Grower Summary

CP 77 (HL01109)

Sustainable Crop and Environment Protection – Target Research for Edibles (SCEPTRE)

Annual 2012

Disclaimer

The results and conclusions in this report may be based on an investigation conducted over one year. Therefore, care must be taken with the interpretation of the results.

Use of pesticides

Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.

Before using all pesticides check the approval status and conditions of use.

Read the label before use: use pesticides safely.

Further information

If you would like a copy of the full report, please email the HDC office (hdc@hdc.ahdb.org.uk), quoting your HDC number, alternatively contact the HDC at the address below.

HDC
Stoneleigh Park
Kenilworth
Warwickshire
CV8 2TL

Tel – 0247 669 2051

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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.

Project Number:	CP 77 (HL01109)
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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		1177
	Switch		
	Thianosan DG		
2.2 Raspberry – large raspberry aphid			
	Calypso		0770
2.3 Strawberry – European tarnished plant bug			
	Calypso	0260	0253
	Chess WG		0254
	Steward		0262
2.4 Bush and cane fruit – perennial weeds			
	1672		
	1673		
	16102		
3.1 Cucumber – powdery mildew			
Rocket[a]	1038	1087	1006
Systhane 20EW		1088	1008
		1089	1010
			1080
			1014
			1077
			1090
3.2 Tomato – grey mould			
Switch			0908
Teldor			0977
Prestop			0909
0938			
3.4 Tomato – whitefly			
	0952	0960	0954
	0953		0962
	0981		
	0982		
3.5 Pepper – WFT			
	0652	0648	0654
	0681	0650	
	0682		
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.