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[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.]

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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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GROWER SUMMARY

Headline

- *Neoseiulus cucumeris* and *Amblyseius barkeri* have potential as effective treatments for control of tarsonemid mite infestations in strawberry*.*

Background and expected deliverables

The strawberry 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.

There has been a significant increase in the frequency and severity of attacks in UK strawberry production in the last few years. The problem was particularly severe in 2010 and 2011, and continues to be a problem in some crops. Strawberry tarsonemid mite is difficult to control as most acaricides are contact acting with no or, at best, limited translaminar activity. The mites are readily controlled when directly intercepted by an acaricide, but penetration into the young folded leaves where the tarsonemid mites live and breed is limited, spray penetration being 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.

The overall aim of this project was to identify effective predatory mites for prevention and control of strawberry tarsonemid mite in polytunnel and glasshouse crops and to improve application timing and treatment methods.

Summary of the project and main conclusions

In 2012, six predatory phytoseiid mite species were evaluated for their effectiveness at controlling strawberry tarsonemid mite at low and high temperatures, for use in polytunnel and glasshouse conditions. Results from the glasshouse trial were hindered by low numbers of tarsonemid mites in the control plots. Significantly less tarsonemid eggs were found in the control plots and those treated with *Neoseiulus californicus,* compared to those treated with *Amblyseius swirskii* or *A. montdorensis*. However, more predatory mites were found on the plants treated with *A. swirskii* and *A. montdorensis* compared to *N. californicus* and the untreated control. A summer polytunnel experiment gave more promising results with fewer tarsonemid mites in the cages treated with *A. barkeri* or *N. cucumeris* compared to *A. andersoni* or the untreated control.

The polytunnel trial in 2013 consisted of 7 treatments. *A. barkeri* and *N. cucumeris* were tested as preventative and curative controls for strawberry tarsonemid mite (curative controls were applied as one or two releases). Predatory mites were found in the plots before the treatments had been applied. Both species of predatory mite (*A. barkeri, N. cucumeris*) appeared to suppress introductions of tarsonemid mites made post predatory mite release. Numbers of tarsonemid mites in the untreated control plots remained constant even though *A. barkeri*, *N. cucumeris* and *N. californicus* were recovered from these plots in substantial numbers. One or two releases of either *A. barkeri* or *N. cucumeris* reduced numbers of tarsonemid mites in the plots. In 2013 higher numbers of *A. barkeri* were recovered from all treatment plots compared to *N. californicus* and *N. cucumeris*. This may be due to the fact that the same site was used, with the possibility of overwintering of the *A. barkeri* from the 2012 experiment.

In 2014, the experiment was, again, in a polytunnel, on strawberry plants in grow bags. *A. barkeri* and *N. cucumeris* were applied as preventative and curative treatments, with a single inoculation being used. As with the 2013 experiment, predatory mites were found in plots ahead of inoculation. In the 2014 trial there were few significant differences between the treatments of predatory mites and the untreated controls. The numbers of tarsonemid motiles were generally low in the preventative experiment. Establishment of both species of predatory mites was seen with a significant increase in eggs of predatory mites over time in the curative experiment (although numbers were low). There was also a significant increase in predatory mites over time in the preventative experiment and significantly more mites where released.

The overall results from the project show that in the glasshouse experiment, less tarsonemid eggs were found where *N. californicus* was introduced (*N. cucumeris* was not a treatment in the glasshouse experiment). Results from the polytunnel experiments show that *N. cucumeris* remains suitable as a preventative and curative treatment. Similarly, *A. barkeri* also established and suppressed populations of tarsonemid, although this species is not marketed in the UK.

A review of the data available on chemical treatment effects on predatory mites in strawberry was completed by Michelle Fountain and Nathan Medds (Syngenta Bioline) in Year 2 which is available on request from HDC.

Financial benefits

Strawberry tarsonemid mite can cause devastating crop losses in highly valuable protected strawberry crops; losses exceeding £10,000 per ha per annum in some instances. New effective predatory mite species and more accurate timing of application of predators with the most effective species for the time of year, will reduce populations of tarsonemid mites in strawberry crops reducing the need for chemical applications.

Action points for growers

- Results from these studies suggest that *N. californicus* is to be recommended as an effective treatment for tarsonemid mites in glasshouse strawberry and *N. cucumeris* in polytunnel crops. *A. barkeri* also gave control in polytunnel crops, however it is not currently marketed to UK growers.
- Tarsonemid mite control is difficult once populations have established and, therefore, we would recommend that growers apply predatory mites early in the season before tarsonemid mite populations can build up. Topping up with predators on a planned basis may also be required.
- It is also important that sprays directed against tarsonemid mites ensure good coverage to the crown and young folded leaves of the plants. We would recommend using water sensitive papers to test this and consider the incorporation of a wetter with the plant protection product.
- Growers should follow recommendations for predatory mite release times after a plant protection product application.

SCIENCE SECTION

Introduction

The pest

Strawberry tarsonemid mite, *Phytonemus (Tarsonemus) pallidus* ssp. *fragariae* is a serious pest of strawberry. It feeds mainly on the upper surfaces of the young folded leaves of strawberry, along the main vein, making leaf surfaces rough and crinkled as they expand (Cross, 2003) (Appendix 1). 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. 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 (Smith and Goldsmith, 1936; Wisemann, 1941; Easterbrook *et al*., 2003). The optimum temperature for development is between 22-28 ˚C (Wisemann, 1941).

Female mites overwinter as adults in the crowns of the plants (Dustan and Matthewman, 1931; Harmsen, 1934; Alford, 1972; Jeppson *et al*., 1975). Oviposition begins at 8 ˚C (Wisemann, 1941) with each female capable of laying 30-40 eggs during her lifetime (Smith and Goldsmith, 1936). In addition, reproduction is facultatively parthenogenetic (Massee, 1928-30).

Increase in attacks

There has been a significant increase in the frequency and severity of damage in UK strawberry production in the last few years, mostly due to pesticide withdrawals, in particular the withdrawal of methyl bromide fumigation of propagation material and its replacement with the CATT method. The problem was at its worse in 2010-11.

Management in UK fruiting plantations

Currently, UK growers use a combination of approaches to control the pest (Table 1).

Difficulty of chemical control

Currently, the UK approved chemical options for tarsonemid control on outdoor and protected strawberry are abamectin (Dynamec), fenpyroximate (Sequel) and tebufenpyrad (Masai). However, tebufenpyrad (Masai) and abamectin (Dynamec) are only partially effective against *P. pallidus.*

The number of applications of abamectin (Dynamec) and tebufenpyrad (Masai) are limited to three and one, respectively, but applying sprays during flowering and fruiting on everbearers is undesirable.

Most acaricides are contact acting with no, or at best limited, translaminar activity. Lack of penetration into the young folded leaves 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 (Fountain *et al*., 2010) 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.

Table 1. Current approaches to tarsonemid control

Control/Prevention	Problem
Source clean certified planting material	Sometimes low levels of infestation present
Inspect plantations frequently in spring and early summer for signs of damage and destroy infested plants	As % of infested plants rises, destruction of plants and loss of yield becomes costly and uneconomic
Apply predatory mites	Only partially effective because mites are not suitable for all conditions, and timings, and application rates need to be planned and optimised
Spray abamectin (Dynamec) or tebufenpyrad (Masai) when damaging infestations start to develop.	Partial control, delaying the spread of infestation and damage (see below)

Predatory mites tested

The introduction of predatory mites on strawberry is a recommended practice for control of tarsonemid and other pests in strawberry. Early research in the US identified *Typhlodromus* sp. as a controlling predatory mite of tarsonemids on strawberry (Huffaker and Spitzer, 1951; Huffaker and Kennet, 1953). Today, *Neoseiulus cucumeris* is used most commonly for biocontrol of strawberry tarsonemid mite in the UK, but other species were tested in this project to determine if they are more efficacious and cost effective.

Biological control, although effective, if it is applied when population levels are low to moderate (Croft *et al*., 1998), is slow acting and does not eliminate the pest on whole plants. This is probably because the position of *P. pallidus* in the fold of young strawberry leaves (Easterbrook *et al*., 2001; 2003; Fitzgerald *et al*., 2007; 2008) means that natural enemies need to spend time searching and populations need to build. Larger predators such as anthocorids and *Orius* sp. are not effective because they cannot access the pest.

Repeated and increasing introductions of predatory mites may need to be made until the predator has established (Petrova *et al*., 2002). The most effective species may be temperature dependant, e.g. *A. andersoni* is active from <8 ˚C and *A. swirskii* from 12 ˚C. This will have implications for applications of use. A more voracious predator may be needed if tarsonemid populations peak in high summer. *Neoseiulus barkeri* is sold as a preventative treatment for tarsonemid mites. Some other commercially available species are reported to give some reductions in tarsonemid populations although they are not specifically recommended for control of this pest.

In laboratory tests with US species, predation on *P. pallidus* was highest by *Typhlodromus pyri* > *Neoseiulus fallacies* > *Neoseiulus californicus* > *Amblyseius andersoni* > *Galendromus occidentalis* (Croft *et al*., 1998). Other workers found *N. californicus* and *N. cucumeris* to be more effective than *T. pyri* as predators of *P. pallidus* (Fitzgerald *et al*., 2007). In UK crops *Phytoseiulus persimilis* used to control *Tetranychus urticae* was also found to keep *P. pallidus* in check (Simmonds, 1970).

Earlier experiments at EMR (Fitzgerald *et al*., 2004) showed that *N. californicus* consumed similar numbers of tarsonemids to *N. cucumeris* when they were presented on a leaf arena, but this species was not tested on plants. However, it was found on the old rather than folded leaves (Fitzgerald et al., 2008). Currently, *N. californicus* may only be used in UK protected crops that are sealed throughout their life. However this species now overwinters outside and natural populations now occur in outdoor crops in the UK and efforts are being made to register the mite for use outdoors.

Increasingly *Amblyseius swirskii* and *Amblyseius montdorensis* are being used to control a suite of pests in protected crops. *A. swirskii* has been shown to give good control of broad mite on Azalea (Gobin *et al*., 2011) and *Tarsonemus violae* on gerbera (Pijnakker and Leman, 2011).

The way forward

- The potential to exploit new species of predatory mite for the control of tarsonemid mite in strawberry needs to be explored;
- In addition, the timing and methods of application are very important for the predator to be able to work effectively.

Objectives

The overall aim of the project was to identify effective predatory mites for prevention and control of strawberry tarsonemid mite in outdoor and glasshouse crops and improve application timing and treatment methods.

In 2014 the most effective species of predatory mite for tarsonemid control in polytunnels, as found from the previous experiments, were tested at different rates of release as either curative or preventative methods of control.

Materials and methods

Site and site manager

The experiment was done in two dedicated polytunnels in plot WF221 at Rocks Farm, East Malling Research, Kent ME19 6BJ. The site was managed by Graham Caspell, Farm Manager.

Treatments

In a replicated field trial *Amblyseius barkeri* and *Neoseiulus cucumeris* were tested in polytunnel conditions (Table 2).

Table 2. Two species of predatory mite were tested for efficacy for control of tarsonemid mite in strawberry in 2014

Species	Commercially available	Native to UK	Use	Notes
Amblyseius barkeri	Yes	Yes	Polytunnel	Small species may be able to enter folded leaf more effectively
Neoseiulus cucumeris	Yes, limited supplies in the UK	Yes	Polytunnel	Commercial standard

Treatments were applied either preventatively (plants inoculated with tarsonemid mites after addition of predatory mites) or curatively (plants inoculated with predatory mites which were already infested with tarsonemid mites).

Tarsonemids were introduced in two stages:

- Stage 1 of the tarsonemid inoculations were introductions for the early curative treatments on 27 June, 18 July and 25 July. Following establishment of tarsonemids, predatory mites were introduced to all of the plots on 31 July;
- Stage 2 of the tarsonemid inoculations were for the late tarsonemid inoculations for the preventative treatments on 4, 8 and 14 August.

The preventative treatments (Table 3) were applied before tarsonemid mite infestation.

Table 3. Application programme of predatory mites to strawberry plants to protect against or control tarsonemid mites, both treatments had 1 predatory mite application

Treatment	Colour code	Species	Timing of tarsonemid inoculation	Application rate (predatory mites) per 0.4 m^2 grow bag
1Curative	Red	*A. barkeri*	Early	200
2Curative	Blue	*N. cucumeris*	Early	200
3Curative	Yellow	Untreated control	Early	-
1Preventative	Black	*A. barkeri*	Late	10
2Preventative	Green	*N. cucumeris*	Late	10
3Preventative	White	Untreated control	Late	-

Experimental design and statistical analyses

The experiment was set up as a randomised split plot block design with five replicates of six treatments (Table 3). There were two mite species *A. barkeri,* and *N. cucumeris*, plus an untreated control. The two polytunnels (Appendix. 1) housed cv. Flamenco strawberry plants in 1 m x 0.4 m peat grow bags (10 plants per bag). Each treated sub-plot was two growbags. Drip irrigation was provided. The grow bags were placed onto Mypex and were at least 2.5 m apart.

Artificial infestation

Infested plants were obtained from a field source (kindly provided by Steve Greenaway). Young leaves from these plants were inspected under the microscope and any predators were removed prior to introduction. A folded leaf from the infested plants was placed between the trifoliate emerging leaves in the crown of each plant in all of the grow bags, initially for the early introductions, then for the late introductions. Regular monitoring and a pre-treatment assessment of tarsonemid infestation were done to determine the initial infestation level to experimental blocks.

Treatment application

Syngenta Bioline recommends 20 mites per m^2 for preventative treatments with predatory mites. Peat bags are approximately 1 m x 0.4 m in area = 0.4 m^2. Hence, **10 mites** per bag for preventative treatments were used.

For the curative treatments a rate of 400 mites per m^2 was needed. Hence, **<u>200 mites</u>** per bag were used.

N. cucumeris were kindly supplied by Syngenta Bioline (Holland Road, Clacton on Sea, UK), *A. barkeri* were kindly supplied by Biotus (Finland). The numbers of mites per ml of carrier were counted under a binocular microscope to determine the volume of product to apply per bag. At least five replicates were counted at each of three levels within each product container. Eppendorf tubes were used to distribute the required volume of product accurately.

Husbandry

At planting and subsequently for the duration of the experiment, the plants were de-blossomed, to ensure strong vegetative growth. Each grow bag was provided with dripper irrigation, with feeding as necessary, to ensure vigorous growth.

Assessments

Tarsonemid and phytoseiid mites were counted on samples of young folded leaves (five leaves per plot). Three assessments on 7, 13 and 27 August were done. Leaves were transferred in labelled polythene bags to the laboratory and mites counted under a bionocular microscope. Any additional species of alternative prey were identified and counted e.g. *Tetranychus urticae,* thrips etc. where possible.

Samples of predatory mites collected during the assessments were mounted onto microscope slides and identified to species to confirm the correct species were present on the plants.

Statistical analyses

Experiments were analysed using ANOVA using the Genstat® 13 statistical package. Following initial analysis, it was found to be more appropriate to analyse the preventative and curative treatments as two separate experiments with a randomised block design. Data was square-root transformed and pre-treatment values were used as a co-variate. Analyses were checked by the EMR biometrician Dr Phil Brain.

Results

The mean numbers of predatory mites per plot were low (Tables 4-7). However there was a significant increase in predatory mite eggs over time in the curative experiment (Table 4), mean SQRT numbers per plot were 0.09, 0.12 and 0.47 on 7, 13 and 27 August respectively ($p = 0.048$, s.e.d = 0.142, l.s.d = 0.325, d.f. = 14.8). There was also a significant increase in predatory mites over time in the preventative experiment and significantly more mites where they were released (Table 5). Predatory mites were found at each assessment date, including the pre-treatment. Nearly all mites were either *A. barkeri* or *N. cucumeris*, and both of these species were present prior to introduction of the treatments. Numbers of predatory mites were generally low with a maximum of five *N. cucumeris* found per five folded leaves, with a mean of 0 to 2 *N. cucumeris* and/or *A. barkeri* per five folded leaves. *N. cucumeris* may have been present on the bare-rooted plants at planting.

There were no significant differences between treatments in either the preventative or curative experiments (Tables 6 and 7), but there were fewer tarsonemid motiles in the curative experiment (Table 6).

Table 4. Mean (adjusted for covariate) numbers of phytoseiid mite eggs and motiles per five leaves in the curative treatments

	Backtransformed means of Phytoseiid egg numbers			Backtransformed means of Phytoseiid motile numbers		
Treatment	7 Aug 14	13 Aug 14	27 Aug 14	7 Aug 14	13 Aug 14	27 Aug 14
Control	0.00	0.01	0.14	0.18	0.28	0.28
A. barkeri	0.01	0.03	0.11	0.26	0.26	0.83
N. cucumeris	0.03	0.01	0.48	0.59	0.62	0.59

	Sqrt means of egg numbers			Sqrt means of motile numbers		
Treatment	7 Aug 14	13 Aug 14	27 Aug 14	7 Aug 14	13 Aug 14	27 Aug 14
Control	0.00	0.09	0.37	0.42	0.53	0.53
A. barkeri	0.09	0.18	0.33	0.51	0.51	0.91
N. cucumeris	0.18	0.09	0.69	0.77	0.79	0.77

Analysis on transformed data						
	Trt	Date	Trt x Date	Trt	Date	Trt x Date
Rep	15	15	5	15	15	5
F pr	0.228	0.048	0.682	0.393	0.366	0.575
s.e.d.*	0.091	0.142	0.220	0.196	0.127	0.263
l.s.d. *	0.210	0.325	0.495	0.464	0.268	0.559
d.f. *	8	14.80	19.96	7	21.31	19.87
* Except when comparing means with same level of trt						
s.e.d.	0.254			0.221		
l.s.d.	0.562			0.468		
d.f.	14.80			21.31		

Cells with filled colour indicate a significant effect

Table 5. Mean (adjusted for covariate) numbers of phytoseiid mite eggs and motiles per five leaves in the preventative treatments

	Backtransformed means of egg numbers			Backtransformed means of motile numbers		
Treatment	7 Aug 14	13 Aug 14	27 Aug 14	7 Aug 14	13 Aug 14	27 Aug 14
Control	0.00	0.01	0.16	0.00	0.02	0.35
A. barkeri	0.00	0.01	0.05	0.07	0.35	0.52
N. cucumeris	0.01	0.01	0.35	0.13	0.48	0.56

	Sqrt means of egg numbers			Sqrt means of motile numbers		
Treatment	7 Aug 14	13 Aug 14	27 Aug 14	7 Aug 14	13 Aug 14	27 Aug 14
Control	0.00	0.09	0.40	0.00	0.13	0.59
A. barkeri	0.00	0.09	0.22	0.26	0.59	0.72
N. cucumeris	0.09	0.09	0.59	0.36	0.69	0.75

Analysis on transformed data						
	Trt	Date	Trt x Date	Trt	Date	Trt x Date
Rep	15	15	5	15	15	5
F pr	0.715	0.083	0.789	0.002	<0.001	0.186
s.e.d.*	0.184	0.152	0.283	0.064	0.068	0.115
l.s.d. *	0.423	0.356	0.642	0.152	0.141	0.238
d.f. *	8	13.46	21.24	7	22.45	28.90
* Except when comparing means with same level of trt						
s.e.d.	0.263			0.118		
l.s.d.	0.616			0.238		
d.f.	13.46			22.45		

Cells with filled colour indicate a significant effect

Table 6. Mean (adjusted for covariate) numbers of tarsonemid mite eggs and motiles per five leaves in the curative treatments

	Backtransformed means of egg numbers			Backtransformed means of motile numbers		
Treatment	7 Aug 14	13 Aug 14	27 Aug 14	7 Aug 14	13 Aug 14	27 Aug 14
Control	7.02	6.71	4.84	5.02	4.84	5.24
A. barkeri	6.45	3.50	5.43	2.72	2.96	3.80
N. cucumeris	10.56	8.01	2.46	4.28	3.50	2.13

	Sqrt means of egg numbers			Sqrt means of motile numbers		
Treatment	7 Aug 14	13 Aug 14	27 Aug 14	7 Aug 14	13 Aug 14	27 Aug 14
Control	2.65	2.59	2.20	2.24	2.20	2.29
A. barkeri	2.54	1.87	2.33	1.65	1.72	1.95
N. cucumeris	3.25	2.83	1.57	2.07	1.87	1.46

Analysis on transformed data						
	Trt	Date	Trt x Date	Trt	Date	Trt x Date
Rep	15	15	5	15	15	5
F pr	0.897	0.141	0.349	0.472	0.897	0.701
s.e.d.*	0.714	0.371	0.861	0.381	0.290	0.553
l.s.d. *	1.688	0.795	1.870	0.902	0.652	1.220
d.f. *	7	20.23	16.39	7	16.24	21.62
* Except when comparing means with same level of trt						
s.e.d.	0.656			0.512		
l.s.d.	1.406			1.151		
d.f.	20.23			16.24		

Table 7. Mean (adjusted for covariate) numbers of tarsonemid mite eggs and motiles per five leaves in the preventative treatments

	Backtransformed means of egg numbers			Backtransformed means of motile numbers		
Treatment	7 Aug 14	13 Aug 14	27 Aug 14	7 Aug 14	13 Aug 14	27 Aug 14
Control	0.58	0.74	0.44	0.42	0.40	1
A. barkeri	0.34	0.85	0.59	0.31	0.79	0.88
N. cucumeris	0.02	0.37	0.32	0.03	0.40	0.29

	Sqrt means of egg numbers			Sqrt means of motile numbers		
Treatment	7 Aug 14	13 Aug 14	27 Aug 14	7 Aug 14	13 Aug 14	27 Aug 14
Control	0.76	0.86	0.66	0.65	0.63	1.00
A. barkeri	0.58	0.92	0.77	0.56	0.89	0.94
N. cucumeris	0.15	0.61	0.57	0.17	0.63	0.54

Analysis on transformed data						
	Trt	Date	Trt x Date	Trt	Date	Trt x Date
Rep	15	15	5	15	15	5
F pr	0.676	0.341	0.842	0.470	0.124	0.766
s.e.d.*	0.424	0.204	0.497	0.305	0.174	0.382
l.s.d. *	1.002	0.440	1.093	0.720	0.367	0.816
d.f. *	7	19.42	15.05	7	21.52	18.19
* Except when comparing means with same level of trt						
s.e.d.	0.361			0.307		
l.s.d.	0.779			0.649		
d.f.	19.42			21.52		

Discussion and conclusions

Overall conclusion for species used in 2014 trials:

- *A. barkeri* and *N. cucumeris* can establish within the crop and results from previous experiments show both species can suppress populations of tarsonemid mites;
- *N. cucumeris* is readily available from bio-control suppliers and will also provide control for thrips that may be present in the strawberry crop at the same time;
- *A. barkeri* is approved for release in polytunnels, but is not currently marketed in the UK. A significant increase in the effectiveness of *A. barkeri* compared to *N. cucumeris* would need to be seen to make it cost effective to import for UK growers;
- As with all predatory mites, they should be used within an IPM programme and any insecticides should be chosen to be compatible with the mite applications.

In all of the experiments it should be noted that the predatory mites are not restricted to the young folded strawberry leaves and, therefore, may disperse not only over the entire plant but beyond. Drawing conclusions from numbers of predators on young folded leaves is not a reliable way of estimating predatory mite numbers in strawberry crops. As predatory mites are highly associated with their prey, in experiments where high numbers of predatory mites were recovered from the untreated controls this may be due to the higher concentrations of tarsonemid mites found.

Knowledge and Technology Transfer

EMRA/HDC soft fruit day, EMR, 21 November 2012

HDC Fruit Agronomists' Day, EMR, 5 March 2013

German visitors, EMR, 9 September 2014

AAB IPM conference, Grantham, 19-20 November 2014

EMRA soft fruit day, EMR, 26 November 2014

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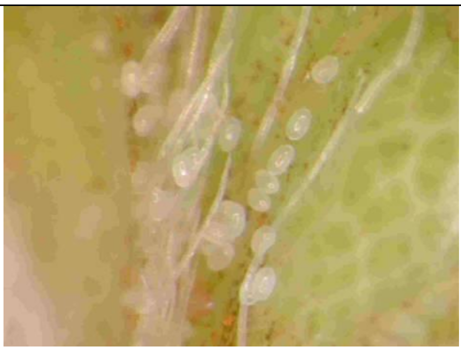
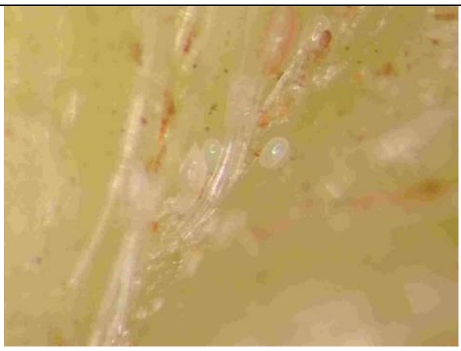
Appendices

Appendix 1. Photographs from HDC strawberry trial

1  Tarsonemid mite eggs	2  Tarsonemid mite eggs and nymph
3  Tarsonemid mite adult	4  Tarsonemid damage to strawberry leaf
5  Polytunnel and cages used in trial, 2014	6

Appendix 2. The 2014 Experiment, Rocks Farm.