Project title:	Sustainable Crop and Environment Protection – Target Research for Edibles (SCEPTRE)
Project number:	CP 77
HortLINK project:	HL 01109
Government sponsor:	Defra
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Annual report:	Year 1, January 2012
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Date project commenced: 1 October 2010

Expected completion date: 30 September 2014

Key words: biopesticides, crop protection, field vegetables, herbicides, pesticides, protected edible crops, soft fruit, top fruit, integrated disease management (IPM), alternative weed control strategies

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The results and conclusions in this report are based on investigations 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 results, especially if they are used as the basis for commercial product recommendations.

CONTENTS

GROWER SUMMARY

Headline

- Potential new control treatments identified for key pests on field vegetables, strawberry, raspberry, tomato, cucumber, pepper and apple.

Background

Numerous widely used pesticides have already or are predicted to become unavailable over the next decade as new European legislation takes effect. Resultant gaps in crop protection threaten severely to reduce the profitability of growing some edible crops – carrots, lettuce and soft fruit for example – and will likely impact on the profitability of many others.

The decline in availability of approved crop protection chemicals is occurring for several reasons:

- failure of active ingredients to make Annex 1 listing (a positive list of active ingredients permitted in the EC) as they are reviewed under the Pesticide Registration Directive (91/414/EEC);
- some active ingredients were not supported by crop protection companies for economic reasons and were withdrawn from the pesticides review;
- implementation of a new approvals Regulation (EC) (1107/2009) that requires assessment of inherent hazard as well as risk;
- implementation of the Water Framework Directive (WFD), a measure that particularly impacts on herbicides and molluscicides;
- adoption of the Sustainable Use Directive (SUD) whereby crop protection chemicals must be used only to supplement alternative (non-chemical) methods of control.

The effect of these measures on future availability of pesticides, the resultant gaps in crop protection, and the likely impact on profitability of growing major crops has been estimated in studies funded by the HDC and Defra (project IF01100). The outcomes from these reports were used to help identify the highest propriety targets for research in the Sceptre project (Appendix 1).

The costs of finding and developing new pesticides are prohibitive for many crops; horticultural crops are 'minor crops' in a global crop protection market. Registration of products is complex and expensive and requires detailed biological and residue studies for each specific crop. Microbial pesticides and botanical pesticides (biopesticides) also face large registration costs.

New technologies and a new approach are needed to develop crop protection treatments that support sustainable production of edible crops. Opportunities available include:

- new chemical actives;
- a rapidly increasing number of biopesticides in the registration pipeline;
- better targeted application;
- greater use of non-chemical crop protection methods;
- anti-resistance strategies to prolong the life of actives;
- a coordinated approach so that the majority of products and treatments with potential are evaluated;
- interaction between researchers so that results on one pest are used to inform studies on a similar pest;
- collection of all relevant data so that results can be immediately used to support registration data packages;
- training of the next generation of applied crop protection specialists.

This project aims to identify effective chemical crop protection opportunities with the potential to fill the gaps and to develop integrated pest, disease and weed management programmes compliant with the new Sustainable Use Directive. The most promising pesticides and biopesticides now coming to the market and some new technologies, including non-chemical methods of pest control, will be evaluated.

A broad Consortium has been assembled to deliver this work comprising applied crop protection researchers and representatives of growers, agrochemical companies, biological crop protection companies, produce marketing organisations, retailers and the industry levy body; organisations outside the consortium are invited to supply products. The Consortium researchers comprise three teams (pests, diseases and weeds) working across the major organizations currently delivering applied crop protection research.

Summary

In Year 1, 76 chemicals, 57 biopesticides and 23 botanical pesticides were offered for screening against pest, disease and weed problems identified as high priority targets. Twenty-one experiments were completed and a further two are in progress.

New products/actives with good potential have been identified for various crops in all edible sectors (field vegetables, soft fruit, protected edibles and top fruit).

An overview of results is given in Table 1 and 2 below. Table 3 gives the registration position of products which achieved 50% control or more in trials where there was a moderate or severe pest challenge. The results of individual experiments are then presented.

Table 1. Overview of crop pest combinations where potential new control products have been identified

Pest			**Crop**		
	Brassica	Carrot	Lettuce	Leek	Field veg
Alternaria leaf spot	✓				
Downy mildew	✓				
Aphid	✓	✓	✓		
Cabbage root fly	✓				
Thrips				✓	
Annual weeds					✓
	Strawberry	Raspberry	Bush/Cane		
Mucor soft rot	✓				
Aphid		✓			
European bug	✓				
Perennial weeds			✓		
	Cucumber	Tomato	Pepper		
Powdery mildew	✓				
Grey mould		✓			
Whitefly		✓			
WFT			✓		
	Apple				
Powdery mildew	✓				

Table 2. Overview of experiments – January 2012

Topic	Number treatments evaluated		Number treatments demonstrating control		Pest level on untreated
	Chemical	**Biological/ Other**	**Chemical**	**Biological/ Other**	
Field vegetables					
1.1 Brassica: Alternaria leaf spot	11	10	6	5	Moderate
1.2 Brassica: Downy mildew	14	10	13	1	Moderate
1.3 Brassica: Caterpillars	5	3	(5)	NR	Low
1.4 Brassica: Aphids	4	3	4	2	Moderate
1.5 Brassica: Cabbage root fly	3	3	3	0	Moderate
1.6 Lettuce: Currant lettuce aphid	5	2	2	0	Moderate
1.7 Leek: Thrips	4	4	4	0	Moderate
1.8 Carrot: Willow carrot aphid	6	2	6	0	Moderate
1.9. Vegetables: Herbicide crop safety	6*	0	NA	NA	Severe
1.10 Vegetables: Herbicide residues	6	0	NA	NA	-
Soft fruit					
2.1 Strawberry: Mucor/Rhizopus rot	9	2	4	0	Moderate
2.2 Raspberry: Aphid	2	4	2	4	Moderate
2.3 Strawberry: European tarnished bug	5	2	5	2	Moderate
2.4 Bush/Cane fruit: Perennial weeds	6*	0	5	0	Moderate
2.5 Blackcurrant: Perennial weeds	0	4	0	4	Moderate
2.6 Strawberry: Residual herbicides	4	0	NR	0	Low
Protected edibles					
3.1 Cucumber: Powdery mildew	9	7	9	1	Moderate/ Low
3.2 Tomato: Grey mould	14*	9	5	1	Severe
3.3 Tomato: Spidermites	1	6	NR	NR	Low
3.4 Tomato: Whitefly	2	5	2	5	Moderate
3.5 Pepper: Western flower thrips	3	4	3	4	Moderate
Top fruit					
4.1 Apple: Powdery mildew	6	5	6	3	Severe
4.2 Pear: Botrytis rot in store	Experiment in progress				

NR – no results; NA – Not applicable.
( ) – due to low caterpillar numbers there were no significant differences but data suggest all test chemicals had an effect.
* Number of unique products is less than number of treatments due to investigation of rate, timing or other factor.

Table 3. Summary of products providing control (50% or more in at least one assessment) in experiments with moderate or severe pest challenge and significant differences between treatments – 2011

Current UK product Approved on crop Current target (inc. standards)	**Current UK product Approved on crop New target pest**	**Current UK product Not approved on this crop**	**New product or new active to UK**
1.1 Brassica (Chinese cabbage) – dark leaf spot			
Signum Nativo 75WG Rudis		0428	0410 0424 0425 0426 0440 0443 0447
1.2 Brassica (cauliflower) – downy mildew			
Folio Gold Previcur Energy	Signum	0420 0423 0426 0484	0422 0424 0425 04103
1.3 Brassica (Brussels sprout) – caterpillar			
Steward		0467 0469	0448 0450 0468
1.4 Brassica (Brussels sprout) – aphid			
Movento		0460 0492	0450 0459 0462
1.5 Brassica (cauliflower) - cabbage root fly			
Tracer			0550 0555
1.6 Lettuce – currant lettuce aphid			
Movento			1554
1.7 Leeks – thrips			
Tracer			0348
			0350
			0354
1.8 Carrot – willow carrot aphid			
Biscaya		1475 14100 1460	1450 1454
1.9 Field vegetables – annual weeds			
			0105

2.1 Strawberry – Mucor soft rot			
	Signum Switch Thianosan DG		1177
2.2 Raspberry – large raspberry aphid			
	Calypso		0770
2.3 Strawberry – European tarnished plant bug			
	Calypso Chess WG Steward	0260	0253 0254 0262
2.4 Bush and cane fruit – perennial weeds			
	1672 1673 16102		
3.1 Cucumber – powdery mildew			
Rocket[a] Systhane 20EW	1038	1087 1088 1089	1006 1008 1010 1080 1014 1077 1090
3.2 Tomato – grey mould			
Switch Teldor Prestop 0938			0908 0977 0909
3.4 Tomato – whitefly			
	0952 0953 0981 0982	0960	0954 0962
3.5 Pepper – WFT			
	0652 0681 0682	0648 0650	0654
4.1 Apple – powdery mildew			
			1147 1177

[a] Emergency approval expired 6 January 2012.

Note that the target pest on a crop is not a statutory condition of approval (ie provided a product is approved for use on a crop, it can be used against any pest on that crop).

Field vegetables

1.1. Brassicas: Evaluation of fungicides and biofungicides for control of dark leaf spot on young plants

Fungicide (Trial 1) and biofungicide (Trial 2) treatments were compared with an untreated control and an industry standard fungicide Nativo 75WG (tebuconazole + trifloxystrobin) for the control of *Alternaria* on Chinese cabbage seedlings cv. Bilko. Fungicides were applied once and inoculated later the same day while biofungicides were applied twice, at this time and 7 days before inoculation. After 14 days, several products in Trial 1 significantly reduced the incidence and severity of Alternaria leaf spot. Nativo 75WG gave the best control while SF2011-0424, SF2011-0427 and Signum (boscalid + pyraclostrobin) also significantly reduced incidence by 80%. In Trial 2, SF2011-0447, SF2011-0443, SF2011-0406 and SF2011-0440 significantly reduced dark leaf spot at 7 days but no products showed significant persistence of activity.

1.2. Brassicas: Evaluation of fungicides and biofungicides for control of downy mildew on seedlings

Fungicide (Trial 1) and biofungicide (Trial 2) treatments were compared with an untreated control and an industry standard fungicide Folio Gold (chlorothalonil + metalaxyl-M) for the control of downy mildew on cauliflower seedlings cv. Brunel. Fungicides were applied once and inoculated later the same day while biofungicides were applied at this time and 7 days before. After 14 days, several products in Trial 1 significantly reduced downy mildew incidence and severity. SF2011-0424 gave the best control at this time, and SF2011-0420, SF2011-0423 and Signum all reduced incidence by two-thirds and severity greatly. In Trial 2, only product SF2011-0447 significantly reduced downy mildew, evident at 14 and 21 days after inoculation; this product also resulted in some crop damage.

1.3. Brassicas: Novel insecticides for control of caterpillars

Conventional and biological insecticides were evaluated for control of caterpillars on Brussels sprout. The biological treatment plots were infested with diamond-back moth adults and spraying commenced when the insect population was sufficient. Caterpillar counts and identification were done pre- and post-spraying. Caterpillar numbers were low but data for conventional insecticides suggest the most effective treatments were SI2011-0448, SI2011-0450 and SI2011-0467.

1.4. Brassicas: Novel insecticides for control of aphids

Conventional and biological insecticides were investigated for control of aphids on Brussels sprout. Plots were assessed weekly and spraying commenced when sufficient insects had colonised. Out of the conventional insecticides, Movento (spirotetramat), SI2011-0450, SI2011-0459 and SI2011-0460 gave good control of aphids 8 days post spray. Movento, SI2011-0450 and SI2011-0459 gave best control of aphids 21 days post spray. Out of the biopesticides, SI2011-0462 gave best control of aphids and SI2011-0492 showed some activity.

1.5. Cauliflower: Pre-transplant drench treatment to control the larvae of cabbage root fly

Conventional and biological insecticides applied as seed or drench treatments were evaluated for control of cabbage root fly larvae on cauliflower in a pot trial. Approximately 4 weeks after inoculation with cabbage root fly eggs, the roots were harvested and assessed for damage and the cabbage root fly pupae were washed from the soil and counted. SI2011-0555, SI2011-0550 and Tracer (spinosad) were the most effective products in controlling cabbage root fly larvae. These products reduced the number of pupae per plant, produced plants with the greatest mean root weight and limited root damage. None of the three bio-insecticides evaluated was effective.

1.6. Lettuce: Control of currant-lettuce aphid

Conventional and biological insecticides were evaluated for the control of aphids on lettuce. When the aphids had established, a pre-spray assessment was made. The most effective treatment 7 days after spraying was Movento and the most effective treatments 15 days after spraying were Movento and SI2011-1554. Neither bio-insecticide tested showed any activity.

1.7. Leek: Control of thrips with novel insecticide sprays

Conventional and biological insecticides were evaluated for control of thrips on leek. The conventional insecticides were applied at 2-week intervals (total of 4 applications) and the biopesticides were applied at 1-week intervals (total of 4 applications). All four conventional insecticides (Tracer, SI2011-0348, SI2011-0350, SI2011-0354) reduced thrips damage but none of the bio-insecticides were effective.

1.8. Carrot: Control of willow carrot aphid with novel treatments

Conventional and biological insecticides were evaluated for control of aphids on carrot. Aphid activity was monitored. The data suggest the most effective treatments were SI2011-1450, SI2011-1460 and SI2011-1475. Neither of the two novel bio-insecticides was effective.

1.9. Field vegetables: Evaluation of herbicides for crop safety and weed control

This study was carried out to evaluate SH2011-0105 for crop safety and weed control on 14 crops. SH2011-0105 applied pre-emergence at 2.0 L/ha was safe to peas and broad beans. At a lower application rate it had potential for carrots, parsnips and coriander pre- and post- emergence and possibly iceberg lettuce at 0.5 L/ha. Applied post-emergence it was also safe at 2.0 L/ha in drilled bulb onion, leek and post-planting in celery. SH2011-0105 gave excellent control of small nettle and shepherd's purse pre- and post-emergence at 1.0 L/ha and it was effective on groundsel at 2.0 L/ha.

1.10. Field vegetable: Herbicide residue studies

Two herbicides are being examined, SH2011-0174 and SH2011-01101, to gain residues data to support new applications for authorisations of extension of use on products where satisfactory efficacy and phytotoxicity data is already available. SH2011-0174 is being tested on lettuce, SH2011-01101 on cabbage, calabrese, cauliflower, kale and swede. Field trials are being done across a range of grower sites (Bedfordshire, Cornwall, Essex, Lancs, Lincs and Warwickshire) to provide good geographical diversity. Each treatment has been applied at one rate as recommended by the manufacturer. Work is still in progress. It is anticipated that data will be submitted to CRD in 2012.

Soft fruit

2.1. Strawberry: evaluation of products for control of *Mucor* and *Rhizopus* soft rot

Eleven treatments were compared with an untreated control in a Spanish tunnel crop of Elsanta. Sprays were applied from green fruit and soft rot was assessed in post-harvest tests. *Mucor* was the predominant casue of soft rotting. *Mucor* soft rot was reduced by Switch (cypodonil + fludioxonil), Signum (boscalid + pyraclostrobin), Thianosan DG (thiram) and one coded product.

2.2. Raspberry: novel insecticides for control of large raspberry aphid (*Amphorophora idaei*)

Six novel insecticides were compared with Calypso (thiacloprid) and a water control in a glasshouse experiment. Sprays were applied three times at weekly intervals after loading plants with aphids, apart from SI2011-0770 which was sprayed once at the start of the experiment. Aphid numbers increased greatly on the untreated control and appeared to be reduced by all treatments. The coded product SI2011-0770 and Calypso were particularly effective.

2.3. Strawberry: evaluation of novel products for control of European tarnished plant bug (*Lygus rugulipennis*)

Four coded products were compared with Calypso, Chess WG (pymetrozine), Steward (indoxacarb) and an untreated control in a cage experiment in an unheated polytunnel. Adults and nymphs were placed on everbearer strawberry plants 8 days before the first treatment. Populations of the pest failed to increase. Nevertheless, differences were observed between treatments. Chess WG and Steward (approved for use in propagation only; any fruit harvested within 12 months must be destroyed) reduced the pest by around 80%; the other treatments were ineffective.

2.4. Bush and cane fruit: novel herbicides for control of perennial weeds

Six herbicide treatments (predominantly sulfonylureas) were evaluated for control of creeping thistle, broad-leaved dock and nettle. Four treatments gave control of all three weeds; one coded product (SH2011-16102) was outstanding with a vigour score of zero and no re-growth of all three species at 6 weeks after treatment.

2.5. Bush and cane fruit: evaluation of prototype handheld electrical weed control equipment

A shielded high-power electrode was applied to creeping thistle, broad-leaved dock and nettle in a blackcurrant crop in Norfolk, comparing two voltages (3.5 and 5.0 KV) and two travelling speeds (3 and 5 Km/h). Treatment gave good control of thistle and some control of dock and nettle. Control was generally better at the slower travelling speed. Contact with the blackcurrant bush stem or side branch for 1 second had no adverse effect, but contact for 5 seconds caused leaf death.

2.6. Strawberry: evaluation of novel herbicides for control of annual weeds

Four novel herbicides were compared with an untreated control in an open-field unirrigated strawberry crop in Cambridgeshire. Weed seed germination was low due to dry weather and no conclusions could be drawn on levels of weed control. Two of the herbicides caused no crop damage and two caused some foliar damage, from which plants grew away. None of the treatments reduced fruit yield.

Protected edibles

3.1. Cucumber: Evaluation of fungicides and biofungicides for control of powdery mildew

Novel fungicide (Trial 1) and biofungicide (Trial 2) treatments were compared with an untreated control and industry standards (Systhane 20EW, myclobutanil; Rocket, triflumizole) for control of powdery mildew (*Podosphaera xanthii*) on cucumber cv. Roxanna. Fungicides were applied twice and biofungicides three times from immediately after inoculation. In Trial 1, where moderately severe powdery mildew developed, SF2011-1077 provided almost complete control and SF2011-1008 and SF2011-1088 were also very effective. The standard fungicides provided relatively poor control, reflecting current commercial practice; this is most likely due to fungicide resistance. In Trial 2, powdery mildew failed to spread from the inoculated leaf so disease levels were low. At this low disease pressure, four biofungicides (SF2011-1088, SF2011-1008, SF2011-1066 and SF2011-1090) significantly reduced powdery mildew levels.

3.2. Tomato: Evaluation of fungicides and biofungicides for control of grey mould

Novel fungicide (Trial 1) and biofungicide (Trial 2) treatments were compared with an untreated control and industry standards (Switch, cyprodinil + fludioxonil; Teldor, fenhexamid; Prestop, *Gliocladium catenulatum*) for control of grey mould (*Botrytis cinerea*) on tomato cv. Elegance. Fungicides were applied to the crop twice and biofungicides three times. Levels of stem botrytis that developed on inoculated treated plants were highly variable and there were no significant differences between treatments. In Trial 1, laboratory experiments on inoculated detached leaves showed SF2011-0908 and SF2011-0977 gave some control; neither Teldor nor Switch were effective in this severe test. In Trial 2, one product (SF2011-0909) significantly reduced Botrytis; both Teldor and Prestop were ineffective in this detached leaf test.

3.3. Tomato: Evaluation of insecticides for control of spidermites

Seven insecticides were examined for control of spidermites (*Tetranychus urticae*) on a glasshouse tomato crop, cv. Dometica. At an assessment 7 days after the first spray, results suggested that all treatments were reducing levels of the pest. The glasshouse heating subsequently failed and no more valid assessments were possible. This experiment will be repeated in spring 2012.

3.4. Tomato: Evaluation of insecticides and bio-insecticides for control of glasshouse whitefly

Two insecticides and five bio-insecticides were evaluated for control of glasshouse whitefly (*Trialeurodes vaporariorum*) on a glasshouse tomato crop, cv. Dometica. The pest was established throughout the crop before spray treatments commenced. All treatments significantly reduced the number of whitefly adults and scales compared with a water-treated control. Two new insecticide treatments (SI2011-0954 and SI2011-0960) gave a high level of control. The five bio-insecticide treatments could offer part of a solution to glasshouse whitefly when used in a programme with other treatments.

3.5. Pepper: Evauation of insecticides and bio-insecticides for control of Western flower thrips (WFT)

Three insecticides and four bio-insecticides were evaluated for control of WFT (*Frankliniella occidentalis*) in a glasshouse crop of sweet pepper cv. Ferrari. The pest was established at a low level throughout the crop before treatments were applied. The three conventional insecticides (SI2011-0648, SI2011-0650 and SI2011-0654) and one bio-insecticide (SI2011-0648) significantly reduced the pest. The capacity to integrate these treatments within an IPM programme using macrobiologicals requires evaluation.

Top fruit

4.1 Apple: Evaluation of fungicides and biofungicides for control of powdery mildew

Five fungicides and five biofungicides were evaluated for control of powdery mildew (*Podesphaera leucotricha*) on apple cv. Cox in an established orchard. Products were applied five times at 2-3 week intervals from post-blossom. High levels of powdery mildew developed on untreated trees. Powdery mildew was significantly reduced by all five fungicide treatments and three of the biofungicide treatments, albeit the level of control provided by the latter was small (around 20% reduction). One fungicide (SF2011-1177) was outstanding (75% reduction), and another (SF2011-1147) was better than the standard fungicide treatment Systhane 20EW (myclobutanil). All treatments reduced fruit russet, a problem part-caused by powdery mildew, compared with the untreated control. The biofungicides will be re-evaulated in 2012 on container-grown apples with treatments applied at a shorter spray interval of 7-10 days; weather conditions in 2011 constrained the planned 7-day spray application interval.

4.2 Pear: Evaluation of biofungicides for control of Botrytis rot in stored pear

Four biofungicides were evaluated as pre-storage dip treatments for control of Botrytis fruit rot (*Botrytis cinerea*) in boxes of pears, cv. Conference, in comparison with Rovral WG (iprodione). All of the treatments were applied on the same day and placed in cold store at -1ºC. An additional treatment was included for three of the biofungicides where the treated crate was left at ambient for 24 hours after treatment before placing in the cold store. Ten fruit deliberately infected with *B. cinerea* were placed in each box. This experiment is still in progress; a final assessment is due in March 2012.

Milestones

Milestone	Target month	Title	Status	Further work required*
P2.1	12	Efficacy tests for Y1 completed		
		Brassica Alternaria leaf spot	Complete	-
		Brassica downy mildew	Complete	-
		Brassica caterpillar	Complete	Yes
		Brassica aphid	Complete	-
		Brassica cabbage root fly	Complete	-
		Lettuce aphid	Complete	-
		Leek thrips	Complete	-
		Carrot aphid	Complete	-
		Strawberry mucor	Complete	-
		Raspberry large aphid	Complete	-
		Strawberry tarnished plant bug	Complete	-
		Bush fruit perennial weeds	Complete	-
		Strawberry annual weeds	Complete	Yes
		Cucumber powdery mildew	Complete	Yes
		Tomato Botrytis	Complete	Yes
		Tomato spidermite	Complete	Yes
		Tomato whitefly	Complete	-
		Pepper WFT	Complete	-
		Apple powdery mildew	Complete	Yes
P3.1	12	IPM component for Y1 completed		
		Bush/cane fruit weed control	Complete	-
P4.1	12	Herbicide crop safety for Y1 completed		
		Field vegetable annual weeds	Complete	-

*Original objectives not fully met due to lack of sufficient pest attack or other reason.

SCIENCE SECTION

Individual experiments are summarised below. Unless stated otherwise:

- No problems were encountered during mixing or application of any of the products under test;
- No phytotoxicity or treatment related crop vigour differences were observed;
- The results for the standard treatment were as expected and it can be considered a valid trial.

Products currently approved for use on the test crop and included as standard treatments are shown underlined in the Tables.

1. Field vegetables

1.1. Assessment of the efficacy of several fungicides and biofungicides against Alternaria leaf spot in brassica crops

- Two trials were carried out in 2011 in unheated polytunnels at ADAS Boxworth to screen fungicides (Trial 1) and biofungicides (Trial 2) for the control of dark leaf spot (*Alternaria brassicicola*) on Chinese cabbage seedlings cv. Bilko. The results obtained were compared with an untreated control and an industry standard fungicide (Rudis).
- Fungicides were applied as single sprays and allowed to dry before inoculation later the same day, biofungicides were applied at this time and 7 days before. Treatments applied are listed below:

Table 1.1.1. Fungicides evaluated for control of dark leaf spot on brassica - 2011

Treatment	Product	Rate of product	Application date
1.	Untreated	-	-
2.	Rudis	0.4 L/ha	13 Jun
3.	Signum	1.0 kg/ha	13 Jun
4.	Folio Gold	2.0 L/ha	13 Jun
5.	Nativo 75WG	0.3 L/ha	13 Jun
6.	SF2011-0410	-	13 Jun
7.	SF2011-0424	-	13 Jun
8.	SF2011-0425	-	13 Jun
9.	SF2011-04104	-	13 Jun
10.	Potassium bicarbonate + wetter	4 kg/ha + 0.1%	13 Jun
11.	SF2011-04103	-	13 Jun
12.	SF2011-0428	-	13 Jun

Table 1.1.2. Biofungicides evaluated for control of dark leaf spot - 2011

Treatment	Product	Rate of product	Application dates
1.	Untreated	-	-
2.	Rudis	-	6 Jun, 13 Jun
3.	SF2011-0447	-	6 Jun, 13 Jun
4.	SF2011-0438	-	6 Jun, 13 Jun
5.	SF2011-0406	-	6 Jun, 13 Jun
6.	SF2011-0421	-	6 Jun, 13 Jun
7.	SF2011-0443 Rate 1	-	6 Jun, 13 Jun
8.	SF2011-0443 Rate 2	-	6 Jun, 13 Jun
9.	SF2011-0480	-	6 Jun, 13 Jun
10.	SF2011-0440	-	6 Jun, 13 Jun
11.	SF2011-0403	-	6 Jun, 13 Jun

Results

Table 1.1.3. Effect of fungicides and salts on *Alternaria brassicicola* at 14 days (30 Aug) and 21 days (5 Sept) after inoculation - 2011

Treatment	**Product name or code**	**Incidence *Alternaria* (% plants)**		**Severity *Alternaria* (% leaf area)**	
		14 days*	**21 days**	**14 days**	**21 days**
1.	Untreated	33.3 (4.6)	59.3 (8.3)	0.109	1.371
2.	Rudis	**6.3 (3.3)**	**39.6 (11.4)**	0.014	**0.066**
3.	Signum	**6.3 (3.3)**	**25.0 (10.2)**	**0.001**	**0.013**
4.	Folio Gold	22.9 (5.7)	66.7 (11.1)	0.017	0.589
5.	Nativo 75WG	**0.0 (0.0)**	**20.8 (9.6)**	**0.00**	**0.088**
6.	SF2011-0410	**18.7 (5.7**)	43.7 (11.6)	0.028	**0.227**
7.	SF2011-0424	**6.3 (3.3)**	**20.8 (9.6)**	**0.002**	**0.023**
8.	SF2011-0425	**8.3 (3.7)**	**39.6 (11.5)**	**0.004**	**0.087**
9.	SF2011-04104	31.2 (6.4)	75.0 (10.2)	0.034	0.704
10.	Potassium bicarbonate + wetter	41.6 (6.7)	70.8 (10.6)	0.123	1.507
11.	SF2011-04103	39.6 (6.7)	72.9 (10.4)	0.199	1.607
12.	SF2011-0428	**12.5 (4.5)**	**22.9 (9.9)**	**0.003**	**0.025**
Probability (F value)		<0.001	0.002	0.012	0.002
LSD vs. treatment (37 d.f.)		-	-	0.1172	1.0174
LSD vs. untreated (37 d.f.)		-	-	0.1015	0.8811

Values shown in bold are significantly different from the untreated. Values in () are standard errors.

Table 1.1.4. Effect of biological treatments on *Alternaria brassicicola* at 7, 14 and 21 days after inoculation - 2011

Treatment	Product name or code	Incidence of *Alternaria* (% plants)			Severity (% leaf area)
		7 days	**14 days**	**21 days**	**14 days**
1.	Untreated	28.4 (3.9)	71.4 (5.7)	63.2 (5.3)	0.97
2.	<u>Rudis</u>	30.6 (5.7)	**34.7 (8.2)**	**23.6 (6.6)**	0.41
3.	SF2011-0447	**15.3 (4.5)**	70.4 (7.6)	61.1 (7.5)	0.54
4.	SF2011-0438	30.6 (5.7)	70.4 (7.6)	59.7 (7.5)	0.97
5.	SF2011-0406	**19.4 (4.9)**	69.1 (7.7)	69.4 (7.2)	1.06
6.	SF2011-0421	26.4 (5.5)	75.9 (7.5)	52.7 (7.7)	1.33
7.	SF2011-0443 Rate 1	37.5 (6.1)	85.4 (6.1)	72.2 (6.9)	2.84
8.	SF2011-0443 Rate 2	**13.9 (4.4)**	97.4 (2.7)	80.6 (6.2)	5.97
9.	SF2011-0480	27.8 (5.6)	85.4 (6.1)	77.8 (6.5)	1.70
10.	SF2011-0440	**19.4 (4.9)**	74.6 (7.4)	70.8 (7.1)	2.31
11.	SF2011-0403	20.8 (5.1)	61.2 (8.4)	51.4 (7.7)	0.78
Probability (F value)		0.002	<0.001	<0.001	<0.001
LSD vs. treatment (55 d.f.)		-	-	-	1.791
LSD vs. untreated (55 d.f.)		-	-	-	1.551

Values shown in bold are significantly different from the untreated. Values in ( ) are standard errors.

- Disease pressure was moderate (high incidence but low severity) in both trials.
- For Trial 1 there were significant efficacy effects for products Nativo 75WG, SF2011-0410, SF2011-0424, SF2011-0425, Signum and SF2011-0428.
- For Trial 2 there were significant efficacy effects for products SF2011-0447, SF2011-0443 Rate 2, SF2011-0406 and SF2011-440.
- The trial was carried out on young plants which were not taken to maturity therefore no observations were made on crop yield or marketable yield.

Discussion

Disease pressure was moderate and this allowed a good assessment of disease control. After 14 days, several products in Trial 1 (fungicides) significantly reduced *Alternaria* incidence and severity. Nativo 75WG gave the best control at this time, while products SF2011-0424, SF2011-0425 and Signum also significantly reduced incidence by 80%. At

21 days after inoculation in Trial 1 (fungicides), products Nativo 75WG, SF2011-0424, SF2011-0428 and Signum still significantly reduced incidence by at least half and reduced severity greatly.

In Trial 2 (biofungicides) products SF2011-0447, SF2011-0443 Rate 2, SF2011-0406 and SF2011-440 significantly reduced *Alternaria* at 7 days but no products showed significant persistence of activity at 14 and 21 days after inoculation. SF2011-0403 appeared to give some control at all assessment dates and may warrant re-testing. Although products SF2011-0443 Rate 2, SF2011-0406 and SF2011-440 significantly reduced *Alternaria* incidence at 7 days, severity of the lesions was increased 14 and 21 days after inoculation.

1.2. Assessment of the efficacy of several fungicides and biofungicides against downy mildew in brassica crops

- Two trials were carried out in 2011 in unheated polytunnels at ADAS Boxworth to screen fungicides (Trial 1) and biofungicides (Trial 2) for the control of downy mildew (*Hyaloperonospora parasitica*) on cauliflower seedlings cv. Brunel. For both experiments there was double replication of the untreated plots. The results obtained were also compared with an industry standard fungicide (Folio Gold).
- Fungicides were applied and allowed to dry before inoculation later the same day, while biofungicides were applied at this time and 7 days before. Treatments applied are listed below:

Table 1.2.1. Fungicides evaluated for control of brassica downy mildew - 2011

Treatment	Product	Rate of product	Application date
1.	Untreated	-	-
2.	Folio Gold	2.0 L/ha	15 Aug
3.	Signum	1.0 kg/ha	15 Aug
4.	Previcur Energy	2.5 L/ha	15 Aug
5.	SF2011-0420	-	15 Aug
6.	SF2011-0422	-	15 Aug
7.	SF2011-0423	-	15 Aug
8.	SF2011-0424	-	15 Aug
9.	SF2011-0425	-	15 Aug
10.	Signum +	1.0 kg/ha	15 Aug
	SF2011-0483	-	
11.	SF2011-0483	-	15 Aug
12.	SF2011-0426	-	15 Aug
13.	SF2011-0484	-	15 Aug
14.	Potassium bicarbonate + wetter	4 kg/ha + 0.1%	15 Aug
15.	SF2011-04103	-	15 Aug

Table 1.2.2. Biofungicides evaluated for control of brassica downy mildew - 2011

Treatment	Product	Rate of product	Application dates
1.	Untreated	-	-
2.	Folio Gold	2.0 L/ha	8 Aug, 15 Aug
3.	SF2011-0447	-	8 Aug, 15 Aug
4.	SF2011-0438	-	8 Aug, 15 Aug
5.	SF2011-0406	-	8 Aug, 15 Aug
6.	SF2011-0421	-	8 Aug, 15 Aug
7.	SF2011-0443 Rate 1	-	8 Aug, 15 Aug
8.	SF2011-0443 Rate 2	-	8 Aug, 15 Aug
9.	SF2011-0480	-	8 Aug, 15 Aug
10.	SF2011-0440	-	8 Aug, 15 Aug
11.	SF2011-0403	-	8 Aug, 15 Aug

Results

Table 1.2.3. Effect of fungicides and salts on downy mildew at 14 days (30 Aug) and 21 days (5 Sept) after inoculation - 2011

Trt	Product name or code	Incidence of downy mildew (% seedlings)		Severity of downy mildew (% leaf area)			
				Layer 1		Layer 2	
		7 days	14 days	14 days	21 days	14 days	21 days
1.	Untreated	42.5	60.3	17.6	42.4	5.7	23.2
2.	<u>Folio Gold</u>	**16.1**	42.2	5.3	34.3	2.5	19.3
3.	Signum	**2.1**	**23.7**	**1.1**	26.3	1.1	10.5
4.	Previcur Energy	**2.8**	**24.0**	**1.8**	30.3	1.4	8.7
5.	SF2011-0420	**5.6**	**16.8**	**4.0**	**16.7**	1.5	8.6
6.	SF2011-0422	**10.3**	**30.2**	**3.0**	31.7	2.0	14.4
7.	SF2011-0423	**4.2**	**21.1**	**3.8**	35.0	2.5	26.5
8.	SF2011-0424	**0.0**	**3.9**	**0.1**	**2.5**	0.0	2.0
9.	SF2011-0425	**6.5**	**30.4**	6.8	40.3	1.9	16.3
10.	Signum + SF2011-0483	**0.0**	**22.8**	**0.5**	**15.6**	0.7	9.6
11.	SF2011-0483	43.7	54.0	17.8	46.3	11.3	15.0
12.	SF2011-0426	**21.8**	**27.5**	**2.7**	25.0	5.1	14.3
13.	SF2011-0484	**12.3**	42.3	8.5	40.0	15.0	19.0
14.	$KHCO_3$ + wetter	26.2	48.2	13.9	**23.5**	3.5	11.5
15.	SF2011-04103	**19.6**	55.3	16.5	24.0	13.3	10.5
Probability (F value)		<0.001	<0.001	0.06	0.008	0.038	NS
LSD vs. treatment (46 d.f.)		19.35	24.62	14.80	21.55	9.64	-
LSD vs. untreated (46 d.f.)		16.76	21.32	12.82	18.66	8.35	-

Values shown in bold are significantly different from the untreated.

Table 1.2.4 Effect of biological treatments on brassica downy mildew at 14 days and 21 days after inoculation- 2011

Treatment	**Product name or code**	**Incidence of downy mildew (% seedlings)**		**Severity of downy mildew on layer 1 (% leaf area)**	
		14 days	**21 days**	**14 days**	**21 days**
1.	Untreated	48.6	99.2	7.8	41.0
2.	Folio Gold	31.8	88.3	3.6	15.0
3.	SF2011-0447	**10.7**	**67.8**	**1.1**	15.3
4.	SF2011-0438	51.9	95.2	10.8	42.0
5.	SF2011-0406	61.4	94.8	7.3	37.8
6.	SF2011-0421	39.8	98.8	8.2	34.7
7.	SF2011-0443 Rate 1	48.7	99.4	11.7	42.8
8.	SF2011-0443 Rate 2	40.0	97.6	5.5	34.7
9.	SF2011-0480	68.3	99.4	13.8	41.7
10.	SF2011-0440	48.1	100.0	8.6	28.6
11.	SF2011-0403	49.8	100.0	8.8	35.6
Probability (F value)		0.035	<0.001	0.041	NS
LSD vs. treatment (56 d.f.)		29.42	14.14	7.09	-
LSD vs. untreated (56 d.f.)		25.48	12.25	6.14	-

Values shown in bold are significantly different from the untreated.

- Disease pressure was moderate to severe (high incidence with moderate severity).
- Phytotoxicity was observed on plants treated with potassium bicarbonate, SF2011-04103 and SF2011-0447 at the rates used.
- The results obtained for the standard treatment Folio Gold were unexpected; poor control may have been due to metalaxyl resistance.
- For Trial 1 there were significant efficacy effects for products SF2011-0424, SF2011-0420, SF2011-0422, SF2011-0423 and Signum.
- For Trial 2 only product SF2011-0447 gave significant control.
- The trial was carried out on young plants which were not taken to maturity therefore no observations were made on crop yield or marketable yield.

Discussion

Disease pressure was moderate to severe and this allowed a stern assessment of disease control. Folio Gold (used as commercial standard) gave poor control that may be due to metalaxyl resistance. After 14 days, several products in Trial 1 (fungicides) significantly reduced downy mildew incidence and severity. SF2011-0424 gave the best control at this time, while products SF2011-0420, SF2011-0423 and Signum reducing incidence by two-thirds and severity greatly. At 21 days after inoculation in Trial 1 (fungicides), products SF2011-0420, SF2011-0424 and potassium bicarbonate + wetter still significantly reduced severity on leaf layer 1. SF2011-0424 performed especially well (2.5% leaf area affected).

In Trial 2 (biofungicides) only product SF2011-0447 significantly reduced downy mildew 14 and 21 days after inoculation. Some further work on rate and timing with this product is needed to reduce phytotoxicity. SF2011-0443 at the higher rate appeared to give some control at 14 days and may warrant re-testing.

1.3. Assessment of the efficacy of several insecticides and bio-insecticides against caterpillars in brassica crops

- One replicated trial was conducted in 2011 at Warwick Crop Centre to evaluate the efficacy of insecticides and bio-insecticides for the control of caterpillars in brassica crops (Brussels sprout cv. Doric). The results obtained were compared with untreated controls and the trial protocol was validated by inclusion of the standard treatments (positive controls) Steward (indoxacarb) and Dipel (*Bacillus thuringiensis*) applied at recommended rates.
- One application of each treatment was made. Treatments applied are listed below (C=conventional; B=bio-insecticide):

Table 1.3.1. Insecticides and bio-insecticides evaluated against caterpillar on brassicas (Brussels sprout) - 2011

Treatment	Product	Product/ha	Water volume (l/ha)	Application dates
C1.	Untreated			
C2.	Steward	85 g	300	30 September 2011
C3.	SI2011-0448	1600 g	300	30 September 2011
C4.	SI2011-0450	750 ml	300	30 September 2011
C5.	SI2011-0467	175 ml	300	30 September 2011
C6.	SI2011-0469	200 ml	300	30 September 2011
B1.	Untreated			
B2.	Dipel	1000 g	400	14 October 2011
B3.	SI2011-0464	1000 g	400	14 October 2011
B4.	SI2011-0494	2000 million	400	14 October 2011

Results

- The caterpillar infestation was very low. Data for the conventional insecticide trial only are shown (Table 1.3.2 and Figure 1.3.1). Caterpillar numbers in the bio-insecticide trial were too low to provide meaningful results.
- Statistical analysis revealed no significant differences but there is evidence that all of the test chemicals were providing some control.

Discussion

Natural infestations of lepidopterous pests of brassica crops were very low in 2011. There is an indication that all of the conventional insecticides reduced caterpillar numbers compared with the untreated control. However these results are based on a mean number of 4 caterpillars per plot and it should be noted that only just over 30% of caterpillars seen initially on untreated plots were found after spraying. Attempts will be made to evaluate the bio-insecticide treatments against laboratory-reared *Plutella xylostella* in a greenhouse test prior to the 2012 field season.

Table 1.3.2. Percentage of caterpillars found after treatment with conventional insecticides compared with a pre-spray count

Treatment	Product	% caterpillars found after spraying	
		Angular	Back trans.
1.	Steward	9.43	17.9
2.	SI2011-0448	2.90	9.8
3.	SI2011-0450	1.70	7.5
4.	SI2011-0467	2.35	8.8
5.	SI2011-0469	6.70	15.0
6.	Untreated	27.02	31.3
Probability (F value)		0.739	
SED		17.03	
LSD		36.31	
d.f.		15	

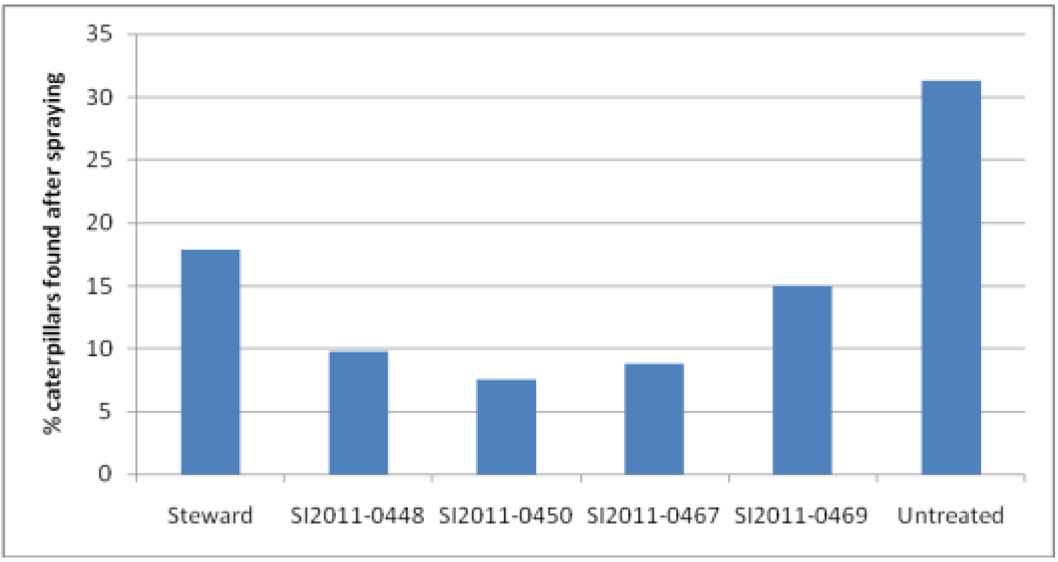

Figure 1.3.1. Percentage of caterpillars found after treatment with conventional insecticides compared with a pre-spray count.

1.4. Assessment of the efficacy of several insecticides and bio-insecticides against aphids in brassica crops

- One replicated trial was conducted in 2011 at Warwick Crop Centre to evaluate the efficacy of insecticides and bio-insecticides for the control of aphids in brassica crops (Brussels sprout cv. Doric). The results obtained were compared with untreated controls and the trial protocol was validated by inclusion of a standard treatment (positive control) (Movento).
- One application of each treatment was made. Treatments applied are listed below (C = conventional; B = bio-insecticide):

Table 1.4.1. Insecticides and bio-insecticides evaluated against aphids on brassicas (Brussels sprout) - 2011

Treatment	Product	Product/ha	Water volume (l/ha)	Application dates
C1.	Untreated			
C2.	Movento	480 ml	300	27 Sep
C3.	SI2011-0450	750 ml	300	27 Sep
C4.	SI2011-0459	200 ml	300	27 Sep
C5.	SI2011-0460	160 g	300	27 Sep
B1.	Untreated			
B2.	SI2011-0492	3000 ml	400	27 Sep, 3 Oct, 10 Oct
B3.	SI2011-0453	4000 ml	1000	27 Sep, 3 Oct, 10 Oct
B4.	SI2011-0462	4000 ml	400	27 Sep, 3 Oct, 10 Oct

Results

- Data for conventional insecticides are displayed in Table 1.4.2 and Figure 1.4.1.
- All conventional insecticides provided very good to moderate control for 21 days post-spraying despite increasing aphid numbers on untreated plots.
- Data for bio-insecticides are displayed in Table 1.4.3 and Figure 1.4.2.
- SI2011-492 reduced the rate of increase of aphid numbers but only SI2011-462 produced any decrease in aphid numbers compared to pre-spray counts.

Table 1.4.2. Live wingless aphids (mainly *Brevicoryne brassicae*), pre- and post-treatment, in plots treated with conventional insecticides (sprayed 27 September 2011).

Treatment	Product	Number of aphids/plant					
		Pre-spray		8 days		21 days	
		SqRt	Back trans.	SqRt	Back trans.	SqRt	Back trans.
1.	SI2011-0450	9.62	92.6	**2.04**	**4.2**	**3.52**	**12.4**
2.	Movento	15.38	236.4	**0.76**	**0.6**	**0.43**	**0.2**
3.	SI2011-0459	5.97	35.6	**1.96**	**3.8**	**1.51**	**2.3**
4.	SI2011-0460	9.27	85.9	**1.64**	**2.7**	**5.83**	**34.0**
5.	Untreated	6.40	40.9	12.42	154.3	10.52	110.6
Probability (F value)		0.685		<0.001		<0.001	
SED		7.00		1.27		1.29	
LSD		15.25		2.77		2.81	
d.f.		12		12		12	

Values shown in bold are significantly different from the untreated.

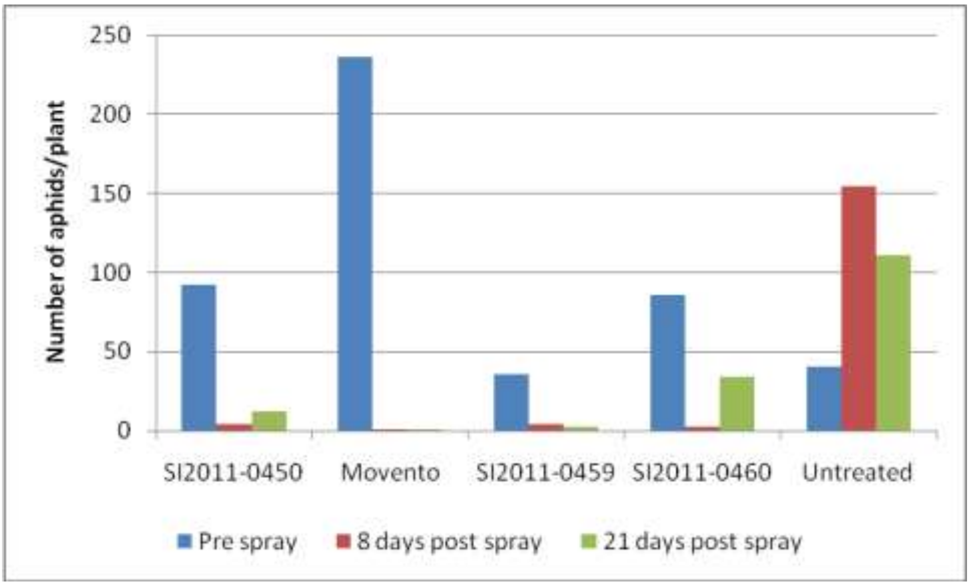

Figure 1.4.1. Live wingless aphids (mainly *Brevicoryne brassicae*), pre- and post-treatment, in plots treated with conventional insecticides (sprayed 27 September 2011).

Table 1.4.3. Live wingless aphids (mainly *Brevicoryne brassicae*), pre- and post-treatment, in plots treated with bio-insecticides (sprayed 27 September, 3 and 10 October 2011 and assessed on 19 October).

Treatment	**Product**	**Number of aphids/plant**			
		Pre-spray		**Post-sprays**	
		SqRt	**Back trans.**	**SqRt**	**Back trans.**
1.	SI2011-0453	7.15	51.1	9.68	93.7
2.	SI2011-0492	27.74	27.7	**8.48**	**71.9**
3.	SI2011-0462	43.46	43.5	**5.74**	**33.0**
4.	Untreated	15.48	15.5	12.70	161.2
Probability (F value)		0.403		0.018	
SED		1.99		1.90	
LSD		4.25		4.04	
d.f.		15		15	

Values shown in bold are significantly different from the untreated.

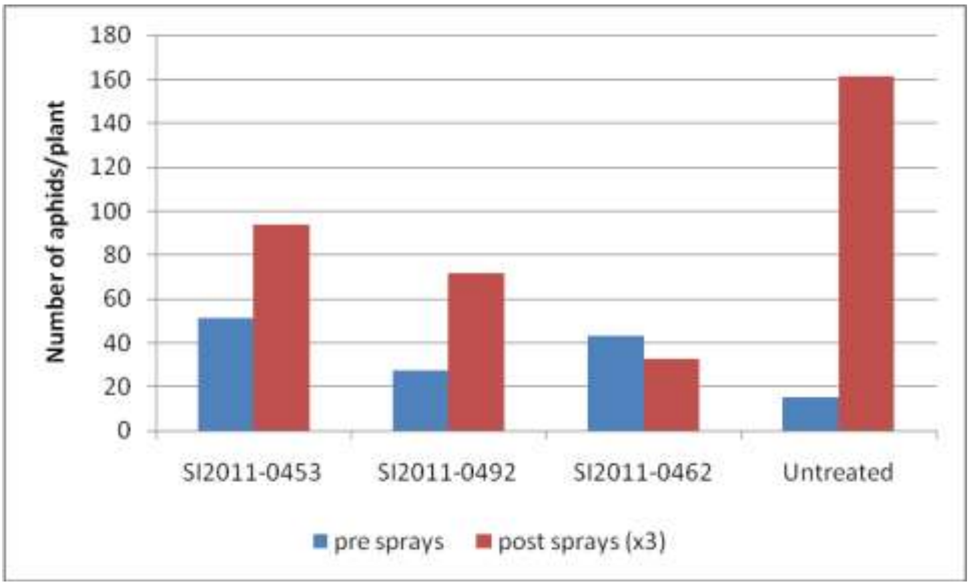

Figure 1.4.2. Live wingless aphids (mainly *Brevicoryne brassicae*), pre- and post-treatment, in plots treated with bio-insecticides (sprayed 27 September, 3 and 10 October 2011 and assessed on 19 October).

Discussion

Natural infestations of pest aphids of brassica crops were low and late in 2011. However, there were sufficient aphids to apply treatments in late September and the results indicated that all of the products evaluated had some activity against *Brevicoryne brassicae*. All conventional insecticide treatments provided good to excellent aphid control. In the trial evaluating bio-insecticides, aphid numbers increased in all plots in the period between the pre-spray assessment and the post-spray assessment (27 September – 19 October). However, the increase in aphid numbers was significantly smaller in plots treated with SI2011-0462 or SI2011-0492 than in the untreated control and SI2011-0462 appeared to be the most effective treatment.

1.5. Assessment of the efficacy of several insecticides and bio-insecticides against cabbage root fly in cauliflower

- One replicated pot trial was conducted in 2011 at Warwick Crop Centre to evaluate the efficacy of insecticides and bio-insecticides for the control of cabbage root fly larvae feeding on cauliflower cv. Skywalker. The results obtained were compared with untreated controls and the trial protocol was validated by inclusion of a standard treatment, Tracer (spinosad) applied at the recommended rate.

- One application of each treatment was made. Treatments applied are listed in Table 1.5.1.

Table 1.5.1. Insecticides and bio-insecticides evaluated for control of cabbage root fly on cauliflower - 2011

Treatment	Product	Rate/1000 plants	Inoculation time (days after treatment)
1.	Untreated		
2.	Tracer	12 ml	7
3.	SI2011-0550	15 ml	7
4.	SI2011-0555	0.30 ml	7
5.	SI2011-0557 (bio-insecticide)	163 ml	7
6.	SI2011-0565 (bio-insecticide)	14 ml	7
7.	SI2011-0594 (bio-insecticide)	35,000/plant	7
1.	Untreated		
2.	Tracer	12 ml	28
3.	SI2011-0550	15 ml	28
4.	SI2011-0555	0.30 ml	28
5.	SI2011-0557 (bio-insecticide)	163 ml	28
6.	SI2011-0565 (bio-insecticide)	14 ml	28
7.	SI2011-0594 (bio-insecticide)	35,000/plant	28

Results

- Data for 7-day and 28-day inoculations are displayed in Table 1.5.2 and Figure 1.5.1.
- All conventional insecticides provided excellent control of cabbage root fly larvae for at least 28 days after transplanting (treatment).
- The bio-insecticide SI2011-0594 reduced numbers of pupae a little compared to the untreated control after the 7-day inoculation but this effect was no longer apparent after the 28-day inoculation.

Table 1.5.2 Numbers of pupae recovered per plant (plants inoculated with cabbage root fly eggs 7 and 28 days after transplanting into pots)

Treatment	Product	Number of pupae/plant			
		Day 7		Day 28	
		SqRt	**Back trans.**	**SqRt**	**Back trans.**
1.	Untreated	2.435	5.931	2.310	5.334
2.	Tracer	**0.000**	**0.000**	**0.062**	**0.004**
3.	SI2011-0550	**0.063**	**0.004**	**0.187**	**0.035**
4.	SI2011-0555	**0.000**	**0.000**	**0.125**	**0.016**
5.	SI2011-0557 (bio-insecticide)	2.510	6.298	2.402	5.768
6.	SI2011-0565 (bio-insecticide)	2.743	7.525	2.215	4.907
7.	SI2011-0594 (bio-insecticide)	**2.075**	**4.307**	2.285	5.223
Probability (F value)		<0.001		<0.001	
SED		0.178		0.232	
LSD		0.353		0.460	
d.f.		90		90	

Values shown in bold are significantly different from the untreated.

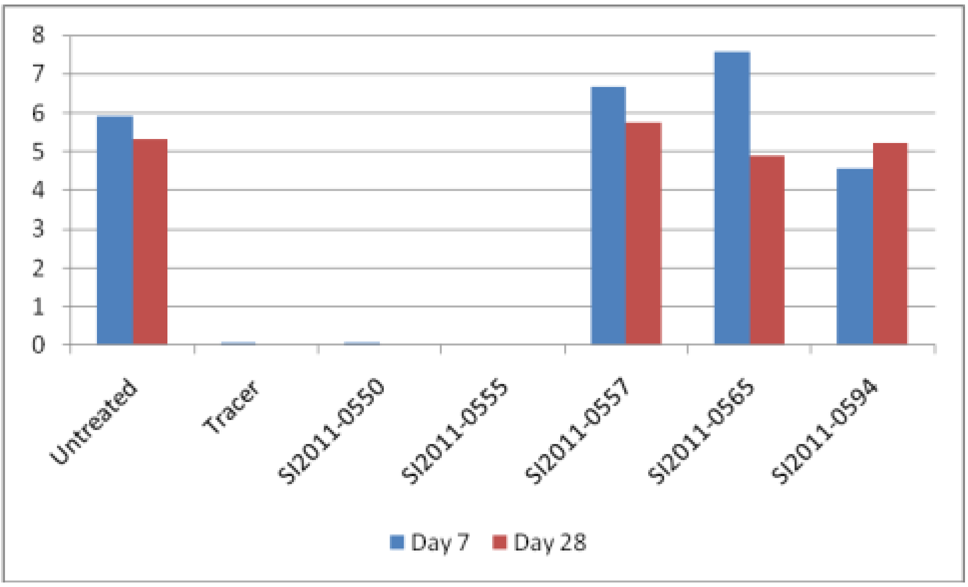

Figure 1.5.1. Numbers of pupae recovered per plant (plants inoculated with cabbage root fly eggs 7 and 28 days after transplanting into pots).

Discussion

The 3 conventional insecticides were very, and equally, effective. By comparison with Tracer, the 2 novel products could both be expected to perform similarly well in a field situation. Of the 3 bio-insecticides, only SI2011-0594 showed any control but this was so marginal it would be of little benefit to field grown brassicas.

1.6. Assessment of the efficacy of several insecticides and bio-insecticides against currant-lettuce aphid in lettuce

- One replicated field trial was conducted in 2011 at Warwick Crop Centre to evaluate the efficacy of insecticides and bio-insecticides for the control of currant-lettuce aphid on lettuce (cv. Saladin). The results obtained were compared with untreated controls and the trial protocol was validated by inclusion of standard treatments (positive controls) Plenum (pymetrozine) and Movento (spirotetramat) applied at the recommended rates. The lettuce plants were infested artificially prior to transplanting on 25 July 2011.
- One application was made of each conventional treatment and two applications of each bio-insecticide treatment. Treatments applied are listed below:

Table 1.6.1. Insecticides and bio-insecticides evaluated against currant–lettuce aphid on lettuce - 2011

Treatment	Product	Product/ha	Spray volume (L/ha)	Application dates
1.	Plenum	400 ml		
2.	Movento	480 ml	300	15 August
3.	SI2011-1550	750 ml	300	15 August
4.	SI2011-1554	250 ml	400	15 August
5.	SI2011-1560	160 ml	300	15 August
6.	SI2011-1562 (bio-insecticide)	4000 ml	300	15 August, 22 August
7.	Untreated		300	
8.	SI2011-1553 bio-insecticide	4000 ml	400	15 August, 22 August

Results

- Data for all insecticides are displayed in Table 1.6.2 and Figure 1.6.1.
- Only Movento had significantly reduced aphid numbers compared to the untreated control 7 days after spraying.
- Movento and SI2011-1554 significantly reduced aphid numbers compared to the untreated control 15 days after spraying.
- Neither bio-insecticide reduced aphid numbers.

Table 1.6.2. Live wingless currant-lettuce aphids (*Nasonovia ribis-nigri*), pre- and post-treatment. Assessments were made 7 and 15 days after the first spray treatments were applied

Treatment	**Product**	**Number of aphids/plant**					
		Pre spray		**7 days**		**15 days**	
		SqRt	**Back trans.**	**SqRt**	**Back trans.**	**SqRt**	**Back trans.**
1	Plenum	2.66	7.08	5.46	29.79	11.82	139.77
2.	Movento	2.49	6.20	**3.41**	**11.65**	**1.14**	**1.31**
3.	SI2011-1550	2.92	8.53	7.91	62.51	11.01	121.22
4.	SI2011-1554	1.36	1.85	6.57	43.19	**5.25**	**27.60**
5.	SI2011-1560	1.60	2.55	6.27	39.32	8.26	68.29
6.	SI2011-1562 (bio-insecticide)	1.30	1.68	6.82	46.45	8.13	66.16
7.	Untreated	2.13	4.55	6.09	37.07	9.00	81.05
8.	SI2011-1553 (bio-insecticide)	2.15	4.61	5.33	28.38	10.13	102.63
Probability (F value)		0.129		0.015		<0.001	
Max. SED		0.666		1.000		1.627	
Max. LSD		1.368		2.131		3.381	
d.f.		26		15		21	

Values shown in bold are significantly different from the untreated.

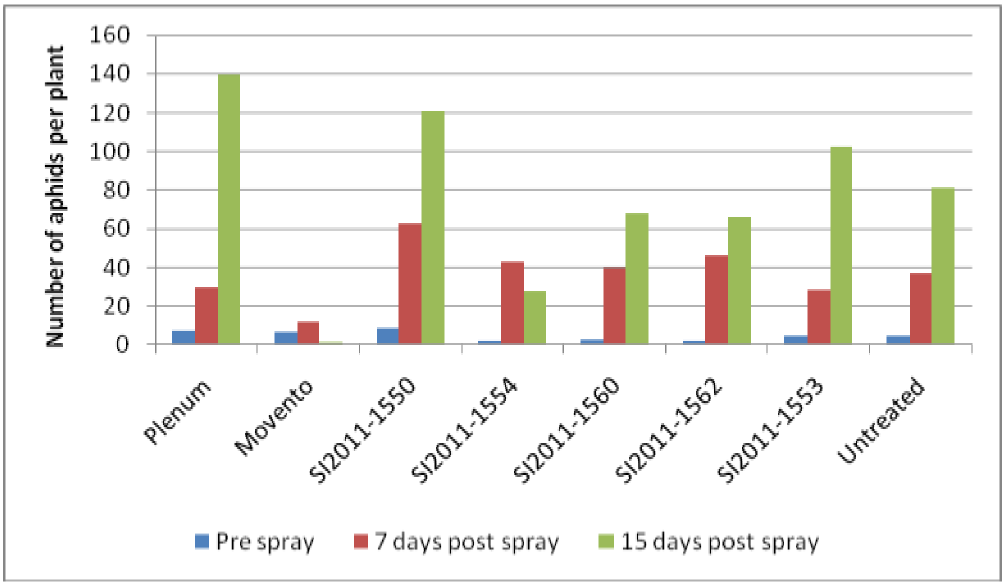

Figure 1.6.1. Live wingless currant-lettuce aphids (*Nasonovia ribis-nigri*), pre- and post-treatment. Assessments were made 7 and 15 days after the first spray treatments were applied.

Discussion

The plants were first treated 3 weeks after transplanting and so were beginning to heart. Consequently it is likely that treatments with systemic activity were more likely to control aphids that were hidden within the foliage. Movento (spirotetramat) was the most effective treatment and SI2011-1554 also provided a degree of control which was not observed until the 15 day assessment.

1.7. Assessment of the efficacy of several insecticides and bio-insecticides against thrips in leek crops

- One replicated trial was conducted in 2011 at Warwick Crop Centre to evaluate the efficacy of insecticides and bio-insecticides for the control of thrips in leek crops (cv. Jolant). The results obtained were compared with untreated controls and the trial protocol was validated by inclusion of a standard treatment (positive control) (Tracer) applied at the recommended rate.
- Four applications of each treatment were made. Treatments applied are listed below (C=conventional; B=biological):

Table 1.7.1. Insecticides and bio-insecticides evaluated for control of thrips in leeks - 2011

Treatment	Product	Product/ha	Spray volume (L/ha)	Application dates
C1.	Untreated			
C2.	Tracer	200 ml	200	2 Aug, 19 Aug, 2 Sep, 15 Sep
C3.	SI2011-0348	1600 ml	200	2 Aug, 19 Aug, 2 Sep, 15 Sep
C4.	SI2011-0350	750 ml	200	2 Aug, 19 Aug, 2 Sep, 15 Sep
C5.	SI2011-0354	250 ml	200	2 Aug, 19 Aug, 2 Sep, 15 Sep
B1.	Untreated			
B2.	SI2011-0352	2500 ml	400	2 Aug, 9 Aug, 19 Aug, 30 Aug
B3.	SI2011-0353	4000 ml	400	2 Aug, 9 Aug, 19 Aug, 30 Aug
B4.	SI2011-0362	4000 ml	400	2 Aug, 9 Aug, 19 Aug, 30 Aug
B5.	SI2011-0392	3000 ml	1000	2 Aug, 9 Aug, 19 Aug, 30 Aug

Results

- Data for conventional insecticides are displayed in Table 1.7.2 and Figure 1.7.1 (damage to second youngest leaf).
- All conventional insecticides significantly reduced damage throughout the assessment period. Tracer and SI2011-0350 were the most effective.
- Data for bio-insecticides are displayed in Table 1.7.3 and Figure 1.7.3 (damage to second youngest leaf).
- None of the bio-insecticides showed any evidence of control of thrips.

Table 1.7.2. Mean percentage leaf area damaged (second youngest leaf) by thrips in plots treated with conventional insecticides

Product	**% Leaf area damaged**							
	Pre spray		**After 1 spray**		**After 3 sprays**		**After 4 sprays**	
	Ang	**Back trans.**	**Ang**	**Back trans.**	**Ang**	**Back trans.**	**Ang**	**Back trans.**
Tracer	26.91	20.48	22.27	14.36	**11.85**	**4.22**	**19.30**	**10.93**
SI2011-0348	26.52	19.93	26.18	19.47	**13.91**	**5.78**	**26.74**	**20.25**
SI2011-0350	27.59	21.45	26.81	20.35	**7.82**	**1.85**	**18.14**	**9.69**
SI2011-0354	28.05	22.12	24.98	17.84	**12.62**	**4.77**	**22.96**	**15.21**
Untreated	30.14	25.22	27.57	21.42	20.98	12.82	32.02	28.12
Probability (F value)	0.495		0.695		0.003		<0.001	
SED	2.083		3.90		2.125		1.619	
LSD	4.804		8.98		4.900		3.732	
d.f.	8		8		8		8	

Values shown in bold are significantly different from the untreated.

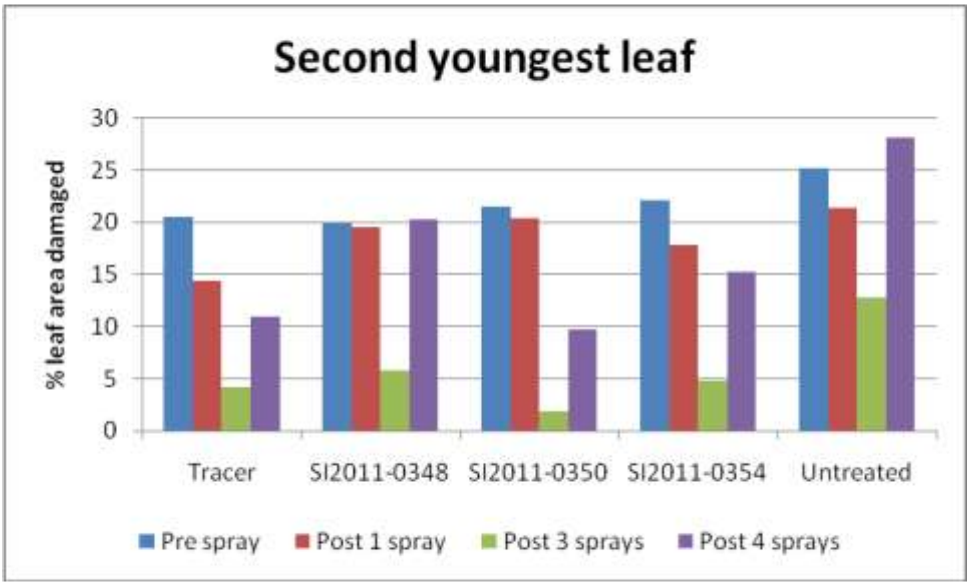

Figure 1.7.1. Mean percentage leaf area damaged (second youngest leaf) by thrips in plots treated with conventional insecticides.

Table 1.7.3. Mean percentage leaf area damaged (second youngest leaf) by thrips in plots treated with bio- insecticides

Product	**% Leaf area damaged**					
	Pre spray		**After 1 spray**		**After 4 sprays**	
	Ang	**Back trans.**	**Ang**	**Back trans.**	**Ang**	**Back trans.**
SI2011-0362	29.30	23.95	31.22	28.86	23.85	16.35
SI2011-0353	28.28	22.45	32.36	28.65	22.27	14.36
SI2011-0352	27.93	21.94	32.56	28.97	22.83	15.05
SI2011-0392	27.92	21.93	30.49	25.75	21.02	12.87
Untreated	28.51	22.78	31.02	26.55	22.74	14.94
Probability (F value)	0.930		0.686		0.460	
SED	1.755		1.668		1.488	
LSD	3.720		3.535		3.154	
d.f.	16		16		16	

Values shown in bold are significantly different from the untreated.

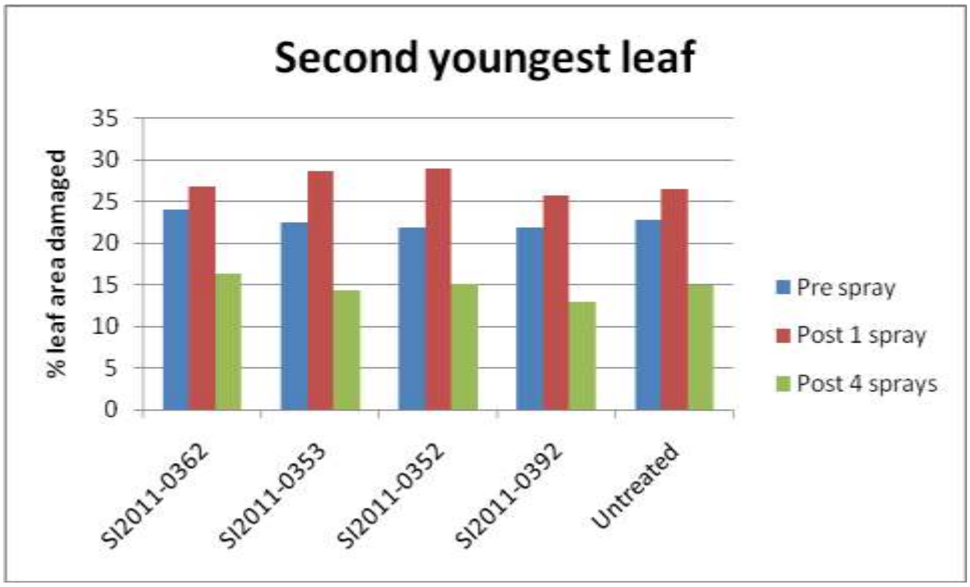

Figure 1.7.3. Mean percentage leaf area (second youngest leaf) damaged by thrips in plots treated with biological insecticides.

Discussion

Thrips in leeks are difficult to control and even the best performing conventional insecticides could only reduce damage to the second youngest leaf by a maximum of 65% compared to the untreated control. A concentrated (weekly) spray program of bio-insecticides had little effect on leaf damage.

1.8. Assessment of the efficacy of several insecticides and bio-insecticides against willow-carrot aphid in carrot crops

- One replicated trial was conducted in 2011 at Warwick Crop Centre to evaluate the efficacy of insecticides and bio-insecticides for the control of willow-carrot aphid in carrot crops (cv. Nairobi). The results obtained were compared with untreated controls and the trial protocol was validated by inclusion of a standard treatment (positive control) (Biscaya) applied at the recommended rate.
- One application of each conventional treatment (two applications of SI2011-14100) and three applications of each bio-insecticide were made. Treatments applied are listed in Table 1.8.1.

Table 1.8.1. Insecticides and bio-insecticides evaluated for control of willow-carrot aphid on carrot - 2011

Treatment	Product	Product/ha	Spray volume (L/ha)	Application dates
1.	Untreated			
2.	SI2011-14100	400 g	300	31 May, 14 Jun
3.	SI2011-1475	480 ml	300	31 May
4.	Biscaya	400 ml	300	31 May
5.	SI2011-1450	750 ml	300	31 May
6.	SI2011-1453 (bio-insecticide)	4000 ml	400	31 May, 7 Jun, 14 Jun
7.	SI2011-1454	250 ml	300	31 May
8.	SI2011-1460	160 g	300	31 May
9.	SI2011-1462 (bio-insecticide)	4000 ml	400	31 May, 7 Jun, 14 Jun

Results

- Data for all insecticides are displayed in Table 1.8.2 and Figure 1.8.1.
- All conventional insecticides reduced aphid numbers compared to the control, 9 to 16 days after spraying.
- Biscaya and SI2011-1450 were the most effective conventional insecticide treatments and SI2011-14100 was the least effective.
- Neither bio-insecticide reduced aphid numbers.

Table 1.8.2. Numbers of aphids per metre length of row 9 and 16 days after application of the first treatment

Treatment	Product	Number of aphids/plant			
		9 days post spray		16 days post spray	
		Log	Back trans.	Log	Back trans.
1.	Untreated	2.47	291.4	2.48	303.4
2.	SI2011-14100	**1.48**	**29.3**	**1.92**	**82.3**
3.	SI2011-1475	**1.08**	**11.1**	**0.86**	**6.2**
4.	<u>Biscaya</u>	**0.41**	**1.56**	**1.16**	**13.5**
5.	SI2011-1450	**0.57**	**2.73**	**0.62**	**3.1**
6.	SI2011-1453 (bio-insecticide)	2.36	229.5	2.57	367.7
7.	SI2011-1454	**1.30**	**19.1**	**1.42**	**25.4**
8.	SI2011-1460	**1.49**	**29.8**	**0.97**	**8.3**
9.	SI2011-1462 (bio-insecticide)	2.15	139.8	2.53	339.9
Probability (F value)		<0.001		<0.001	
Max. SED		0.3625		0.5243	
Max. LSD		0.7557		1.0972	
d.f.		20		19	

Values shown in bold are significantly different from the untreated.

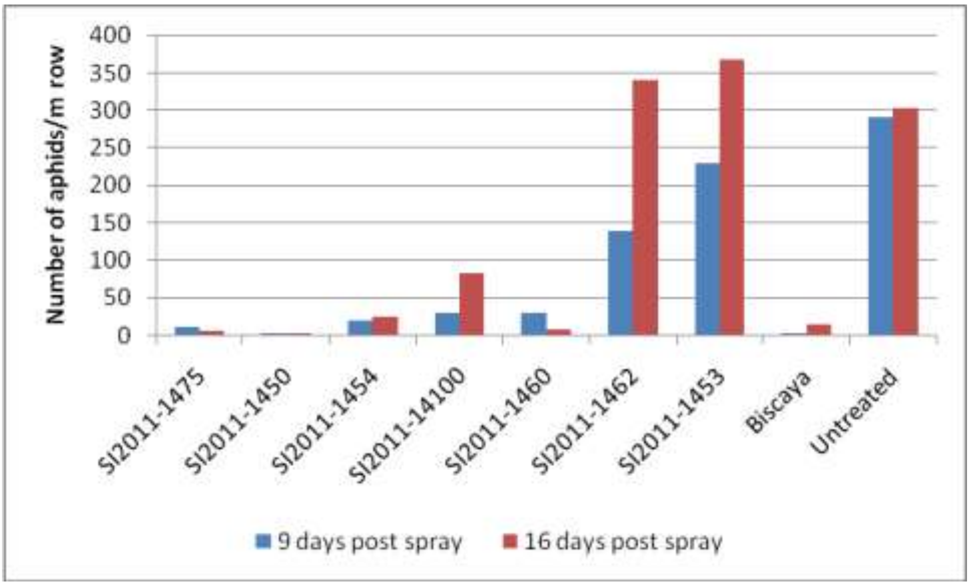

Figure 1.8.1. Numbers of aphids per metre length of row 9 and 16 days after application of the first treatment

Discussion

All of the conventional insecticide treatments reduced aphid numbers compared with the untreated control. The bio-insecticide treatments were not effective. Aphid numbers in the plots increased very slowly initially and the first treatment was applied when numbers were relatively low. However, numbers were sufficiently high to demonstrate treatment differences. Whilst all the conventional treatments reduced aphid numbers, a trial of this type cannot evaluate the effect of different treatments on virus transmission by the aphids.

1.9. Assessment of the selectivity and efficacy of a herbicide in 14 vegetable crops

- In a field screening trial in 2011 carried out at Elsom's trial ground, Lincolnshire, by the Allium and Brassica Centre, herbicide SH2011-0105 was applied pre- or post-weed-emergence at a range of dose rates in 14 crops.
- Crop safety and weed species controlled in comparison with those on untreated plots were evaluated. 'Volunteer' potatoes were planted to see whether they might be suppressed by the herbicide.
- The "Normal" dose rate for SH2011-0105 was 2.0 L/ha. Dose rates were 2 x 'Normal (N)', Normal, ½ Normal in all crops, except in onion and leek post-

emergence, where N, ½ N, ¼ N dose rates were applied. A 4 x N dose of 8.0 L/ha was also applied pre-emergence. SH2011-0105 was applied: pre-emergence of weeds and when drilled crops were at dry seed stage, but before transplanting of celery, cauliflower and lettuce; post-emergence of drilled crops and post planting.

Table 1.9.1. Crop planting dates; cultivar; SH2011-0105 application dates; crop growth stages when treated post-weed-emergence (leaf L; true leaves TL)

Crop (Cultivar)	**Sowing /transplant date**	**Pre-emergence/pre-transplant application**	**Post-emergence application**	**Crop growth stage**
'Volunteer' potatoes	11 April	13 April	13 May	2-3 shoots
Onion (Hystar)	11 April	13 April	13 May	1 L
Leek (Striker)	11 April	13 April	13 May	1 L
Carrot (Nairobi)	11 April	13 April	13 May	1-1½ TL
Parsnip (Palace)	11 April	13 April	13 May	1 TL
Celery transplant (Tango)	11 May	11 May	2 June	established
Cauliflower transplant (Jerez)	11 May	11 May	2 June	established
Lettuce transplant (Challenge)	11 May	11 May	2 June	established
Coriander (Filtro)	9 May	11 May	7 June	1-2 TL
Pea (Cabree)	9 May	11 May	2 June	2 node
Dwarf French Bean (Parker)	9 May	11 May	2 June	simple Leaf
Swede (Magres)	9 May	11 May	2 June	2 TL
Mizuna (Early)	9 May	11 May	2 June	2-3 TL
Spinach baby-leaf (Renegade)	9 May	11 May	2 June	2-4 TL
Broad beans (Manita)	9 May	11 May	2 June	2 node

Results

- Phytotoxicity symptoms from pre-emergence applications of SH2011-0105 were necrosis of lower leaves of some crops as a result of herbicide leaching and root uptake, or reduced or no emergence of sensitive crops; post-emergence it caused scorch.

- Potatoes are a frequent problem in vegetable crops. SH2011-0105 at 2.0 or 4.0 L/ha applied pre-emergence had no effect on potatoes. Applied post-emergence, it caused severe scorch at 2.0 L/ha, but more potato shoots grew so there was little long term reduction of potato vigour.
- Crop safety and weed control results are shown below.

Table 1.9.2. Crop safety of SH2011-0105 at various doses applied pre-emergence of drilled crops and pre-transplanting; post-emergence of drilled crops and post-transplanting; √ safe; x not safe, N 'normal' dose

Herbicide SH2011-0105	**Onion**	**Leek**	**Carrot**	**Parsnip**	**Coriander**	**Celery transplants**	**Cauliflower transplants**	**Lettuce transplants**	**Dwarf Bean**	**Vining Pea**	**Swede**	**Mizuna**	**Spinach**	**Broad bean**
Pre-emergence	X	X	√ ½ N	√ ½ N	√ N	√ N	√ N	√ ¼ N	√ ½ N	√ N	X	X	√ ¼ N	√ N
Post-emergence	√ N	√ N	√ ½ N	√ ½ N	√ ½ N	√ N	X	√# ¼ N	X	X	X	X	X	X

growth check to iceberg lettuce, unlikely to be safe on more sensitive varieties e.g. Lollo Rosso.

Table 1.9.3. Weed species controlled by SH2011-0105 applied pre- or post-weed-emergence at various dose rates: √ weed species controlled; x poor control or not controlled; x√ variable control; 0 none on the untreated plots; - controlled with a low dose of a standard pre-emergence

Herbicide dose rate/ha	Fool's parsley	Small nettle	Red dead-nettle	Groundsel	Fat-hen	Chickweed	Redshank	Pale persicaria	Black-bindweed	Shepherd's purse	Knotgrass
Pre-weed-emergence											
8.0L	√	√	√	√	√	√	√	√	√	√	√
4.0L	X	√	√	√	√	√	√	√	√	√	√
2.0L	X	√	√	√	√	√	X	x√ st	X	√	X
1.0L	X	√	√	X	X	√	X	X	X	√	X
Post-weed-emergence											
4.0L	√	√	√	√	√	√	√	√	√	√	0
2.0L	X	√	√	X	√	√	√	√	√	√	0
1.0L	X	√	√ sc st	X	√	√	X	X	X	√	0
0.5L	X	√#	X	X	-	-	X	X	X	√	0

controlled if small 2-4 TL; sc scorched; st stunted

Discussion

On an irrigated, light, silt loam soil, this herbicide appears to be safe to several vegetable crops at the timing and dose rates suggested. Damage will be increased where crops are grown on a sand soil and in a season with higher rainfall.

SH2011-0105 applied pre-emergence at 2.0 L/ha was safe to peas and broad beans and could be a replacement for Skirmish (terbuthylazine/isoxaben). At a lower dose it had potential for carrots, parsnips and coriander pre- and post-emergence and possibly iceberg lettuce at 0.5 L/ha. Applied post-emergence it was also safe at 2.0 L/ha in drilled bulb onion, leek and post-planting in celery. A post-weed-emergence herbicide would be useful particularly for celery and iceberg lettuce grown on organic soils where there are very few herbicide options.

SH2011-0105 gave excellent control of small nettle and shepherd's purse pre- and post-emergence at 1.0 L/ha and it was effective on groundsel at 2.0 L/ha. A few Polygonums escaped control and efficacy on fool's parsley was poor. Nettles are a nuisance in hand-harvested lettuce, cauliflower and celery. Fool's parsley and groundsel are contaminants in machine harvested crops (parsley and mizuna). Several flushes of groundsel have become a problem in some crops following the loss of propachlor. Mayweeds are frequently found in carrots – there were none on the trial site but the combination of actives is likely to control them.

SH2011-0105 is authorised for maize in Germany, but it is not authorised yet in the UK and vegetable crop approvals are unlikely for some years. However, in the longer term there is potential for on-label approvals or Extension of Authorisation for Minor Use (EAMU) for some vegetables.

1.10. Vegetable – herbicide residue studies

- The objective is to provide residues data to support new applications for authorisations of extension of use on products where satisfactory efficacy and phytotoxicity data is already available.
- Two herbicides are being tested, SH2011-0174 and SH2011-01101. The former is being tested on lettuce, the latter on cabbage, calabrese, cauliflower, kale and swede.
- Field trials are being done across a range of grower sites (Bedfordshire, Cornwall, Essex, Lancs, Lincs and Warwickshire to provide good geographical diversity. Each treatment has been applied at one rate as recommended by the manufacturer.

Results

- Work is still in progress. It is anticipated that data will be submitted to CRD in early 2012.

2. Soft fruit

2.1 Assessment of the efficacy of several fungicides and biofungicides against Mucor soft rot in strawberry

- One replicated trial was conducted in 2011 at East Malling Research to evaluate the efficacy of four fungicides, three biofungicides and four alternative chemicals for the control of soft rots caused by *Mucor* sp. or *Rhizopus*. in a protected crop of strawberry cv. Elsanta. The results obtained were compared with untreated controls. There is no standard treatment for control of soft rots for comparison.
- Five applications of each treatment were made starting at green fruit. Treatments applied are listed below:
-

Table 2.1.1. Fungicides, biofungicides and other products evaluated for control of strawberry soft rot - 2011

Treatment	Product	Rate of product	Application dates
1.	Untreated	-	-
2.	Switch	1.0 kg/ha	18/8, 26/8, 5/9, 12/9,19/9
3.	Signum	1.8 kg/ha	18/8, 26/8, 5/9, 12/9,19/9
4.	Thianosan DG	3 kg/1000 L/ha	18/8, 26/8, 5/9, 12/9,19/9
5.	SF2011-0277	0.8 L/ha	18/8, 26/8, 5/9, 12/9,19/9
6.	SF2011-0296	2 ml/L	18/8, 26/8, 5/9, 12/9,19/9
7.	Potassium bicarbonate	5 kg/ha	18/8, 26/8, 5/9, 12/9,19/9
8.	SF2011-02104	5 L/ha	18/8, 26/8, 5/9, 12/9,19/9
9.	SF2011-0249	10 g/L + 2.5 ml	18/8, 26/8, 5/9, 12/9,19/9
10.	SF2011-0297	2.5 ml/L	18/8, 26/8, 5/9, 12/9,19/9
11.	SF2011-0238	10 L/ha	18/8, 26/8, 5/9, 12/9,19/9
12.	Prestop	5 g/L	18/8, 26/8, 5/9, 12/9,19/9

Results

- The incidence of *Mucor* soft rot in the trial was moderate to high (Table 2.1.2).
- There is no recognised standard treatment for control of *Mucor* / *Rhizopus* but the results obtained reflect those found previously in laboratory tests.

- There were significant reductions in the incidence of soft rot in post-harvest tests for treatments Switch, Signum, Thianosan DG and SF2011-0277 and possibly SF2011-0296 and potassium bicarbonate at some harvest dates. None of the other treatments were effective.
- There was a significant increase in yield for Switch and SF2011-0277 compared with the untreated control. No significant differences in fruit number were observed between any of the treatments. The yields achieved were comparable with the untreated.

Table 2.1.2. Effect of various fungicides applied as five sprays from green fruit on *Mucor* rot incidence (in post-harvest tests following incubation at ambient temperature for 7 days), plot yield and fruit number in 2011. Data presented for *Mucor* are angular transformed with back transformed means in parenthesis

Treatment	Product	% *Mucor* fruit rot in fruit harvested 14 September	Total yield Overall mean (kg)	Total fruit number Overall mean
1.	Untreated	41.8 (44.4)	4.3	257.4
2.	Switch	31.0 (26.5)	**5.2**	302.1
3.	Signum	**13.6** (5.5)	4.5	279.9
4.	Thianosan DG	**27.6** (21.4)	4.0	239.5
5.	SF2011-0277	**21.9** (13.9)	**5.2**	250.0
6.	SF2011-0296	33.8 (31.0)	4.4	275.1
7.	Potassium bicarbonate	31.4 (27.2)	4.4	285.4
8.	SF2011-02104	38.9 (39.4)	4.4	258.1
9.	SF2011-0249	37.7 (37.5)	4.1	239.3
10.	SF2011-0297	43.2 (46.9)	4.7	250.1
11.	SF2011-0238	38.6 (39.0)	4.7	290.3
12.	Prestop	39.1 (39.8)	4.0	244.5
F Probability		<0.001	0.016	0.091
SED (df)		5.98	0.344	22.4
LSD (p= 0.05)		12.17	0.699	45.6

Figures in bold are significantly different from the untreated.

Discussion

Laboratory tests showed that most of the soft rots were caused by *Mucor*. The fruit was picked over four harvests. The four fungicide treatments reduced the incidence of *Mucor* in two or three of the harvest dates. By the fourth harvest the incidence of *Mucor* was high and none of the treatments were effective in reducing rotting. Treatments to reduce soft rots need to be applied during fruiting and harvest. Unfortunately none of the biocontrol agents or alternative chemicals was effective in reducing soft rots. The trial will be repeated in 2012 focusing on evaluating other biocontrol agents and alternative chemicals.

2.2 Assessment of the efficacy of insecticides and bio-insecticides against large raspberry aphid in raspberry

- One replicated trial was conducted in July 2011 at the James Hutton Institute to evaluate the efficacy of coded biopesticides and new conventionals for the control of large raspberry aphid, *Amphorophora idaei*, in protected raspberry (glasshouse). The results obtained were compared with untreated controls and the trial protocol was validated by inclusion of the standard treatment Calypso, applied at recommended rates.
- One to three applications of each treatment were made. Treatments applied are listed below:

Table 2.2.1. Insecticides and bio-insecticides evaluated for control of large raspberry aphid - 2011

Treatment	Product	Rate of product	Application dates
1.	Untreated	-	28 July, 4 Aug, 11 Aug
2.	Calypso	0.05% v/v	28 July, 4 Aug, 11 Aug
3.	SI2011-0791*	2% v/v	28 July, 4 Aug, 11 Aug
4.	SI2011-0753*	1% v/v	28 July, 4 Aug, 11 Aug
5.	SI2011-0762*	0.5% v/v	28 July, 4 Aug, 11 Aug
6.	SI2011-0785*	2 g/L	28 July, 4 Aug, 11 Aug
7.	SI2011-0770	0.125% v/v	28 July 2011

*Bio-insecticide.

Results

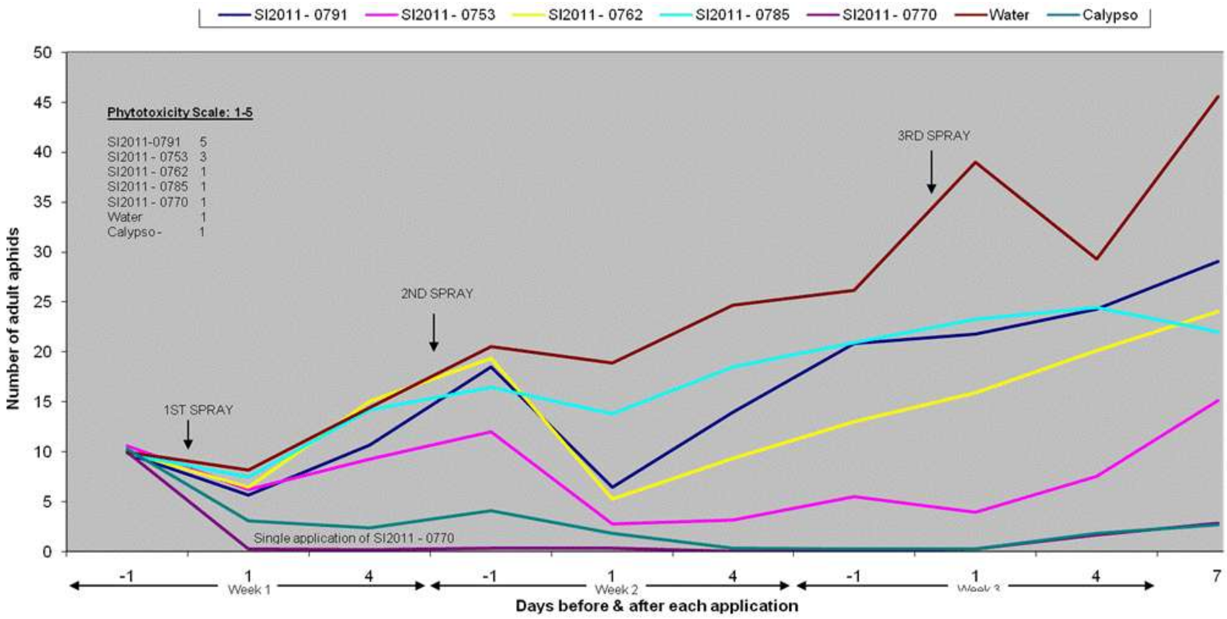

Figure 2.2.1. Effect of three treatment applications on large raspberry aphid numbers.

- The amount of *Amphorophora ideai* was moderate-high by the end of the experiment (inoculated with 10 adults at start).
- Some phytotoxic symptoms or treatment related crop vigour differences were observed during assessment timings. Phytotoxicity was observed on plants treated with SI2011-0791 and SI2011-0753 at the suppliers' recommended rates used.
- There were significant ($p < 0.001$) efficacy effects for treatments. One treatment (SI2011-0770), even applied only once, statistically gave as good control as the commercial standard Calypso, which was applied 3 times.
- At the end of the 28 day trial, the most effective treatment (SI2011-0770) reduced total aphid numbers (adult and nymph) by 98%, compared to 95% control after 3 applications of the commercial standard, Calypso.
- Of the two next most effective test treatments, only one (SI2011-0762) was not phytotoxic to raspberries under the trial conditions, so could be worth considering in future polytunnel trials, particularly if compatible with biocontrol agents.
- Yields of fruit were not assessed in this trial (juvenile potted plants were used).

2.3. Assessment of the efficacy of several insecticides and bio-insecticides against European tarnished plant bug in strawberry

- One replicated trial was conducted in 2011 at East Malling Research to evaluate the efficacy of Chess WG, Steward, SI2011-0254 or SI2011-0260, SI2011-0253 or SI2011-0262 for the control of European tarnished plant bug (*Lygus rugulipennis*) in strawberry.
- The results obtained were compared with untreated controls and the trial protocol was validated by inclusion of the standard treatment Calypso applied at recommended rates.
- Two applications were made of Calypso (standard), Chess WG, Steward, SI2011-0254 or SI2011-0260 and four applications of the bio-insecticides SI2011-0253 or SI2011-0262. Treatments applied are listed below:

Table 2.3.1. Insecticides and bio-insecticides evaluated for control of European tarnished plant bug on strawberry - 2011

Treatment	Product	Rate of product	Application dates
1.	Untreated	-	
2.	Calypso	250 ml	16 Aug, 30 Aug
3.	Chess WG	400 g	16 Aug, 30 Aug
4.	Steward	250 g	16 Aug, 23 Aug, 30 Aug, 6 Sep
5.	SI2011-0253*	20 L	16 Aug, 30 Aug
6.	SI2011-0254	1 kg	16 Aug, 30 Aug
7.	SI2011-0260	140 g	16 Aug, 30 Aug
8.	SI2011-0262*	10 L	16 Aug, 23 Aug, 30 Aug, 6 Sep

*Bio-insecticide.

Results

Table 2.3.2. Effect of treatments on mean and mean $log_{10}(n+1)$ transformed numbers of nymphs, adults and total *L. rugulipennis* recorded per cage per sampling occasion in tap sampling assessments; also, mean fruit damage score

Treatment	Nymphs		Adults		Total		Mean fruit damage score
	$Log_{10}(n+1)$	**n**	**$Log_{10}(n+1)$**	**n**	**$Log_{10}(n+1)$**	**n**	
Untreated	0.438	2.600	0.4865	2.450	0.708	5.050	2.151
Calypso (x2)	0.081	0.325	0.1248	0.425	0.192	0.750	**1.310**
Chess WG (x2)	0.050	0.175	0.1292	0.500	0.163	0.675	**1.405**
Steward (x2)	0.081	0.450	0.0376	0.125	0.106	0.575	**1.262**
SI2011-0253 (x4)	0.137	0.500	0.2948	1.175	0.386	1.675	**1.360**
SI2011-0254 (x2)	0.149	0.600	0.1424	0.550	0.248	1.150	**1.228**
SI2011-0260 (x2)	0.200	1.150	0.1725	0.650	0.334	1.800	**1.649**
SI2011-0262 (x4)	0.291	1.500	0.1962	0.750	0.406	2.250	**1.830**
F prob	<0.001		<0.001		<0.001		0.052
SED (28 df)	0.0719		0.06085		0.0868		0.3020
LSD (P=0.05)	0.1473		0.1264		0.1778		0.6187
2 treat. applic	0.112	0.540	0.1213	0.450	0.209	0.990	1.649
4 treat. applic	0.214	1.000	0.2455	0.962	0.396	1.962	1.830
F prob	0.024		0.002		0.001		0.220

Figures in bold are significantly different from the untreated.

- The amount of *Lygus rugulipennis* in the experimental cages was high compared to field populations.
- There were significant efficacy effects for treatments Calypso, Chess WG, Steward, SI2011-0253, SI2011-0254, SI2011-0260 and SI2011-0262, although the effect of the SI2011-0262 treatment was marginal and inconsistent.
- Note that Steward is approved for use in propagation only; any fruit harvested within 12 months must be destroyed.
- Significant crop damage from the pest was observed in the untreated control, SI2011-0260 and SI2011-0262 treatments.

Discussion

All of the products reduced numbers of *L rugulipennis* adults and nymphs significantly compared to the untreated control, although the effect of the SI2011-0262 treatment was marginal and inconsistent. None of the products gave a high standard of (> 90%) control, the best treatments reducing *L. rugulipennis* numbers by about 80%. The four treatments comprising two sprays of the chemical pesticide products were significantly more effective than the two treatments comprising four sprays of biopesticide products. Of the treatments tested, Chess WG x2 and Steward x2 were the most promising as the products are already available commercially as well as being selective and probably compatible with the phytoseiid predatory mites commonly used as BCAs in commercial strawberry growing (*Amblyseius* sp. and *Phytoseiulus persimilis*). Chess is already approved for use on protected strawberry in the UK and Plenum, an identical formulation, is approved on outdoor strawberry. If further work in 2012 confirms these 2011 findings, then an application for a SOLA for Steward could be justified. This product would also be useful for selective control of a wide range of lepidopeteran pests of strawberry. Of the other treatments tested, SI2011-0254 and SI2011-0260 are the highest priority for further investigation in 2012. It is unlikely that these selective products alone will give a sufficiently rapid kill of *L rugulipennis* to prevent significant crop damage in commercial practice. Use in admixture with a rapid knockdown product of short persistence (e.g. pyrethrins) may be more effective and it is proposed that this is evaluated in 2012.

It is proposed the same general methodology is used for the experiment to be done in August-September 2012, but providing potted *Alyssum saxitale* and/or *Chenopodium album*, and fly larvae and bean pods in the cages, in addition to two potted strawberry plants. Treatments comprising two sprays of the following products at a 14 day interval are proposed: Chess WG, Steward, SI2011-0254, SI2011-0260, Pyrethrum, Chess WG + pyrethrum and Steward + pyrethrum.

2.4. Assessment of the efficacy and crop safety of a range of herbicides against perennial weeds commonly found in bush and cane fruit.

- One replicated trial was conducted in 2011 at ADAS Boxworth to evaluate the efficacy of a range of herbicides (predominately sulfonylureas) to control perennial weeds in bush and cane fruit. The results obtained were compared with untreated controls. The selected weed species for investigation were creeping thistle (*Cirsium arvense*), common nettle (*Urtica dioica*) and broadleaved dock (*Rumex obtusifolius*).

- One application of each treatment was made as weeds were emerging (1-2 leaves)*. Treatments applied are listed below:

Table 2.4.1. Herbicides evaluated for control of perennial weeds - 2011

Treatment	Product	Rate of product	Application dates
1.	Untreated	-	-
2.	SH2011-1673*	150 g/ha	23 May, 14 Jul
3.	Roundup + SH2011-1673*	1.5 l/ha + 150 g/ha	23 May, 14 Jul
4.	SH2011-1672	150 g/ha	23 May, 14 Jul
5.	Roundup + SH2011-1672	1.5 l/ha + 150 g/ha	23 May, 14 Jul
6.	Roundup + Shark	1.5 l/ha + 330 ml/ha	23 May, 14 Jul
7.	SH2011 - 16102	2.0 l/ha	23 May, 14 Jul

(* treatment 2 and 3 were repeated including a mineral oil at 2.5 l/ha as this was omitted in the first run).

Results

Table 2.4.2. Effect of herbicide treatments on three perennial weeds - 2011

Treatment	Herbicide	Mean vigour score ***(scale – 9=healthy, 0=dead)***		
		Nettles	**Docks**	**Thistles**
1.	Untreated	9.00	9.00	8.83
2.	SH2011-1673*	5.00	9.00	1.00
3.	Roundup + SH2011-1673*	9.00	9.00	8.83
4.	SH2011-1672	1.17	1.33	0.00
5.	Roundup + SH2011-1672	2.67	1.17	0.00
6.	Roundup + Shark	0.50	1.69	1.17
7.	SH2011-16102	0.00	0.00	0.00
P value using chi-square approx.		<0.001	<0.001	<0.001

(* see table below with treatments 2 and 3 repeated including a mineral oil)

Table 2.4.3. Effect of herbicide treatments on three perennial weeds (re-run of treatments 2 and 3) - 2011

Treatment	Herbicide	Mean vigour score ***(scale – 9=healthy, 0=dead)***		
		Nettles	**Docks**	**Thistles**
1.	Untreated	9.00	8.75	9.00
2.	SH2011-1673*	1.25	8.50	2.25
3.	Roundup + SH2011-1673*	4.00	8.50	4.00
P value using chi-square approx.		0.018	0.607	0.039

Discussion

- SH2011-16102 gave complete control of nettles, docks and creeping thistles.
- SH2011-1672 (+/- glyphosate) and Shark + glyphosate also gave complete or extremely high levels of control of all three perennial weeds.
- A treatment of Shark alone could be included in future trials.
- SH2011-1673 was more variable in levels of control and was most effective at controlling thistles. Moderate control was achieved on nettles and poor control on docks.
- There were clear signs of herbicide antagonism with the addition of glyphosate to SH2011-1673 and this could be investigated further.
- There are likely to be crop safety issues with SH2011-16102 and this needs further investigation. A range of lower dose rates could be trialed which may be crop tolerant and still effective on the weeds.
- A range of lower doses of both SH2011-1672 and Shark could also be investigated in further work.

It must be remembered that this trial was carried out with plants in controlled conditions, with no competition from crop or other weed species. The weed plants had been transplanted and so had relatively small rooting systems, which would not be the case in a field crop situation.

2.5. Assessment of the efficacy of electrical weed control using a shielded high powered electrode against perennial weeds in bush and cane fruit

- One replicated trial was conducted in 2011 by ADAS to evaluate the efficacy of electrical weed control on perennial weeds in bush and cane fruit. The selected weed species for investigation were creeping thistle (*Cirsium arvense*), common nettle (*Urtica dioica*) and broadleaved dock (*Rumex obtusifolius*).
- One application of each treatment was made on 4 May 2011. Treatments applied are listed below:

Table 2.5.1. Electrical voltage and speed of travel used in assessment of electrical weed control equipment

Treatment	Voltage	Speed of travel
1.	Untreated	-
2.	3.5 kV	3.0 km/hr (SLOW)
3.	3.5 kV	5.0 km/hr (MEDIUM)
4.	5.0 kV	3.0 km/hr (SLOW)
5.	5.0 kV	5.0 km/hr (MEDIUM)

Results

Table 2.5.2. Effect of high voltage electrical contact on vigour of three perennial weeds - 2011

Treatment	**Voltage (kV)**	**Speed**	**Mean vigour score *(Scale- 9= healthy, 0=dead)***		
			Assessment 1 (18/05/11)	**Assessment 2 (02/06/11)**	**Assessment 3 (14/07/11)**
Dock					
1.	UTC	UTC	9.0	8.8	6.8
2.	3.5	Slow	0.5	0.0	0.0
3.	3.5	Medium	2.0	3.8	4.5
4.	5.0	Slow	2.0	1.5	4.5
5.	5.0	Medium	5.8	5.0	9.0
P-value based on chi-square approx. (Friedman's test)			0.008	0.018	0.092
Nettle					
1.	UTC	UTC	9.0	9.0	6.8
2.	3.5	Slow	1.3	2.8	4.0
3.	3.5	Medium	1.5	1.0	1.5
4.	5.0	Slow	3.3	3.3	4.3
5.	5.0	Medium	5.0	5.3	4.8
P-value based on chi-square approx. (Friedman's test)			0.045	0.031	0.347
Thistle					
1.	UTC	UTC	9.0	9.0	8.0
2.	3.5	Slow	0.0	0.0	0.0
3.	3.5	Medium	0.0	0.0	4.0
4.	5.0	Slow	0.0	0.0	0.0
5.	5.0	Medium	2.0	1.8	3.3
P-value based on chi-square approx. (Friedman's test)			0.007	0.006	0.055
(*all weed species*) df			4	4	4

- The natural populations of all three target weeds were high.
- The electronic weeder gave almost complete control of creeping thistle.
- Docks were also well controlled at the slower travelling speed with little re-growth although more re-growth occurred at the higher travelling speed.
- Generally the slower the travelling speed the higher the level of weed control for all species. The slower travelling speed gave complete control of thistles.
- Re-growth was observed for nettles. The nettles were in thick clumps and caused the electrical weeder to cut out at the higher voltage rate of 5.0 kV.
- Blackcurrant plants that had the weeder touch for five seconds showed symptom of leaf death. No fruit yields were recorded. When the plants were touched for one second (as would be more likely in a practice) there were no effects observed.

Discussion

- The electronic weeder is in an early stage of development but looks extremely promising for thistle and dock control and with some further work could have potential on docks and nettles.
- This could be investigated in further work looking at a range of voltages, travelling speeds and repeated treatments.
- Currently the practical application of the electronic weeder is unclear. To be of practical value it needs further development as a tractor-mounted shielded rig adaptable for use in fruit plantations or as a large-scale piece of equipment for use in vegetable crops.
- The economics of the comparison of electrical weed control versus mowing or cutting could be investigated further.
- The weeder was only tested on one day and at one site in this particular experiment and ideally should be tested further on a range of different soil types and with a number of different weather conditions. This particular season of the trial was unseasonably dry which may have had an influence on the results.

2.6. Assessment of the efficacy of several residual herbicides against annual weeds in strawberry

- One replicated trial was conducted in March to June 2011 by ADAS to evaluate the efficacy and crop safety of residual herbicides for the control of annual weeds in June bearer strawberries. The results obtained were compared with an untreated control.
- One application of each treatment was made. Treatments applied are listed below:

Table 2.6.1. Herbicides evaluated for control of annual weeds in strawberry - 2011

Treatment	Product	Rate of product	Application dates
1.	Untreated	-	-
2.	SH2011-0274	4.0 L/ha	16 March 2011
3.	Gamit 36CS	0.25 L/ha	16 March 2011
4.	SH2011-0205	2.0 L/ha	16 March 2011
5.	SH2011-0276	4.0 L/ha	16 March 2011

Results

Table 2.6.2. Effect of herbicides on annual weeds in strawberry, crop damage and fruit yield - 2011

	Weeds/m^2 26 April 2011	Weeds/m^2 27 June 2011	Phytotoxicity score 0 = nil 9 = severe 26 April 2011	Average fruit yield/plant (g)
1. Untreated control	1.25	6.25	0	330.72
2. SH2011-0274	0.63	4.38	0	334.62
3. Gamit 36CS	2.50	6.25	**5.25**	301.02
4. SH2011-0205	1.25	5.63	1	296.23
5. SH2011-0276	0.63	0.63	0	311.94
F. pr (12 df)	ns	ns	<0.001	ns
LSD			1.274	

Figures in bold are significantly different from the untreated.

- The levels of annual weeds were low.
- Phytotoxic symptoms were observed for two treatments Gamit 36CS and SH2011-0205 at the second assessment date.
- Note that Gamit 36CS is not approved for use on strawberry.
- There were no significant efficacy effects for any of the treatments, likely due to the low germination rates observed as a result of the exceptionally dry spring experienced in East Anglia.
- No significant differences in total crop yield and marketable yield in g/plant were observed between any of the treatments. The yields achieved were comparable with the standard treatment and the untreated.

Discussion

Phytotoxicity symptoms were recorded in plots treated with Gamit 36CS (clomazone) and SH2011-0205 at the second assessment six weeks after treatment. Symptoms started to appear 4 weeks after treatment. The Gamit 36CS caused the most severe phytotoxicity symptoms displaying interveinal chlorosis on the leaves. The SH2011-0205 caused minor twisting and up cupping of leaves. Neither symptom was visible by the onset of harvest.

Due to the exceptionally dry spring experienced in East Anglia with only 1mm of rain falling in March and 9.4mm falling in April, and the fact that no irrigation was applied, there was very little germination of annual weed seedlings in the period after treatment. The lack of moisture in the soil also meant the action of the residual herbicide has not been characteristic, therefore little can be gleaned from the weed assessments carried out and no real trends can be drawn from the data, except to say the SH2011-0276 treatments appeared to have slightly better control of late germinating weeds that were apparent by the end of harvest, however this trend was not statistically significant.

Yield was recorded on four occasions, picking all ripe fruit. Yield tended to be slightly depressed in plots treated with SH2011-0205 and to a lesser extent Gamit 36CS however these differences were not statistically significant.

3. Protected edibles

3.1 Assessment of the efficacy of several fungicides and biofungicides against powdery mildew in glasshouse cucumber

- Two replicated trials were conducted in a section of a glasshouse at Stockbridge Technology Centre in 2011 to evaluate the efficacy and crop safety of a range of fungicides (Trial 1) and biofungicides (Trial 2) to control powdery mildew (*Podosphaera xanthii*) in cucumber cv. Roxanna. The results obtained were compared with untreated controls and two standard fungicide treatments. The crop was artificially inoculated with a spore suspension of the pathogen prior to the start of treatment application.
- Following artificial inoculation of the plants the pathogen established quickly in Trial 1 and a moderate to high infection level developed. This provided an excellent test for the various products under evaluation. In Trial 2, the pathogen established very slowly due to the prevailing weather conditions and only a low infection level developed during the time period of the study. This provided, at best, a moderate test for the various bio-control products under evaluation.
- Two applications of each fungicide treatment were made and three applications of each biofungicide treatment. Treatments applied are listed below:

Table 3.1.1. Fungicides evaluated for control of cucumber powdery mildew - 2011

Treatment	Product	Rate of Product	Application dates
1.	Uninoculated untreated	-	-
2.	Inoculated untreated	-	-
3.	<u>Systhane 20 EW</u>	0.375 L/ha	8 Aug, 23 Aug
4.	<u>Rocket</u>	100 ml/100L	8 Aug, 23 Aug
5.	SF2011-1008	0.4 L/ha	8 Aug, 23 Aug
6.	SF2011-1077	0.8 L/ha	8 Aug, 23 Aug
7.	SF2011-1010	1.0 L/ha	8 Aug, 23 Aug
8.	SF2011-1014	1.0 L/ha	8 Aug, 23 Aug
9.	SF2011-1087	0.25 L/ha	8 Aug, 23 Aug
10.	SF2011-1088	0.125 L/ha	8 Aug, 23 Aug
11.	SF2011-1089	0.25 L/ha	8 Aug, 23 Aug

Table 3.1.2. Biofungicide treatments evaluated for control of cucumber powdery mildew – 2011

Treatment	Product	Rate of Product	Application dates
1.	Uninoculated untreated	-	-
2.	Inoculated untreated	-	-
3.	Systhane 20 EW	0.375 L/ha	29 Jun, 6 Jul, 16 Jul
4.	SF2011-1038	10 L/ha	29 Jun, 6 Jul, 16 Jul
5.	SF2011-1011	70 g/ha	29 Jun, 6 Jul, 16 Jul
6.	SF2011-1080	0.15%	29 Jun, 6 Jul, 16 Jul
7.	SF2011-1090	1.25%	29 Jun, 6 Jul, 16 Jul
8.	SF2011-1006	7.5 L/ha	29 Jun, 6 Jul, 16 Jul
9.	SF2011-1079	0.75 L/ha	29 Jun, 6 Jul, 16 Jul
10.	SF2011-1009	ready to use	29 Jun, 6 Jul, 16 Jul

Results

Table 3.1.3. Effect of fungicides on cucumber powdery mildew (Trial 1, one week after second application)

Treatment	Mean % Leaf Area Affected			% Healthy Leaves
	1st TL*	2nd TL	3rd TL	
1. Uninoculated untreated	50.8	45.6	37.3	45.4
2. Inoculated untreated	96.7	63.3	56.9	40.2
3. Systhane 20EW	84.1	**30.9**	26.6	47.1
4. Rocket	50.9	**10.6**	**7.0**	55.0
5. SF2011-1008	**5.1**	**7.0**	**1.9**	**76.9**
6. SF2011-1077	**0.02**	**0.1**	**0.2**	**91.4**
7. SF2011-1010	**16.8**	**1.2**	**5.1**	**58.4**
8. SF2011-1014	**19.8**	**1.8**	**2.4**	**60.8**
9. SF2011-1087	**23.2**	**8.7**	**13.3**	48.1
10. SF2011-1088	**1.2**	**0.2**	**0.8**	**69.6**
11. SF2011-1089	**25.2**	**12.7**	**12.4**	53.7
LSD (P=0.05)	21.8	13.8	12.1	9.8
SD	14.9	9.6	8.4	6.8
F probability (5 d.f.)	0.0001	0.0001	0.0001	0.0001

* Inoculated leaf. Figures in bold are significantly different from the untreated.

Table 3.1.4. Effect of biofungicides on cucumber powdery mildew (Trial 2, 2 days after the third application)

Treatment	Mean % Leaf Area Affected		
	1st TL*	2nd TL	3rd TL
1. Uninoculated untreated	0.0	0.0	0.0
2. Inoculated untreated	8.3	0.0	0.0
3. Systhane 20EW	**0.0**	0.0	0.0
4. SF2011-1038	**1.8**	0.1	0.1
5. SF2011-1011	5.5	0.0	0.0
6. SF2011-1080	**1.6**	0.0	0.0
7. SF2011-1090	**0.6**	0.0	1.9
8. SF2011-1006	**1.8**	0.2	3.6
9. SF2011-1079	5.6	0.5	8.0
10. SF2011-1009	4.4	0.0	7.5
LSD (P=0.05)	3.9	0.4	6.0
SD	2.7	0.3	4.2
F probability (5 d.f.)	0.0011	0.2866	0.0417

* Inoculated leaf. Figures in bold are significantly different from the untreated.

Discussion

- Following artificial inoculation in Trial 1 (fungicides), a moderate to severe infection level by powdery mildew occurred and this provided an excellent test for the standard and experimental fungicides under evaluation.
- The standard fungicides Systhane 20EW and Rocket provided relatively poor or, at best, mediocre suppression of powdery mildew in this trial. This reflects commercial practice and is most likely to be due to the development of mildew-resistant or tolerant strains in the pathogen population.
- Note that the emergency approval for use of Rocket on protected cucumber expired on 6 January 2012.
- A number of the experimental fungicides provided better control of the disease than the standard products and this is very encouraging.
- SF2011-1077 provided almost complete control of powdery mildew in this small-scale study though SF2011-1008, and SF2011-1088 were also very effective.
- Some of the other fungicides also significantly reduced infection and still warrant further evaluation in a commercial-scale trial in 2012.

- No phytotoxicity effects were observed.
- Following artificial inoculation in Trial 2 (biofungicides), a relatively poor infection level by powdery mildew occurred considered to be due to the prevailing weather conditions. As disease development was slow it provided a relatively poor test for the standard fungicides and bio-control products under evaluation.
- The majority of leaf lesions were confined to the inoculated leaf (1^{st} true leaf), with relatively little movement of infection onto the younger leaves.
- The standard fungicide selected (Systhane 20EW) provided an excellent level of mildew control but it is important to note that this was under low disease pressure.
- Under conditions of low disease pressure in this study, several of the biopesticides (SF2011-1038, SF2011-1080, SF2011-1090 and SF2011-1006) significantly reduced infection on the 1^{st} true leaf when compared to the inoculated control.
- Whilst some evidence of efficacy against powdery mildew was obtained, none of the biological control products evaluated completely controlled the mildew infection even under relatively low disease pressure, though SF2011-1080 did appear to prevent infection moving up the plants. Further evaluation of these products is required under higher disease pressure.
- Phytotoxicity effects were observed on plants treated with SF2011-1009 which was supplied as a ready-to-use product.

3.2. Assessment of the efficacy of several fungicides and biofungicides for control of grey mould on tomato

- Two replicated trials were conducted in a glasshouse at Stockbridge Technology Centre in 2011 to evaluate the efficacy of a range of fungicides to control grey mould (*Botrytis cinerea*) in tomatoes cv. Elegance; these were primary screens on young plants.
- The crop was artificially inoculated (using a range of different techniques) with a virulent culture of the fungus, recently isolated from tomato, prior to the start of treatment application. Following application of the trial products detached leaf laboratory bioassays were carried out to provide additional efficacy data on mycelial control and inhibition of spore germination.
- The results were compared with untreated controls and two standard fungicide treatments (Trial 1) or a standard fungicide and a standard biofungicide (Trial 2).

- In Trial 1, two applications of each treatment were made. In Trial 2 three applications were made. Fungicides were applied at the normal (N) and ½ N rate. Treatments applied are listed below:

Table 3.2.1. Fungicides evaluated for control of tomato grey mould - 2011

Treatment	Product	Rate of product	Application dates
1.	Untreated	-	-
2.	Teldor	1 g/L	11 Oct, 25 Oct
3.	Teldor	0.5 g/L	11 Oct, 25 Oct
4.	Switch	1 kg/ha	11 Oct, 25 Oct
5.	Switch	0.5 kg/ha	11 Oct, 25 Oct
6.	SF2011-0908	0.4 L/ha	11 Oct, 25 Oct
7.	SF2011-0908	0.2 L/ha	11 Oct, 25 Oct
8.	SF2011-0914	1.0 L/ha	11 Oct, 25 Oct
9.	SF2011-0914	0.5 L/ha	11 Oct, 25 Oct
10.	SF2011-0930	1.25 L/ha	11 Oct, 25 Oct
11.	SF2011-0930	0.63 L/ha	11 Oct, 25 Oct
12.	SF2011-0931	1.5 L/ha	11 Oct, 25 Oct
13.	SF2011-0931	0.75 L/ha	11 Oct, 25 Oct
14.	SF2011-0977	0.8 L/ha	11 Oct, 25 Oct
15.	SF2011-0977	0.8 L/ha	11 Oct, 25 Oct

Table 3.2.2. Biofungicides evaluated for control of tomato grey mould - 2011

Treatment	Product	Rate of product	Application dates
1.	Untreated	-	10 Oct, 17 Oct, 24 Oct
2.	Teldor	1 g/L	10 Oct, 17 Oct, 24 Oct
3.	Prestop	3.5% v/v	10 Oct, 17 Oct, 24 Oct
4.	SF2011-0904	0.12% w/v	10 Oct, 17 Oct, 24 Oct
5.	SF2011-0909	RTU	10 Oct, 17 Oct, 24 Oct
6.	SF2011-0921	360 g/ha	10 Oct, 17 Oct, 24 Oct
7.	SF2011-0934	5 g/L	10 Oct, 17 Oct, 24 Oct
8.	SF2011-0936	1 g/L	10 Oct, 17 Oct, 24 Oct
9.	SF2011-0938	10 L/ha	10 Oct, 17 Oct, 24 Oct
10.	SF2011-0940	1 g/L	10 Oct, 17 Oct, 24 Oct
11.	SF2011-0980	0.15%	10 Oct, 17 Oct, 24 Oct

Results

Table 3.2.3. Effect of fungicides on tomato grey mould in detached leaf bioassays

Treatment	Mean % LA infected following inoculation using plug from agar culture (1.11.11)	Mean % LA infected following inoculation with spore suspension (3.11.11)
1. Untreated	78.4	24.9
2. Teldor N	71.9	**1.0**
3. Teldor ½ N	71.2	25.6
4. Switch N	**50.6**	**4.0**
5. Switch ½ N	**50.3**	**7.9**
6. SF2011-0908 N	**23.4**	**0.7**
7. SF2011-0908 ½ N	**22.1**	**0.4**
8. SF2011-0914 N	61.2	24.1
9. SF2011-0914 ½ N	73.4	**7.5**
10. SF2011-0930 N	69.7	31.4
11. SF2011-0930 ½ N	65.0	38.6
12. SF2011-0931 N	**45.9**	11.8
13. SF2011-0931 ½ N	78.7	31.6
14. SF2011-0977 N	**24.7**	**0.2**
15. SF2011-0977 ½ N	**14.7**	**0.5**
LSD (P=0.05)	17.3	15.8
SD	12.1	11.1
F probability (3 d.f.)	0.0001	0.0001

Figures in bold are significantly different from the untreated.

Table 3.2.4. Effect of biofungicides on tomato grey mould in detached leaf bioassay

Treatment	Mean lesion diameter (mm) infected following inoculation with agar plug (17.10.11)	Mean % LA infected following inoculation with spore suspension (2.11.11)
1. Untreated	42.0	47.8
2. Teldor	35.0	**14.9**
3. Prestop	31.8	**15.4**
4. SF2011-0904	54.4	26.3
5. SF2011-0909	**17.7**	**9.2**
6. SF2011-0921	33.0	34.4
7. SF2011-0934	59.0	28.8
8. SF2011-0936	44.8	27.0
9. SF2011-0938	42.3	**23.0**
10. SF2011-0940	56.7	32.6
11. SF2011-0980	48.1	37.8
LSD (P=0.05)	14.6	22.3
SD	10.1	15.4
F probability (3 d.f.)	0.0001	0.0561

Figures in bold are significantly different from the untreated

Discussion

- Data was collected from *in-planta* petiole inoculations which formed aggressive stem lesions. Unfortunately, due to high levels of variability within treatments no significant differences between treatments could be determined in these tests.
- Efficacy data collected from the detached leaf bioassays provided the most consistent results from the various inoculation methods used in the study. These are discussed below.
- In Trial 1 (fungicides), neither Teldor nor Switch at full-rate reduced Botrytis significantly. Further investigation would be required to determine whether this was due to a shift in sensitivity in the pathogen population or some other factor associated with the methods applied.
- Whilst none of the experimental products provided complete inhibition of Botrytis in these small-scale studies, SF2011-0908 proved to be partially effective and was the

most effective product for control of *Botrytis* in both the mycelium and spore suspension inoculation tests.

- SF2011-0977 also showed a moderate level of control of mycelial spread, but was more effective at inhibiting spore germination and this difference could be important depending on the particular infection site targeted.
- In Trial 2 (biofungicides), the standard fungicide Teldor did not effectively control the Botrytis following artificial inoculation (see comment above).
- The standard bio-control product (Prestop), whilst providing a slight reduction in lesion development, was not significantly different from the untreated inoculated control in this study.
- Only one of the biopesticide products applied (SF2011-0909) provided a significant reduction in Botrytis development.
- Of the other biopesticide treatment evaluated none looked particularly promising in terms of Botrytis suppression and this makes decisions on which products to take forward into larger-scale studies in 2012 quite difficult.

3.3. Assessment of the efficacy of several insecticides and bio-insecticides against spidermite in tomato

- A replicated trial was conducted at Stockbridge Technology Centre in 2011 to evaluate the efficacy of seven treatments for the control of spidermites (*Tetranychus urticae*) on protected tomatoes, cv. Dometica. The results obtained were compared with a water control and the trial protocol was validated by inclusion of the standard treatment applied at recommended rates.

Table 3.3.1. Insecticides and bio-insecticides evaluated against mixed development stages of spidermites on protected tomatoes -2011

Treatment	Product code	Rates	Application date
1.	SI2011-0953*	1%	14 Oct
2.	SI2011-0962*	0.5-1%,	14 Oct
3.	SI2011-0952*	1.25 L/ha (400-800 l/ha)	14 Oct
4.	SI2011-0901*	1 L/ha, 100 ml/100 L	14 Oct
5.	SI2011-0986	50 ml per 100 L,	14 Oct
6.	SI2011-0992*	1.5 L/ha (i.e. 1.5 L/1000L)	14 Oct
7.	SI2011-0991*	2 L/100L,	14 Oct
8.	Water Control		14 Oct

*Bio-insecticide

Results

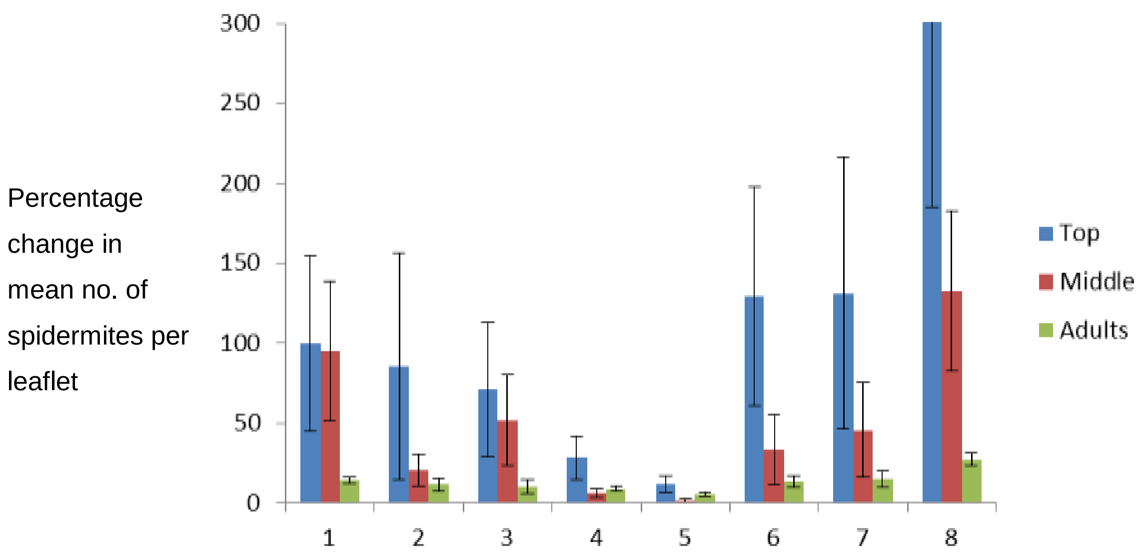

Figure 3.1.1. The percentage change in the numbers of spidermites (adults, nymphs and eggs) following the first application of treatments, comparing the pre-treatment and post-treatment counts.

- The results suggest that all treatments are reducing the numbers of spidermites (adults, nymphs and eggs) in comparison to the control plots ($p<0.05$).

Discussion

The first assessment showed that all treatments had significantly ($p<0.05$) reduced the numbers of spidermite stages in total (eggs, nymphs and adults). Following this first assessment the glasshouse heating system developed serious mechanical issues, and the subsequent drop in the temperatures (particularly during the night) over the next six days resulted in reduced numbers of spidermites across all treatments including the water treated control plots. It has not been possible to repeat this trial due to the pressure of reduced daylength and its subsequent effect on the behavior of spidermites. This trial will therefore be repeated in spring 2012.

3.4. Assessment of the efficacy of insecticides and bio-insecticides against glasshouse whitefly in protected tomato crops

- A replicated trial was conducted in July at Stockbridge Technology Centre to evaluate the efficacy of several products for the control of glasshouse whitefly (*Trialeurodes vaporariorum*) in tomatoes cv. Dometica. The results obtained were compared with water treated controls.
- Prior to the start of the trial even populations of whiteflies were established throughout the tomato crop.
- Four applications of each treatment (listed below) were made.

Table 3.4.1. Insecticides and bio-insecticides evaluated against mixed development stages of whitefly *(T. vaporariorum*) on protected tomatoes - 2011

Treatment	Code	Rate	Application dates
1	SI2011-0953*	1%	24 Jun, 1 Jul, 8 Jul, 15 Jul
2	SI2011-0962*	0.5-1%	24 Jun, 1 Jul, 8 Jul, 15 Jul
3	SI2011-0952*	1.25 L/ha (400-800 L/ha)	24 Jun, 1 Jul, 8 Jul, 15 Jul
4	SI2011-0954	1000 ml/ha	24 Jun, 1 Jul, 8 Jul, 15 Jul
5	SI2011-0960	140 g/ha (200-1000 L water/ha)	24 Jun, 1 Jul, 8 Jul, 15 Jul
6	SI2011-0992*	1.5 L/ha (ie 1.5 l/1000L)	24 Jun, 1 Jul, 8 Jul, 15 Jul
7	SI2011-0981*	0.1% + (0.25%)	24 Jun, 1 Jul, 8 Jul, 15 Jul
8	Water Control	-	24 Jun, 1 Jul, 8 Jul, 15 Jul

*Bio-insecticide.

Results

Table 3.4.2. Counts of immature stages (eggs/scales recorded on top and middle leaves) and the number of adult whitefly present at the final assessment following four applications of insecticides - 2011

Treatment	Top		Middle		Adults	
	Mean	SE	Mean	SE	Mean	SE
SI2011-0953*	**100.03**	54.60	94.92	43.72	**14.17**	2.13
SI2011-0962*	**85.50**	70.77	**20.92**	9.91	**11.58**	4.17
SI2011-0952*	**71.11**	42.18	**51.75**	28.52	**10.19**	4.10
SI2011-0954	**28.44**	13.67	**6.28**	2.87	**8.97**	2.34
SI2011-0960	**11.72**	4.50	**1.56**	1.27	**5.58**	1.11
SI2011-0992*	**129.78**	68.61	**33.47**	21.98	**13.28**	3.66
SI2011-0981*	**131.42**	84.77	**45.83**	29.88	**15.24**	5.00
Water Control	347.31	162.16	133.03	50.07	27.25	5.38
LSD (p=0.05)	190.00		65.70		9.35	

Figures in bold are significantly different from the water control.

- All treatments significantly ($p<0.05$) reduced numbers of whitefly adults and scales at the top and middle of the tomato plants in comparison to the water treated control.
- Numbers of adults were lowest in plots treated with the conventional insecticides SI2011-0954 and SI2011-0960, but these numbers where not significantly different from the other treatments.
- Analysis of data on the whitefly scales recorded on the middle leaves, demonstrated that at the final assessment there was a reduction in the numbers of surviving scales for all treatments (except for treatment SI2011-0953) in comparison to the control ($p<0.05$).
- Eggs and early instars, recorded at the top of the tomato plants did not appear in the trial until adults began to lay eggs in large numbers after the 8 July. At the final assessment all treatments significantly ($p<0.05$) reduced the numbers of eggs and early instars in comparison to the control plots. Treatments SI2011-0954 and SI2011-0960 again produced the lowest levels of whitefly, but this was not significantly different from the other treatments ($p>0.05$).

Discussion

- Overall, treatments appeared to produce two levels of efficacy against whitefly in tomatoes. New conventional insecticide treatments SI2011-0954 and SI2011-0960 provided the highest levels of efficacy. These higher levels of control were similar to levels that would be expected of conventional insecticides.
- Treatments SI2011-0953, SI2011-0962, SI2011-0952, SI2011-0992 and SI2011-0981 provided a level of efficacy that was not as high as treatments SI2011-0954 and SI2011-0960, but pest levels were consistently lower than the numbers recorded in the control plots. As single solutions to whitefly control, these products would not suffice. However as part of a designed programme they could offer part of a solution. In addition, these very short term products were subjected a relatively high level of pest pressure due to pest invasion from control plots, which would not be expected under conditions where single glasshouses are treated.

3.5. Assessment of the efficacy of several insecticides and bio-insecticides against western flower thrips (WFT) in protected peppers

- A replicated trial was conducted at Stockbridge Technology Centre in August/ September 2011 to evaluate the efficacy of three insecticides and four bio-insecticides for the control of WFT (*Frankliniella occidentalis*) in protected peppers cv. Ferrari. The results obtained were compared with a water treated control.
- Equally low numbers of adults and nymphs were recorded for all treatment plots prior to the first application of treatments.
- Three applications of each treatment were made. Treatments applied are listed below:

Table 3.5.1. Insecticides and bio-insecticides evaluated against mixed development stages of WFT *(F. occidentalis*) on protected peppers - 2011

Treatment	Code	Rate	Application dates
1.	SI2011-0648	1.5 kg/ha	18 Aug, 25 Aug, 1 Sep
2.	SI2011-0650	600 ml/ha	18 Aug, 25 Aug
3.	SI2011-0652*	1.25 L/ha (400-800 L/ha)	18 Aug, 25 Aug, 1 Sep
4.	SI2011-0654	1000 ml/ha	18 Aug, 25 Aug, 1 Sep
5.	SI2011-0682*	1250 L/ha	18 Aug, 25 Aug, 1 Sep
6.	SI2011-0681*	0.1% + (0.25%)	18 Aug, 25 Aug, 1 Sep
7.	SI2011-0692*	1.5 L/ha (i.e. 1.5 L/1000L)	18 Aug, 25 Aug, 1 Sep
8.	Water control	-	18 Aug, 25 Aug, 1 Sep

* Bio-insecticide

Results

- During the trial, the numbers of WFT (adults and larvae) slowly increased in the water treated control plots.
- All treatments resulted in lower numbers of WFT compared with the water control.

Table 3.5.2. Effect of insecticides and bio-insecticides on the final mean number of thrips (nymphs and adults) per flower, after three applications of treatments

Treatment		Adult		Nymph		Total	
		Mean	SE	Mean	SE	Mean	SE
1	SI2011-0648	**0.42**	0.12	**0.22**	0.09	**0.64**	0.17
2	SI2011-0650	**1.06**	0.20	**0.56**	0.14	**1.61**	0.38
3	SI2011-0652	**0.89**	0.20	**1.69**	0.38	**2.58**	0.73
4	SI2011-0654	**0.86**	0.24	**0.81**	0.20	**1.67**	0.33
5	SI2011-0682	**1.42**	0.24	**0.97**	0.22	**2.39**	0.36
6	SI2011-0681	**1.69**	0.32	**0.92**	0.19	**2.61**	0.54
7	SI2011-0692	2.22	0.32	**1.00**	0.26	**3.22**	0.49
8	Water control	2.92	0.42	3.17	0.47	6.08	0.82
LSD (p=0.05)		0.88		0.98		1.37	

Figures in bold are significantly different from the water control.

- Treatments SI2011-0648, SI2011-0650 and SI2011-0654 (conventional insecticides) provided a consistently low number of WFT throughout the trial.
- When comparing the more conventional products (SI2011-0648, SI2011-0650 and SI2011-0654) to the biopesticides, only treatment SI2011-0648 produced significantly lower numbers of thrips than the biopesticides (SI2011-0652, SI2011-0682, SI2011-0681, and SI2011-0692).

Discussion

The results suggest that all experimental products have potential to be part of a programme for thrips control. However capacity for integration within an IPM programme needs to be evaluated.

4. Top fruit

4.1. Assessment of the efficacy of several fungicides and biofungicides against powdery mildew in apple

- One replicated trial was conducted at East Malling Research in 2011 to evaluate the efficacy of five fungicides, three biofungicides and two alternative chemicals for the control of powdery mildew in apple. The results obtained were compared with untreated controls and the trial protocol was validated by inclusion of the standard treatment Systhane 20EW (myclobutanil) applied at recommended rates.
- Five applications of each treatment were made. Treatments applied are listed below:

Table 4.1.1. Fungicides and biofungicides evaluated for control of apple powdery mildew - 2011

Treatment	Product	Rate of product	Application dates
1.	Untreated	-	-
2.	Systhane 20EW	330 ml/ha	12/5, 23/5, 13/6, 30/6, 14/7
3.	SF2011-1147	0.625 L/ha	12/5, 23/5, 13/6, 30/6, 14/7
4.	SF2011-1177	0.6 L/ha	12/5, 23/5, 13/6, 30/6, 14/7
5.	SF2011-1117	0.8 L/ha	12/5, 23/5, 13/6, 30/6, 14/7
6.	SF2011-1114	0.25 L + 0.2 L/ha	12/5, 23/5, 13/6, 30/6, 14/7
7.	Cyflamid (Cosine)	0.5 L/ha	12/5, 23/5, 13/6, 30/6, 14/7
8.	SF2011-1106*	10 L/ha	12/5, 23/5, 13/6, 30/6, 14/7
9.	SF2011-1138*	10 L/ha	12/5, 23/5, 13/6, 30/6, 14/7
10.	SF2011-1111*	70 g/ha	12/5, 23/5, 13/6, 30/6, 14/7
11.	SF2011-1190*	10 ml/L	12/5, 23/5, 13/6, 30/6, 14/7
12.	SF2011-1180*	1 ml A + 1 ml B + 2.5 ml wetter	12/5, 23/5, 13/6, 30/6, 14/7

* Biofungicide or alternative chemical.

Results

Table 4.1.2. Mean % mildewed leaves (mean of 5 assessments), mean russet score on fruit and mean % fruit drop recorded on apple cv. Cox following five sprays of various treatments applied to apple trees post-blossom in 2011

Treatment	Product	Overall mean % mildewed leaves	Mean russet score*	Mean % fruit drop
1.	Untreated	78.9	50.2	49.7
2.	Systhane 20EW	**51.4**	**22.0**	52.3
3.	SF2011-1147	**28.4**	34.2	30.1
4.	SF2011-1177	**19.7**	39.8	43.5
5.	SF2011-1117	**50.6**	**30.8**	39.2
6.	SF2011-1114	**42.7**	**32.0**	48.5
7.	Cyflamid (Cosine)	**39.7**	34.5	48.7
8.	SF2011-1106	66.7	39.0	38.7
9.	SF2011-1138	**63.9**	39.8	46.3
10.	SF2011-1111	67.3	**25.0**	35.7
11.	SF2011-1190	**63.8**	42.2	54.1
12.	SF2011-1180	**62.9**	**19.2**	40.0
F Prob		<0.001	0.044	0.728
SED (33)		7.018	8.63	12.28
LSD (p=0.05)		14.532	17.55	24.98

*Russet score 0-4 where 0= no russet 4= rough russet with cracking. Figures in bold are significantly different from the untreated control.

- The incidence and severity of powdery mildew in the trial was high.
- There were significant reductions in powdery mildew incidence for Systhane 20EW, SF2011-1147, SF2011-1177, SF2011-1117, SF2011-1114, Cyflamid, SF2011-1138 and SF2011-1190. SF2011-1177 was more effective than all other treatments.
- There were no significant effects of treatments on fruit drop or fruit size. All treatments reduced fruit russet compared to the untreated control.

Discussion

Overall the experimental fungicides were more effective than the biocontrol agents or alternative chemicals. However, in the orchard trial with weather constraints, it was difficult to maintain a 7 day spray programme which might have affected the efficacy of the biocontrol agents. The treatments will be re-evaluated in 2012. The fungicides will be evaluated in an orchard small plot experiment, but the biocontrol agents will be evaluated on potted rootstocks (MM106) to ensure a 7 day programme to give maximum opportunity for assessment of efficacy.

4.2. Assessment of the efficacy of several biofungicides against Botrytis rot in stored pears

- One trial was done in 2011/2012 at East Malling Research to evaluate the efficacy of biofungicides for control of grey mould (*Botrytis cinerea*) in cold storage of pear cv. Conference. A standard fungicide, Rovral WG (iprodione) and an untreated control were included.
- Crates of fruit were dipped in the test product immediately prior to placing them in cold store at -1ºC. All the treatments were applied on the same day. An additional treatment was included for three of the biofungicides (SF2011-1299, SF2011-1221 and SF2011-1298) where the treated crates were left at ambient for 24 h after treatment before placing in the cold store. Ten fruit artificially inoculated with *B. cinerea* were placed in each crate. Treatments applied are listed below.

Table 4.2.1. Biocontrol products tested against botrytis rot in stored pears in 2011/2012

Treatment*	Product	Rate of product/L	Application date
1.	Untreated	-	-
2.	Untreated Uninoculated	-	-
3.	Rovral WG	1.3 g	7 Sep
4.	SF2011-1238	10 ml	7 Sep
5.	SF2011-1299	7	6 Sep
6.	SF2011-1299	1 g	7 Sep
7.	SF2011-1221	0.4 g	7 Sep
8.	SF2011-1221	0.4 g	7 Sep
9.	SF2011-1298	5 g	7 Sep
10.	SF2011-1298	5 g	7 Sep

* All treatments were inoculated except for Treatment 2.

Results

- This experiment is still in progress. A final assessment will be made in March 2012.

Technology transfer

Articles

O'Neill TM (2011). Securing pesticides and biopesticides for sustainable production. Project launch publicity abstract.

O'Neill TM (2011). The cutting edge of crop protection. *HDC News,* 173, 15-17.

First results emerge from Sceptre crop protection trials. *HDC News*, 176, p.8.

O'Neill TM (2011). Sceptre: new crop protection methods for soft fruit. East Malling Research Association – Members Day 23 November 2011.

Presentations

Collier R (2011). Research into IPM strategies to control the pest insects of vegetables. IOBC working group meeting on integrated control in field vegetables, September 2011.

O'Neill TM (2011). Securing pesticides and biopesticides for sustainable production. ADAS-Syngenta Vegetable Conference, Peterborough, 1 February, 2011.

O'Neill TM (2011). Sceptre: new crop protection methods for soft fruit. EMRA/HDC Soft Fruit Day, 23 November 2011.

Powell V and Neve B (2011). An Introduction to SCEPTRE. AAB Biopesticides Conference, Grantham, 29 November 2011.

Posters

Huckle A., Atwood J., Tatnell L., Richardson A., Knott C., and O'Neill T. (2011). Solutions to the loss of active ingredients for weed control in field vegetable and fruit crops. European Weeds Research Society - workshop, Huesca, Spain, September 2011.

Field demonstrations

Evaluation of herbicides for weed control and crop safety on field vegetables, Spalding, 22 June 2011. Cathy Knott.

Sceptre project work on soft fruit and top fruit. Fruit Focus, East Malling, July 2011. HDC staff.

Website

Project area on HDC website: http://www.hdc.org.uk/Sceptre

Appendix 1 Crop protection targets (revised December 2011)

Summary of planned work on disease targets

Year	Item	Disease type	FV	PE	SF	TF
1	1	Powdery mildew	-	Cucumber	-	Apple
	2	Downy mildew	Brassica	-	-	-
	3	Leaf/cane spots	Brassica (Alternaria)	-	Raspberry cane (spur blight, cane blight, cane spot)	-
	4	Botrytis	-	Tomato	-	Pear
	5	Fusarium wilts	Lit Review	-	-	-
	6	Pythium/ Phytophthora	-	-	-	-
	7	Other	-	-	Mucor/Rhizopus	-
2	1	Powdery mildew	Brassica	Cucumber	-	Apple
	2	Rust	Leek	-	-	-
	3	Leaf/cane spots	Brassica (Ringspot)	-	Raspberry cane	-
	4	Botrytis	-	Tomato	-	Pear
	5	Downy mildew	-	-	-	-
	6	Pythium/ Phytophthora	-	-	Strawberry crown rot	-
	7	Other	-	-	Mucor/Rhizopus	-
	8	IPM work	Brassica	-	-	-
3	1	Powdery mildew	Brassica	Cucumber	Strawberry	Apple
	2	Downy mildew	Brassica, Onion	-	-	-
	3	Leaf/cane spots	Brassica/other	-	Raspberry cane	-

	4	Botrytis	Lettuce	-	-	Pear
	5	Fusarium wilt	Onion	-	-	-
	6	Pythium/ Phytophthora	-	Cucumber	Raspberry	-
	7	Other	-	Phomopsis	Mucor/Rhizopus	-
4	1	Powdery mildew	Brassica	Cucumber	Strawberry	Apple
	2	Downy mildew	Brassica	-	-	-
	3	Leaf/cane spots	Brassica/ other	-	Raspberry cane	-
	4	Botrytis	Lettuce	-	-	Pear
	5	Fusarium wilts	Onion	-	-	-
	6	Pythium/ Phytophthora	-	Cucumber	Raspberry	-
	7	Other	-	Phomopsis	Mucor/Rhizopus	-

Summary of planned work on pest targets

Year	Item	Pest type	FV	PE	SF
1	1	Aphid	B/L/C	-	Raspberry
	2	Cabbage root fly	Brassica	-	-
	3	Moth/butterfly caterpillar	Brassica	-	-
	4	Spider mite	-	Tomato	-
	5	Thrips	Allium	Pepper	-
	6	Capsid	-	-	Strawberry
	7	Whitefly	Brassica	Tomato	
2	1	Aphid	Lettuce	-	Raspberry
	2	Cabbage root fly	-	-	-
	3	Moth/butterfly caterpillar	Lettuce		-
	4	Spider mites	-	Tomato	-
	5	Thrips	Allium	Pepper	-
	6	Capsid	-		Strawberry
	7	Whitefly		Tomato	
	8	IPM	Brassica	-	-
3	1	Aphid	B or L or C	-	Strawberry
	2	Cabbage root fly	Brassica	-	-
	3	Moth/butterfly caterpillar	Brassica		-
	4	Spider mites	-		-
	5	Thrips	Allium		-
	6	Whitefly			
	7	IPM	Lettuce or Carrot	Tomato/ pepper	Raspberry

4	1	Aphid	B or L or C	-	Strawberry
	2	Cabbage root fly	-	-	-
	3	Moth/butterfly caterpillar	Carrot/Lettuce		-
	4	Spider mites	-		-
	5	Thrips	Allium		-
	6	Whitefly	-		
	7	IPM	Lettuce/Carrot/ Brassica	Tomato/ pepper	Raspberry

L - lettuce; C - carrot; B - Brassica.

Summary of planned work on weeds targets

Year	Item	Work area	FV	SF
1	1	Residue studies	Several crops	-
	2	Annual broad leaf weeds	Many crops	Strawberry
	3	Perennial weeds	-	Bush & cane fruit
	4	Alleyways/runners	-	-
	5	Band spraying	-	-
	6	Non-herbicide methods	-	Test rig for electric weed control
2	1	Residue studies	-	-
	2	Annual broad leaf weeds	Many crops	Strawberry
	3	Perennial weeds	-	Bush & cane fruit
	4	Alleyways/runners	-	Strawberry
	5	Band spraying	Vegetables	-
	6	Non-herbicide methods	Several	Electric weed control
3	1	Residue studies	-	-
	2	Annual broad leaf weeds	Many crops	Strawberry
	3	Perennial weeds	-	Bush & cane fruit
	4	Alleyways/runners	-	Strawberry
	5	Band spraying	Vegetables	-
	6	Non-herbicide methods	Several	-
4	1	Residue studies	-	-
	2	Annual broad leaf weeds	Many crops	-
	3	Perennial weeds	-	Bush & cane fruit
	4	Alleyways/runners	-	Strawberry
	5	Band spraying	Vegetables	-
	6	Non-herbicide methods	Several	Electric weed control