Project Title: Evaluation of foliar sprays of acaricides for control of tarsonemid mite in strawberry 2011

Project Number: SF 125

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Report: 2012 year 1 report

Previous reports: None

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Date Project commenced: March 2011

Expected completion date: 31 March 2013

Key words: tarsonemid mite, acaricides, *Phytonemus (Tarsonemus) pallidus* ssp. *fragariae*, strawberry, abamectin (Dynamec), spirodiclofen (Envidor), tebufenpyrad (Masai), fenpyroximate (Sequel), etoxazole (Borneo).

East Malling Research is an officially recognised efficacy testing station and this work is registered as study number ORETO 2010/007

DISCLAIMER

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.

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CONTENTS

GROWER SUMMARY

Headline

Due to poor establishment of tarsonemid mite in this project, no conclusions could be drawn from the first year's work.

Background and expected deliverables

The tarsonemid mite, *Phytonemus (Tarsonemus) pallidus* ssp. *fragariae*, sometimes called the strawberry mite, is a serious pest of strawberry. It feeds mainly on the upper surfaces of the young folded leaves of strawberry, making their surfaces rough and crinkled as they expand. Sometimes the leaves turn brown and die and the whole plant usually becomes stunted. Mites also feed in the flowers and fruits, seriously affecting yield and quality which can halt berry production.

There has been a significant and threatening increase in the frequency and severity of attacks in UK strawberry production in the last few years and the problem was particularly bad in 2010 and threatens to get worse.

The fact that most acaricides are contact acting with no or at best limited translaminar activity makes it difficult to gain control of the mite. Although readily controlled when directly intercepted by an acaricide, spray penetration in to the young folded leaves where the tarsonemid mites live and breed can be limited, and this further reduces control efficacy. Furthermore, strawberry leaves are waxy and covered in hairs, and many products are not specifically formulated for the crop and have insufficient wetting properties. Work by EMR in HDC project SF 79 clearly demonstrated substantive improvements in the efficacy of abamectin (Dynamec) when admixed with a silicone wetter.

There is a clear need to identify new, more effective spray treatments for tarsonemid mite. Ideally, these need to be compatible with biocontrol agents as well as being safe to plants, the environment and humans.

The overall objective of this trial was to identify new effective acaricide treatments for control of strawberry tarsonemid mite in propagation and/or fruiting crops.

Summary of the project and main conclusions

In the first year of the project, tarsonemid mite populations on the strawberry plants failed to build up to more than a few per leaflet, despite repeated attempts at artificial infestation. As a result of this problem in 2011, few results and conclusions could be drawn on the efficacy of the control measures applied. The project will continue in 2012 when it is hoped that artificial infestation will be more successful on a different strawberry variety.

The populations of tarsonemid mite failed to develop sufficiently to show any differences between the treatments applied and the untreated control. The multiple infestations of the plots should have resulted in very high mite populations. A possible explanation is low susceptibility of the variety Evie 2 to strawberry tarsonemid mite (the cultivar used for the trial). It has generally been considered that all strawberry varieties are highly susceptible to strawberry tarsonemid mite. However, new strawberry varieties have recently been bred in Russia with good resistance to strawberry tarsonemid mite, using the variety Spasskaya as a source of resistance. It is therefore possible that there is considerable variation in susceptibility to strawberry tarsonemid mite of cultivars commonly grown in the UK, and that this variation is not appreciated and has not been quantified. A low susceptibility of Evie 2 would explain the difficulty in establishing strawberry tarsonemid mite populations on it, despite repeated attempts, a problem which had not been encountered previously. Predatory mites might have been another contributory factor but they were present only in low numbers.

Financial benefits

Strawberry tarsonemid mite can cause devastating crop losses in highly valuable protected strawberry crops. Losses exceed £10,000 per ha per annum in some instances. New effective chemical treatments for control typically cost <£100 per ha per application, so the cost benefit ratio of any new acaricide treatment is likely to be very high and will benefit UK strawberry propagators and fruit producers.

Action points for growers

- There are no grower action points arising from this project thus far, but growers will benefit from good crop hygiene, regular crop inspections, early applications of predatory mites and the use of Dynamec with a silicone wetter when necessary.

SCIENCE SECTION

Introduction

Background

The tarsonemid mite, *Phytonemus (Tarsonemus) pallidus* ssp. *fragariae*, sometimes called the strawberry mite, is a serious pest of strawberry. It feeds mainly on the upper surfaces of the young folded leaves of strawberry, making their surfaces rough and crinkled as they expand. Sometimes the leaves turn brown and die and the whole plant usually becomes stunted. Mites also feed in the flowers and fruits, seriously affecting yield and quality which can halt berry production. Damage is most severe in everbearing varieties and on plants grown under protection. June bearers can also be severely attacked. Populations build up rapidly in warm conditions, the generation time being nine days at 25 ˚C. There has been a significant and threatening increase in the frequency and severity of attacks in UK strawberry production in the last few years and the problem was particularly bad in 2010 and threatens to get worse.

The difficulty of controlling strawberry tarsonemid mite is because most acaricides are contact acting with no, or at best limited, translaminar activity. The mites are readily controlled when directly intercepted by an acaricide. However, penetration into the young folded leaves, where the tarsonemid mites live and breed, is limited, and this is the chief factor limiting efficacy. Furthermore, strawberry leaves are waxy and covered in hairs, and many products are not specifically formulated for the crop and have insufficient wetting properties. Work by EMR in HDC project SF 79 (report issued 2 Jan 2008) clearly demonstrated substantive improvements in the efficacy of abamectin (Dynamec) when admixed with a silicone wetter. Nevertheless a very high degree of efficacy is only likely to be achieved with a systemic acaricide.

Currently UK growers use a combination of approaches to control the pest:

(1) They source clean certified planting material. However experience shows that the material from the main Dutch and Spanish suppliers often has low levels of infestation.

(2) Plantations are inspected frequently in spring and early summer for signs of damage and infestation and infested plants are grubbed and destroyed. This approach rapidly becomes costly and uneconomic.

(3) *Amblyseius* spp. predatory mites are introduced to prevent or suppress outbreaks, but this approach is only partially effective and cannot contain outbreaks in hot weather

conditions.

(4) Sprays of abamectin (Dynamec) or tebufenpyrad (Masai) are applied when damaging infestations start to develop and give partial control, so delaying the spread or infestation and damage. The number of applications of abamectin (Dynamec) and tebufenpyrad (Masai) are limited to three and one respectively, and in any event sprays used during flowering and fruiting on everbearers are undesirable.

Fountain *et al*. (2010) reported the results of HDC project SF 79, an experiment at East Malling Research in 2007 which determined the efficacy of acaricides for controlling tarsonemid mite in polytunnel-protected everbearer strawberry plants in grow bags. Treatments evaluated included both approved acaricides (Dynamec and Masai) at recommended and non-recommended rates, along with novel products. Some treatments were applied in admixture with the silicone adjuvant Silwet L-77. The trial confirmed the importance of the use of a silicone wetter with acaricide products. Only the novel product HDCI 011 + Silwet and Dynamec 500ml + Silwet reduced all life stages of the tarsonemid mite compared to the untreated control.

The data obtained were encouraging for the prospect of chemical control of tarsonemid mites in commercial strawberry. It was recommended that further tests be executed to evaluate the efficacy of higher rates of Dynamec with the addition of a silicone wetter, and efficacy of the addition of other adjuvant classes to Dynamec and HDCI 011.

Objectives

The overall objective of this study was to identify new effective acaricide treatments for control of strawberry tarsonemid mite in propagation and/or fruiting crops.

Materials and methods

Experimental design

A small plot replicated experiment comparing foliar sprays of the acaricidal products was carried out on tarsonemid mite infested everbearer strawberry plants (cv. Evie 2) in a polytunnel at East Malling Research (EMR) between March and September 2011.

Tarsonemid culture

Infested control plants from the previous year were kept in two glasshouses at EMR in order to culture the tarsonemid mites. Approximately 100 elite cv. Evie 2 cold-stored strawberry runner plants were planted into individual pots and placed amongst the infested plants

(Appendix 1) to increase the number of inoculation plants available for the trial. The mite populations were very slow to increase.

Plot infestation

On 27 May 2011, tarsonemid infected plants from the glasshouse culture were moved to the polytunnel and two infested potted plants planted in the centre of each plot (peat bag). Young leaves from the strawberry plants in the polytunnel were checked for tarsonemids on 2 and 21 June. Mites and eggs were developing but the numbers were low. Heavily infested strawberry plants were collected and introduced to the plots on 29 June 2011. The infested plants were laid between the plants in the peat bags. The plots were assessed on 11 and 18 July but numbers of mites were still low and the remaining plants from the glasshouse culture were introduced to the plots by placing on top of peat bags. On 3 August the numbers of mites present were again low but uniform across the plots. A full pre-assessment was done on 9 August and although numbers of tarsonemid mites were low they were evenly distributed across the experimental area so a decision was made to apply the treatments.

Experimental design and layout

The experimental strawberry plantation consisted of 64 plots in a 22 x 6 m Spanish polythene tunnel (EMR plot code WF211) remote from other strawberry plantations. A randomised block experiment with four replicates of 16 treatments was used. Each plot consisted of a standard 1 m peat bag planted with 10 cv. Evie 2 everbearer strawberries on 25 April 2011. Each bag was provided with trickle irrigation/fertigation. The plots were arranged in four rows of 16, within the polytunnel (Appendix 1). Plots were separated by 0.5 m (Appendix 1).

Treatments

Treatments were seven day programmes of up to three sprays (not exceeding the maximum number of applications permissible) of Agrimec, Envidor, Masai, Sequel, Borneo, Naturalis L, HDC coded products HDCB 004, HDCB 005, HDCB 006, HDCB 007, HDCI 011 and HDCI 012 at their full recommended rate for curative control of tarsonemid mite on strawberry. Agrimec, Envidor, Masai, Sequel, Borneo, HDCB 004, HDCB 005, HDCB 006, HDCI 011 and HDCI 012 were used in admixture with the silicone wetter Silwet L77. Naturalis L and HDCB 007 were not used in admixture with Silwett L77. Single and three spray treatments of Agrimec + Silwet L77, and a three spray treatment of Silwet L77 were included as standards (Table 1).

Table 1. Treatments

Trt No.	Colour Code‡	Product(s)	Product rate/ha (spray volume 1000 l/ha)	Day of application		
				0	7	14
1	R	Agrimec+Silwet L-77	500 ml	1	0	0
2	R Blk	Agrimec+Silwet L-77	500 ml	1	1	1
3	B	Envidor+Silwet L-77	400 ml	1	0	1
4	B Blk	Masai+Silwet L-77	750 g	1	0	0
5	Y	Sequel+Silwet L-77	2.0 l	1	0	0
6	Y Blk	Borneo+Silwet L-77	350 ml	1	0	0
7	Gry	Naturalis L	3.0 l	1	1	1
8	Gry Blk	HDCB 004+Silwet L-77	1.0 l	1	1	1
9	R R	HDCB 005+Silwet L-77	20 l	1	1	1
10	R R Blk	HDCB 006+Silwet L-77	10 l	1	1	1
11	B B	HDCB 007	2.5 l	1	1	1
12	B B Blk	HDCI 011+Silwet L-77	1.0 l	1	0	1
13	Y Y	HDCI 012+Silwet L-77	20.0 l	1	1	1
14	Y Y Blk	Silwet L-77	50 ml	1	1	1
15,16	G	Untreated	-	-	-	-

‡R = Red, Y = Yellow, B =Blue, G = Green, Blk = Black, Gry = Grey

Treatment application

Treatments were applied at a volume rate of 1,000 l/ha using knapsack sprayer with a hand lance (not air-assisted). This minimised inter-plot contamination by spray drift. The accuracy of application of each treatment was estimated by measurement of the amount of spray that had actually been applied (calculated from the initial minus the final volume of sprayate left in the tank, minus the amount that should have been left had the spray been applied at exactly the correct volume rate). Applications were generally within 10% of required (Table 2). Though some larger deviation occurred, five applications were within 25% of target. One application was over at 160% due to a mechanical fault in the sprayer.

Table 2. Accuracy of spray application estimated from the amount of sprayate remaining in the spray tank after spray application

Treatment		Accuracy of application (%)			
		10 Aug	17 Aug	24 Aug	01 Sep
1	Dynamec+Silwet L-77	78			
2	Dynamec+Silwet L-77	78	120	92	
3	Envidor+Silwet L-77	75*		112	
4	Masai+Silwet L-77	122			
5	Sequel+Silwet L-77	90*			
6	Borneo+Silwet L-77	110			
7	Naturalis L	90	100	110	
8	HDCB 004+Silwet L-77	90*	100	100	
9	HDCB 005+Silwet L-77	110	100	100	
10	HDCB 006+Silwet L-77	160*	100	100	
11	HDCB 007	90*	100	105	
12	HDCI 011+Silwet L-77	115		110	
13	HDCI 012+Silwet L-77	†	100	100	105
14	Silwet L-77	100	110	110	

*Note * denotes a problem with the new sprayer - an internal pipe had come loose, resulting in highly fluctuating pressures.* † sample delayed in post by courier.

Assessments

A pre-treatment assessment was made on 09 August 2011 of the degree of tarsonemid mite infestation in the polytunnel. Five young trifoliate leaves from each of the plots was collected and examined using a microscope and the number of tarsonemid mites and eggs recorded. A note was made of any potential predators.

The effects of the treatments were assessed seven days after the second (23 August 2011) and third spray applications (6 September 2011) by counting the number of mite adults, nymphs and eggs on five trifoliate leaves per plot (grow bag) under a binocular microscope. The upper and lower surface of each trifoliate leaf was examined. Predatory mites were also counted on the same leaves. Unfortunately the international courier used to deliver HDCI 012 misplaced the shipment and so it arrived too late for the start of the trial. HDCI 012 was therefore removed from the main trial and assessed independently, with the three sprays being applied exactly seven days later than the main trial. It was assessed appropriate to its treatment dates, along with the control.

Plot maintenance

Glasshouse plants were directly watered daily. Trickle irrigation was supplied to the plants in the polytunnel. There was a normal overall spray programme of fungicides for mildew control. Overall sprays of pirimicarb (Aphox) were applied for aphid control. The plantation was inspected weekly to check for pests, disease and any other problems. Plants were de-flowered and de-fruited at the same time to encourage new leaf growth, which favours tarsonemid mites.

Meteorological records

Dry and wet bulb temperature, wind speed and direction were recorded before and after each spray occasion. RH% was estimated from the dry and wet bulb temperature readings (Table 3). In addition, two Lascar USB-502 loggers were used to take hourly temperature and humidity readings inside the polytunnel (Appendix 2).

Table 3. Weather conditions at the time of spray application

Date	Time	Air temperature		% rh	Wind	
		^{o}C dry	^{o}C wet		speed (Kmph)	direction
10 Aug	15:00	22.5	17	60	5.5	S
17 Aug	17:50	19	14	57	0	N/A
24 Aug	13:00	24	20	70	0	N/A
01 Sep	15:20	24.5	17	45	0	N/A

Statistical analysis

Due to the low numbers of mite infestation statistical analysis of the data obtained was not possible.

Experimental approval and crop destruction

The novel coded products were not approved for use on strawberry and an experimental approval was acquired for all non-approved products by EMR. No fruit was harvested and the experimental plants were destroyed at the end of the experiment.

Phytotoxicity

Determination of any phytotoxic effects of the treatments was not a central aim of this work. However, plots were inspected for any visual signs of phytotoxicity from the treatments on each sampling occasion.

Quality assurance

East Malling Research is an officially recognised efficacy testing organisation (Certificate no. 0232). The work was done according to GEP quality standards and according to East Malling Quality Assurance (EMQA) procedures and requirements (experiment no. GEP11/012).

Results

Pre-assessment

In the pre-treatment assessment on 09 August 2011 five young tri foliate leaves per plot were assessed for the total number of motile mite, eggs and predators (Figure 1). The total numbers of mites and eggs on the 320 leaves was 54 motile mites, 71 eggs and six predatory mites. The presence of eggs on the plants in the grow bags indicated that the mites had transferred to the experimental plants and were reproducing, albeit slowly.

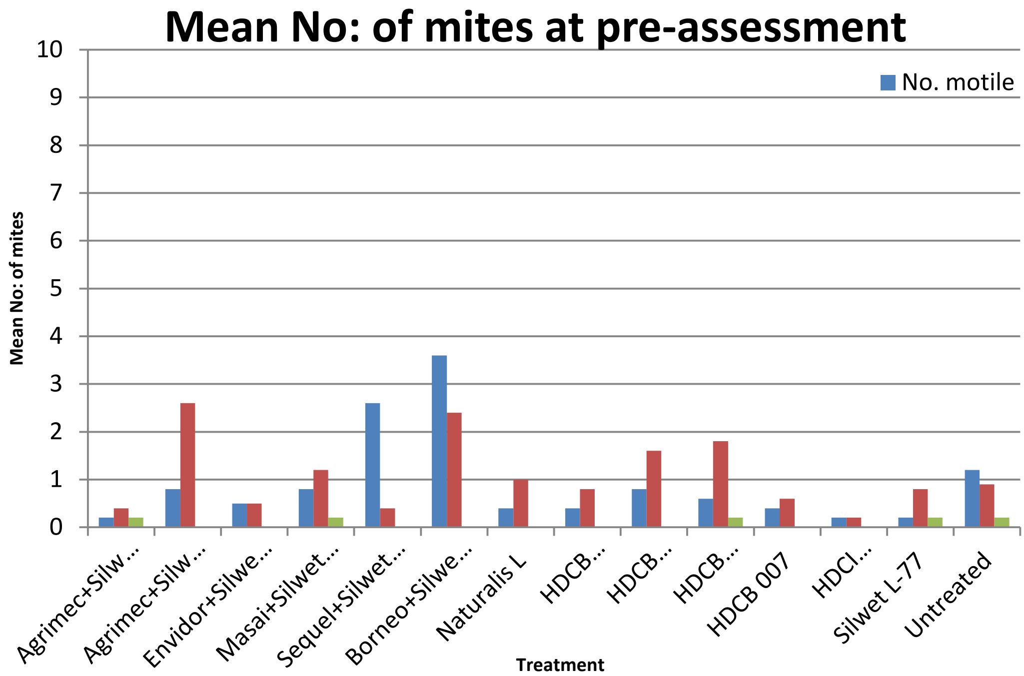


Figure 1. Mean numbers of tarsonemid mites (motiles and eggs) recorded on five trifoliate leaves on 9 August 2011, the day before the first spray application

First assessment

Seven days after the second spray application, on 23 August 2011, the assessment was repeated. The number of tarsonemid mites on each plot was low, hence statistical analysis was not appropriate (Figure 2).

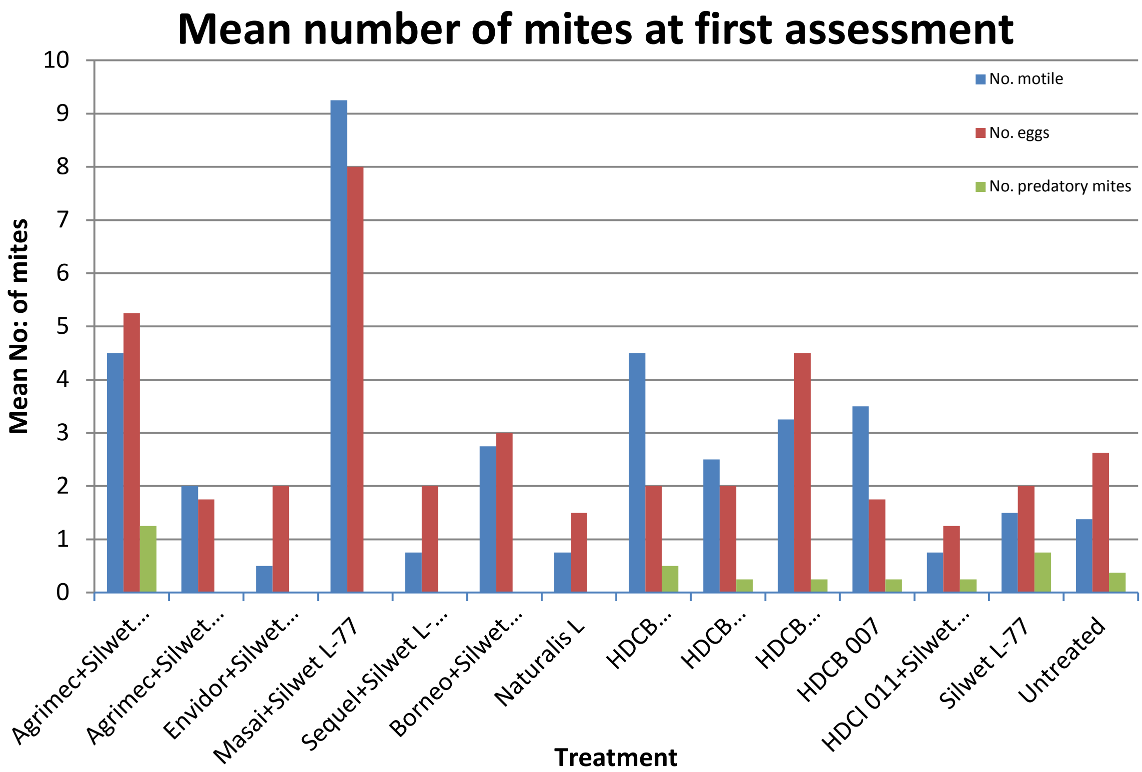


Figure 2. Mean numbers of tarsonemid mites (motiles and eggs) recorded on five trifoliate leaves on 23 August 2011, seven days after the second spray application

Second assessment

Seven days after the third spray application on 6 September 2011, the numbers of mites had decreased across all the plots (Figure 3).

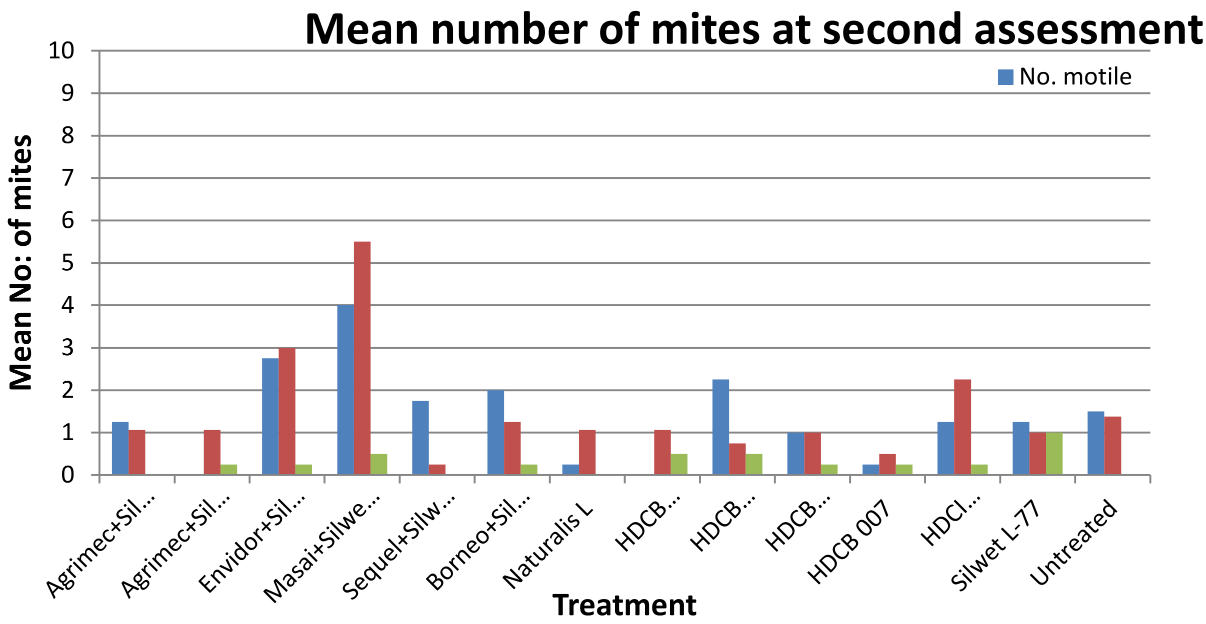


Figure 3. Mean numbers of tarsonemid mites (motiles and eggs) recorded on five trifoliate leaves on 6 September 2011, seven days after the second spray application

Assessments of HDCI 012

The trial was assessed concurrently with the main trial, and received a final assessment seven days after the final application of HDCI12 on 13 September 11. Hence, this product was assessed three times. However the numbers of tarsonemid mites did not develop as expected, therefore, the data was un-suitable for statistical analysis.

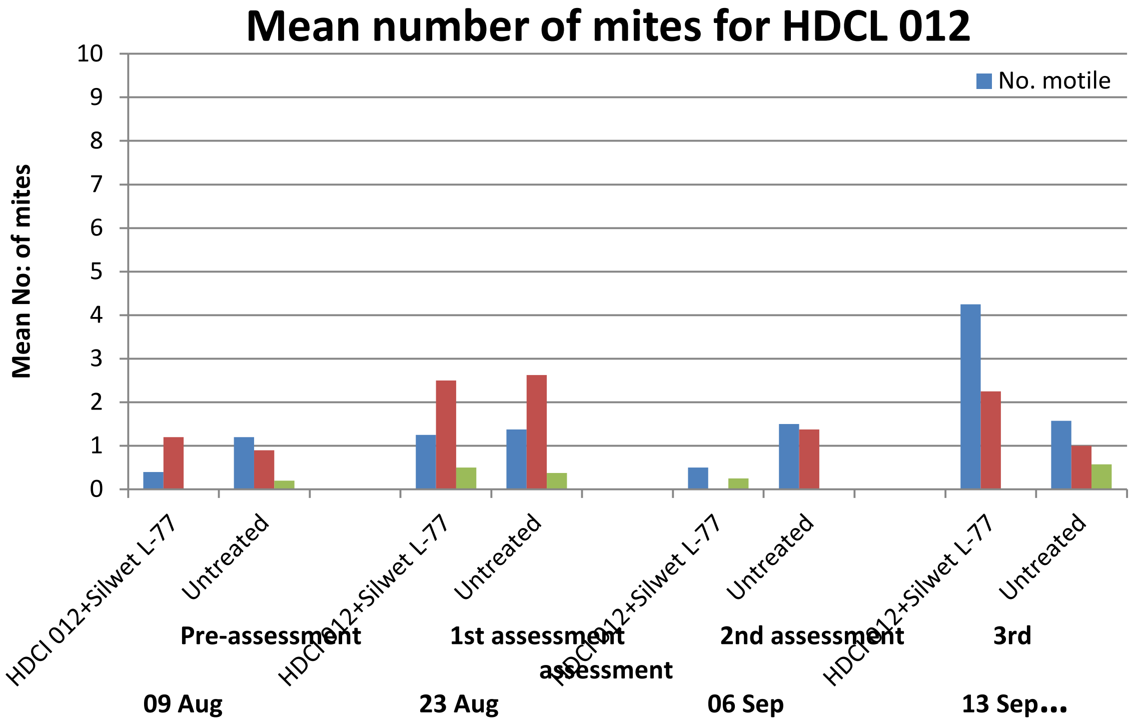


Figure 4. Mean numbers of tarsonemid mites (motiles and eggs) recorded on five trifoliate leaves on 13 September 2011, seven days after the three spray application of HDCI 012

Discussion

The populations of tarsonemid mite failed to develop sufficiently to show any differences between the untreated control and the treatments applied. The multiple infestations of the plots carried out should have resulted in very high mite populations.

A possible explanation for the poor development of tarsonemid populations on the test plants is low susceptibility of the cultivar used for the trial, cv. Evie 2, to strawberry tarsonemid mite, a possibility that was not appreciated at the outset of the trial. It has generally been considered that all strawberry varieties are highly susceptible to strawberry tarsonemid mite. However, recently Galitsina *et al*. (2009) in the Moscow region of Russia investigated resistance to strawberry tarsonemid mite in hybrids obtained from crosses of Borovitskaya, Rusich, Makovka, Solovushka, Vityaz', Estafeta, Neznakomka and Spasskaya. Mathematical models were used to determine average levels of resistance of hybrids to the strawberry mite. High levels of resistance were found in hybrids Spasskaya, Makovka, Spasskay, Rusich and Neznakomka, Estafeta. They concluded that Spasskaya remained a good source of resistance.

Thus it is possible that there is considerable variation in susceptibility to strawberry tarsonemid mite of varieties commonly grown in the UK, and that this variation is not appreciated and has not been quantified. A low susceptibility of cv. Evie 2 would explain the difficulty experienced in establishing strawberry tarsonemid mite populations on it, despite repeated attempts, a problem which had not encountered previously at EMR.

Predatory mites might have been another contributory factor but they were present only in low numbers.

Conclusions

No conclusions about the efficacy of any of the treatments tested could be drawn from this trial.

Future Work

Because of the poor establishment of the pest on cv. Evie 2 in this trial it is recommended that a further trial is conducted in 2012, to repeat the work on a different variety.

Acknowledgements

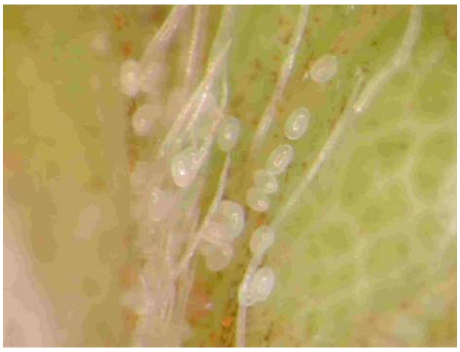
We are grateful to Graham Caspell and his team for the erection and maintenance of the polytunnel and husbandry of the plants. We would also like to thank Tracie Evens and Gloria Endredi of EMR, who assisted with the spraying, sampling and mite counts.

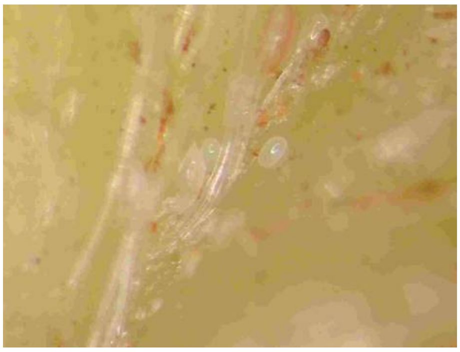
Reference

Galitsina, N. V., Popova, I. V., Shesteperov, A. A. 2009. Resistance of strawberry hybrids to the strawberry mite. Zashchita i Karantin Rastenii, 3, 34-35.

APPENDIX

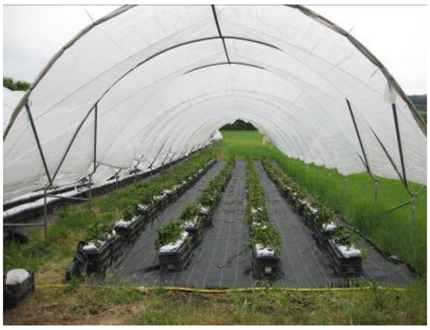
Photographs from HDC strawberry trial 2011


Tarsonemid mite eggs


Tarsonemid mite eggs and nymph

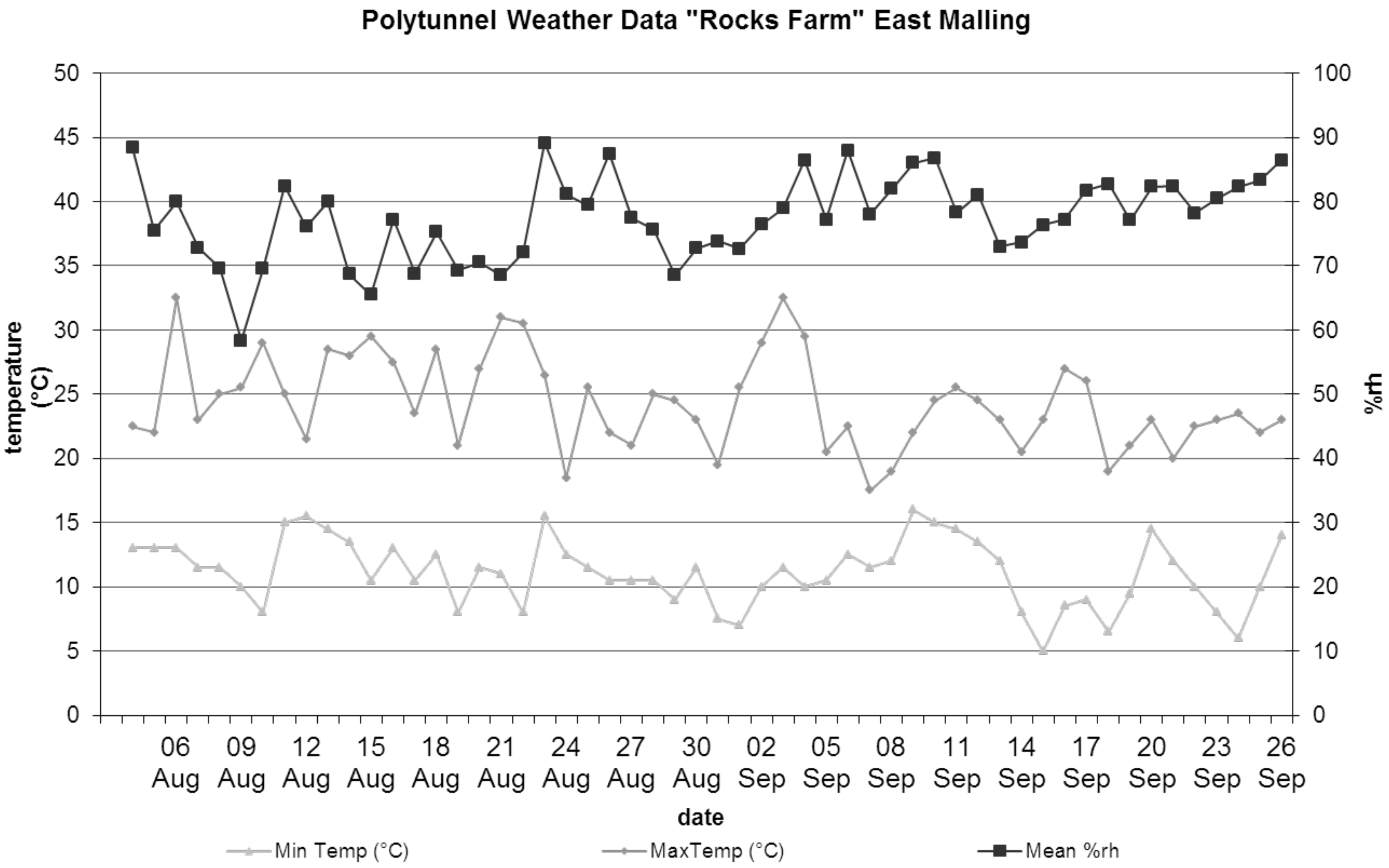

Tarsonemid mite adult


Tarsonemid damage to strawberry leaf


Polytunnel used in trial, 6 June 2011


Plants in grow bags, 6 June 2011


Tarsonemid culture plants, October 2010



Polytunnel Weather Data "Rocks Farm" East Malling
temperature (°C)
%rh
50
45
40
35
30
25
20
15
10
5
0
100
90
80
70
60
50
40
30
20
10
0
06 Aug
09 Aug
12 Aug
15 Aug
18 Aug
21 Aug
24 Aug
27 Aug
30 Aug
02 Sep
05 Sep
08 Sep
11 Sep
14 Sep
17 Sep
20 Sep
23 Sep
26 Sep
date
Min Temp (°C)
MaxTemp (°C)
Mean %rh

