Project Title:	**Raspberry: Alternative insecticides for raspberry cane midge and raspberry beetle control**
Project Number:	SF 59
Report:	Second interim report issued 13 October 2004
Previous reports:	None
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Date Project commenced:	1 April 2003
HRI file reference:	ntsm03/cross//HDC raspberry beetle and cane midge 2003-05/General/Raspberry beetle and cane midge 2004 report.doc

INTERIM CONTRACT REPORT 2004
EMR project No. 32685
GEP No.s 04/005 & 04/006

Raspberry: Alternative insecticides for raspberry cane midge and raspberry beetle control

HDC Project SF59

CONTENTS

EAST MALLING RESEARCH

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Authentication

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

....J V Cross
Signature

Date ....

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Raspberry: Alternative insecticides for raspberry cane midge and raspberry beetle control. Interim report 2003

Summary for growers

Two replicated field experiments were conducted in 2003 to screen alternative products for control of raspberry beetle and raspberry cane midge.

Raspberry beetle

Programmes of three sprays (500 l/ha) of Aztec, Calypso, Decis, Dynamec, Lorsban, Plenum or Talstar were applied at fortnightly intervals at first flower, mid-flowering and the end of flowering to replicated plots in a heavily blackberry plantation at Church farm, Tunstead, Norwich which was very heavy infested with raspberry beetle. A further treatment of two sprays of Tracer at the latter two timings only was also applied.

- Lorsban, Dynamec, Decis, Calypso, Talstar and Tracer were all highly effective for raspberry beetle control, reducing larval infestations and damage by > 95%.
- Dynamec, Claypso and Tracer provide three possible alternatives to the standard Lorsban and Decis treatments. It is recommended that two for these three are chosen for more detailed investigation in the final year of this project
- Of these, Tracer is of the greatest interest because of its selectivity to natural enemies, safety to bees and environmental and human safety profile. The rate of application of Tracer that was tested in this trial was high. However, only two sprays were applied compared to three for the other treatments.
- It is recommended that the parent companies for the three alternative products (Syngenta Bioline, Bayer and Dow AgroSciences respectively) are contacted to ascertain the existence of residues data for their products on cane fruits. Their support in obtaining such data if it does not already exist also needs to be gauged. Depending on the response, the second alterative should be chosen. The likelihood of the occurrence of residues, even below the MRL, needs to be taken into account.
- Trigard, Aztec and Plenum were at best only partially effective and further investigation is not warranted.
- It is recommended that a further experiment investigating the use of Tracer at a range of rates and of Dynamec and/or Calypso at a standard rate, exploring a range of different at different timings of both products, is conducted in the final year of this project (2005). The heavily infested blackberry crops at Church Farm, Tunstead, Norwich provide an ideal site for such a trial.

Raspberry cane midge

The raspberry cane midge experiment in 2004 was unsuccessful because populations of the pest failed to develop despite an extended effort to provide artificial splits for oviposition. Sprays were applied at the appropriate time. The reason for this is unknown. The site was very heavily infested in 2003 and a successful trial conducted there. It is suggested that an additional site is sought for 2005 and the 2004 trial repeated at the best site.

Introduction

Raspberry beetle and raspberry cane midge are two of the most damaging pests of raspberry. Either pest can render production uneconomic in the absence of effective control measures. Raspberry beetle has little effect on yield but there is a virtual zero tolerance of the presence of larvae or damage in ripe fruit in the market place. Raspberry cane midge does not attack the fruits directly and low populations may not cause significant crop damage and may go unnoticed. However, the pest can build up rapidly and cause severe damage to canes and crop loss.

Growers in the UK rely currently on a narrow range of broad-spectrum insecticides to control these pests.

Chlorpyrifos (Dursban etc) (harvest interval = 14 days), deltamethrin (Decis etc) (harvest interval = zero days) and rotenone (Derris)(harvest interval = zero days) are approved for use currently for control of raspberry beetle. Derris is used mainly in organic production as it is of short persistence and hence is considered to be less effective. Sprays are applied at the first pink fruit stage and may be repeated 10-14 days later. Note that in some European countries, post-flowering sprays are not permitted. Applications in the UK at the late green or first pink fruit stage are uncomfortably close to harvest. If persistent broad-spectrum insecticides are sprayed onto raspberries close to harvest it is inevitable that residues will be detected on the harvested produce. If harvest intervals are observed, the residue should be below the MRL, but even detectable residues below the MRL are undesirable. Chlorpyrifos (Dursban etc), an OP insecticide, is not favoured by users, markets or consumers. It has a 14-day harvest interval and a maximum of two sprays per annum on raspberry. All these products, but especially Deltamethrin (Decis), are harmful to biocontrol agents including *Phytoseiulus persimilis* predatory mites introduced to control two-spotted spider mite.

Chlorpyrifos (Dursban etc) is the only insecticide approved for control of raspberry cane midge. It is normal practice to apply a spray against the first generation in spring according to the time of emergence predictions supplied by ADAS. The aim is to control the first generation adequately in order to prevent the second and third generation from being sufficiently numerous to cause significant damage. Sprays are directed to the base of the canes where most of the splits, and hence infestation, occurs.

Alternative chemical control treatments need to be identified for both these pests. In 2003, two replicated field experiments were conducted to screen alternative products for control of raspberry beetle and raspberry cane midge. For raspberry beetle, single sprays of Dynamec, Tracer, Talstar and Trigard applied at first pink fruit were tested in comparison with an untreated control and the approved products Dursban, Decis and Rotenone. Raspberry beetle proved comparatively easy to kill with insecticides and all the products tested were effective. For raspberry cane midge, two sprays of Decis, Dursban, Dynamec, Tracer (contains spinosad), Calypso, Mavrik , Trigard (contains cyromazine) and 60145C (contains fipronil) were sprayed against second generation attack on 24 June and 3 July 2003. Only the standard product Dursban was effective. None of the other treatments gave a satisfactory standard of control. It is assumed that chlorpyrifos is effective as it was able to kill the larvae inside the splits as well as kill adults and possibly prevent egg laying. Dursban contains particularly effective wetting agents and this may have aided penetration into the splits.

The results of two further pesticide screening trials conducted in 2004, one evaluating insecticides for raspberry beetle control and the second evaluating insecticides for raspberry cane midge control are reported here.

Screening trial for new raspberry beetle active products

Methods and materials

In 2004, a single replicated field experiment was done to evaluate insecticides for control of raspberry beetle (*Byturus tomentosus*) in a heavily infested blackberry plantation as follows:

Site

The trial was located in rows 14-20 of 'Pond Piece' blackberry plantation, Place UK Ltd, Church Farm, Tunstead, Norfolk NR12 8RQ by kind agreement of Roger Debbage (manager). The plantation is at National Grid Reference TG 314 230 (Landranger sheet 134). Pond Piece was a blackberry plantation of cv Bedford Giant, planted in 1993/94. The row spacing was 9' = 2.75 m and the plant spacing in the row was4' = 1.22m. Posts and wirework are provided to support plants. Posts are after every 4 plants. The site was chosen because it was exceptionally heavily infested with raspberry beetle.

Treatments

Treatments were sprays of 9 different insecticide products, including standard treatments with the existing approved products Dursban and Decis, plus and an untreated control as given in Table 1. For treatments B – I, three spray applications were made on 10 June at the start of flowering, on 23 June in the middle of flowering and on 6 July at the end of flowering when the first pink fruits were visible. Note that only the latter two sprays were of spinosad were applied for treatment J. No sprays were applied to the untreated control (treatment A)

Table 1. Treatments applied in the raspberry beetle trial at Church farm, Tunstead, Norfolk in 2004

Treatment	Active substance and formulation	Product	Product dose /ha	Conc. Product /litre	Sprays	
					No.	Dates
A	Untreated	Untreated	--		0	-
B	Chlorpyrifos 480 g/l EC	Lorsban WG	0.6 kg	1.2 g	3	10/6, 23/6, 6/7
C	Abamectin 18 g/l EC	Dynamec	0.5 litre	1.0 ml	3	10/6, 23/6, 6/7
D	Deltamethrin 25 g/l EC	Decis	0.6 litre	1.2 ml	3	10/6, 23/6, 6/7
E	Thiacloprid 480 g/l SC	Calypso	0.25 litre	0.5 ml	3	10/6, 23/6, 6/7
F	Bifenthrin 100 g/l EC	Talstar	0.4 litre	0.8 ml	3	10/6, 23/6, 6/7
G	Cyromazine 10% w/v WP	Trigard	0.3 kg	0.6g	3	10/6, 23/6, 6/7
H	Triazamate 140 g/l EW	Aztec	0.5 litre	1.0 ml	3	10/6, 23/6, 6/7
I	Pymetrozine 50% w/w WG	Plenum WG	0.4 kg	0.8 g	3	10/6, 23/6, 6/7
J	Spinosad 480 g/l SC	Tracer	0.6 l	1.2 ml	2	23/6, 6/7
		-	-	-		

Spray application

Sprays were applied at a volume rate of 500 l/ha using a Cooper Peglar Tornado air assisted knapsack sprayer fitted with fitted with pink micron flow restrictor. Calibration of the sprayer before treatment application showed the sprayer delivered spray at a flow rate of 0.56 l/min. Measurement of the volume of sprayate in the tank before and after spraying each insecticide treatment showed that the volumes actually applied (and hence the doses) were somewhat greater than the target dose but generally within 16% of the required volume of 500 l/ha (Table 2). The calibrations were done with clean water and it was found the formulated product generally increased flow rates

Table 2. Accuracy of spray applications in the raspberry beetle trial†

Treatment	Accuracy of spray applications (%)†		
	10 June	23 June	6 July
B. Lorsban WG	112	130	107
C. Dynamec	116	110	110
D. Decis	114	103	110
E. Calypso	114	107	109
F. Talstar	110	103	112
G. Trigard	108	103	109
H. Aztec	105	103	105
I. Plenum WG	105	107	110
J. Tracer	-	107	112

†Values given relate to each spray tank filling required to complete the corresponding treatment

Experimental design

A randomised complete block experiment design with 4 replicates was used for treatments A - I. However, plots for treatment J were added subsequently two at each end of the trial area and thus strictly speaking cannot be included in the analysis. Plots consisted of 8 adjacent plants in a row and were 9.8 m long. They were guarded on each side by an unsprayed guard row. Although all the plants in each plot received the appropriate treatment, assessments were only done on the central 4 plants in each plot.

Assessments

On the 7 July 2004, one day after the third spray had been applied, 100 flowers on the central 4 plants in each plot were examined and the numbers of raspberry beetle adults they contained counted. On 27 July and 4 August 2004, 3 and 4 weeks respectively after the last sprays had been applied, samples of approximately 200 ripe fruits were taken per plot, approximately 50 berries from each of the four plants in the centre of each plot. Each sample of approximately 50 berries was held in a small plastic punnet itself in an individual plastic bag to prevent larvae from escaping. The samples were transported to East Malling Research where they were held overnight at 4 ºC in a cold store. The following day, each individual fruit was examined for infestation and or damage by raspberry beetle. The larvae that had exited the fruit and were in the bottom of the punnet were counted. Fruit possibly damaged by raspberry beetle but where it was not possible to be certain, were recorded separately. Thus for each punnet of fruit sampled from each plant on each sampling occasion, the following records were taken

Total number of fruit
Number of fruit infested by larvae (= loose larvae + larvae found in fruit)
Number of fruit damaged by raspberry beetle
Number of fruit possibly damaged by raspberry beetle (uncertain diagnosis of cause of damage)

Statistical analysis

An initial ANOVA of percentage infested, percentage damaged, and percentage possibly damaged fruits was carried out to look specifically at any overall differences between harvests and interaction of harvest date with treatments; if there were no interactions it was hoped that a more rigorous analysis could be made on the total data from both harvests using a GLM with binomial distribution and logit link function. However, for each of the three ANOVAs (analysed after an angular transformation to improve variance homogeneity) there was strong evidence of a significant interaction between treatments and harvest date. To include this hierarchical structure within in the context of GLMs would require a more complex mixed model approach with a corresponding complexity in explicit testing between treatments and presentation of results. For this reason, results from the ANOVAs on the transformed scale have been presented for simplicity.

As treatment J (Tracer) was not included in the original trial design, it was not explicitly included in the analyses, but the corresponding means (based on the same number of punnets) are added to the respective tables *in italics*. In no analysis was there any indication of significant block effects so it is hoped that these extra means are reasonably comparable with the other treatments. In the tables the means are of the angular-transformed data, with SEDs and LSDs on the same scale; alongside are similar tables of back-transformed estimated % figures

Results

Adults

Numbers of adults recorded in the flowers 24 hours after the last spray were rather variable and the data unsuitable for statistical analysis. However, simple examination of the data (Table 3) indicates that the Lorsban, Decis, Claypso, Talstar and Plenum treatments were reducing numbers of adults in the flowers, probably by direct mortality. Dynamec, Trigard, Aztec and Tracer appeared to have little or only limited effect in this respect.

Table 3. Numbers of raspberry beetle adults recorded on a sample of 100 flowers per plot (25 on each of the 4 central plants) 24 hours after the third spray application

Treatment	Block				
	1	2	3	4	Total
A. Untreated	6	0	6	5	23
B. Lorsban WG	0	0	0	0	0
C. Dynamec	5	7	4	1	17
D. Decis	0	0	0	0	0
E. Calypso	1	0	0	1	2
F. Talstar	0	0	1	0	1
G. Trigard	0	6	7	7	20
H. Aztec	6	5	5	0	16
I. Plenum WG	0	0	0	1	1
J. Tracer	3	2	3	3	11

Larvae and damage in berries

Treatment and harvest main effects and their interaction were highly significant (all with $p<0.001$)

Statistically, the first 5 treatments (Dursban, Dynamec, Decis, Calypso and Talstar) have negligible infestation at either date, significantly lower that untreated (Table 4). For the other four (Trigard, Aztec, Plenum and Untreated) there is a significant decrease from harvest 1 to harvest 2. Of these, Plenum gives significantly lower infestation at harvest 1 than the untreated, but still higher than the first 5 treatments (Tracer appears to lie within the range of the group of 5 highly effective treatments).

Discussion

A very high level of raspberry beetle infestation and damage occurred in the 2004 trial reported here and the treatments were well tested. The trial was effective and discriminated well between effective and less effective treatments. The trial in 2003 (Cross, 2003) was less satisfactory because very few berries were present for sampling in the abandoned raspberry plantation that was used and the data obtained was variable. In that trial, raspberry beetle proved comparatively easy to kill with insecticides and all the products tested appeared effective including Dynamec, Tracer, Talstar and Trigard as well as the approved products Dursban, Decis and Rotenone. These results concur well with the results of the 2004 trial, except in respect of Trigard which was found to be ineffective in the 2004 trial.

Insecticidal control of raspberry beetle can be achieved though control of adults, eggs or larvae or by control of a combination of these life stages. The assessment of adults in flowers after spraying indicate that Lorsban, Decis, Talstar, Calypso and possibly Plenum have strong activity against adults, probably by causing direct mortality or possibly by repellency. These products may also have activity against eggs and/or larvae except in the case of Plenum which was only partially effective. The Dynamec and Tracer treatments did not greatly reduce adult numbers though total numbers were somewhat smaller than numbers on the control. This suggests that these two products, which were both highly effective, were also acting against larvae or possibly eggs.

Dynamec, Claypso and Tracer provide three possible alternatives to the standard Lorsban and Decis treatments. The Tracer is the most interesting of these because of its safety to bees and safety to insect and mite predators. It is of comparatively short persistence and is less likely to leave detectable residues than more persistent products such as synthetic pyrethroids, Lorsban or Calypso. The parent companies for the three alternative products (Syngenta Bioline, Bayer and Dow AgroSciences respectively) need to be contacted to ascertain the existence of residues data on cane fruits and their support in obtaining that data if it does not already exist. Depending on the response, a second alterative should be chosen for future trials and development. The likelihood of the occurrence of residues, even below the MRL, needs to be taken into account in choosing the second alternative for further development.

Conclusions and recommendations (raspberry beetle)

- In this trial, Lorsban, Dynamec, Decis, Calypso, Talstar and Tracer were all highly effective for raspberry beetle control, reducing larval infestations and damage by > 95%.
- Dynamec, Claypso and Tracer provide three possible alternatives to the standard Lorsban and Decis treatments.
- It is recommended that two for these are chosen for more detailed investigation in the final year of this project
- Of these, Tracer is of the greatest interest because of its selectivity to natural enemies, safety to bees and environmental and human safety profile. The rate of application of Tracer that was tested in this trial was high. However, only two sprays were applied, the first in the middle of the flowering period, the second towards the end of flowering at the first pink fruit stage, compared to three sprays for the other treatments.
- It is recommended that the parent companies for the three alternative products (Syngenta Bioline, Bayer and Dow AgroSciences respectively) are contacted to ascertain the existence of residues data fro their products on cane fruits and their support in obtaining such data if it does not already exist. Depending on the response, the second alterative should be chosen. The likelihood of the occurrence of residues, even below the MRL, needs to be taken into account in choosing the second alternative for further development.
- Trigard, Aztec and Plenum were at best only partially effective against raspberry beetle.
- It is recommended that a third experiment investigating the use of Tracer at a range of rates and of Dynamec and/or Calypso at a standard rate, exploring a range of different at different timings is conducted in the final year of this project (2005). The heavily infested blackberry crops at Church Farm, Tunstead, Norwich provide an ideal site for such a trial.

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Table 4. Mean angular transformed and back transformed % berries infested (upper table) or damaged (lower table) with raspberry beetle

Treatment	Angular transformed 1st harvest	Angular transformed 2nd harvest	Back-transformed % 1st harvest	Back-transformed % 2nd harvest
	% berries infested by raspberry beetle larvae			
A. Untreated	19.64	7.15	11.30	1.55
B. Lorsban WG	1.22	0.00	0.05	0.00
C. Dynamec	1.95	1.02	0.12	0.03
D. Decis	0.00	0.96	0.00	0.03
E. Calypso	2.28	0.00	0.16	0.00
F. Talstar	1.01	0.49	0.03	0.01
G. Trigard	20.06	10.28	11.76	3.18
H. Aztec	23.94	8.40	16.46	2.13
I. Plenum WG	10.56	4.82	3.36	0.71
J. Tracer	3.2	0.00	0.31	0.00
Comparisons	SED (df)	LSD (p=0.05)		
(i)	2.667 (39)	5.42		
(ii)	1.894 (27)	3.89		
	% berries damaged by raspberry beetle larvae			
A. Untreated	34.03	19.75	31.33	11.42
B. Lorsban WG	3.38	29.63	0.35	24.44
C. Dynamec	9.86	13.13	2.93	5.16
D. Decis	6.97	17.43	1.47	8.97
E. Calypso	3.55	8.40	0.38	2.13
F. Talstar	5.45	27.87	0.90	21.86
G. Trigard	31.06	30.81	26.62	26.23
H. Aztec	42.73	35.37	46.04	33.51
I. Plenum WG	25.46	36.39	18.48	35.20
J. Tracer	7.06	12.43	1.51	4.63
Comparisons	SED (df)	LSD (p=0.05)		
(i)	7.355 (48)	14.79		
(ii)	6.675 (27)	13.70		

Screening trial for new raspberry can midge active products

Methods and materials

Site

The experiment was located in a different part of the same previously organic primocane (cv Autumn Bliss) raspberry plantation at Gallants Farm, East Farleigh (see above). The plantation was chosen because it had been heavily infested with raspberry cane midge (*Resseliella theobaldi*) in 2003 when a successful trial had been conducted.

Monitoring midge populations

The ADAS midge warnings based on air temperature interpolated from local met stations predicted emergence of first emergence of the first generation to be on 9 May 2004.

Twice weekly from 27 April to 11 August 2004, artificial splits were made in 10 canes in each of three well separated areas of the experimental area. Splits from the previous week were collected and examined in the lab under a binocular microscope for raspberry cane midge eggs. Unfortunately, only one egg and a few larvae were found for the first generation on 24 and 28 May respectively. It was therefore decided to delay the application of treatments until the second generation. The first generation of the pest had been virtually absent in 2003 but good numbers subsequently developed for the second generation allowing a very successful experiment to be conducted.

The twice weekly monitoring was continued seeking the second generation attack for application of treatments. On 26 July, small numbers of eggs and young larvae were found in about 10% of the artificial splits. This prompted application of treatments at the earliest opportunity the following week

Treatments

On 26 July, artificial splits were made in 30 canes per plot. The spray treatments were applied on 29 July. Treatments were a single spray of a range of 7 insecticides as shown in Table 5.

Table 5.Treatments applied in the raspberry cane midge trial on 28 July 2004

Treat no.	a.i.	Product	Product dose (/ha)	Conc (/litre)
1	Chlorpyrifos 75% w/w WG	Lorsban WG	0.6 kg	0.6g
2	Bifenthrin 100 g/l EC	Talstar	0.5 litres	0.5 ml
	+ LI700	+ LI700	2.5 litres	2.5 ml
3	Taufluvalinate 240 g/l EW	Mavrik	200 ml	0.2 ml
	+ LI700l	+ LI700	2.5 litres	2.5 ml
4	Acetamprid	NI25	250 g	0.25 g
5	Triazamate 140 g/l EW	Aztec	500 ml	0.5 ml

6	Pymetrozine 50% w/w WG	Plenum	300 g	0.3 g
7	Formetanate†	Dicarzol	2000 g	2.0 g
8, 9	Untreated (double replicated)	-	-	-

Spray application
Sprays were applied in a volume of 1000 l/ha on 29 July 2004 using a Birchmeier B 7014 air assisted knapsack sprayer fitted with a pink micron flow restrictor. where splits likely to be infested were present.

Experiment design
A randomised block experiment design was used with 4 replicates. The untreated control was double replicated, there being two untreated control plots in each block. Plots were 20m long, single row wide, and were guarded on each side by an unsprayed guard row.

Assessments
On the 4 and 11 August, 20 canes with artificial splits were collected from each control plot. The number of larvae it contained counted in the laboratory..

Results

Regrettably, no larvae were found in the samples from the untreated controls and the experiment was abandoned.

Conclusions and recommendations (raspberry cane midge)

- This raspberry cane midge experiment was unsuccessful. Populations of the pest failed to develop despite an extended effort to provide artificial splits for oviposition. Sprays were applied at seemingly the appropriate time. The reason for this is unknown. The site was very heavily infested in 2003 and a successful trial conducted there.
- It is suggested that an additional site is sought for 2005 and the 2004 trial repeated at the best site.

Acknowledgements

These insecticide screening trials were funded by the HDC as part of a 3 year programme of research to identify alternative chemical controls for these pests. Thanks to Eric Nancarrow for help with the spraying and to Jonathon Hall, Marc Petzer and Anita Kovacs for help with the assessments.

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