applied to give leaf cover, just prior to run-off. Recommended application rates were used following consultation with the companies' technical experts. All treatments and the water control were applied using an Oxford Precision Sprayer fitted with an HC/1.74/3 nozzle, in 750 litres of water per hectare (recommended for conventional treatment 199) using 3 bar pressure. No adjuvants were used with any of the treatments. The water volume selected was consistent with the range of water volumes recommended by the suppliers and in consultation with David Talbot, ADAS spray application expert. Each treatment was applied at weekly intervals for five weeks, on 13, 20 and 27 August and 4 and 14 September. Treatments were applied in the late afternoon on an overcast or cloudy day.

Numbers of damaged leaves (grazed, rolled or spun together) and numbers live caterpillars per plot were recorded on five assessment dates. In order to assess numbers of live caterpillars, any rolled or spun leaves were gently opened and then closed again after checking. The assessment dates were on 19 and 26 August and 3, 11 and 21 September, six, six, seven, eight and ten days after the previous spray application respectively. Any phytotoxicity was assessed on the same dates.

Results and Conclusions

- None of the treatments significantly reduced mean numbers of live caterpillars per plot compared with the untreated or water controls (Table 2, Figure 1). There was a low survival rate of the ten caterpillars added per plot in untreated controls, with a maximum mean of 0.7 per plot recorded on any of the five assessment dates. The low survival rate in untreated controls may have been due to physical damage of the young caterpillars during infestation or due to the caterpillars dropping from the plants when rolled up leaves were opened during assessments and failing to re-establish on the plants.
- None of the treatments significantly reduced mean numbers of damaged leaves per plot compared with the untreated or water controls (Table 3, Figure 2). The maximum mean numbers of damaged leaves per untreated plot reached 5.8 on the final assessment date.
- No phytotoxicity symptoms were recorded with any of the treatments.

Table 2. Mean numbers of live caterpillars per plot. NS = no significant differences between treatments ($P<0.05$).

Product name or MOPS code	19 August	26 August	3 September	11 September	21 September
1. Untreated control	0.33	0.83	0.67	0.83	1.0
2. Water control	0.67	0.17	0	0	0.17
3. Steward (+ve control)	0	0.17	0	0	0
4. 200	0	0	0	0	1.17
5. 48	0	0	1.17	0	0
6. 198	0	0	0	0.17	1.33
7. 130	0	0	0	1.33	0.17
8. Nemasys C	0.50	1.33	0.17	0.67	1.0
9. 199	0	0	0	2.83	0
	N.S.	N.S.	N.S.	N.S.	N.S.

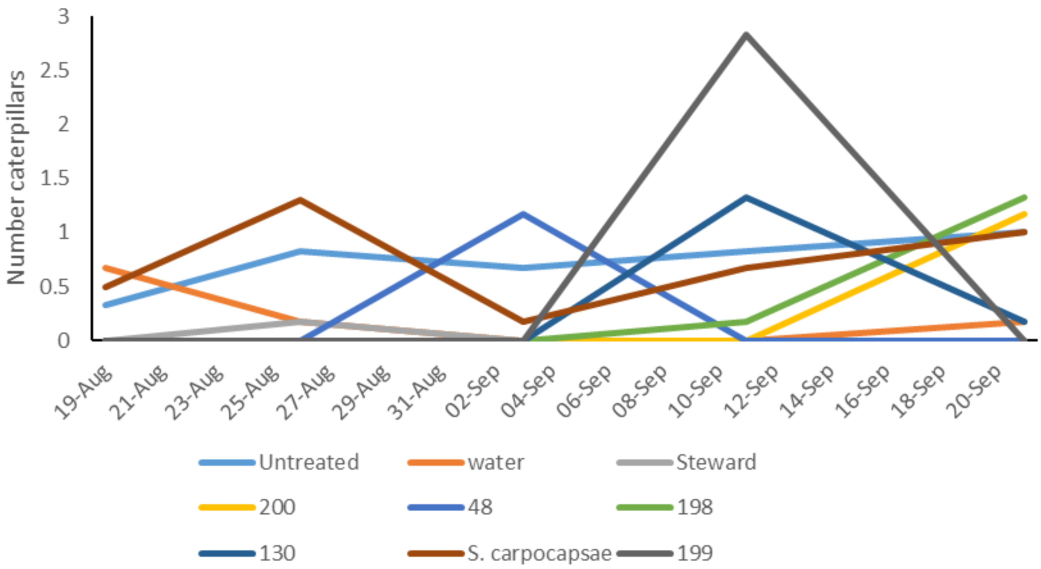


Figure 1. Mean numbers of live caterpillars per plot on 19 and 26 August and 3, 11 and 21 September.

Table 3. Mean numbers of damaged leaves per plot on 19 and 26 August and 3, 11 and 21 September. NS = no significant differences between treatments (P<0.05).

Product name or MOPS code	19 August	26 August	3 September	11 September	21 September
1. Untreated control	1.0	1.83	3.17	4.33	5.83
2. Water control	2.0	2.5	1.83	4.0	5.17
3. Steward (+ve control)	2.33	1.17	1.17	1.83	3.67
4. 200	0.83	1.83	2.0	2.17	2.50
5. 48	1.0	1.67	2.0	2.0	2.50
6. 198	3.67	2.33	2.67	3.17	4.67
7. 130	3.17	4.33	5.33	6.0	7.50
8. Nemasys C	2.17	1.67	1.67	3.83	6.17
9. 199	0.5	1.50	2.50	2.67	3.0
	N.S.	N.S.	N.S.	N.S.	N.S.

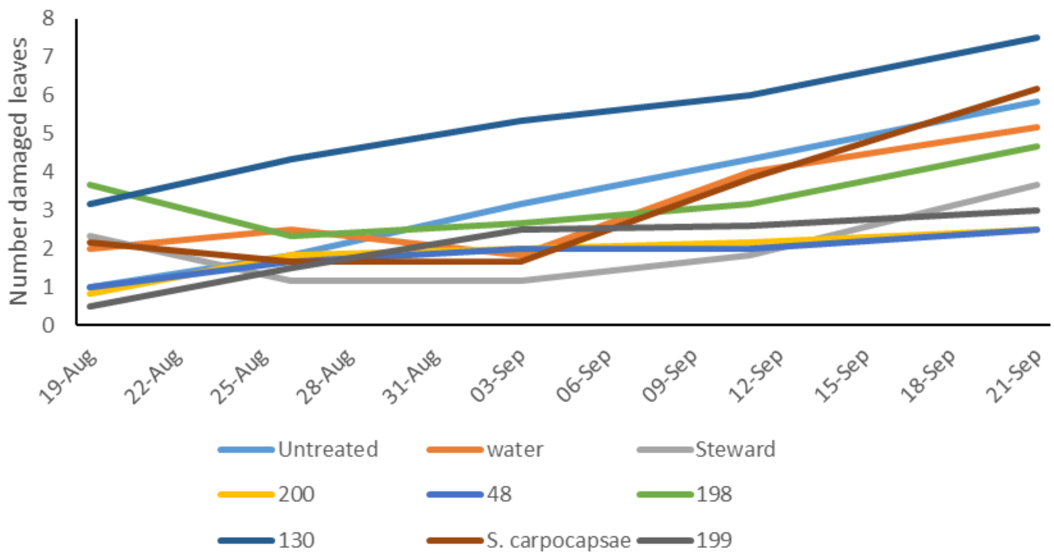


Figure 2. Mean numbers of damaged leaves per plot on 19 and 26 August and 3, 11 and 21 September.

Action points

- No action for control can be recommended as no significant treatment-related effects on carnation tortrix caterpillar numbers or leaf damage were observed in the trial. This was most likely to be due to low numbers of surviving caterpillars even on untreated plants.
- It is recommended to use water-sensitive paper when selecting the water volume to apply plant protection sprays to any target plant species. Many growers apply 1000 L/ha as a routine on containerized HNS, irrespective of plant size or pest or disease target. In this experiment, 1000 L/ha caused total run-off of droplets from the top leaves, where most of the tortrix caterpillars were found, whereas 750 L/ha gave good coverage but before run-off.

SCIENCE SECTION

Introduction

Carnation tortrix moth, *Cacoecimorpha pronubana* and the light brown apple moth (LBAM), *Epiphyas postvittana* have become common leaf-rolling caterpillar pests of many HNS species grown under protection. Female moths lay egg masses on upper leaf surfaces. The larvae of both species roll up the leaves in the tips of growing points, spinning them together with silk to form a shelter in which they feed, causing irregular leaf holing. Damage can render the host plants unmarketable. Both species have a wide HNS host plant range including *Choisya*, *Chaenomeles* and *Photinia* and carnation tortrix can also damage carnations and pinks. Adult moths are first active in April/May and can be detected using pheromone traps in order to aid pesticide spray timings. As the caterpillars are protected by webbing and rolled leaves they are a difficult target for contact-acting pesticides. Most growers using IPM programmes use *Bacillus thuringiensis* (Dipel DF) for control but this must be timed carefully as it is only effective against young caterpillars. As Dipel DF acts by ingestion, the caterpillars die after eating sprayed leaf material. Diflubenzuron (e.g. Dimilin Flo) is also used within IPM but as this is an insect growth regulator, like Dipel DF it is effective mainly against young caterpillars so must be timed carefully for optimum control. Other pesticide options within IPM include spinosad (Conserve) and indoxacarb (Steward). Pyrethroid insecticides such as cypermethrin (e.g. Toppel 100 EC), deltamethrin (e.g. Decis) are also used by growers who do not use IPM (these pesticides are very harmful to biological control agents used for control of other pests). As repeated pesticide sprays are needed from late spring to autumn, a few growers have started to use the egg parasitoid *Trichogramma brassicae* within an IPM programme as a result of HDC-funded research that showed that this can reduce the number of Dipel DF sprays needed (Buxton & Talbot, 2011).

Materials and methods

Site and crop details

Table 1. Test site and plot design information

Test location:	ADAS Boxworth
County	Cambridgeshire
Postcode	CB23 4NN
Soil type/growing medium	Herbaceous mix
Nutrition	Osmocote granules at potting
Crop	*Choisya ternata*
Cultivar	N/A
Glasshouse or Field	Poly tunnel 6
Date of planting/potting	Liners potted on 29 April 2015
Pot size	1 litre pots
Number of plants per plot	6
Trial design (layout in Appendix C)	Randomised block
Number of replicates	6
Plot size w (m), l (m), total area (m^2)	Plot size 0.5 x 0.5 m (0.25 m^2), total plot area 13.5 m^2
Method of statistical analysis	Analysis of variance (ANOVA)

Seven plant protection products were tested against carnation tortrix caterpillars, *Cacoecimorpha pronubana* on *Choisya ternata* plants grown in a poly tunnel between April and September 2015 at ADAS Boxworth. Each experimental plot consisted of six Choisya plants. There were six replicate plots per treatment. Temperature was regulated in the poly tunnel during the summer by rolling up the polythene covering the mesh lower sides of the tunnel and by opening the tunnel doors.

Plants were obtained as liners and potted on into 1 L pots on 29 April. On 26 June, plants for the experiment were selected, choosing plants uniform in size and vigour. Six plants were arranged in two rows of three plants in each plot. The pots were stood on capillary matting and watered using sub-irrigation as overhead watering could lead to young caterpillars being washed from the leaves.

Treatment details

Table 2. Detail of products tested

MOPS code number	Active ingredient(s)	Manufacturer	Batch number	% a.i.	Formulation type
1. Untreated (-ve control)	-	-	-	-	-
2. Water (-ve control)	-	-	-	-	-
3. Steward (+ve control)	indoxacarb	Du Pont	FEB15CE201	300 g/kg	WG
4. 200	N/D	N/D	N/D	N/D	N/D
5. 48	N/D	N/D	N/D	N/D	N/D
6. 198	N/D	N/D	N/D	N/D	N/D
7. 130	N/D	N/D	N/D	N/D	N/D
8. Nemasys C	*Steinernema carpocapsae*	BASF	SC 9.1A 11.14A	87%	In an inert carrier with water (13%)
9. 199	N/D	N/D	N/D	N/D	N/D

Table 3. Treatments

Product name or MOPS code number	Application timing	Product rate	Spray volume (L/ha)
1. Untreated (-ve control)	-	-	-
2. Water (-ve control)	Weekly x 5	-	750
3. Steward (+ve control)	Weekly x 5	12.5 g/100 L water	750
4. 200	Weekly x 5	0.1875 kg/ha	750
5. 48	Weekly x 5	1.5 kg/ha	750
6. 198	Weekly x 5	2 L/ha	750
7. 130	Weekly x 5	3 L/ha	750
8. Nemasys C (*Steinernema carpocapsae)*	Weekly x 5	500,000 per m^2	750
9. 199	Weekly x 5	0.1 L/ha	750

Application timing	
A1	13 August 2015
A2	20 August 2015
A3	27 August 2015
A4	4 September 2015
A5	14 September 2015

Table 4. Application details

Application No.	A1	A2	A3	A4	A5
Application date	13/8/2015	20/8/2015	27/8/2015	4/9/2015	14/9/2015
Time of day	15.00-15.50	15.35-16.10	16.00-16.45	15.10-15.45	15.40-16.10
Application method	Oxford Precision Sprayer fitted with a HC/1.74/3 nozzle, in 750 litres water/ha using 3 bar pressure	Oxford Precision Sprayer fitted with a HC/1.74/3 nozzle, in 750 litres water/ha using 3 bar pressure	Oxford Precision Sprayer fitted with a HC/1.74/3 nozzle, in 750 litres water/ha using 3 bar pressure	Oxford Precision Sprayer fitted with a HC/1.74/3 nozzle, in 750 litres water/ha using 3 bar pressure	Oxford Precision Sprayer fitted with a HC/1.74/3 nozzle, in 750 litres water/ha using 3 bar pressure
Air temperature (°C)	Start: 20.2 Finish: 18.6	Start: 22.9 Finish: 21.9	Start: 19.0 Finish: 23.6	Start: 16.2 Finish: 15.0	Start: 15.40 Finish: 16.10
Relative humidity (%)	Start: 81.6 Finish: 92.6	Start: 64.2 Finish: 71.1	Start: 61.1 Finish: 44.5	Start: 59.1 Finish: 64.7	Start: 61.9 Finish: 60.2
Cloud cover (%)	100	0	0	100	0
Crop growth stage	Vegetative	Vegetative	Vegetative	Vegetative	Vegetative

All treatments were applied to give good leaf cover, just prior to run-off. Recommended application rates were used following consultation with the companies' technical experts. The water volume selected (750 litres per ha) was consistent with the range of water volumes recommended by the suppliers and with ADAS spray application expert, David Talbot. Spray deposition at both 750 and 1000 litres per ha was assessed before the first treatment application by attaching water-sensitive paper to spare *Choisya* plants in pots. Papers were clipped to the upper and lower surfaces of top, middle and bottom leaves.

Target pest(s)

Table 5. Target pest(s)

Common name	Scientific Name	Infestation level pre-application
Carnation tortrix moth	*Cacoecimorpha pronubana*	10 newly hatched caterpillars per plot

Tortrix adults and caterpillars were obtained from commercial HNS nurseries by collecting detached leaves with symptoms of damage. The leaves were placed onto potted *Choisya* plants in an insect-proof tent cage in a glasshouse compartment at ADAS Boxworth. As and when adult moths emerged, they were identified to species and pairs of moths of the same species (a male with one or two females) were added to individual *Choisya* plants in small insect-proof cages in the glasshouse to allow them to mate and for the females to lay egg batches.

The first moths to emerge from the culture were light brown apple moth (LBAM) as a naturally-occurring parasitoid was found to be parasitizing the carnation tortrix pupae. Each plot was initially infested with LBAM egg batches of synchronized age on 26 June. This was done by collecting individual *Choisya* leaves with egg batches from the glasshouse culture during June, refrigerating them until sufficient batches had been collected, then incubating them at 21°C until they were almost ready to hatch. Each detached leaf had a mean of 26 eggs per batch and one detached leaf per plot was attached to a leaf on a central *Choisya* plant in each plot. The plants were touching to allow the caterpillars to spread between the six plants per plot after egg hatch. Due to exceptionally hot weather during the following few days, most of the LBAM eggs had died by 8 July and did not successfully hatch. Therefore the detached leaves were removed from the experimental plants and further tortrix caterpillars were collected from a commercial nursery in order to rear more moths to infest the experiment. A second infestation was made to the experimental plants between 10 and 12 August, this time with carnation tortrix caterpillars rather than LBAM. In order to avoid the risk of repeated egg death due to the continuing high temperatures, the second infestation was done with newly hatched caterpillars rather than with eggs. Egg batches were reared as before with LBAM, but incubated until egg hatch. Ten newly emerged caterpillars were carefully transferred to the plants in each plot using a fine paintbrush, after checking all the plants for older caterpillars surviving from the first infestation with LBAM eggs and removing any older caterpillars and damaged leaves.

Assessments

Numbers of caterpillars per plot

Numbers of live caterpillars per plot were assessed ‘in situ’ on each of the six plants per plot on each of the five assessment dates. Assessments continued until the first pupae were observed. Each leaf was examined using a head-band magnifier. Rolled up leaves were opened gently at one end I order to assess whether there was a caterpillar inside and whether or not it was alive or dead, then the rolled up leaf was gently closed again.

Numbers of damaged leaves per plot

Numbers of leaves per plot showing symptoms of tortrix caterpillar damage were recorded at each of the five assessment dates. Damage symptoms included grazing of the leaf surface by young caterpillars and leaf rolling and webbing caused by older caterpillars.

Phytotoxicity

Phytotoxicity scores and photographs of any symptoms were taken at each application date. Records of any observed effects attributable to phytotoxicity were recorded by comparing them to the control plants. Symptoms were scored from 0-9 where 0 was no damage and 9 was where damage was very severe.

Table 6. Assessments

Assessment No.	Date	Growth stage	Timing of assessment relative to last application	Assessment of WFT numbers, WFT damage and phytotoxicity
1	19 August 2015	Vegetative	6 days after first application	No. live caterpillars per plot, no. damaged leaves per plot and crop safety
2	26 August 2015	Vegetative	6 days after second application	As for assessment 1
3	3 September 2015	Vegetative	7 days after third application	As for assessment 1
4	11 September 2015	Vegetative	7 days after fourth application	As for assessment 1
5	21 September 2015	Vegetative	7 days after fifth application	As for assessment 1

Statistical analysis

The data from each assessment were analysed using analysis of variance (ANOVA) to calculate means, variance and LSDs ($P<0.05$).

Results

Spray coverage

The application method using 750 L/ha achieved good spray coverage of the upper surface of top and middle leaves but less good coverage of bottom leaves (Figure 1).

Figure 1. Spray coverage on water-sensitive paper at 750 L/ha

The application method using 1000 L/ha achieved similar spray coverage of middle and bottom leaves as 750 L/ha but deluged the top leaves causing total run-off (Figure 2). As most of the tortrix caterpillars were on top leaves or inside folded top leaf tips it was considered more important to achieve a good coverage of top leaves but before run-off, therefore 750 L/ha was selected as the water volume for all treatments.

Figure 2. Spray coverage on water-sensitive paper at 1000 L/ha

Control of carnation tortrix

Numbers of caterpillars per plot

None of the treatments significantly reduced mean numbers of live caterpillars per plot compared with the untreated or water controls (Table 7, Figure 3). There was a low survival rate of the ten caterpillars added per plot in untreated controls, with a maximum mean of 0.7 per plot recorded on any of the five assessment dates. The low survival rate in untreated controls may have been due to physical damage of the young caterpillars during infestation or due to the caterpillars dropping from the plants when rolled up leaves were opened during assessments and failing to re-establish on the plants.

Table 7. Mean numbers of live caterpillars per plot. NS = no significant differences between treatments.

Product name or MOPS code	19 August	26 August	3 September	11 September	21 September
1. Untreated control	0.33	0.83	0.67	0.83	1.0
2. Water control	0.67	0.17	0	0	0.17
3. Steward (+ve control)	0	0.17	0	0	0
4. 200	0	0	0	0	1.17
5. 48	0	0	1.17	0	0
6. 198	0	0	0	0.17	1.33
7. 130	0	0	0	1.33	0.17
8. Nemasys C	0.50	1.33	0.17	0.67	1.0
9. 199	0	0	0	2.83	0
	N.S.	N.S.	N.S.	N.S.	N.S.

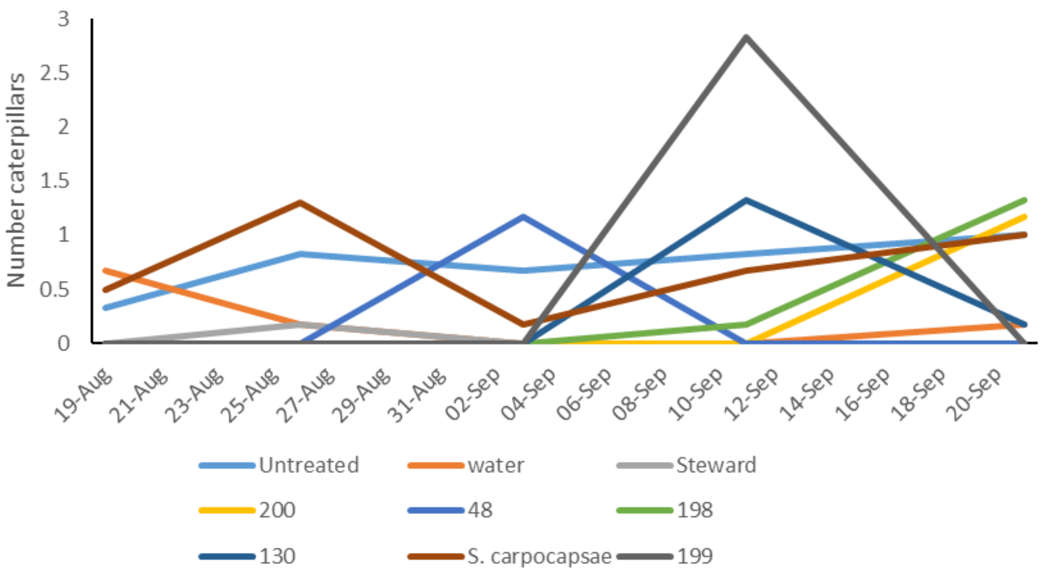


Figure 3. Mean numbers of live caterpillars per plot on 19 and 26 August and 3, 11 and 21 September.

Numbers of damaged leaves per plot

None of the treatments significantly reduced mean numbers of damaged leaves per plot compared with the untreated or water controls (Table 8, Figure 4). The maximum mean numbers of damaged leaves per untreated plot reached 5.8 on the final assessment date.

Table 8. Mean numbers of damaged leaves per plot on 19 and 26 August and 3, 11 and 21 September. NS = no significant differences between treatments.

Product name or MOPS code	19 August	26 August	3 September	11 September	21 September
1. Untreated control	1.0	1.83	3.17	4.33	5.83
2. Water control	2.0	2.5	1.83	4.0	5.17
3. Steward (+ve control)	2.33	1.17	1.17	1.83	3.67
4. 200	0.83	1.83	2.0	2.17	2.50
5. 48	1.0	1.67	2.0	2.0	2.50
6. 198	3.67	2.33	2.67	3.17	4.67
7. 130	3.17	4.33	5.33	6.0	7.50
8. Nemasys C	2.17	1.67	1.67	3.83	6.17
9. 199	0.5	1.50	2.50	2.67	3.0
	N.S.	N.S.	N.S.	N.S.	N.S.

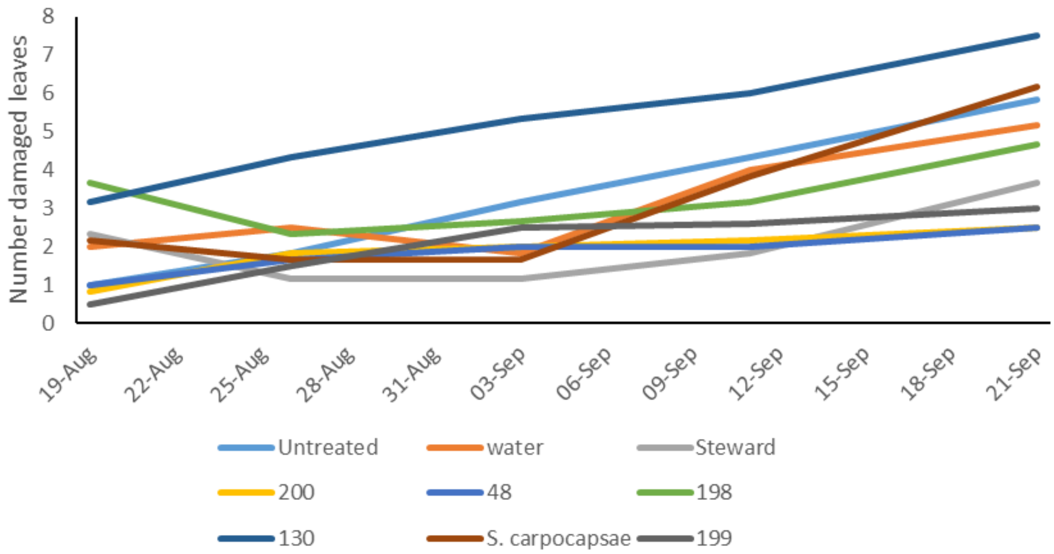


Figure 4. Mean numbers of damaged leaves per plot on 19 and 26 August and 3, 11 and 21 September.

Crop damage (phytotoxicity)

No symptoms of phytotoxicity were recorded with any of the treatments on any of the assessment dates.

Formulations

No problems were encountered during mixing or application of any of the product formulations under test.

Effect on non-targets

No effects on other pests were noted during completion of this experiment.

Discussion

None of the treatments significantly reduced plant damage or numbers of carnation tortrix caterpillars per plot compared with the untreated or water-treated controls on any assessment date. The low survival rate of caterpillars in untreated controls (maximum mean of 0.7 per plot) meant that it was difficult to achieve a significant treatment effect. The low survival rate may have been due to physical damage to caterpillars during plant infestation or to caterpillars dropping off the plants when unrolling damaged leaves for assessments. In any future experiment evaluating efficacy of plant protection products against tortrix caterpillars, it is recommended that only one final assessment of numbers of caterpillars is done, rather than weekly assessments following each treatment date.

Steward (indoxacarb) was used as the positive control in this experiment as it was considered to be the most widely used insecticide for tortrix caterpillar control on UK HNS crops. However, the future approval of indoxacarb for use on ornamental plants is uncertain.

Conclusions

- No effective plant protection products were identified in this experiment for control of tortrix caterpillars on HNS due to no treatment-related effects being observed. This was likely to have been due to low survival of caterpillars even on untreated control plants.

References

Buxton, J. & Talbot, D. (2011). Evaluation of *Trichogramma brassicae* for the control of carnation tortrix moth and light brown apple moth in protected nursery stock. *IOBC/wprs Bull* **68**, 33-36.

Appendix A – Study conduct

ADAS is officially recognised by United Kingdom Chemical Regulations Directorate as competent to carry out efficacy testing. The experiments reported were carried out according the internal ADAS operating procedures

GLP compliance will not be claimed in respect of this study.

Relevant EPPO/CEB guideline(s)		**Variation from EPPO**
PP 1/152(3)	Design and analysis of efficacy evaluation trials	none
PP 1/135(3)	Phytotoxicity assessment	none
PP 1/181(3)	Conduct and reporting of efficacy evaluation trials including GEP	none

There were no significant deviations from the EPPO and national guidelines other than those indicated above.

Appendix B – Meteorological data

Location of the weather station	On site (ADAS Boxworth)			
Distance to the trial site	0 m			
Origin of the weather data	Weather station for long term average Data logger for average conditions during the trial			
Long-term outdoor averages from *location* Boxworth 30 year mean				
Month/period	**Av temp (ºC)**	**Min temp (ºC)**	**Max temp (ºC)**	**Rainfall (mm)**
May	11.9	7.0	16.8	43.7
June	14.9	9.7	20.0	48.6
July	17.4	12.0	22.9	48.6
August	17.4	12.4	22.5	56.3
September	14.5	10.1	19.0	52.8

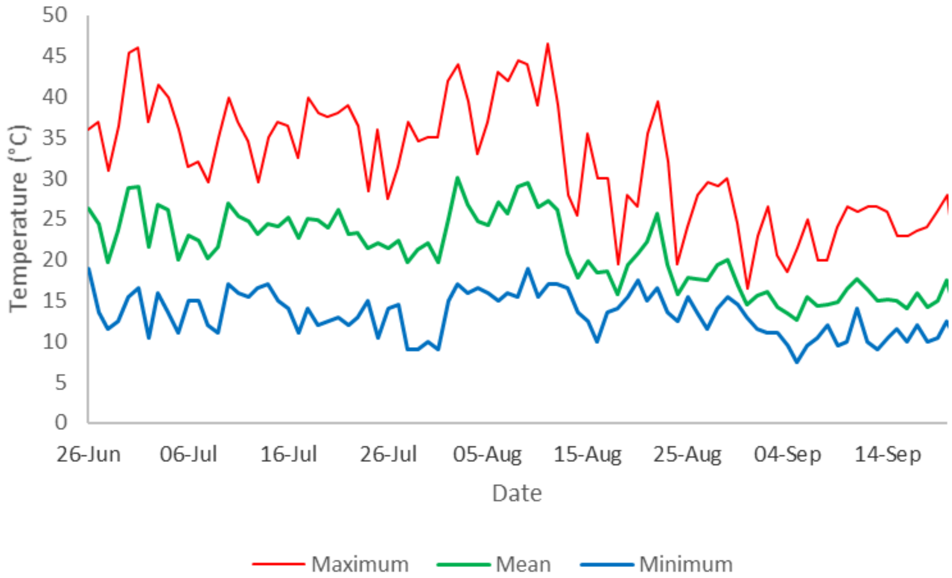
Average conditions during the trial (May-Sep in poly tunnel):

Av temp (ºC)	Min temp (ºC)	Max temp (ºC)	Av RH (%)*	Rainfall (mm)
21	7.5	46.5	56.3	n/a

***protected crops only**

Weather (recorded in crop canopy) at treatment application period (in poly tunnel 6):

Month/period	Min temp (ºC)	Max temp (ºC)	RH (%)
13/8/2015	18.6	20.2	81.6-92.6
20/8/2015	21.9	22.9	64.2-71.1
27/8/2015	19.0	23.6	44.5-61.1
4/9/2015	15.0	16.2	59.1-64.7
14/9/2015	20.5	24.1	60.2-61.9



Mean, maximum and minimum temperatures in crop canopy in the poly tunnel in which the experiment was located

Appendix C – Agronomic details

Growing system

Crop	Planting/sowing date	Row width (m) or pot spacing
Choisya ternata	Liners potted up into 1 L pots on 29 April 2015	Six plants per plot in 2 rows of 3 plants (plot size 1.5m^2)

Other pesticides - active ingredient(s) / fertiliser(s) applied to the trial area

Date	Product	Rate	Unit
	The predatory mite *Amblyseius andersoni* applied for preventive control of two-spotted spider mite	1 sachet per 2 m^2 on 18 May 2015	Mini-sachet

Details of irrigation regime (pot-grown crops)

Type of irrigation system employed (e.g. overhead sprinkler, hand watering, drip, ebb and flow, capillary sandbed or capillary matting)
Drip-irrigation onto capillary matting underneath pots (separate piece of matting for each plot)

Appendix D – Trial layout in poly tunnel plot, B = block, number 1-9 = treatment number)

PLOT	1	10	19	28	37	46
BLOCK	1	2	3	4	5	6
TREATMENT	2	6	2	6	2	4
PLOT	2	11	20	29	38	47
BLOCK	1	2	3	4	5	6
TREATMENT	9	8	5	8	1	8
PLOT	3	12	21	30	39	48
BLOCK	1	2	3	4	5	6
TREATMENT	8	7	7	9	5	2
PLOT	4	13	22	31	40	49
BLOCK	1	2	3	4	5	6
TREATMENT	4	5	3	2	3	3
PLOT	5	14	23	32	41	50
BLOCK	1	2	3	4	5	6
TREATMENT	1	2	4	1	7	9
PLOT	6	15	24	33	42	51
BLOCK	1	2	3	4	5	6
TREATMENT	3	3	1	7	6	5
PLOT	7	16	25	34	43	52
BLOCK	1	2	3	4	5	6
TREATMENT	5	9	6	5	8	6
PLOT	8	17	26	35	44	53
BLOCK	1	2	3	4	5	6
TREATMENT	6	4	8	4	4	7
PLOT	9	18	27	36	45	54
BLOCK	1	2	3	4	5	6
TREATMENT	7	1	9	3	9	1

Polytunnel entrance

Trt	Product code
1	Untreated control
2	Water-treated control
3	Steward (+ve insecticide control)
4	200
5	48
6	198
7	130
8	Nemasys C - *Steinernema carpocapsae*
9	199

Appendix E – Copy of the Certificate of Official Recognition of Efficacy Testing Facility or Organisation

Certificate of

Official Recognition of Efficacy Testing Facilities or Organisations in the United Kingdom

This certifies that

ADAS UK Limited

complies with the minimum standards laid down in Regulation (EC) 1107/2009 for efficacy testing.

The above Facility/Organisation has been officially recognised as being competent to carry out efficacy trials/tests in the United Kingdom in the following categories:

Agriculture/Horticulture
Stored Crops
Biologicals and Semiochemicals

Date of issue:	10 May 2013
Effective date:	18 March 2013
Expiry date:	17 March 2018

Signature

Authorised signatory

Certification Number
ORETO 339

HSE
Chemicals Regulation Directorate

Department of
Agriculture and Rural Development

Appendix f – Photographs

Figure 1. Trial layout in poly tunnel

Figure 2. Carnation tortrix adult male

Figure 3. Egg mass on upper leaf surface

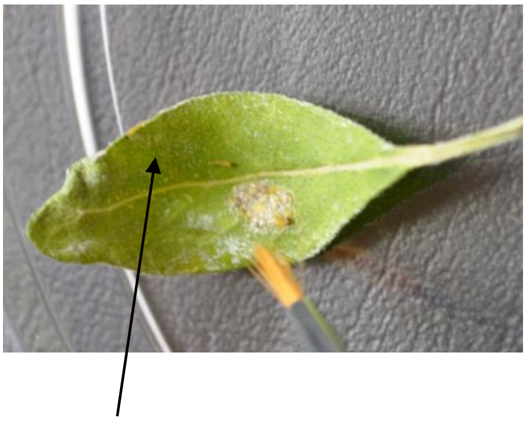


Figure 4. Collecting newly hatched caterpillar with paintbrush for infesting experimental plants

	
Figure 5. Grazing damage to Choisya leaf caused by young caterpillars	**Figure 6.** Caterpillar exposed from rolled and webbed leaf tips