Grower Summary

CP 77 (HL01109)

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

Annual 2014

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

HDC is a division of the Agriculture and Horticulture Development Board.

Intellectual Property Rights are invested in ADAS UK Ltd on behalf of the consortium members for LINK project number HL01109.

The following are members of the Consortium for LINK project HL01109:

ADAS UK Ltd

•

Allium and Brassica Centre

•

BASF

•

Bayer CropScience Ltd

•

Belchim Crop Protection Ltd

•

Berry Garden Growers Ltd

•

BerryWorld Ltd

•

Dow AgroSciences Ltd

•

Du Pont (UK) Ltd

•

East Malling Research

•

Fresh Produce Consortium

•

H & H Duncalfe Ltd

•

Agriculture and Horticulture Development Board (via the HDC division)

•

International Produce Ltd

•

J E Piccaver & Co

•

James Hutton Institute

•

Koppert UK Ltd

- Marks & Spencer plc
- Rationale Biopesticide Strategists
- Stewarts of Tayside
- Stockbridge Technology Centre
- Syngenta Crop Protection Ltd
- Total World Fresh Ltd
- University of Warwick

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.

David Piccaver

David Piccaver, chairman of the Sceptre project from its inception, sadly, died suddenly on 13 December 2013 aged 69 after a short illness. David was a highly effective chairman, much respected by all consortium members. He was a strong advocate for the project's aims, his views were always well considered and he listened to each individual's contribution. As well as that more public 'front,' David also worked tirelessly behind the scenes. He gave his time to meet all the Sceptre research groups, encouraging researchers and identifying where he could help. A key attribute was he was always well prepared. David will be greatly missed and has set the standard for others to follow.

Project Number:	CP 77 (HL01109)
Project Title:	Sustainable Crop and Environment Protection – Target Research for Edibles (SCEPTRE)
Project Coordinator:	Dr Tim O'Neill, ADAS
Report:	Third Annual Report, Year 3, March 2014
Publication Date:	21 March 2014
Start Date:	1 October 2010
End Date:	30 September 2014
HDC Project Cost (total project cost):	£ 740,500 (£2,034,247.00)

Headline

- Potential new pesticide and biopesticide control treatments identified for key pests, diseases and weeds on field vegetables, soft fruit, protected edibles and top fruit.
- Bandsprayed residual herbicides applied between planting rows, combined with a low dose over the row, improves weed control options in leek and cauliflower.

Background

Numerous widely used conventional chemical 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 substances to remain Annex I (a positive list of active substances permitted in the EC) following review of substances that had been approved under the Pesticide Registration Directive (91/414/EEC);
- some active substances were not supported by crop protection companies for economic reasons and were withdrawn from the pesticides review;
- implementation of 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), which became compulsory on 1 January 2014, 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 priority 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 usually expensive and requiring detailed biological and residue studies for each specific crop (in some instances extrapolation from one crop to another similar crop is permitted). Microbial pesticides and botanical pesticides (biopesticides) also face large registration costs.

New technologies and a new approach are needed to develop treatments with plant protection products 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 plant 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 conventional pesticides and biopesticides now coming to the market and some new technologies, including non-plant protection product 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 3, 52 conventional plant protection products based on chemical pesticides, 21 based on microorganisms, 7 based on botanical extracts and 3 others were screened against pest, disease and weed problems identified as high priority targets on edible crops. Twenty-nine experiments were completed and a further two are in progress.

An overview of the target pests investigated in 2013, by sector and crop, is given (Table 1). The numbers and types of products tested in each experiment shown (Table 2) and the broad results are listed (Table 3) and then described. Novel products with good potential to fill crop protection gaps have been identified in all crop sectors (Tables 4-6).

Table 1. Overview of crop pest combinations with experiments completed in 2013

Sector and Pest	Crop				
Field vegetables	Brassica	Lettuce	Leek	Onion	Field veg
Downy mildew				✓	
Powdery mildew	✓				
Ring spot	✓				
Rust			✓		
Aphid	✓	✓			
Caterpillar	✓	✓	✓		
Cabbage root fly	✓				
Thrips			✓		
Annual weeds					✓
Soft fruit	Strawberry	Raspberry	Bush/Cane		
Crown rot	✓				
Mucor/Botrytis	✓				
Aphid		✓			
Capsid (Lygus)	✓				
Annual weeds		✓	✓		
Perennial weeds	✓	✓	✓		
Protected edibles	Cucumber	Tomato	Pepper		
Botrytis		✓			
Pythium	✓				
Whitefly		✓			
Red spider		✓			
Aphid			✓		
Top fruit	Apple	Pear			
Powdery mildew	✓				
Botrytis in store		✓			

Table 2. Overview of experiments in 2013 showing numbers and types of products tested individually

Trial	Crop	Target	Novel products tested					
			micro-org	Botanical	Salt/ other	Total bio	Chemical	TOTAL products
1.1	Leek	Rust	2	1	0	3	8	11
1.2	Brassica	Powdery mildew	2	1	0	3	5	8
1.3	Brassica	Ring spot	1	1	0	2	2	4
1.4	Spring onion	Downy mildew	2	0	1	3	7	10
1.5	Leek	Onion thrips	0	2	0	2	3	5
1.6	Lettuce	Aphid	2	2	0	4	3	7
1.6	Lettuce	Caterpillar	3	1	0	4	2	6
1.7	Brassica (sprouts)	CRF, aphids, caterpillar	2	3	2	7	6	13
1.7a	Brassica	CRF (2012)	2	2	0	4	0	4
1.8	Field Vegetables	Annual Weeds	0	0	0	0	3	3
1.9	Cauliflower and leek	Band spraying for weeds	N/A	N/A	N/A	N/A	N/A	N/A
1.10	Cauliflower, leek	Electric weed control	N/A	N/A	N/A	N/A	N/A	N/A
2.1	Raspberry	Cane diseases[b]	-	-	-	-	-	-
2.2	Strawberry	Mucor and Botrytis	0	0	3	3	1	4
2.3	Strawberry	Crown rot	2	0	0	2	3	5
2.4	Strawberry	Capsid (Lygus)	0	0	0	0	2	2
2.5	Raspberry	Aphid	1	2	0	3	1	4
2.6	Blackcurrant	Herbicide crop safety	0	2	0	2	4	6
2.7	Raspberry	Herbicide crop safety	0	2	0	2	1	3
2.8	Soft fruit	Bioherbicides & herbicides for perennial weeds	0	2	0	2	1	3
3.1	Tomato	Botrytis	4	1	0	5	4	9
3.2	Cucumber	Pythium	7	1	1	9	11	20
3.3	Cucumber	Phomopsis[b]	-	-	-	-	-	-
3.4	Tomato	Spider mite and whitefly	2	1	0	3	0	3
3.5	Pepper	Aphid	2	1	0	3	0	3
4.1	Apple	Powdery mildew	2	3	0	5	2	7
4.2	Pear	Botrytis	3	0	0	3	0	3
	Annual unique products for FV[c]		10	5	0	15	25	40
	Annual unique products for PE		8	3	0	11	23	34
	Annual unique products for SF		5	5	2	12	18	30
	Annual unique products for TF		7	2	1	10	8	18
	Annual unique products – herbicides		0	2	0	2	7	9
	Annual unique products – fungicides		15	2	3	20	37	57
	Annual unique products – insecticides		6	3	0	9	8	17
	TOTAL UNIQUE PRODUCTS Y3		**21**	**7**	**3**	**31**	**52**	**83**

[a] Excluding the standard (reference) product and treatments using 2 or more products.

[b] Experiment still in progress.

[c] Annual totals include products used in IPM programmes.

N/A – not applicable.

Table 3. Overview of experiment results on individual products[a] – 2013

Topic	Number treatments demonstrating control*			Pest level on untreated
	Pesticides	Bio-pesticides	Other method	
Field vegetables				
1.1 Leek: Rust	8 (8)	2 (2)	-	Low
1.2 Brassica: Powdery mildew	5 (4)	2 (0)	-	High
1.3 Brassica: Ring spot	2 (2)	1 (0)	-	Low
1.4 Spring onion: Downy mildew	2 (2)	1 (0)	-	Moderate
1.5 Leek: Thrips	3 (1)	2 (0)	-	Moderate
1.5 Leek moth	3 (3)	2 (2)	-	Moderate
1.6 Lettuce: Aphids (3 trials)	3 (3)	4 (0)	-	Low
1.6 Lettuce: Caterpillar	2 (2)	4 (4)		High
1.7 Brassica: CRF	2 (2)	0 (0)	-	High
1.7 Brassica: Aphid	3 (2)	4 (2)	-	Moderate
1.7 Brassica: Caterpillar	3 (2)	4 (3)	-	Moderate
1.7a Brassica: CRF (2012)	NT	4 (1)	-	High
1.8 Vegetables: Annual weeds	3 (NR)	NT	-	High
1.9 Vegetables: Band spraying (4 sites)	NA	NA	✓	High
1.10 Vegetables: Electrical weed control (2 sites)	NA	NA	✓	Moderate
Soft fruit				
2.2 Strawberry: Soft rot	1 (1)	0 (0)	-	Moderate
2.3 Strawberry: Crown rot	-	-	-	Very low
2.4 Strawberry: European tarnished bug	3 (2)	NT	-	High
2.5 Raspberry: Aphid	1 (1)	2 (1)	-	Moderate
2.6 Blackcurrant: Herbicides	-	-	-	NA
2.7 Raspberry: Herbicides	1 (1)	2 (2)	-	Moderate
2.8 Fruit: Perennial weeds	1 (1)	2 (2)	-	High
Protected edibles				
3.1 Tomato: Grey mould	4 (4)	5 (0)	-	Moderate
3.2 Cucumber: Pythium	11 (5)	9 (0)	-	Moderate
3.4 Tomato: Spider mites & whitefly	IPM	IPM	-	Moderate
3.5 Pepper: Aphids	NT	1 (1)	-	Moderate-
Top fruit				
4.1 Apple: Powdery mildew (2 trials)	2 (2)	5 (5)	-	High
4.2 Pear: Botrytis rot in store (2012/13)	NT	1 (0)	-	High

[a] Many experiments also tested treatment programmes using two or more products applied alternately or in mixture; results are presented in the individual experiment reports.

* Compared with untreated; excludes approved reference products. ( ) – number equal to or better than the chemical reference product. NR – no reference product for comparison. NT – none tested. NA – not applicable.

Table 4. Leading novel products (product name or code number in numerical order) identified for control of diseases: 2011-2013

Target	Crop	Year	Exp ref.	Reference product	Leading 3 products					
					Fungicides			Biofungicides		
Field vegetables										
Alternaria	Brassica	2011	1.1	Rudis	Sig	24	28	06	43	47
	Brassica	2012	1.4	Signum	*	*	*	06	40	49
Downy mildew	Brassica	2011	1.2	Folio Gold	24	26	83	47	-	-
	Onion	2013	1.4	Mixtures	20	24	-	-	-	-
Powdery mildew	Brassica	2012	1.1	Rudis	24	28	89	90	11+adj	136
	Brassica	2013	1.2	Rudis	24	28	89	11	90	90+40
Ring spot	Brassica	2012	1.2	Signum	10	24	Nat	38	43	90
	Brassica	2013	1.3	Ami/Rud	10	24	25a	90	-	-
Rust	Leek	2012	1.3	Amistar	10	27	46	*	*	*
	Leek	2013	1.1	Amistar Top	Ami	31	118	Ser	105	-
Soft fruit										
Crown rot	Strawberry	2012	2.3	Paraat	24	-	-	40	Pre	-
Soft rot	Strawberry	2011	2.1	-	Sig	Thi	77	-	-	-
		2012	2.3	Signum	25a	77	-	-	-	-
		2013	2.2	-	37	-	-	-	-	-
Spur blight	Raspberry	2012	2.1	Switch	08	32	77	*	*	*
Protected edibles										
Botrytis	Tomato	2011	3.2	Switch	08	31	77	Pre	09	38
	Tomato	2012	3.2	Signum	08	25a	118	-	-	-
	Tomato	2013	3.1	Rov/Swi/Sig	**31**	**77**	**118**	-	-	-
Powdery mildew	Cucumber	2011	3.1	Systhane	10	77	88	38	80	90
	Cucumber	2012	3.1	Sys/Nim	08	25a	77	90	105	90+03
Pythium	Cucumber	2013	3.2	Previcur Energy	46	139	183	-	-	-
Top fruit										
Botrytis	Pear	2012	4.2	Rovral WG	*	*	*	38	98	99
	Pear	2012	4.2	Rovral WG	*	*	*	38	-	-
Powdery mildew	Apple	2011	4.1	Systhane	47	77	Cos	38	80	90
	Apple	2012	4.1	Systhane	**25a**	**32**	**159**	158	160	162
	Apple	2013	4.1	Systhane	88	118	-	90	105	11+adj

* – no products in this category evaluated. Ami – Amistar; Cos – Cosine; Nat – Nativo 75WG; Nim – Nimrod; Pre – Prestop; Rov – Rovral WG; Ser – Serenade ASO; Sig – Signum, Swi – Switch; Sys – Systhane 20EW; Thi – Thianosan DG; adj – adjuvant.

Please see individual experiment reports, within the annual reports, for full details.

Up to 3 leading products are listed, arranged in numerical order. All products listed resulted in a significant reduction compared with the untreated control and were equal to or better than (numbers in bold) the reference product. Products resulting in severe phytotoxicity have been excluded.

Table 5. Leading novel products (product name or code number in numerical order) identified for control of pests: 2011-2013

Target	Crop	Year	Exp ref.	Reference product	Leading 3 products					
					Insecticides			Bio-insecticides		
Field vegetables										
Aphid	Brassica	2011	1.4	Movento	50	59	60	62	92	-
	Brassica	2013	1.7	Movento	59	60	-	62	130	-
	Carrot	2011	1.8	Biscaya	50	54	75	-	-	-
	Lettuce	2011	1.6	Movento	54	-	-	-	-	-
	Lettuce	2013	1.6	Movento	50	59	60	51	62	-
Caterpillar	Brassica	2013	1.7	Steward	48	143	-	64	Lep	130
	Lettuce	2013	1.6	Tracer	48	50	-	Lep	94	130
Cabbage root fly	Brassica	2011	1.5	Tracer	50	55	-	-	-	-
	Brassica	2012	1.8	Tracer	50	55	-	*	*	*
	Brassica	2013	17a	Tracer	*	*	*	130	-	-
	Brassica	2013	1.7	Tracer	50	55	-	*	*	*
Moth	Leek	2012	1.7	Tracer	50	-	-	62	130	-
	Leek	2013	1.5	Tracer	48	50	142	62	-	-
Thrips	Leek	2011	1.7	Tracer	48	50	54	-	-	-
	Leek	2013	1.5	Tracer	48	50	142	62	130	-
Whitefly	Brassica	2012	1.8	Movento	54	59	60	*	*	*
Soft fruit										
Aphid	Raspberry	2011	2.2	Calypso	70	-	-	62	-	-
	Raspberry	2012	2.4	Calypso	50	54	60	51	62	130
	Raspberry	2013	2.5	Calypso	50	-	-	62	130	-
Lygus	Strawberry	2011	2.3	Calypso	Che	149	54	53	-	-
	Strawberry	2012	2.5	Calypso	60	149	-	*	*	*
	Strawberry	2013	2.4	Chess	**59**	149	-	*	*	*
Protected edibles										
Aphid	Pepper	2013	3.5	Chess	*	*	*	130	-	-
	Tomato	2011	3.3	-	53	86	-	01	52	62
Spider mite	Tomato	2012	3.3	Oberon	131	-	-	01	62	92
	Tomato	2012	3.3	Borneo	131	-	-	62	Nat	92
	Tomato	2013	3.4	Borneo	*	*	*	51	62	130
WFT	Pepper	2012	3.5	Pyrethrum	*	*	*	01	62	Nat
	Pepper	2011	3.5	-	48	50	54	52	81	82
Whitefly	Tomato	2011	3.4	-	54	60	-	52	62	92
	Tomato	2012	3.4	Chess	54	106	-	01	62	130
	Tomato	2013	3.4	Chess	*	*	*	51	-	-

* – no products in this category evaluated. Che – Chess; Lep- Lepinox Plus; Nat – Naturalis-L

See Table 4 footnotes. Please see individual experiment reports, within the annual reports, for full details.

Table 6a. Leading novel herbicide products[a] identified for crop safety– multi field vegetable crop screening, Lincolnshire. Pre = applied pre-emergence of drilled crop or pre-transplanting crop; post = post-emergence of drilled crop or post-transplanting crop; () possibly safe

Crop	2011		2012		2013					
	pre	post	post	post	pre	post	pre	post	pre	post
Drilled										
Broad bean	105			(123)			165		166	
Bulb onion		105	76	(123)	164		165	165	166	166
Carrot	105	105	76		164				166	166
Coriander	105	105	76						166	
Dwarf French bean	105				164		165		166	
Leek		105	76	(123)	164		165	165	166	166
Parsnip	105	105	76						166	166
Pea	105			(123)			165	165	166	
Transplanted										
Cauliflower	105						165	165	166	
Celery	105	105	76						166	166
Courgette	NT	NT	NT	NT			165	165	166	
Lettuce	(105)	(105)		(123)				165	166	

NT courgette not tested in 2011 and 2012.

Mizuna, rocket, swede and baby leaf spinach - no safe solutions.

[a] 105 tested pre-and post-weed emergence in 2011; 123 (at low doses) and 76 tested post-weed-emergence only in 2012; 164, 165 and 166 tested pre-and post-weed emergence in 2013. 165 did not control emerged weeds.

Please see Sceptre Annual Reports for full details.

Table 6b. Leading novel products (product name or code number in numerical order) identified for control of weeds: 2011-2013

Target	Crop/weed	Year	Exp. Ref.	Reference product	Leading 3 products					
					Herbicides			Bioherbicides		
Field vegetables										
Annual weeds	Cauliflower	2012	1.10	Rapsan + Gamit	74	DG	SA	*	*	*
	Cauliflower	2013	1.9	Rapsan + Gamit	A	B	-	*	*	*
	Leek	2013	1.9	Wing P + Defy	C	D	-	*	*	*
	Onion	2012	1.10	Stomp Aqua	WP	DG	-	*	*	*
Fruit										
Annual weeds	Mixture	2012	1.12	Rosate 36	*	*	*	116	-	-
		2013	2.7	Shark	124	-	-	109	116	-
Perennial weeds	Dock	2011	2.4	-	R+S	72	102	-	-	-
	Dock	2012	1.12	Rosate 36	124	-	-	116	-	-
	Dock	2013	2.8	Rosate 36	124	-	-	109	116	-
	Nettle	2011	2.4	-	R+S	72	102	-	-	-
	Nettle	2012	1.12	Rosate 36	124	-	-	-	-	-
	Nettle	2012	2.7	Roundup	72	-	-	*	*	*
	Nettle	2013	2.8	Rosate 36	124	-	-	109	116	-
	Thistle	2011	2.4	-	R+S	72	102	-	-	-
	Thistle	2012	1.12	Rosate 36	124	-	-	116	-	-
	Thistle	2012	2.7	Roundup	72	109	135	*	*	*

* – no products in this category evaluated.

Please see individual reports, within the Annual Sceptre reports, for details.

A – Wing P + Dual Gold + Gamit 36CS + Kerb Flo; B – Rapsan 500 (in row) with Wing P + Dual Gold + Gamit 36CS + Kerb Flo between rows; C – Wing P (in row) with Wing P + Defy between rows; D – Wing P (in row) with Stomp Aqua + Defy between rows.

DG – Dual Gold; SA – Stomp Aqua; WP – Wing P; R+S – Roundup + Shark.

Field vegetables

1.1. Leek: Evaluation of fungicides and biofungicides for control of rust

A trial was conducted outside in summer 2013 to evaluate nine fungicides and three biofungicides for control of rust (*Puccinia allii*) on leek cv. Darwin. An untreated control and a grower standard, Amistar Top (azoxystrobin + difenoconazole) were included. Fungicides were applied twice at 14 day intervals from inoculation and biofungicides five times at 7 day intervals from 1 week pre-inoculation. Although disease severity was low (1% leaf area affected on untreated plants) there were significant differences between treatments. At 6 weeks after inoculation, rust severity was reduced by Amistar, Amistar Top, Signum and six coded fungicides (10, 27, 31, 24, 25a, 118). Amistar Top, 31 and 118 gave >90% control. Serenade ASO and two coded biofungicides (40, 105) gave no reduction at 6 weeks although Serenade ASO and 105 had less disease than the untreated at 8 weeks. No phytotoxic symptoms were observed.

1.2 Brassicas: Evaluation of fungicides and biofungicide programmes for control of powdery mildew

A trial was conducted in an unheated polythene tunnel in summer 2013 to evaluate seven fungicides, three biofungicides and two fungicide/biofungicide programmes for control of powdery mildew (*Erysiphe cruciferarum*) on swede cv. Emily. Rudis (prothioconazole) and Nativo 75WG (tebuconazole + trifloxystrobin) were included as grower standards. Fungicides were applied twice at a 14 day interval from inoculation, and biofungicides and the fungicide/biofungicide programmes at 7 day intervals. At 6 weeks after inoculation disease severity on untreated plants was high (73% leaf area affected). All treatments reduced powdery mildew with Rudis, two coded fungicides (24, 28) and one five spray programme (90 applied 3x followed by Rudis twice), reducing it by >90%. The three biofungicide treatments (90, 90+40 and 11) each reduced mildew by around 25%. The biofungicide 90 applied four times, followed by Rudis, was much more effective than Rudis at inoculation followed by biofungicide 90 applied three times. Moderate phytotoxicity was observed with the biofungicide 11, which was used as recommended with a wetter; and slight phytotoxicity with biofungicide 90.

1.3 Brassicas: Evaluation of funigicide and biofungicide programmes for control of ring spot and other foliar diseases

A field trial was conducted in Lincolnshire in autumn 2013 to evaluate three fungicide products (Rudis, and coded products 24 and 25a), four fungicide programmes (Amistar/Rudis/Amistar; Signum/Rudis/Signum; Nativo 75WG/Rudis/Nativo 75WG; 10/Amistar Top/10), two biofungicides (Serenade ASO and coded product 90) and one programme of mixtures of a biofungicide (105) with Amistar and Rudis, for control of ring spot (*Mycosphaerella brassicicola*) and other leaf spots on cabbage cv. Caraflex. Brassica leaf debris affected by ring spot was laid between plots to provide natural infection. Fungicide treatments consisted of three sprays at 14 day intervals and biofungicides of six sprays at 7 day intervals. Widespread ring spot occurred in late November and affected 3% leaf area and 1% area of heads. The disease was reduced by all treatments except Serenade ASO. Several treatments were still providing good control over 1 month after the final spray. Low levels of downy mildew (*Hyaloperonospora parasitica*), dark leaf spot (*Alternaria* spp.), white blister (*Albugo candida*), black rot (*Xanthomonas campestris* pv. *campestris*) and light leaf spot (*Pyrenopeziza brassicae*) occurred naturally. The most effective treatment for ring spot was biofungicide 105 admixed with Amistar alternating with 105 admixed with Rudis in a 3-spray programme. Fungicide 24 was the best single product for ring spot and also reduced downy mildew and dark leaf spot. Total yield and mean head weight were increased by the Nativo 75WG/Rudis/Nativo 75WG programme and by fungicide 25a.

1.4 Spring onion: Evaluation of fungicides and biofungicides for control of downy mildew

A field trial was conducted in summer 2013 to evalute seven fungicides, three biofungicides and a fungicide + biofungicide mixture for control of downy mildew (*Peronospora destructor*) on spring onion cv. Slender Star. An untreated control and both spring onion (Invader + Amistar/Invader + Signum/Invader + Olympus) and bulb onion (Valbon + Olympus/Unicur + Dithane/Valbon + Dithane) grower standard programmes were included. Fungicides and the mixture were applied four times and biofungicides six times at 7-14 day intervals. Disease severity was moderate with 6% leaf area affected on untreated plants at 2 weeks after the final spray, rising to 36% at 4 weeks. The two grower standard programmes, each of which used six different active ingredients, were very effective, reducing downy mildew by ≥75%. Two novel fungicide products, coded 20 and 24, both significantly reduced downy mildew by >50%. Signum used alone was ineffective as were fungicides 22, 23, 25a and 41 and the fungicide + biofungicide mixture (22 + 105). None of the biofungicides (40, 47 and 188) reduced the disease. Persistene of control was greatest with the bulb onion standard programme, with <2% leaf area affected 4 weeks after the final spray.

1.5 Leek: Evaluation of insecticides and bio-insecticides for control of onion thrips

Two field trials were conducted in 2013 to evaluate the efficacy of insecticides (Trial 1) and bio-insecticides (Trial 2) for control of onion thrips (*Thrips tabaci*) on leek cv. Surfer. Insecticides were applied at 14 day intervals and bio-insecticides at 7 day intervals with four sprays of each. Damage by the pest was moderate with 20% leaf area affected on untreated plants. All four insecticides reduced damage with the standard product Tracer (spinosad) and coded insecticide 50 being the only 2 which reduced damage significantly, reducing the damage by around 50%. Bio-insecticide 62 gave a slight reduction in thrips damage when applied at 1,000 L/ha, but not at 200 L/ha. Leek moth caterpillar (*Acrolepiosis assectella*) also occurred and affected 60% of untreated plants. Damage by this pest was reduced by all four conventional insecticides, with Tracer and 50 the most effective, reducing the incidence of affected plants by 90%; the two bio-insecticides (62 and 130) at both application volumes gave a small reduction.

1.6 Lettuce: Evaluation of insecticides and bio-insecticides for control of currant-lettuce aphid and caterpillar

Six field trials (three for insecticides and three for bio-insecticides) were conducted in 2013 to evaluate the efficacy of products in an IPM programme for control of currant-lettuce aphid (*Nasonovia ribisnigri*) and caterpillars on lettuce cv. Saladin. Treatments for aphid control were applied once (insecticides) or twice (bio-insecticides) when a moderate infestation was present. Movento (spirotetramat) was included as a standard. Movento and insecticide 59 were the most effective conventional products; little efficacy on aphids was observed with any of four bio-insecticides (51, 62, 92 and 130). No caterpillars occurred in any of the field trials so treatments were tested on pot grown lettuce infested with a culture of silver Y moth (*Autographa gamma*). Treatments were applied once and plants assessed 7 days later. Tracer (spinosad) was included as a standard. Tracer and two conventional insecticides (48 and 50) resulted in 100% mortality of caterpillars. Four bio-insecticides (51, 68, 94, 130) all resulted in some caterpillar mortality and a reduction in feeding holes; bio-insecticide 68 was the most effective.

1.7 Brassica: Evaluation of insecticides and bio-insecticides against cabbage root fly, aphids and caterpillars

Two field trials were conducted simultaneously in 2013 to evaluate five insecticide programmes (Trial 1) and five bio-insecticide programmes (Trial 2) for control of cabbage root fly (*Delia radicum*), aphids (cabbage aphids – *Brevicoryne brassicae*) and caterpillars (small white butterfly – *Pieris rapae*) on Brussels sprout cv. Faunus. Insecticides were applied once and bio-insecticides three times at 7 day intervals. A standard programme of Tracer (spinosad) for cabbage root fly, Movento (spirotetromat) for aphids and Steward (indoxacarb) for caterpillars was included. The biopesticides trial used Dursban (chlorpyrifos) for cabbage root fly control in all programmes. Levels of pest infestation were high. All three insecticides tested (Tracer, 50 and 55) gave excellent control of CRF damage on roots; moderate control on stems. No bio-insecticides were tested. Movento and insecticides 59 and 60 gave good control of aphids, with Movento appearing the most effective (although there were no statistical differences). Bio-insecticides 62 and 130 gave reasonable control (but this was only statistically significant with 130) while 01 and 92 were ineffective. All three insecticides (Steward, 48 and 143) gave good control of caterpillars, with 143 the most effective. Bio-insecticides 64, 68 and 130 gave good control of caterpillars, whereas 93 was ineffective.

1.7a Brassica: Evaluation of bio-insecticides against cabbage root fly (2012)

A trial was conducted in winter 2012 to evaluate the efficacy of four bio-insecticides for control of cabbage root fly (*Delia radicum*) on cauliflower. Results were compared with an untreated control and with a standard insecticide, Tracer (spinosad). Bio-insecticide 130 was partially effective when applied either as a granule to the soil surface or as a drench (post transplanting), but was extremely phytotoxic when granules were incorporated and ineffective when drenched onto modules pre-transplanting. The other three bio-insecticides gave no control. Tracer gave good control both as a drench pre-transplanting and when incorporated at sowing (‘Phytodrip’ application).

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

Field trials were conducted in 2013 on a light, sandy silt loam soil to evaluate three conventional hericides applied pre- or post weed emergence at a range of dose rates for weed control and crop safety in 15 crops. Additionally, volunteer potatoes were planted to determine if the herbicides suppressed their growth. Untreated control plots were included for comparison. The season was characterised by lower than average temperatures from March to June resulting in slow crop emergence and growth; and by heavy rainfall after application of the pre-weed-emergence herbicides. Product 164 applied pre-emergence has potential for use in drilled carrot, parsnip, leek and bulb onion. It controlled a wide weed spectrum including mayweeds and groundsel but not annual meadow grass. No crop was safe to post-emergence applications of this product. Product 165 applied pre-emergence has potential for bulb onion, broad bean, vining pea and dwarf French bean. Weed control was excellent on all species at 2.0 L/ha but at 1.0 L/ha it was less effective on small nettle and fat hen. Applied post-emergence, 165 did not control emerged weeds but was safer to the crops and has potential for use soon after planting, before weeds emerge, on cauliflower and courgette. Product 166 applied pre-emergence has potential for use in carrot, parsnip and coriander at 0.5 L/ha and to bulb onion, leek, dwarf French bean, broad bean and pea used at 0.25 L/ha. It did not control groundsel and annual meadow grass. Applied post-emergence, 166 suppressed volunteer potato foliage by up to 75% and has potential for use in carrot, parsnip, onion and leek. None of the three herbicides tested was safe to rocket.

1.9 Vegetables: Evaluation of bandsprayed residual herbicides for control of annual broad-leaf weeds

1.9a Cauliflower – site 1

A field trial was conducted in 2013 to evaluate a banded herbicide treatment for control of weeds and crop safety in a July planted crop of cauliflower cv. Diwan on sandy loam soil in Lincolnshire. Whole plots were treated once with either Rapsan 500SC (metazachlor) + Gamit 36CS (chlomazone) or coded 74 + Dual Gold (S-metolachlor) + Gamit 36CS + Kerb Flo (propyzamide). In the banded treatment, the first mixture was applied to crop rows and the second mixture between rows. An untreated was included. The weed population was very low and no firm conclusions could be drawn with regard to weed control. The second herbicide mixture applied over whole plots caused some phytotoxicity and reduced crop vigour. The banded treatment of Rapsan

SC (metazachlor) applied to crop rows and 74 + Dual Gold (metolachlor) + Gamit 36CS (clomazone) + Kerb Flo (propyzamide) applied between rows did not cause damage or reduce vigour.

1.9b Cauliflower – site 2

The same treatments were evaluated in spring 2013 in cauliflower cv. Skywalker on a silt soil in Lincolnshire. The weed population was very high and was greatly reduced by all treatments; the banded herbicide treatment gave 94% control, equally effective as the best whole plot treatment. One herbicide mixture (coded 74 + Dual Gold + Gamit 36CS + Kerb Flo) appeared to cause slight phytotoxicity both when used over whole plots and as a band spray. There were no significant effects on crop vigour.

1.9c Leeks – site 1

A field trial was conducted in spring 2013 to evaluate a banded herbicide treatment for control of weeds and crop safety in leeks cv. Triton on a sandy loam soil in Lincolnshire. Whole plots were treated once with Wing P (dimethenamid-P + pendimethalin) at 2 and 4 L/ha and with Wing P at the high rate plus Defy (prosulfo-carb). One banded treatment consisted of Wing P (2 L/ha) applied to rows and Wing P (4 L/ha) + Defy applied between rows. A second banded treatment consisted of Wing P (2 L/ha) applied to rows and Stomp Aqua (pendimethalin) + Defy between rows. An untreated control was included. The first banded treatment of Wing P/Wing P + Defy gave the best overall control, reducing weeds by 82.5%. The high rate Wing P + Defy whole plot treatment and the second banded treatment (Wing P + Stomp Aqua) reduced weeds by 67.5 and 65% respectively. No phytotoxic symptoms were observed and no treatments reduced crop vigour.

1.9d Leeks – site 2

The same treatments were evaluated in spring 2013 in leeks cv. Galvani on a silt soil in Lincolnshire. The two banded spray treatments and the high rate Wing P whole plot treatment gave similar high levels (86-88%) of weed control. These three treatments gave slight crop phytotoxicity 1 month after spray application which was not evident two weeks later. No treatment reduced crop vigour.

1.10 Field vegetables: Electrical treatment for control of annual weeds

1.10a Cauliflower

A field trial was conducted in summer 2013 to evaluate electrical weeding used alone and one month after a herbicide spray for control of weeds and crop safety in cauliflower cv. Skywalker on a silt soil in Lincolnshire. The electrical treatments were compared with Rapsan 500SC (metazachlor) + Gamit 36CS (clomazone) herbicide treatment, mechanical weeding and the herbicide spray followed one month later by mechanical weeding. An untreated control was included. The combined treatments of herbicide followed by electrical or mechanical weeding gave similar high levels (86-88%) of weed control. Mechanical weeding alone and herbicide alone were comparable, with 54-56% control. The electrical treatment alone gave a 19% reduction in weeds; treatment efficacy was reduced due to a cloddy seedbed. No phytotoxicity symptoms were observed and no adverse effects on crop vigour.

1.10b Leeks

Similar treatments were evaluated in summer 2013 in drilled leeks cv. Galvani on a silt soil in Lincolnshire. The herbicide treatment in this trial was Wing P (dimethenamid-P + pendimethalm) at 2 L/ha. The combined treatments of herbicide followed by electrical or mechanical weeding gave similar moderate levels of weed control (56-63%), slightly better than the herbicide alone (54%). The electrical treatment alone (11% weed control) and mechanical treatment alone (19% weed control) were poor, probably due to a delay in treatment due to rainfall. No phytotoxicity symptoms and no differences in crop vigour were observed.

Soft fruit

2.1 Raspberry: Evaluation of fungicides for control of cane spot and spur blight

This work is in progress and will be reported in 2015.

2.2 Strawberry: Evaluation of fungicides and biofungicides for control of soft rots

A trial was conducted in summer 2013 to evaluate the efficacy of one fungicide, one biofungicide, two alternative products, three fungicide programmes and two fungicide + alternative products programmes for control of fruit soft rots (*Mucor* and *Rhizopus* spp.) in a tunnel crop of strawberry cv. Finesse. Treatments were compared with an untreated control. Products were applied on five occasions during fruit development and resultant mature fruit were assessed in post harvest tests. Over 40% of untreated fruit developed *Mucor* soft rot. Fungicide 37 and two programmes (Thianosan, Switch, Signum; Thianosan, Switch, fungicide 77) were consistently the best treatments, reducing the disease by 30-34%; the other treatments (fungicide 47, products 186 and 187 and three programmes) had no effect. Botrytis affected 24% of fruit from untreated plants in post harvest tests. This disease was reduced by the same three treatments and also by a programme of Thianosan, Switch and fungicide 25a.

2.3 Strawberry: Evaluation of fungicides and biofungicides for control of crown rot

A polytunnel trial was conducted in summer 2013 to evaluate three fungicides and two biofungicides, each applied by three application methods, for control of crown rot (*Phytophthora cactorum*) in strawberry cv. Elsanta grown in peat bags. Two crown rot infected plants were placed in each bag as a source of inoculum. By February 2014, crown rot symptoms had developed in only two plants. It was not possible therefore to draw any conclusions on treatment efficacy from this work.

2.4 Strawberry: Evaluation of insecticides for control of European tarnished plant bug

A caged trial in a glasshouse was conducted in summer 2013 to evaluate insecticide 59 applied alone and insecticide 149 applied alone and in mixtures with Chess (pymetrozine), Spruzit (pyrethrum) and Silwet L-77 (silicon wetter) for control of European tarnished plant bug (*Lygus rugulipennis*) on strawberry cv. Finesse. An untreated control and the standard treatment Chess were included; Spruzit alone was also tested. Each cage was artificially infested with adults of the pest and plants were sprayed 3 and 5 weeks later. Insecticide 59 greatly reduced numbers of adults and nymphs. Insecticide 149 alone reduced numbers of adults and reduced numbers of nymphs when in admixture with Chess, Spruzit and Silwet-L77. Chess or Spruzit used alone (at a low rate) did not reduce the pest.

2.5 Raspberry: Evaluation of insecticides and bio-insecticides for control of aphids

A field trial was conducted in summer 2013 to evaluate one insecticide and three bio-insecticides used in conjunction with macrobiologicals for control of large raspberry aphid (*Amphorophora idaei*) and potato aphid (*Microsiphum euphorbiae*) in a polytunnel crop of raspberry cv. Glen Ample. Treatments were compared with a water control and the standard insecticide Calypso (thiacloprid). The parasitoid Ervipar (*Aphidius ervi*) was released to suppress potato aphid and Spidex (*Phytoseiulus persimilis*) was used to suppress spider mites; endemic hoverflies were encouraged. Calypso and insecticide 50 gave best control of both aphid species. Biopesticide 62 was the best biopesticide and reduced both aphid species. Biopesticide 130 was very effective against large raspberry aphid but not potato aphid; this bio-insecticide resulted in fruit taint after 4 sprays. Both insecticides had a strong negative effect on released parasitoids and endemic hoverflies whereas none of the biopesticides did.

2.6 Blackcurrant: Evaluation of herbicides and bioherbicides for crop safety

A trial was conducted in spring 2013 on 1-year-old pot grown blackcurrants cvs Ben Gairn and Ben Tirran to determine the crop safety of five herbicides and two bioherbicides applied as directed sprays to the base of bushes around bud break (23 March and 21 April). Following the March application, Roundup, 72 and 151 caused damage to basal buds on Ben Gairn; damage was insignificant on the later variety Ben Tirran. The April application caused more damage to basal buds than the earlier spray, including bud death and leaf yellowing and scorch. No treatments were safe to buds of Ben Gairn at this timing but herbicide 135 and bioherbicide 109 resulted in least damage when applied to breaking buds of Ben Tirran and no damage was evident when whole plants were assessed 6 weeks after the April treatment.

2.7 Raspberry: Evaluation of herbicides and bioherbicides for crop safety

A field trial was conducted in spring 2013 to evaluate the efficacy and crop safety of two herbicides and two bioherbicides applied to the base of raspberry canes, cv. Glen Ample, for control of weeds and initial raspberry spawn growth. An untreated control and the grower standard treatment Shark (carfentrazone-ethyl) were included. Herbicide 124 and bioherbicide 109 showed the greatest control of weeds, including thistle, and appeared better than Shark. No phytotoxicity and no significant effect on spawn control were observed with these products although Shark showed a slight reduction in spawn cover. The lack of overall plant phytotoxicity was likely because the season was late so treatments did not come into contact with broken buds. Bioherbicide 116 gave no sustained weed control.

2.8 Soft fruit: Evaluation of herbicides and bioherbicides for control of three perennial weeds

A field trial was conducted in spring 2013 to evaluate the efficacy of two herbicides and two bioherbicides for control of the perennial weeds broad-leaved dock (*Rumex obtusifolius*) and stinging nettle (*Urtica dioica*). An untreated control and a grower standard Rosate 36 (glyphosate) were included. Each product was applied twice, on 7 and 22 May. At 56 days after the first application, docks were significantly reduced by the bioherbicide 109 and Rosate 36; the latter gave complete control from 28 days after treatment (DAT)1. Herbicide 124 and bioherbicide 116 were ineffective on docks. All products initially reduced nettles, up to 21 DAT1, but by 56 DAT1 re-growth had occurred in all plots, comparable to the untreated, except for Rosate 36 and bioherbicide 116.

Protected edibles

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

A glasshouse trial was conducted in 2013 to evaluate four conventional fungicides and five biofungicides against grey mould (*Botrytis cinerea*) in tomato cv. Elegance grown on Maxifort rootstock. Treatments were compared with an untreated control and a standard fungicide programme of Rovral WG (iprodione) alternated with Signum (boscalid + pyraclostrobin) and Switch (cyprodinil + fludioxonil). Conventional and biofungicides were evaluated in separate, identical glasshouses to preclude possible interactions. Biofungicides were applied eight times at 7 day intervals over a 2 month period and fungicide six times at 14 day intervals, both from the first sign of natural leaf infection in early July; the exception was Prestop (*Gliocladium catenulatum*), which was applied every 3 weeks, as per label. Severe leaf botrytis and ghost spot developed and there was a high incidence of leaf dieback and stem lesions by the final assessment on 6 September. The standard fungicide programme and the four coded conventional fungicides (25a, 31, 77 and 118) all reduced leaf Botrytis with product 77 better than all other treatments; 25a, 77 and 118 also appeared to reduce stem lesions. None of the biofungicides (40, 105, 132, 178 and Prestop) reduced Botrytis at any assessment. No conventional fungicide and no biofungicide reduced ghost spot symptoms on fruit.

3.2. Cucumber: Evaluation of fungicides and biofungicides for control of Pythium root and stem base rot

A glasshouse inoculated trial was conducted in summer 2013 to evaluate 11 fungicides and nine biofungicides for control of Pythium root and stem base rot (*Pythium aphanidermatum*) in cucumber cv. Shakira grown in rockwool blocks. A water-only treatment and a standard fungicide Previcur Energy (propamocarb-HCI + fosetyl-Al) were included. Products were drenched into blocks at 65 ml/block. Fungicides were applied 2 days before and 10 days after inoculation; biofungicides at these times and additionally at seed sowing (2 weeks before inoculation). At 7 weeks after inoculation, stem base lesion severity was reduced by six of the fungicides (44, 46, 139, 169, 171, 183) and none of the biofungicides (38, 40, 43, 47, 98, 105, 121, 188 and 189). Fungicide 183 was best, with no stem lesions and no root discolouration. Fungicides 139 and 171 were phytotoxic at the rates used, resulting in stunting and chlorosis. Biofungicide 189 appeared to reduce the disease. Previcur Energy failed to reduce root discolouration or stem base lesion severity.

3.3. Cucumber: Evaluation of fungicides and biofungicides for control of black root rot

This work is in progress and will be reported in 2015.

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

A glasshouse trial was conducted in summer 2013 to evaluate the efficacy of three bio-insecticides against relatively high levels of spider mite (*Tetranychus urticae*) and whitefly (*Trialeurodes vaporariorum*) on tomato cv. Cheramy. Each treatment was applied twice at 7 day intervals and followed by two introductions of *Phytoseiulus persimilis* for spider mite and of *Encarsia formosa* for whitefly. Treatments were compared with Chess (pymetrozine) for spider mite and Borneo (etoxazole) for white fly each followed by the macrobiologicals; water only and macrobiologicals only treatments were included. At the start of the experiment the mean number of adult plus nymph spider mites was 1-8 per leaflet; the mean number of adult whiteflies was 3-13 per leaflet. All treatments reduced all stages of spider mite with Borneo and the three biopesticides (51, 62, 130) followed by *P. persimilus* giving high levels of control, better than *P. persimilis* only. Spider mite levels were greatly reduced in all treatments by treatment with sulphur for powdery mildew control 4 days after the second biopesticide application; however, whereas levels in the water treatment subsequently increased, the macrobiologicals maintained control in all other treatments. Whitefly adults were reduced by Chess and biopesticide 51, but whitefly scales were not reduced by any treatment. The sulphur spray did not reduce whitefly populations. The experiment provides evidence that Chess and biopesticide 51, 62 and 130 can reduce spider mite, and Borneo and biopesticide 51 can reduce whitefly, to levels sufficient for macrobiologicals to maintain control.

3.5. Pepper: Evauation of insecticides for control of aphids

3.5a Comparison of bio-insecticides

A glasshouse trial was conducted in late summer 2013 to evaluate three bio-insecticides against aphids (*Myzus persicae*) on pepper cv. Ferrari. Treatments were compared with the insecticide Pyrethrum 5EC (pyrethrum) and a water-only control. Treatments were applied three times at 7 day intervals. Aphid levels at the start of the experiment were 5-15 per leaf. The bio-insecticide 130 reduced aphids to around 2 per leaf whereas Pyrethrum and bio-insecticides 51 and 62 were ineffective.

3.5b Integration of bio-insecticides and macrobiologicals

A glasshouse trial was conducted in late summer 2013 to evaluate the bio-insecticide 130 against aphid (*Myzus persicae*) on pepper cv. Ferrari. Treatment was compared with the conventional insecticide Chess (pymetrozine) and a water-only control. Chess and 130 were each applied once followed one day later by introduction of the macrobiological *Aphidius colemani*; an *Aphidlus*-only treatment was also included. At the time of treatment there were 28-48 aphids/plant. Two weeks after application, both Chess and 130 followed by *A. colemani* had reduced aphid numbers compared with the water only treatment; *A. colemani* alone was ineffective at this time.

Top fruit

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

4.1a Fungicides

A trial was conducted in summer 2013 to evaluate the efficacy of six fungicide programmes and two fungicide products (88 and 118) in comparison with a standard fungicide Systhane 20EW (myclobutanil) for control of powdery mildew on apple trees cv. Cox. Five sprays were applied at 7-14 d intervals from the start of extension growth using a motorised knapsack sprayer. Four of the programmes comprised three fungicides from different fungicide groups; two programmes involved two fungicides. The severity of mildew was high. All treatments reduced mildew at all assessments. Fungicides 88 and 118 were both very effective, reducing mildew from 82% to 33 and 32% leaves affected respectively. The most effective programme used fungicides 32 and 159, reducing mildew to 30%. The standard fungicide Systhane 20EW gave relatively poor control (63% leaves affected), probably due to reduced sensitivity.

4.1b Fungicides and integrated fungicide/biofungicide programmes

A trial was conducted in summer 2013 to evaluate the efficacy of six biofungicides in comparison with a standard fungicide Systhane 20EW (myclobutanil) and an inorganic fungicide Kumulus DF (sulphur) for control of powdery mildew (*Podosphaera leucotricha*) on apple cv. MM106 grown in pots. A programme of two sprays of a conventional fungicide (32) followed by three sprays of a biofungicide (105); and a programme alternating one biofungicide (06) with another (105) were also tested. Untreated and water-only controls were included. Treatments were applied five times at 7 day intervals. Conditions were conducive to mildew and over 50% of leaves on untreated and water-treated plants were affected by secondary mildew. All treatments reduced the disease, with Systhane 20EW, Kumulus DF, biofungicide 90, and a programme based on conventional fungicide 32 and biofungicide 105 reducing it to <30%.

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

An inoculated trial was conducted between September 2012 and March 2013 to evaluate four biofungicides against Botrytis rot (*Botrytis cinerea*) in cold-stored pears, cv. Conference. Treatments were compared with the fungicide Rovral WG (iprodione) and untreated controls. Treatments were applied as a dip immediately before transfer to a cold store (0°C). Spread of *B. cinerea* from inoculated to healthy fruit was good with 50% of fruit becoming affected in untreated crates. Botrytis rot was reduced by Rovral WG and the biofungicide 38 and not by other treatments (06, 99 and Nexy 1). Rovral WG (13% fruit rot) was better than biofungicide 38 (39% fruit rot).

Milestones

Milestone	Target month	Title	Status
P2.3	36	<u>Disease and pest efficacy tests for Y3 completed</u>	
		Brassica powdery mildew	Complete
		Brassica ring spot	Complete
		Leek rust	Complete
		Onion downy mildew	Complete
		Lettuce aphid	Complete
		Lettuce caterpillar	Complete
		Leek thrips and moth	Complete
		Raspberry cane diseases	In progress
		Strawberry crown rot	In progress
		Strawberry soft rots	Complete
		Strawberry European tarnished bug	Complete
		Cucumber Phomopsis	In progress
		Cucumber Pythium	Complete
		Tomato grey mould	Complete
		Pepper aphids	Complete
		Apple powdery mildew	Complete
		Pear botrytis rot in storage (2011/12)	Complete
P3.3	36	<u>Disease and pest IPM work for Y3 completed</u>	
		Brassica powdery mildew programmes	Complete
		Brassica ring spot programmes	Complete
		Brassica cabbage root fly, aphid and caterpillar programmes	Complete
		Raspberry aphid – biopesticides and natural enemies	Complete
		Tomato spider mites IPM	Complete
		Tomato whitefly IPM	Complete
		Pepper aphids IPM	Complete
		Apple powdery mildew programmes	Complete
P4.3	36	<u>Herbicide efficacy and crop safety tests for Y3 completed</u>	
		Vegetables herbicide crop safety	Complete
		Blackcurrant crop safety	Complete
		Raspberry crop safety	Complete
		Soft fruit – perennial weeds	Complete
P5.2	36	<u>Sustainable weed control work for Y3 completed</u>	
		Vegetables herbicide band spraying	Complete
		Vegetables electrical weed control	Complete