SCEPTREPLUS

Final Trial Report

Trial code:	W2017.IRU2
Title:	Control of aphids on carrots, lettuce and brassicas
Crop	Group: Field Vegetables – Carrots, lettuce and brassicas
Target	*Myzus persicae* - MYZUPE and *Brevicoryne brassicae* – BRVCBR (brassicas), *Cavariella aegopodii* – CAVAAE (carrot) and *Nasonovia ribisnigri* – NASORN (lettuce)
Lead researcher:	Dr Rosemary Collier
Organisation:	University of Warwick, School of Life Sciences, Wellesbourne, Warwick CV35 9EF
Period:	December 2017 – March 2019
Report date:	December 2019
Report author:	Andrew Jukes and Rosemary Collier
ORETO Number: (certificate should be attached)	381

I the undersigned, hereby declare that the work was performed according to the procedures herein described and that this report is an accurate and faithful record of the results obtained.

17 December 2019

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Date Authors signature

Trial Summary

Introduction

Evaluation of a range of insecticide and bio-insecticide treatments for their efficacy against four species of aphid infesting vegetable and salad crops

The aim of the main set of laboratory trials was to evaluate a range of insecticide and bio-insecticide treatments for their efficacy against four species of aphid infesting vegetable and salad crops. The species were *Myzus persicae, Brevicoryne brassicae*, *Cavariella aegopodii* and *Nasonovia ribisnigri.* All test aphids were obtained from cultures maintained at Warwick Crop Centre, University of Warwick. The aphids (10 per plant) were inoculated onto potted host plants (Brussels sprout (*Myzus persicae, Brevicoryne brassicae)*, carrot (*Cavariella aegopodii*) and lettuce (*Nasonovia ribisnigri)*) and treatments were applied as foliar sprays. Insecticides were applied on one occasion (Day 0) and bio-insecticides on two occasions (Day 0 and Day 7). Adjuvants were used with the treatments applied to brassica plants. Aphid numbers were recorded on treated plants at regular intervals.

The original aim was to determine the efficacy of treatments over a period of two weeks after treatment. However, it seemed that there might be more information to obtain by following some of the tests for longer and in particular by re-inoculating plants where all the aphids died to determine the persistence of the treatments. Therefore, plants were re-infested (with 10 aphids per plant) if no aphids remained after 1 week and, if all the aphids on the re-infested plants again died within one week, the plants were re-infested for a second time. The data were summarized and subjected to Analysis of Variance where appropriate. The largest number of products were tested against *M. persicae* as this species had not been tested previously in SCEPTRE or other related projects. For the other species some of the products available had already been tested

Nasonovia ribisnigri **(currant lettuce aphid) on lettuce – supplementary trial to test treatments used against *Pemphigus bursarius* (Lettuce root aphid) in a field trial**

A further small exploratory laboratory test was undertaken on *N. ribisnigri* in summer 2018 using the treatments that had been applied in a field trial to assess control of lettuce root aphid (*Pemphigus bursarius)*. Lettuce seeds were sown into peat blocks on 29 August 2018. The trial consisted of 11 treatments and each replicate consisted of 5 plants transplanted into FP9 pots on 26 September 2018. The plots were 1 cage in size and there were 2 plots per treatment. Treatments were applied at sowing (Seed treatment or “Phytodrip”), pre-planting (drench) or as post-planting sprays (on 17 October 2018). Plants were inoculated with 10 wingless aphids immediately after spraying and transferred to an insect-proof cage (5 plants/cage to give a total of 10 plants/treatment) then a further 10 winged aphids were added to each cage. Aphid numbers were recorded on treated plants at regular intervals. The data were summarized but not analysed as the replication was limited.

Results

Evaluation of a range of insecticide and bio-insecticide treatments for their efficacy against four species of aphid infesting vegetable and salad crops

Some of the treatments (mainly conventional insecticides) were persistent for at least 2 weeks and continued to be very effective. Overall the bio-insecticides were less effective than the conventional insecticides but some products were very effective against one or more species.

Tables A and B summarise the performance of products screened in laboratory tests, expressed as percentage of aphids remaining on plants 6 days after treatment compared with the insecticide-free control treatment. Of the conventional insecticides, most were rapidly effective, with the exception of AHDB9933 and AHDB9935 versus *N. ribisnigri* and *C. aegopodii*. This may suggest that this is related to product formulation as both of these products were applied with adjuvant against *Myzus persicae* and *Brevicoryne brassicae* and were more effective. A similar pattern can be observed with some of the bio-insecticides. Adjuvants were applied with AHDB9928, AHDB9931, AHDB9932 and AHDB9946 when applied to brassicas (*Myzus persicae, Brevicoryne brassicae*) but not with AHDB9929.

Adjuvants were used in all the tests on brassicas (*M. persicae* and *B. brassicae*) and whilst they appeared to have no 'additional' effect on *M. persicae*, Phase II, even on its own, appeared to be toxic to *B. brassicae*. Once the effect of adjuvants on *B.* brassicae was suspected, an additional treatment of Phase II on its own was included in the last two replicates and it was toxic to *B. brassicae*. As the plants were infested prior to treatment this was likely to have been through direct contact action. Survival of aphids following re-infestation did not appear to be affected by Phase II.

For two of the species (*C. aegopodii* and *N. ribisnigri*), development of infestations was followed for a period of 3 weeks from the first treatment. There was no evidence that any of the products 'started to work' later on. However, it is possible that this is not the best approach for understanding how best to use microbial bio-insecticides which, as living organisms, may be more dependent on environmental conditions and the growth stage of the target pest than conventional insecticides and bio-insecticides based on plant extracts or other non-living substances.

Table A. Performance of conventional insecticides screened in laboratory tests expressed as a percentage of the aphids remaining on untreated control plants 6 days after treatment.

Species	Product	% remaining of control after 6 days
Myzus persicae	AHDB9933	0
Brevicoryne brassicae	AHDB9933	0
Nasonovia ribisnigri	AHDB9933	98
Cavariella aegopodii	AHDB9933	109
Myzus persicae	AHDB9934	0
Brevicoryne brassicae	AHDB9934	0
Cavariella aegopodii	AHDB9934	2
Nasonovia ribisnigri	AHDB9934	2
Myzus persicae	AHDB9935	0
Brevicoryne brassicae	AHDB9935	0
Cavariella aegopodii	AHDB9935	17
Nasonovia ribisnigri	AHDB9935	39
Myzus persicae	AHDB9943	0
Myzus persicae	AHDB9948	0
Myzus persicae	AHDB9951	0
Brevicoryne brassicae	AHDB9951	0
Cavariella aegopodii	AHDB9951	0
Nasonovia ribisnigri	AHDB9951	0
Myzus persicae	AHDB9966	0
Cavariella aegopodii	Movento	0
Myzus persicae	Movento	0
Brevicoryne brassicae	Movento	0
Nasonovia ribisnigri	Movento	0
Myzus persicae	Plenum	0

Table B. Performance of Phase II and bio-insecticides screened in laboratory tests expressed as a percentage of the aphids remaining on untreated control plants 6 days after treatment.

Species	**Product**	**% remaining of control after 6 days**
Brevicoryne brassicae	Phase II	9
Brevicoryne brassicae	AHDB9928	18
Myzus persicae	AHDB9928	53
Nasonovia ribisnigri	AHDB9928	176
Myzus persicae	AHDB9929	23
Cavariella aegopodii	AHDB9929	94
Brevicoryne brassicae	AHDB9931	2
Myzus persicae	AHDB9931	9
Cavariella aegopodii	AHDB9931	114
Brevicoryne brassicae	AHDB9932	0
Myzus persicae	AHDB9932	26
Nasonovia ribisnigri	AHDB9932	129
Brevicoryne brassicae	AHDB9946	0
Myzus persicae	AHDB9946	9
Nasonovia ribisnigri	AHDB9946	50
Cavariella aegopodii	AHDB9946	114
Myzus persicae	AHDB9964	53
Brevicoryne brassicae	AHDB9967	24
Nasonovia ribisnigri	AHDB9967	44
Myzus persicae	AHDB9967	92
Myzus persicae	AHDB9968	12
Brevicoryne brassicae	AHDB9970	17
Myzus persicae	AHDB9970	17
Myzus persicae	AHDB9971	72
Cavariella aegopodii	AHDB9971	77
Nasonovia ribisnigri	AHDB9971	123
Myzus persicae	Majestik	44
Nasonovia ribisnigri	Majestik	70
Myzus persicae	SB Plant Invigorator	61
Cavariella aegopodii	SB Plant Invigorator	103
Cavariella aegopodii	Spruzit	41
Myzus persicae	Spruzit	70

***Nasonovia ribisnigri* (currant lettuce aphid) on lettuce – supplementary trial to test treatments used against *Pemphigus bursarius* (Lettuce root aphid) in a field trial**

Figure A shows the mean number of winged and wingless aphids per plant on lettuce plants treated 1) at sowing with seed or phytodrip treaments, with foliar sprays or with a pre-planting drench treatment (2 replicates only). With the exception of the AHDB9948 drench and phytodrip treatments all other treatments appeared to be effective.

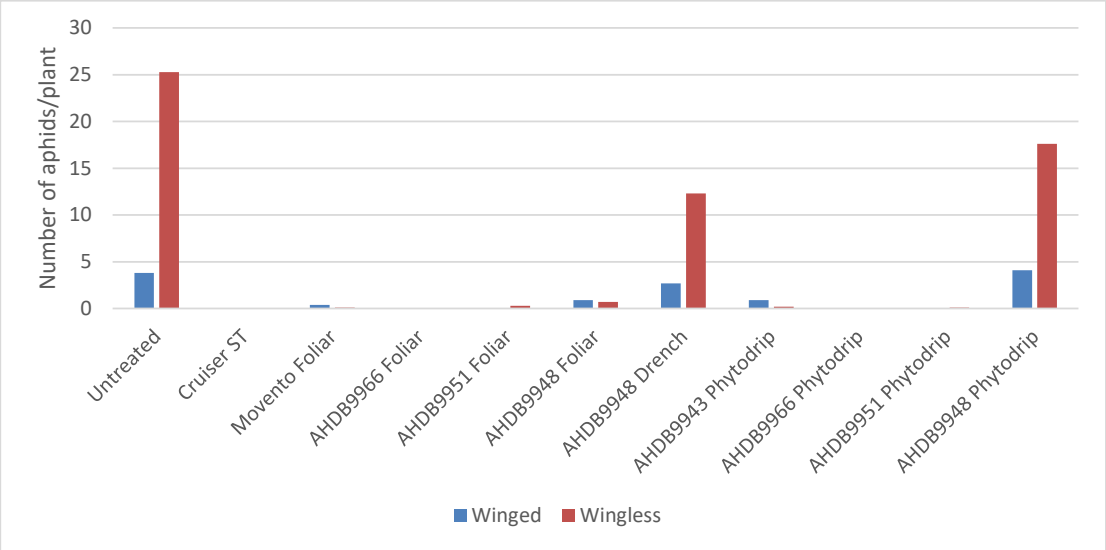

Figure A *Nasonovia ribisnigri* – mean number of winged and wingless aphids per plant on lettuce plants treated 1) at sowing with seed or phytodrip treatments, with foliar sprays or with a pre-planting drench treatment (2 replicates only).

Conclusions

The main study showed that a number of 'novel' insecticides and a few bio-insecticides were effective against one or more species of aphid. Some of the insecticides showed good persistence. The study also highlighted the importance of product formulation and adjuvants in increasing levels of control.

The additional study showed that a number of products were effective as foliar sprays and that some of them may also control foliage aphids when applied as phytodrip treatments, although it would obviously be advisable to test such treatments in the field and to evaluate the persistence of such treatments.

Take home message:

Whilst most of these insecticides and bio-insecticides are not approved for use yet on the target crops there are some potentially very effective products in the pipeline. It is worth considering the use of adjuvants on all crops.

Objectives

1. To evaluate novel insecticides and bio-insecticides as foliar sprays for the control of *Myzus persicae* and *Brevicoryne brassicae brassicae* on brassicas (Brussels sprout), *Cavariella aegopodii* on carrot and *Nasonovia ribisnigri* on lettuce.
2. To monitor the treated crops for phytotoxicity

The largest number of products were tested against *M. persicae* as this species had not been tested previously in SCEPTRE or other related projects. For the other species some of the products available had already been tested

A *Myzus persicae* (Peach potato aphid) on Brussels sprout

Trial conduct

UK regulatory guidelines were followed but EPPO guidelines took precedence. The following EPPO guidelines were followed:

Relevant EPPO guideline(s)		Variation from EPPO
PP 1/152(3)	Design and analysis of efficacy evaluation trials	None
PP 1/135(3)	Phytotoxicity assessment	None
PP 1/181(3)	Conduct and reporting of efficacy evaluation trials including GEP	None

There were no deviations from EPPO guidance.

Test site

Item	Details
Location address	University of Warwick Wellesbourne Campus Wellesbourne Warwick CV35 9EF
Crop	Brussels sprout
Cultivar	Doric
Soil or substrate type	Levingtons M2
Agronomic practice	See Appendix A
Prior history of site	n/a

Trial design

Item	Details
Trial design:	Replication in time
Number of replicates:	4
Row spacing:	n/a
Plot size: (w x l)	n/a
Plot size: (m^2)	n/a
Number of plants per plot:	1
Leaf Wall Area calculations	n/a

Treatment details

Conventional insecticides

AHDB Code	Active substance	Product name/ manufacturers code	Formulation batch number	Content of active substance in product	Formulation type	Adjuvant [1]
Untreated						
Authorized	Spirotetramat	Movento	ECE4101299	150g/l	OD	None
AHDB9948	N/D	N/D	N/D	N/D	N/D	Phase II
AHDB9966	N/D	N/D	N/D	N/D	N/D	Phase II
AHDB9943	N/D	N/D	N/D	N/D	N/D	Phase II
AHDB9951	N/D	N/D	N/D	N/D	N/D	Phase II
AHDB9935	N/D	N/D	N/D	N/D	N/D	Phase II
AHDB9934	N/D	N/D	N/D	N/D	N/D	Silwet L77
AHDB9933	N/D	N/D	N/D	N/D	N/D	Phase II

[1] Adjuvants applied at 0.5 % by volume

Bio-insecticides

AHDB Code	Active substance	Product name/ manufacturers code	Formulation batch number	Content of active substance in product	Formulation type	Adjuvant [1]
Untreated						
Authorized	Pymetrozine	Plenum [2]	POR4F0290	500g/kg	WG	Phase II
AHDB9964	N/D	N/D	N/D	N/D	N/D	None
AHDB9968	N/D	N/D	N/D	N/D	N/D	Phase II
AHDB9970	N/D	N/D	N/D	N/D	N/D	None
AHDB9946	N/D	N/D	N/D	N/D	N/D	Phase II
Not needed	Pyrethrins	Spruzit	5736/APR16	4.59g/l	OD	None
AHDB9928	N/D	N/D	N/D	N/D	N/D	Phase II
Not needed	Maltodextrin	Majestik		49%	SC	None
AHDB9971	N/D	N/D	N/D	N/D	N/D	None
Not needed	Surfactants	SB Plant Invigorator	0305/17	Not specified	EC	None
AHDB9929	N/D	N/D	N/D	N/D	N/D	None
AHDB9932	N/D	N/D	N/D	N/D	N/D	Phase II
AHDB9967	N/D	N/D	N/D	N/D	N/D	None
AHDB9931	N/D	N/D	N/D	N/D	N/D	Silwet L77

[1] Adjuvants applied at 0.5 % by volume

[2] Conventional insecticide used as positive control

Application schedule

Conventional insecticides

Treatment number	Treatment: product name or AHDB code	Rate of active substance (ml or g a.s./ha)	Rate of product (l or kg/ha)	Application code
1	Control			
2	Movento	75g	0.5l	A
3	AHDB9948	75g	0.75l	A
4	AHDB9966	24g	0.2l	A
5	AHDB9943	80g	0.16kg	A
6	AHDB9951	125g	0.625l	A
7	AHDB9935	30g	0.3l	A
8	AHDB9934		0.8334kg	A
9	AHDB9933	75g	0.1875kg	A

Bio-insecticides

Treatment number	Treatment: product name or AHDB code	Rate of active substance (ml or g a.s./ha)	Rate of product (l or kg/ha)	Application code
1	Control			
2	Plenum	200g	0.4kg	A B
3	AHDB9964	837.5g	5l	A B
4	AHDB9968	15g	1.5l	A B
5	AHDB9970	2303ml	4.8l	A B
6	AHDB9946	9.3g	1l	A B
7	Spruzit	27.5g	6l	A B
8	AHDB9928	55g	0.25kg	A B
9	Majestic	4900g	10l	A B
10	AHDB9971	16.8g	0.56l	A B
11	SB Plant Invigorator		0.4l	A B
12	AHDB9929	1 X 10^{13}	5l	A B
13	AHDB9932		0.6l	A B
14	AHDB9967	192ml	3.2l	A B
15	AHDB9931	1320g	8l	A B

Application details
Conventional insecticides

	Application	
	A1	**A2**
	Reps 1 and 2	**Reps 3 and 4**
Application date	20/2/18	13/3/19
Time of day	11.00	11.00
Crop growth stage (Max, min average BBCH)	16	16
Crop height (cm)	16	15
Crop coverage (%)	N/A	N/A
Application Method	Spray	
Application Placement	Foliar	
Application equipment	Berthoud Vermorel 2000HP	
Nozzle pressure	2 bar	
Nozzle type	02F110	
Nozzle size	02	
Application water volume/ha	300	
Temperature of air - shade (°C)	8	10
Relative humidity (%)	N/A	N/A
Wind speed range (m/s)	N/A	N/A
Dew presence (Y/N)	N/A	N/A
Temperature of soil - 2-5 cm (°C)	N/A	N/A
Wetness of soil - 2-5 cm	N/A	N/A
Cloud cover (%)	N/A	N/A

Bio-insecticides

	Application			
	A1	B1	A2	B2
	Reps 1 and 2		Reps 3 and 4	
Application date	6/2/18	13/2/18	10/4/19	17/4/19
Time of day	13.00	13.00	13.30	11.00
Crop growth stage (Max, min average BBCH)	16	17	16	17
Crop height (cm)	15	16	16	17
Crop coverage (%)	N/A	N/A	N/A	N/A
Application Method	Spray			
Application Placement	Foliar			
Application equipment	Berthoud Vermorel 2000HP			
Nozzle pressure	2 Bar			
Nozzle type	02F110			
Nozzle size	02			
Application water volume/ha	400			
Temperature of air - shade (°C)	3	4	9	14
Relative humidity (%)	N/A	N/A	N/A	N/A
Wind speed range (m/s)	N/A	N/A	N/A	N/A
Dew presence (Y/N)	N/A	N/A	N/A	N/A
Temperature of soil - 2-5 cm (°C)	N/A	N/A	N/A	N/A
Wetness of soil - 2-5 cm	N/A	N/A	N/A	N/A
Cloud cover (%)	N/A	N/A	N/A	N/A

Untreated levels of pests/pathogens at application and through the assessment period

Common name	Scientific Name	EPPO Code	Infestation level pre-application	Infestation level at start of assessment period	Infestation level at end of assessment period
Peach potato aphid	*Myzus persicae*	MYZUPE	10/plant	10/plant	>50/plant

Method

Brussel sprout (cv Doric) seeds (1 per pot) were sown in FP7 pots filled with Levingtons M2 compost on 4 occasions (twice for the conventional insecticide trial and twice for the bio-insecticide trial). Plants were allowed to develop to around the 6 true leaf stage. As Brussels sprout plants have a waxy leaf surface a pre-spray adhesion test (whole leaves were dipped in a spray solution and the amount of run-off was assessed) was conducted with all formulations to determine if an adjuvant was required. If it was decided that an adjuvant was required to reduce run-off then Phase II was used at 0.5% by volume unless an alternative was specified by the insecticide manufacturer (see Treatment Tables above). One day before spraying the plants were inoculated with 10 aphids/plant and kept in insect cages in controlled environment rooms (20°C, 16 hours light, 8 hours dark). The plants were removed from the cages and taken outdoors to be sprayed. After spraying they were returned

to the cages in the controlled environment room. Conventional insecticides were sprayed once, bio-insecticides were re-applied 1 week after the first application using the same techniques. Where there was 100% mortality of aphids 6 days after spraying plants were re-inoculated with 10 aphids as before. If 100% mortality of aphids was achieved again plants were re-inoculated with a further 10 aphids 13 days after spraying. Aphid numbers were counted at the times described below. The plants that were not re-inoculated were discarded after 13 days.

Assessment details

Conventional insecticides

Evaluation date	Evaluation Timing (DA)[1]	Crop Growth Stage (BBCH)	Evaluation type (efficacy, phytotox)	Assessment
21/2/18 14/3/18	1	16	Efficacy	Aphid count
23/2/18 16/3/18	3	16	Efficacy	Aphid count
26/2/18 [2] 19/3/18 [2]	6	16	Efficacy	Aphid count
27/2/18 20/3/18	7	16	Efficacy Phytotoxicity	Aphid count Leaf damage
1/3/18 22/3/18	9	17	Efficacy	Aphid count
5/3/18 [3] 26/3/18 [3]	13	17	Efficacy	Aphid count
6/3/18 27/3/18	14	17	Efficacy	Aphid count
8/3/18 29/3/18	16	17	Efficacy	Aphid count
12/3/18 3/4/18	20	17	Efficacy	Aphid count

[1] DA – days after application
[2] First re-infestation in treatments where there were no surviving aphids
[3] Second re-infestation in treatments where there were no surviving aphids

Bio-insecticides

Evaluation date	Evaluation Timing (DA)[1]	Crop Growth Stage (BBCH)	Evaluation type (efficacy, phytotox)	Assessment
7/2/18 11/4/18	1	16	Efficacy	Aphid count
9/2/18 13/4/18	3	16	Efficacy	Aphid count
12/2/18 [2] 16/4/18 [2]	6	16	Efficacy Phytotoxicity	Aphid count Leaf damage
14/2/18 18/4/18	7	16	Efficacy	Aphid count
16/2/18 20/4/18	9	17	Efficacy	Aphid count
19/2/18 23/4/18	13	17	Efficacy	Aphid count

[1] DA – days after application
[2] First re-infestation in treatments where there were no surviving aphids

Statistical analysis

The data were subjected to Analysis of Variance in EXCEL. They were not transformed prior to analysis. The output should be interpreted with care as there are a large number of zeros in the data set and some of the comparisons are based on small numbers of aphids (e.g. nymphs soon after infestation).

Results

Phytotoxicity

Scorching was observed in Treatment 8 (AHDB9934). The percentage of leaf area was recorded (Table 1). No other treatments were affected.

Table 1. Damage to Brussels sprout leaves 6 days after spraying for control of *Myzus persicae*

Treatment				Days after spraying	Number of leaves with damage					Mean % damage
Number	Product	Replicate	Date		0%	10%	20%	30%	40%	
8	AHDB9934	1	26-Feb	6	3	7	3	0	0	10
8	AHDB9934	2	26-Feb	6	7	1	1	1	1	9
8	AHDB9934	3	19-Mar	6	3	3	5	1	1	18
8	AHDB9934	4	19-Mar	6	5	4	2	0	1	10

Aphid counts

Table 2 and Figure 1a-c summarise numbers of live *M. persicae* during the first week after inoculation following treatment with conventional insecticide products. All 8 insecticide treatments led to 100% mortality within 3 days after treatment (first inoculation). All plants were re-inoculated on Day 6 and all aphids died by Day 9 on plants treated with Movento, AHDB9948 and AHDB9933. Additionally all aphids died on plants treated with AHDB9966 or AHDB9935 by Day 13. Following re-infestation on Day 13 (only 1 replicate each of AHDB9943, AHDB9951 and AHDB9934 and 3 replicates of AHDB9935 were re-inoculated), all aphids died by Day 20 on plants treated with Movento, AHDB9935 and AHDB9934.

Table 2. *Myzus persicae* – survival during the first week after inoculation/treatment with conventional insecticide products shown as mean number of aphids per plant. Insecticides applied on Day 0 and bio-insecticides applied on Day 0 and Day 7. Highlighted means are significantly lower than the untreated control (one-sided LSD).

First inoculation		**Day 1**		**Day 3**		**Day 6**	
Treatment		**Adult**	**Nymph**	**Adult**	**Nymph**	**Adult**	**Nymph**
1	Control	5.5	6	5.5	14	7.25	20.75
2	Movento	1.5	0	0	0	0	0
3	AHDB9948	0.25	0	0	0	0	0
4	AHDB9966	0.25	0.25	0	0	0	0
5	AHDB9943	0.25	0	0	0	0	0
6	AHDB9951	0	0	0	0	0	0
7	AHDB9935	2.25	2	0	0	0	0
8	AHDB9934	1.25	0.75	0	0	0	0
9	AHDB9933	0.5	0	0	0	0	0
F		7.649	4.666	40.333	22.615	10.052	5.736
P		<0.001	0.001	<0.001	<0.001	<0.001	<0.001
SED		0.890	1.302	0.408248	1.388	1.078	4.084
LSD (5%) (two-sided)		1.826	2.671	0.837656	2.847	2.212	8.380
LSD (5%) (one-sided)		1.516	2.217	0.695	2.364	1.836	6.957
df		27	27	27	27	27	27

Second inoculation		**Day 7**		**Day 9**		**Day 13**	
Treatment		**Adult**	**Nymph**	**Adult**	**Nymph**	**Adult**	**Nymph**
1	Control	7.25	2.25	6.50	7.67	9.5	20.5
2	Movento	6.00	0.75	3.50	0.00	0	0
3	AHDB9948	2.75	0.75	0.00	0.00	0	0
4	AHDB9966	4.25	1.00	0.50	0.33	0	0
5	AHDB9943	6.50	4.00	3.75	4.00	1.75	3.75
6	AHDB9951	5.75	1.00	4.75	3.33	3.5	5.5
7	AHDB9935	8.25	1.75	3.50	1.67	0.25	0
8	AHDB9934	5.25	4.50	2.75	5.67	2	4
9	AHDB9933	1.25	0.00	0.00	0.00	0	0
F		5.100	3.216	6.961	4.336	10.957	9.320
P		<0.001	0.011	<0.001	0.005	<0.001	<0.001
SED		1.376	1.217	1.204	1.918	1.330	3.081
LSD (5%) (two-sided)		2.823	2.497	2.470	4.030	2.729	6.323
LSD (5%) (one-sided)		2.344	2.073	2.050	3.326	2.265	5.249
df		27	27	27	27	27	27

Third inoculation		Day 14		Day 16		Day 20	
Treatment		Adult	Nymph	Adult	Nymph	Adult	Nymph
1	Control	7.666667	2	6.5	8	9	19
2	Movento	7.5	1	4.25	0.5	0	0
3	AHDB9948	5.75	2.5	1.75	4.25	1.75	3
4	AHDB9966	6.75	2.25	5.25	3.25	2.75	3.5
5	AHDB9943	4	1	4	4	5	5
6	AHDB9951	7	6	5	11	2	12
7	AHDB9935	7.333333	3	5	1.333333	0	0
8	AHDB9934	0	2	0	1	0	0
9	AHDB9933	6.25	0.5	2.5	0.5	1.25	0.75
F		1.697	1.250	2.192	2.456	6.202	4.162
P		0.175	0.334	0.083	0.057	<0.001	0.006
SED		1.739	1.510	1.752	2.802	1.774	4.752
LSD (5%) (two-sided)		3.687	3.202	3.696	5.911	3.743	10.025
LSD (5%) (one-sided)		3.036	2.637	3.047	4.874	3.086	8.266
df		16	16	16	16	16	16

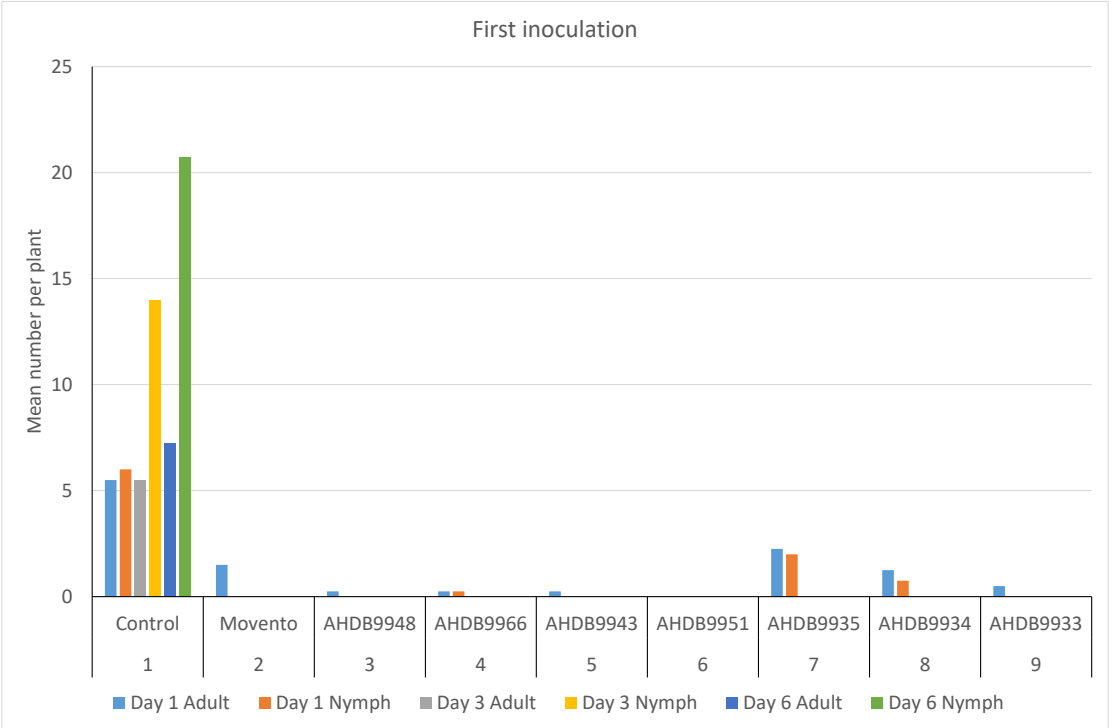

Figure 1a *Myzus persicae* – survival during the first week after inoculation/treatment with conventional insecticide products shown as mean number of aphids per plant. Insecticides applied on Day 0 and bio-insecticides applied on Day 0 and Day 7.

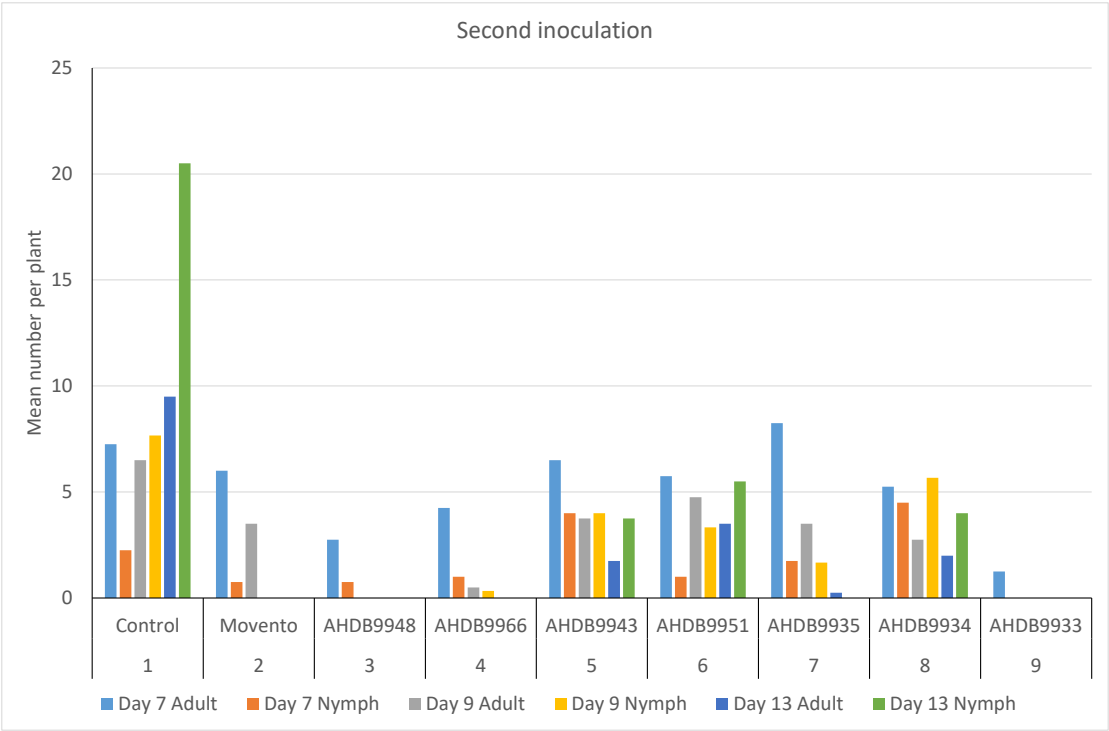

Figure 1b *Myzus persicae* – survival during the first week after inoculation/treatment with conventional insecticide products shown as mean number of aphids per plant. Insecticides applied on Day 0 and bio-insecticides applied on Day 0 and Day 7.

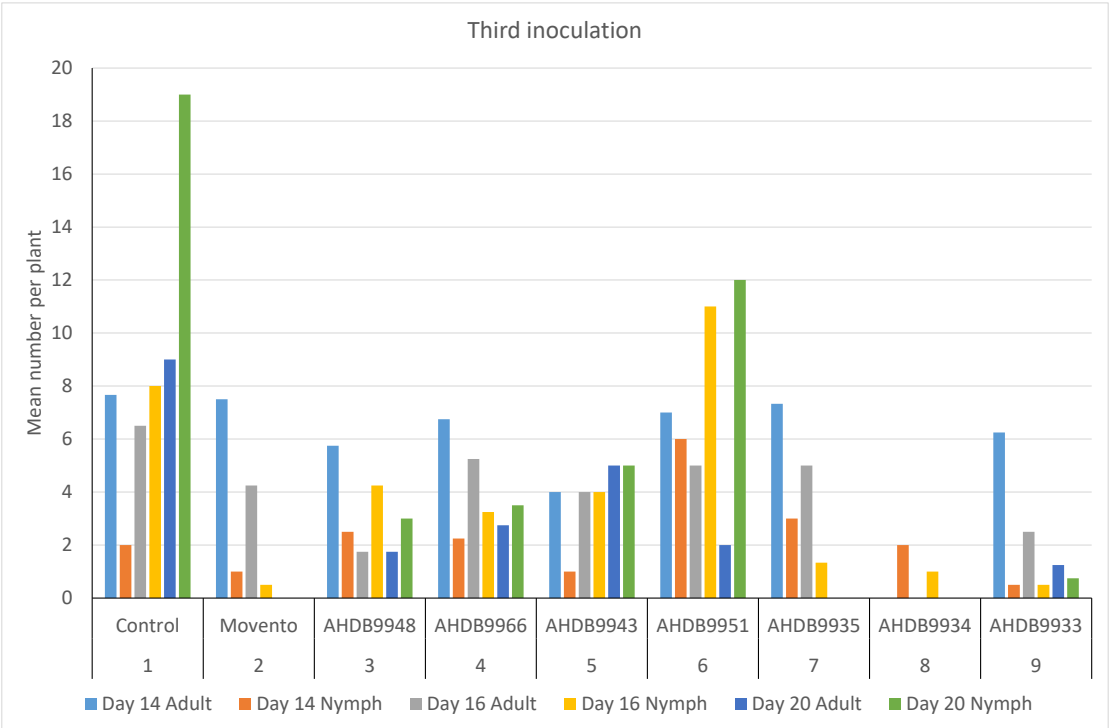

Figure 1c *Myzus persicae* – survival during the first week after inoculation/treatment with conventional insecticide products shown as mean number of aphids per plant. Insecticides applied on Day 0 and bio-insecticides applied on Day 0 and Day 7.

Table 3 and Figure 2a-b summarise aphid survival after treatment with bio-insecticide products (treatments applied on Day 0 and Day 7). The standard treatment (Plenum) led to 100% mortality within 6 days. None of the other treatments led to 100% mortality within the first two weeks. Whilst most of the overall analyses were not statistically significant ($p>0.05$), some of the bio-insecticide treatments did cause relatively high levels of mortality. AHDB9968, AHDB9970, AHDB9946 and AHDB9931 were the most effective treatments. Very few of the plants were re-inoculated after 6 days (second inoculation) and only Plenum (the commercial standard) led to 100% mortality within 6 days after re-infestation.

Table 3. *Myzus persicae* – survival during the first week after inoculation/treatment with bio-insecticide products, shown as mean number of aphids per plant. Bio-insecticides applied on Day 0 and Day 7. Highlighted means are significantly lower than the untreated control (one-sided LSD).

First inoculation		Day 1		Day 3		Day 6	
Treatment		Adult	Nymph	Adult	Nymph	Adult	Nymph
1	Control	7.25	5	7	16	8	24.25
2	Plenum	1.75	1	0.25	0	0	0
3	AHDB9964	4.5	5.5	3.5	8.5	4.75	12.5
4	AHDB9968	4	5.5	1.5	1	2.5	1.25
5	AHDB9970	3.25	4.5	0.75	3.75	1.75	3.75
6	AHDB9946	1.75	1.25	0.5	1.25	0.75	2.25
7	Spruzit	1.75	3.25	2	10.5	5.5	17
8	AHDB9928	4.75	5.5	3.25	7.5	4.5	12.75
9	Majestik	4	5.5	3.5	7.75	5.5	8.75
10	AHDB9971	5.25	6.75	6.5	13.5	4.75	18.5
11	SB Plant Invigorator	5.75	6.75	3.5	10.25	6	13.75
12	AHDB9929	4.5	2	0.75	1.75	2.25	5.25
13	AHDB9932	2.75	2.5	1.5	1.75	3.5	4.75
14	AHDB9967	4.5	7.5	4.25	14.25	8	21.75
15	AHDB9931	3.75	2.75	1	2.75	0.5	2.25
F		1.738	1.140	4.631	2.130	1.322	1.564
P		0.081	0.352	<0.001	0.028	0.232	0.128
SED		1.668	2.758	1.385	5.194	3.137	8.953
LSD (5%) (two-sided)		3.360	5.556	2.790	10.461	6.319	18.033
LSD (5%) (one-sided)		2.802	4.632	2.327	8.723	5.269	15.036
df		45	45	45	45	45	45

First inoculation		Day 8		Day 10		Day 13	
Treatment		Adult	Nymph	Adult	Nymph	Adult	Nymph
1	Control	13.25	27	17.5	37	21.25	60.75
2	Plenum	0	0	0	0	0	0
3	AHDB9964	4.75	9	6.75	13.5	11.25	21
4	AHDB9968	2.25	1.75	1.75	1.5	2.5	0.5
5	AHDB9970	2	3	6.25	7	6.25	7
6	AHDB9946	0.75	0.75	0.75	1	3.5	6.75
7	Spruzit	10.5	22.25	20	38.25	24.5	135.25
8	AHDB9928	5	11.75	6.75	14.5	10.75	32
9	Majestik	7.75	13	9.75	15.5	16.75	34
10	AHDB9971	6.75	14.5	7	23	13.75	37.25
11	SB Plant Invigorator	6	13.5	7.25	12	14	20
12	AHDB9929	3.25	5	6	10.5	12.75	38.75
13	AHDB9932	5.75	12	6.5	18.75	10	35.5
14	AHDB9967	8.75	32.25	12.25	42.25	22.5	66.75
15	AHDB9931	0.25	0.75	0.5	0.5	0.75	1.75
F		1.114	1.349	0.876	0.934	0.920	0.828
P		0.372	0.218	0.588	0.532	0.545	0.636
SED		5.184	12.084	8.784	20.502	11.480	54.515
LSD (5%) (two-sided)		10.441	24.339	17.693	41.292	23.123	109.798
LSD (5%) (one-sided)		8.706	20.295	14.753	34.431	19.281	91.554
df		45	45	45	45	45	45

Second inoculation		Day 8		Day 10		Day 13	
Treatment		Adult	Nymph	Adult	Nymph	Adult	Nymph
1	Control	7.25	2.25	6.50	7.50	9.50	20.50
2	Plenum	0.00	0.00	0.00	0.00	0.00	0.00
5	AHDB9970	6.50	12.50	4.00	17.50	17.00	22.00
6	AHDB9946	4.00	3.00	4.67	3.33	4.33	7.67
7	Spruzit	4.50	3.50	4.00	7.00	2.00	4.50
12	AHDB9929	8.00	8.00	14.00	15.50	16.67	51.67
F		6.931	7.244	2.548	4.558	3.590	3.747
P		0.004	0.003	0.091	0.017	0.032	0.028
SED		1.665	2.171	3.795	4.197	5.325	13.902
LSD (5%) (two-sided)		3.665	4.778	8.353	9.238	11.601	30.290
LSD (5%) (one-sided)		2.990	3.898	6.816	7.538	9.490	24.778
df		12	12	12	12	12	12

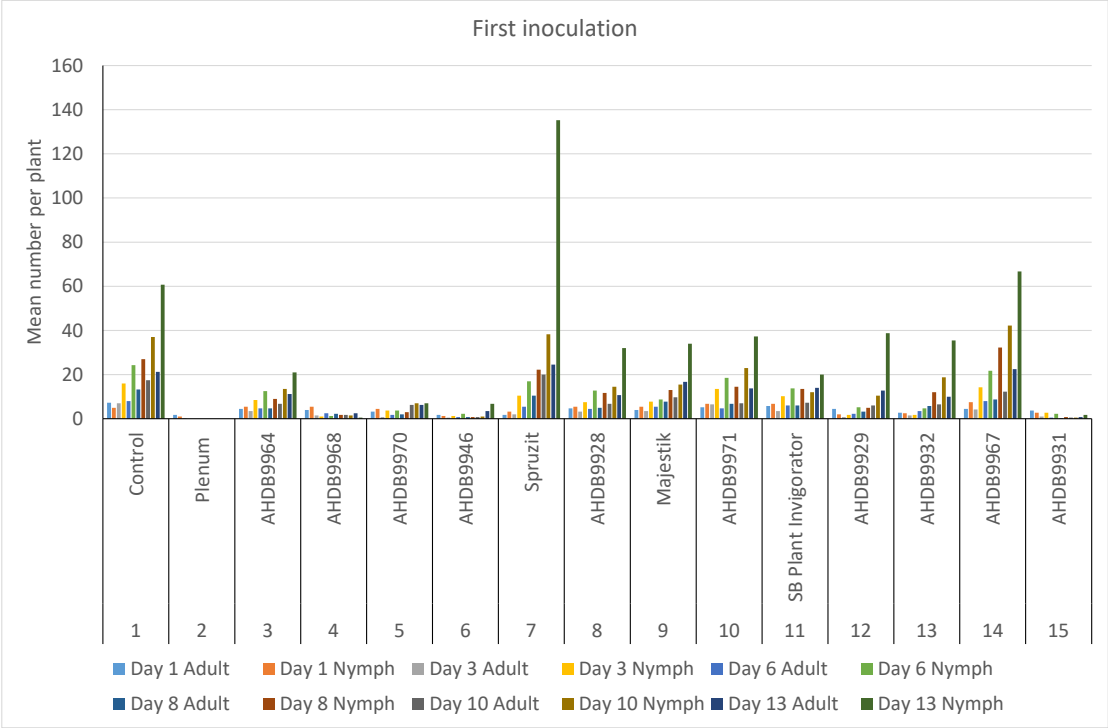

Figure 2a. *Myzus persicae* – survival during the first week after inoculation/treatment with bio-insecticide products, shown as mean number of aphids per plant. Bio-insecticides applied on Day 0 and Day 7.

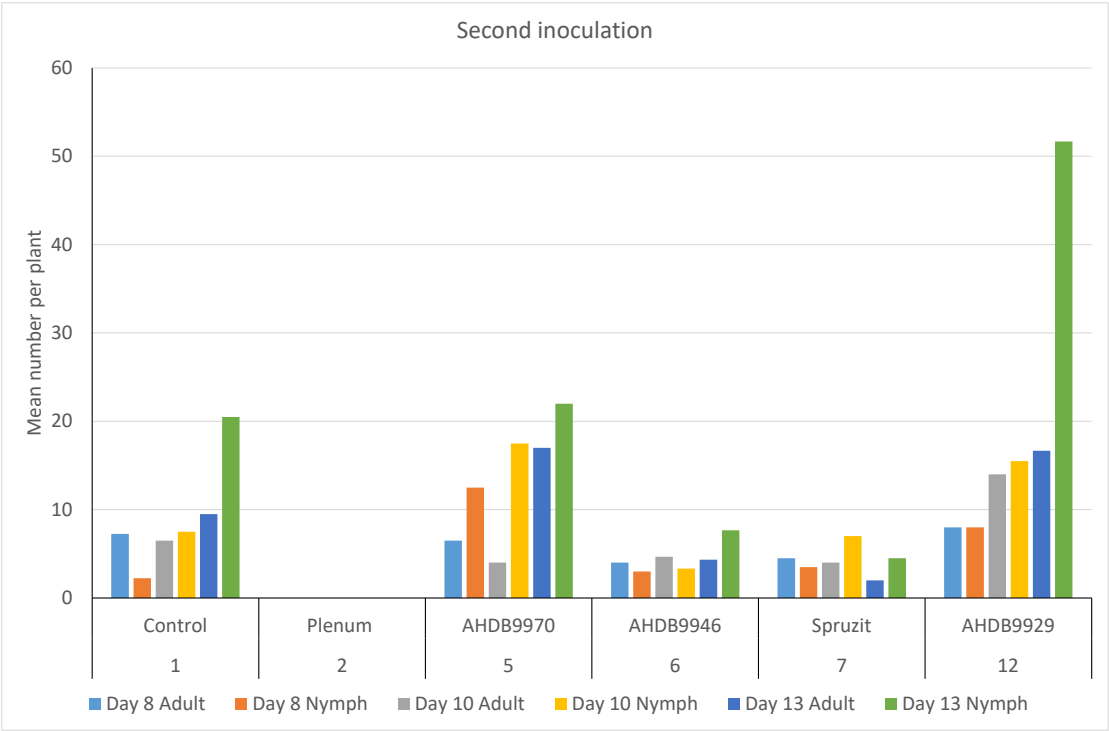

Figure 2b *Myzus persicae* – survival during the first week after inoculation/treatment with bio-insecticide products, shown as mean number of aphids per plant. Bio-insecticides applied on Day 0 and Day 7.

B *Brevicoryne brassicae* (Cabbage aphid) on Brussels sprout

Trial conduct

UK regulatory guidelines were followed but EPPO guidelines took precedence. The following EPPO guidelines were followed:

Relevant EPPO guideline(s)		Variation from EPPO
PP 1/152(3)	Design and analysis of efficacy evaluation trials	None
PP 1/135(3)	Phytotoxicity assessment	None
PP 1/181(3)	Conduct and reporting of efficacy evaluation trials including GEP	None

There were no deviations from EPPO guidance.

Test site

Item	Details
Location address	University of Warwick Wellesbourne Campus Wellesbourne Warwick CV35 9EF
Crop	Brussels sprout
Cultivar	Doric
Soil or substrate type	Levingtons M2
Agronomic practice	See Appendix A
Prior history of site	n/a

Trial design

Item	Details
Trial design:	Replication in time
Number of replicates:	4
Row spacing:	n/a
Plot size: (w x l)	n/a
Plot size: (m^2)	n/a
Number of plants per plot:	1
Leaf Wall Area calculations	n/a

Treatment details

Conventional and bio-insecticides

AHDB Code	Active substance	Product name/ manufacturers code	Formulation batch number	Content of active substance in product	Formulation type	Adjuvant
Untreated						
Authorized	Spirotetramat	Movento	ECE4101299	150g/l	OD	None
AHDB9951	N/D	N/D	N/D	N/D	N/D	Phase II
AHDB9935	N/D	N/D	N/D	N/D	N/D	Phase II
AHDB9934	N/D	N/D	N/D	N/D	N/D	Silwet L77
AHDB9933	N/D	N/D	N/D	N/D	N/D	Phase II
AHDB9970	N/D	N/D	N/D	N/D	N/D	None
AHDB9946	N/D	N/D	N/D	N/D	N/D	Phase II
AHDB9928	N/D	N/D	N/D	N/D	N/D	Phase II
AHDB9931	N/D	N/D	N/D	N/D	N/D	Siwet
AHDB9932	N/D	N/D	N/D	N/D	N/D	Phase II
AHDB9967	N/D	N/D	N/D	N/D	N/D	None

Application schedule

Conventional and bio-insecticides

Treatment number	Treatment: product name or AHDB code	Rate of active substance (ml or g a.s./ha)	Rate of product (l or kg/ha)	Application code
1	Control			
2	Movento	75g	0.5l	A
3	AHDB9951	75g	0.75l	A
4	AHDB9935	24g	0.2l	A
5	AHDB9934	80g	0.16kg	A
6	AHDB9933	125g	0.625l	A
7	AHDB9970	2303ml	4.8l	A B
8	AHDB9946	9.3g	1l	A B
9	AHDB9928	55g	0.25kg	A B
10	AHDB9931	1320ml	8l	A B
11	AHDB9932		0.6l	A B
12	AHDB9967	192ml	3.2l	A B

Application details

Conventional and bio-insecticides

	Application			
	A1	**B1**	**A2**	**B2**
	Reps 1 and 2		**Reps 3 and 4**	
Application date	5/6/18	12/6/18	3/7/18	10/7/18
Time of day	11.00	13.30	11.00	11.00
Crop growth stage (Max, min average BBCH)	16	16	17	17
Crop height (cm)	16	16	16	17
Crop coverage (%)	N/A	N/A	N/A	N/A
Application Method	Spray			
Application Placement	Foliar			
Application equipment	Berthoud Vermorel 2000HP			
Nozzle pressure	2 Bar			
Nozzle type	02F110			
Nozzle size	02			
Application water volume/ha	300 (conventional) and 400 (bio-insecticides)			
Temperature of air - shade (°C)	16	18	20	21
Relative humidity (%)	N/A	N/A	N/A	N/A
Wind speed range (m/s)	N/A	N/A	N/A	N/A
Dew presence (Y/N)	N/A	N/A	N/A	N/A
Temperature of soil - 2-5 cm (°C)	N/A	N/A	N/A	N/A
Wetness of soil - 2-5 cm	N/A	N/A	N/A	N/A
Cloud cover (%)	N/A	N/A	N/A	N/A

Untreated levels of pests/pathogens at application and through the assessment period

Common name	Scientific Name	EPPO Code	Infestation level pre-application	Infestation level at start of assessment period	Infestation level at end of assessment period
Cabbage aphid	*Brevicoryne brassicae*	BRVCBR	10/plant	10/plant	>50/plant

Method

Brussel sprout (cv Doric) seeds (1 per pot) were sown in FP7 pots filled with Levingtons M2 compost on 2 occasions (conventional insecticides bio-insecticides were included in a single trial). Plants were allowed to develop to around the 6 true leaf stage. As Brussels sprout plants have a waxy leaf surface a pre-spray adhesion test (whole leaves were dipped in a spray solution and the amount of run-off was assessed) was conducted with all formulations to determine if an adjuvant was required. If it was decided that an adjuvant was required to reduce run-off then Phase II was used at 0.5% by volume unless an alternative was specified by the insecticide manufacturer (see Treatment Table above). One day before spraying the plants were inoculated with 10 aphids/plant and kept in insect cages in controlled

environment rooms (20ºC, 16 hours light, 8 hours dark). The plants were removed from the cages and taken outdoors to be sprayed. After spraying they were returned to the cages in the controlled environment room. Conventional insecticides were sprayed once, bio-insecticides were re-applied 1 week after the first application using the same techniques. Where there was 100% mortality of aphids 6 days after spraying plants were re-inoculated with 10 aphids as before. If 100% mortality of aphids was achieved again plants were re-inoculated with a further 10 aphids 13 days after spraying. Aphid numbers were counted at the times described below. After higher than expected mortality was observed in bio-insecticide treatments two replicate treatments of the adjuvant Phase II alone (Treatment 13) were assessed. The plants that were not re-inoculated were discarded after 13 days.

Assessment details

Conventional and bio-insecticides

Evaluation date	Evaluation Timing (DA)[1]	Crop Growth Stage (BBCH)	Evaluation type (efficacy, phytotox)	Assessment
6/6/18 4/7/18	1	16	Efficacy	Aphid count
8/6/18 6/7/18	3	16	Efficacy	Aphid count
11/6/18 [2] 9/7/18 [2]	6	16	Efficacy	Aphid count
13/6/18 11/7/18	8	16	Efficacy Phytotoxicity	Aphid count Leaf damage
15/618 13/7/18	10	17	Efficacy	Aphid count
18/6/18 [3] 16/7/18 [3]	13	17	Efficacy	Aphid count
19/6/18 17/7/18	14	17	Efficacy	Aphid count
22/6/18 20/7/18	17	17	Efficacy	Aphid count
25/6/18 23/7/18	20	17	Efficacy	Aphid count

[1] DA – days after application
[2] First re-infestation in treatments where there were no surviving aphids
[3] Second re-infestation in treatments where there were no surviving aphids

Statistical analysis

The data were subjected to Analysis of Variance in EXCEL. They were not transformed prior to analysis. The output should be interpreted with care as there are a large number of zeros in the data set and some of the comparisons are based on small numbers of aphids (e.g. nymphs soon after infestation).

Results

Phytotoxicity

Some phytotoxic effects were observed, but not recorded, in the AHDB9934 treated plants (see Table 1 in *Myzus persicae* section).

Aphid counts

Table 4 and Figure 3a-c summarise aphid survival after treatment. All insecticide treatments led to 100% mortality within 3 days, as did AHDB9946. All treatments were 'effective' when compared with the untreated control ($p<0.05$), including Phase II alone. Following re-infestation on Day 6 (all insecticide treated plants plus all AHDB9946 and AHDB9932, 2 replicates of AHDB9970, AHDB9928 and AHDB9967, 3 replicates of AHDB9931 and 1 replicate of Phase II), all of the insecticides led to 100% mortality by Day 10. The bio-insecticides were much less effective. Following re-infestation on Day 13 (all insecticide treated plants), AHDB9951, AHDB9935 and AHDB9934 all caused 100% mortality by Day 20.

Table 4. *Brevicoryne brassicae* – survival after inoculation/treatment with insecticide and bio-insecticide products shown as mean number of aphids per plant. Insecticides applied on Day 0 and bio-insecticides applied on Day 0 and Day 7. Highlighted means are significantly lower than the untreated control (one-sided LSD).

First inoculation			**Day 1**		**Day 3**		**Day 6**
Treatment		**Adult**	**Nymph**	**Adult**	**Nymph**	**Adult**	**Nymph**
1	Control	**7.25**	**8**	**7.5**	**16**	**7.5**	**29.5**
2	Movento	1	1	0	0	0	0
3	AHDB9951	2	0.75	0	0	0	0
4	AHDB9935	0.75	0.5	0	0	0	0
5	AHDB9934	0.25	0.25	0	0	0	0
6	AHDB9933	0.75	0.25	0	0	0	0
7	AHDB9970	1.25	1	1	3.25	1.25	5
8	AHDB9946	0.5	0.5	0	0	0	0
9	AHDB9928	1.75	0.5	1.25	3	1.5	5
10	AHDB9931	2.75	1.75	1	1.25	0.5	0.25
11	AHDB9932	0.75	0.25	0.5	0.5	0	0
12	AHDB9967	3	2.5	1.75	4.5	1.75	7
13	Phase II	2	0.5	1	2.5	0.5	3
F		6.831	4.483	16.130	8.753	13.250	10.772
P		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SED		0.993	1.396	0.712	2.092	0.797	3.491
LSD (5%) (two-sided)		2.012	2.829	1.442	4.240	1.615	7.073
LSD (5%) (one-sided)		1.676	2.355	1.201	3.530	1.345	5.889
df		37	37	37	37	37	37

First inoculation		Day 8		Day 10		Day 13	
Treatment		**Adult**	**Nymph**	**Adult**	**Nymph**	**Adult**	**Nymph**
1	Control	**11.5**	**34.75**	**14.75**	**44.75**	**27**	**59**
2	Movento	0	0	0	0	0	0
3	AHDB9951	0	0	0	0	0	0
4	AHDB9935	0	0	0	0	0	0
5	AHDB9934	0	0	0	0	0	0
6	AHDB9933	0	0	0	0	0	0
7	AHDB9970	5.25	2	4.75	4.5	5	16
8	AHDB9946	0	0	0	0	0	0
9	AHDB9928	1.5	4.5	1.25	4	3.5	8
10	AHDB9931	0.25	0.25	0	0	0.75	2
11	AHDB9932	0	0	0	0	0	0
12	AHDB9967	2.5	4.75	1.75	4.75	2	4.25
13	Phase II	2	4.5	2	8.5	3.5	8.5
F		4.014	7.247	7.242	14.475	12.159	8.529
P		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SED		2.338	4.975	2.159	4.537	2.982	7.858
LSD (5%) (two-sided)		4.737	10.081	4.375	9.192	6.043	15.922
LSD (5%) (one-sided)		3.944	8.394	3.643	7.654	5.032	13.257
df		37	37	37	37	37	37

Second inoculation		Day 8		Day 10		Day 13	
Treatment		**Adult**	**Nymph**	**Adult**	**Nymph**	**Adult**	**Nymph**
1	Control	5.25	7.50	4.50	13.50	6.25	23.75
2	Movento	1.25	0.50	0.25	0.00	0.00	0.00
3	AHDB9951	0.75	0.25	0.00	0.00	0.00	0.00
4	AHDB9935	2.50	1.25	0.50	0.00	0.00	0.00
5	AHDB9934	1.00	1.00	0.00	0.00	0.00	0.00
6	AHDB9933	0.75	0.50	0.00	0.00	0.00	0.00
7	AHDB9970	5.50	9.00	4.50	14.50	6.00	26.50
8	AHDB9946	3.25	5.25	3.50	9.50	3.00	14.25
9	AHDB9928	3.00	8.00	2.00	11.50	2.00	14.50
10	AHDB9931	6.33	2.33	5.00	9.00	7.33	22.67
11	AHDB9932	4.25	5.75	3.50	6.25	3.75	11.25
12	AHDB9967	7.50	5.00	7.00	21.50	7.50	41.00
13	Phase II	7.00	10.00	6.00	19.00	9.00	39.00
F		5.118	4.129	9.349	6.256	6.811	4.308
P		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SED		1.267	2.029	0.976	3.534	1.512	7.996
LSD (5%) (two-sided)		2.592	4.149	1.996	7.227	3.093	16.353
LSD (5%) (one-sided)		2.153	3.447	1.658	6.004	2.570	13.586
df		29	29	29	29	29	29

Third inoculation		Day 14		Day 17		Day 20	
Treatment		**Adult**	**Nymph**	**Adult**	**Nymph**	**Adult**	**Nymph**
1	Control	7.5	3.25	7.25	20.25	6.5	33.25
2	Movento	4.75	1.5	0.5	0	0.25	0
3	AHDB9951	5.75	1.75	0.75	0.75	0	0
4	AHDB9935	3.5	1.5	0.25	0.25	0	0
5	AHDB9934	5.25	2.75	0.25	0.25	0	0
6	AHDB9933	2.75	0	0.25	0.25	0.5	0.5
F		1.843	0.796	22.867	10.048	21.396	28.941
P		0.155	0.567	<0.001	<0.001	<0.001	<0.001
SED		1.756	1.797	0.829	3.635	0.795	3.558
LSD (5%) (two-sided)		3.689	3.775	1.742	7.637	1.670	7.475
LSD (5%) (one-sided)		3.045	3.116	1.438	6.304	1.378	6.170
df		18	18	18	18	18	18

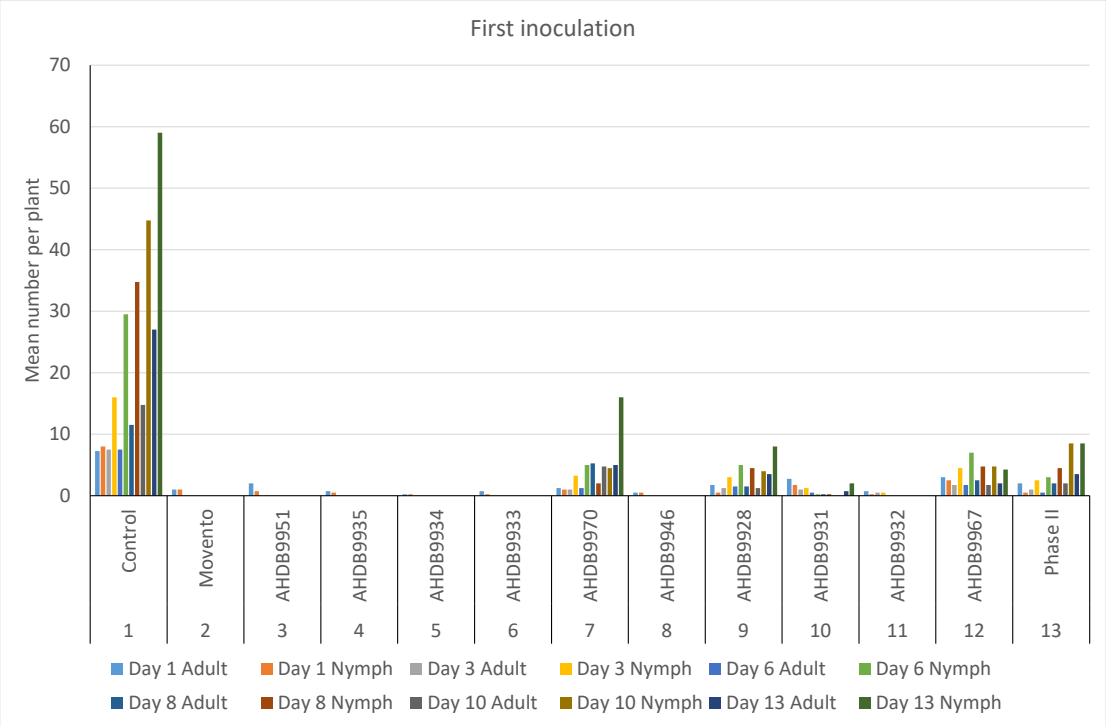

Figure 3a *Brevicoryne brassicae* – survival after inoculation/treatment with insecticide and bio-insecticide products shown as mean number of aphids per plant. Insecticides applied on Day 0 and bio-insecticides applied on Day 0 and Day 7.

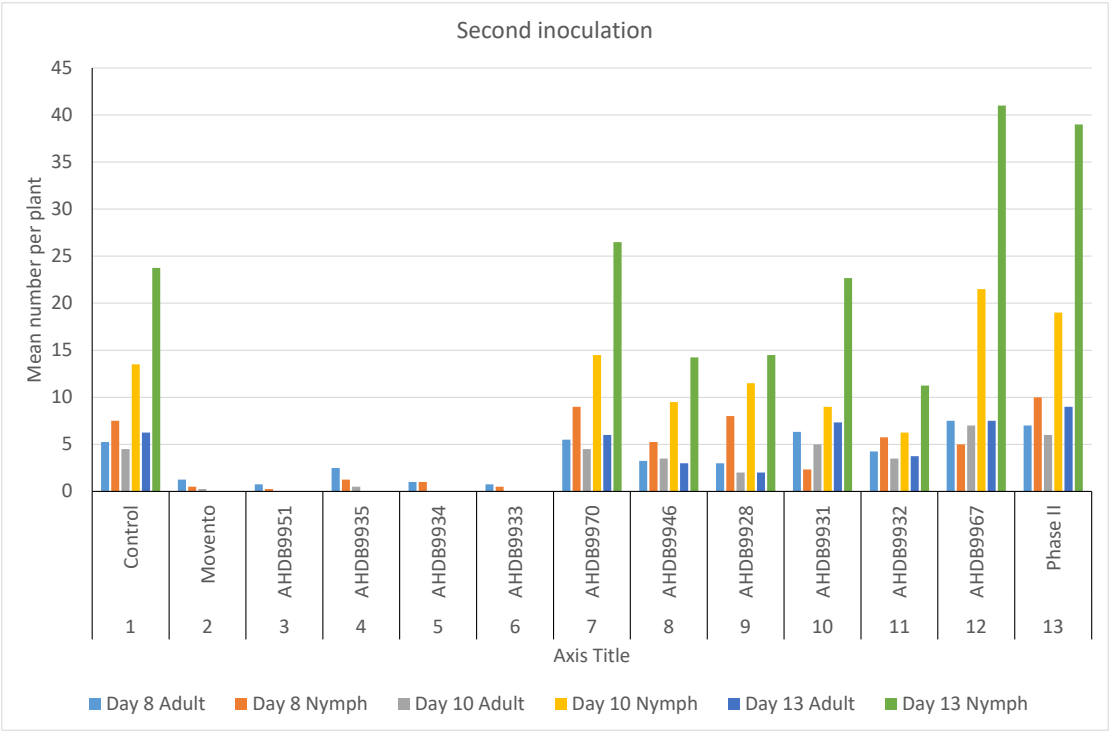

Figure 3b *Brevicoryne brassicae* – survival after inoculation/treatment with insecticide and bio-insecticide products shown as mean number of aphids per plant. Insecticides applied on Day 0 and bio-insecticides applied on Day 0 and Day 7.

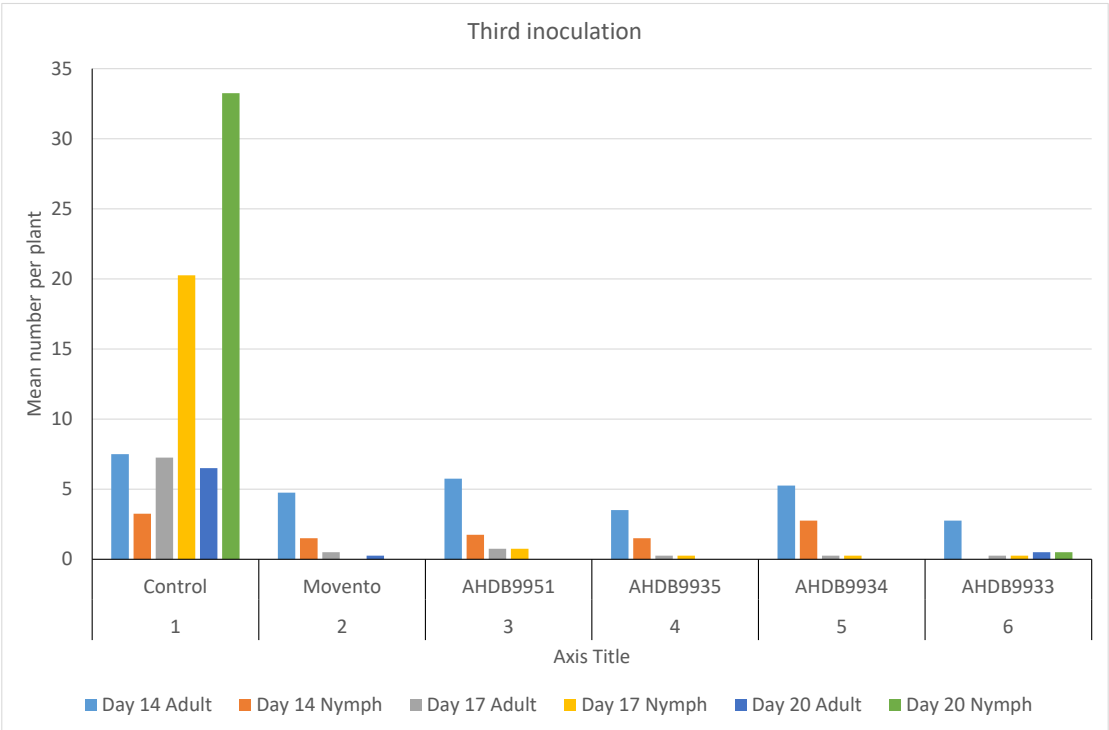

Figure 3c *Brevicoryne brassicae* – survival after inoculation/treatment with insecticide and bio-insecticide products shown as mean number of aphids per plant. Insecticides applied on Day 0 and bio-insecticides applied on Day 0 and Day 7.

C *Cavariella aegopodii* (Willow carrot aphid) on Carrot

Trial conduct

UK regulatory guidelines were followed but EPPO guidelines took precedence. The following EPPO guidelines were followed:

Relevant EPPO guideline(s)		Variation from EPPO
PP 1/152(3)	Design and analysis of efficacy evaluation trials	None
PP 1/135(3)	Phytotoxicity assessment	None
PP 1/181(3)	Conduct and reporting of efficacy evaluation trials including GEP	None

There were no deviations from EPPO guidance.

Test site

Item	Details
Location address	University of Warwick Wellesbourne Campus Wellesbourne Warwick CV35 9EF
Crop	Carrot
Cultivar	Nairobi
Soil or substrate type	Levingtons M2
Agronomic practice	See Appendix A
Prior history of site	n/a

Trial design

Item	Details
Trial design:	Replication in time
Number of replicates:	4
Row spacing:	n/a
Plot size: (w x l)	n/a
Plot size: (m^2)	n/a
Number of plants per plot:	5
Leaf Wall Area calculations	n/a

Treatment details

Conventional and bio-insecticides

AHDB Code	Active substance	Product name/ manufacturers code	Formulation batch number	Content of active substance in product	Formulation type	Adjuvant
Untreated						
Authorized	Spirotetramat	Movento	ECE4101299	150g/l	OD	None
AHDB9951	N/D	N/D	N/D	N/D	N/D	None
AHDB9935	N/D	N/D	N/D	N/D	N/D	None
AHDB9934	N/D	N/D	N/D	N/D	N/D	None
AHDB9933	N/D	N/D	N/D	N/D	N/D	None
AHDB9946	N/D	N/D	N/D	N/D	N/D	None
Not needed	Pyrethrins	Spruzit	5736/APR16	4.59g/l	OD	None
AHDB9971	N/D	N/D	N/D	N/D	N/D	None
Not needed	Surfactants	SB Plant Invigorator	0305/17	Not specified	EC	None
AHDB9929	N/D	N/D	N/D	N/D	N/D	None
AHDB9931	N/D	N/D	N/D	N/D	N/D	None

Application schedule

Conventional and bio-insecticides

Treatment number	Treatment: product name or AHDB code	Rate of active substance (ml or g a.s./ha)	Rate of product (l or kg/ha)	Application code
1	Control			
2	Movento	75g	0.5l	A
3	AHDB9951	125g	0.625l	A
4	AHDB9935	30g	0.3l	A
5	AHDB9934		0.8334kg	A
6	AHDB9933	75g	0.1875kg	A
7	AHDB9946	9.3g	1l	A B
8	Spruzit	27.5g	6l	A B
9	AHDB9971	16.8g	0.56l	A B
10	SB Plant Invigorator		0.4l	A B
11	AHDB9929	1 X 10^{13}	5l	A B
12	AHDB9931	1320g	8l	A B

Application details

Conventional and bio-insecticides

	Application			
	A1	B1	A2	B2
	Reps 1 and 2		Reps 3 and 4	
Application date	26/2/19	5/3/19	19/3/19	26/3/19
Time of day	11.00	13.30	11.00	13.30
Crop growth stage (Max, min average BBCH)	16	16	15	15
Crop height (cm)	12	12	10	10
Crop coverage (%)	N/A	N/A	N/A	N/A
Application Method	Spray			
Application Placement	Foliar			
Application equipment	Berthoud Vermorel 2000HP			
Nozzle pressure	2 Bar			
Nozzle type	02F110			
Nozzle size	02			
Application water volume/ha	300 (conventional) and 400 (bio-insecticides)			
Temperature of air - shade (°C)	16	11	11	13
Relative humidity (%)	N/A	N/A	N/A	N/A
Wind speed range (m/s)	N/A	N/A	N/A	N/A
Dew presence (Y/N)	N/A	N/A	N/A	N/A
Temperature of soil - 2-5 cm (°C)	N/A	N/A	N/A	N/A
Wetness of soil - 2-5 cm	N/A	N/A	N/A	N/A
Cloud cover (%)	N/A	N/A	N/A	N/A

Untreated levels of pests/pathogens at application and through the assessment period

Common name	Scientific Name	EPPO Code	Infestation level pre-application	Infestation level at start of assessment period	Infestation level at end of assessment period
Willow-carrot aphid	*Cavariella aegopodii*	CAVAAE	10/plant	10/plant	>50/plant

Method

Carrot (cv Nairobi) seeds (5 per pot) were sown in FP7 pots filled with Levingtons M2 compost on 2 occasions (conventional insecticides and bio-insecticides were included in a single trial). Plants were allowed to develop to around the 6 true leaf stage. As carrots do not have a waxy leaf surface it was decided that no adjuvants would be required to aid adhesion to the leaf surface. One day before spraying the plants were inoculated with 10 aphids/plant and kept in insect cages in controlled environment rooms (20°C, 16 hours light, 8 hours dark). The plants were removed from the cages and taken outdoors to be sprayed. After spraying they were returned to the cages in the controlled environment room. Conventional insecticides were sprayed once, bio-insecticides were re-applied 1 week after the first application using the same techniques. Where there was 100% mortality of aphids 6 days after

spraying plants were re-inoculated with 10 aphids as before. If 100% mortality of aphids was achieved again plants were re-inoculated with a further 10 aphids 13 days after spraying. Aphid numbers were counted at the times described below.

Assessment details

Conventional and bio-insecticides

Evaluation date	Evaluation Timing (DA)[1]	Crop Growth Stage (BBCH)	Evaluation type (efficacy, phytotox)	Assessment
27/2/19 20/3/19	1	16	Efficacy	Aphid count
1/3/19 22/3/19	3	16	Efficacy	Aphid count
4/3/19 [2] 25/3/19 [2]	6	16	Efficacy	Aphid count
6/3/19 27/3/19	8	16	Efficacy Phytotoxicity	Aphid count Leaf damage
8/3/19 29/3/19	10	17	Efficacy	Aphid count
11/3/19 [3] 1/4/19 [3]	13	17	Efficacy	Aphid count
13/3/19 3/4/19	14	17	Efficacy	Aphid count
15/3/19 5/4/19	17	17	Efficacy	Aphid count
18/3/19 8/4/19	20	17	Efficacy	Aphid count

[1] DA – days after application
[2] First re-infestation in treatments where there were no surviving aphids
[3] Second re-infestation in treatments where there were no surviving aphids

Statistical analysis

The data were subjected to Analysis of Variance in EXCEL. They were not transformed prior to analysis. The output should be interpreted with care as there are a large number of zeros in the data set and some of the comparisons are based on small numbers of aphids (e.g. nymphs soon after infestation).

Results

Phytotoxicity

There was no evidence of phytoxicity from any of the treatments.

Aphid counts

Table 5 and Figure 4a-c summarise aphid survival after treatment with products. Movento and AHDB9951 treatments led to 100% mortality within 3 days (first inoculation). AHDB9934 led to 100% mortality within 8 days. One of the bio-insecticides led to 100% mortality after 13 days, but some were more effective – Spruzit and AHDB9946. Plants treated with the 3 most effective insecticides were re-inoculated after 6 days and all aphids had died on plants treated with Movento and AHDB9951 by Day 13 (second inoculation). These plants were re-inoculated on Day 13 and survival was very low by Day 20 (third inoculation).

Table 5 *Cavariella aegopodii* – survival after inoculation/treatment with insecticide and bio-insecticide products shown as mean number of aphids per plant. Insecticides applied on Day 0 and bio-insecticides applied on Day 0 and Day 7. Highlighted means are significantly lower than the untreated control (one-sided LSD).

First inoculation		Day 1		Day 3		Day 6	
Treatment		Adult	Nymph	Adult	Nymph	Adult	Nymph
1	Control	5.25	1.25	5.5	2.25	7	9.5
2	Movento	1.25	0	0	0	0	0
3	AHDB9951	0.5	0	0	0	0	0
4	AHDB9935	4	0.25	3.25	0.75	2.25	0.5
5	AHDB9934	2.5	0.25	1	0.25	0	0.25
6	AHDB9933	4.25	1.5	4.25	4.75	5.5	12.5
7	AHDB9946	4.75	1	4	4.75	6	12.75
8	Spruzit	2.75	0.25	2.75	1.25	4.5	2.25
9	AHDB9971	4.75	0.5	4.75	5.5	5	7.75
10	SB Plant Invigorator	5.5	1	5.5	2.75	6.5	10.5
11	AHDB9929	5.25	1.75	4.75	2.25	6.5	9
12	AHDB9931	6	1.25	6.25	2.5	8.5	10.25
F		4.538	0.956	5.920	2.223	4.847	2.127
P		<0.001	0.502	<0.001	0.035	<0.001	0.044
SED		1.168	0.886	1.250	1.826	1.928	5.055
LSD (5%) (two-sided)		2.369	1.797	2.535	3.703	3.911	10.252
LSD (5%) (one-sided)		1.972	1.496	2.110	3.082	3.256	8.534
df		36	36	36	36	36	36

First inoculation		Day 8		Day 10		Day 13	
Treatment		Adult	Nymph	Adult	Nymph	Adult	Nymph
1	Control	10.5	15.25	21	21	27.25	25.25
2	Movento	0	0	0	0	0	0
3	AHDB9951	0	0	0	0	0	0
4	AHDB9935	3	0.5	3	1	2.5	1
5	AHDB9934	0	0	0	0	0	0
6	AHDB9933	18.5	21.25	26.75	31.5	37.5	45.25
7	AHDB9946	5.75	7.75	6.25	7	9	9.5
8	Spruzit	2.5	2	3	1.75	5.5	4
9	AHDB9971	10	15.25	9.25	15	17.5	17.25
10	SB Plant Invigorator	15.25	10.75	17	17.75	21.75	30
11	AHDB9929	8.25	8.25	11.75	12	17.25	21.75
12	AHDB9931	13	14.25	17.5	18.75	35.5	32.5
F		3.950	2.952	7.487	3.061	8.784	5.614
P		<0.001	0.007	<0.001	0.005	<0.001	<0.001
SED		4.517	6.138	4.729	8.457	6.574	9.213
LSD (5%) (two-sided)		9.162	12.448	9.590	17.151	13.332	18.684
LSD (5%) (one-sided)		7.627	10.362	7.984	14.278	11.098	15.554
df		36	36	36	36	36	36

First inoculation		Day 15		Day 17		Day 20	
Treatment		Adult	Nymph	Adult	Nymph	Adult	Nymph
1	Control	37.25	48.75	38.25	87.5	65.5	134.25
2	Movento	0	0	0	0	0	0
3	AHDB9951	0	0	0	0	0	0
4	AHDB9935	3	2.75	3	3	4	5.25
5	AHDB9934	0	0	0	0	0	0
6	AHDB9933	34.75	81.25	43	141	93.5	247.5
7	AHDB9946	14	19.25	17.75	33.75	33.25	85.5
8	Spruzit	6.5	8	8	8.5	12.25	26.5
9	AHDB9971	18	22.5	18.75	30.75	19	47.75
10	SB Plant Invigorator	31.25	50.25	42.75	62.5	65.25	127.5
11	AHDB9929	23.75	38.5	31.75	70.25	61.25	131.5
12	AHDB9931	43.25	62	54.25	86.25	81.25	147.25
F		8.672	6.748	10.93	10.72	8.475	8.457
P		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SED		7.718	15.154	8.461	19.815	17.011	38.557
LSD (5%) (two-sided)		15.653	30.733	17.160	40.187	34.501	78.196
LSD (5%) (one-sided)		13.030	25.584	14.285	33.454	28.720	65.095
df		36	36	36	36	36	36

Second inoculation		Day 8		Day 10		Day 13	
Treatment		Adult	Nymph	Adult	Nymph	Adult	Nymph
1	Control	5.25	0.5	6	3.75	8.25	7.5
2	Movento	2.25	0	0.75	0	0	0
3	AHDB9951	0	0	0	0	0	0
5	AHDB9934	3	0	2.5	1.5	3.5	4.75
F		8.182	1	29.17	5.067	37.10	5.913
P		0.003	0.426	<0.001	0.017	<0.001	0.010
SED		1.070	0.354	0.700	1.113	0.907	2.158
LSD (5%) (two-sided)		2.332	0.770	1.525	2.426	1.977	4.702
LSD (5%) (one-sided)		1.908	0.630	1.247	1.984	1.617	3.846
df		12	12	12	12	12	12

Third inoculation		Day 15		Day 17		Day 20	
Treatment		Adult	Nymph	Adult	Nymph	Adult	Nymph
1	Control	5.5	2.25	6.25	12	11.75	28.25
2	Movento	2.25	0.25	1	0.5	0.25	0
3	AHDB9934	0.25	0	0	0	0.25	0
F		12.33	2.547	27.51	4.952	46.34	14.45
P		0.003	0.133	<0.001	0.035	<0.001	0.002
SED		1.067	1.093	0.905	4.314	1.379	6.068
LSD (5%) (two-sided)		2.414	2.472	2.048	9.759	3.120	13.727
LSD (5%) (one-sided)		1.956	2.003	1.659	7.908	2.529	11.123
df		9	9	9	9	9	9

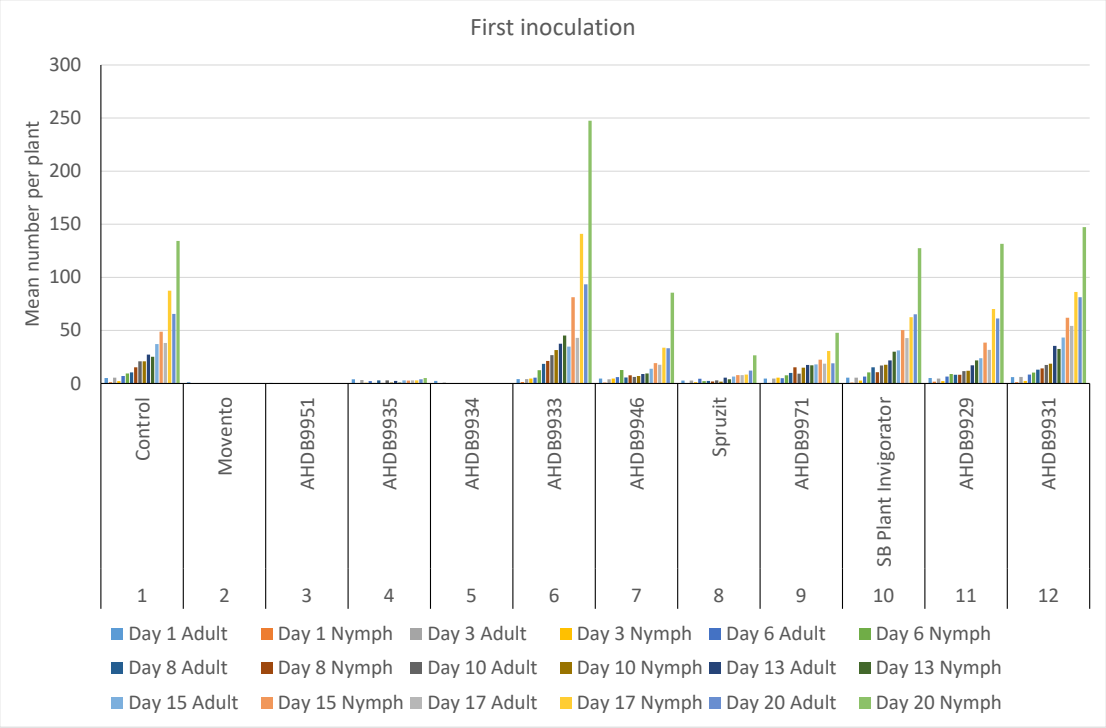

Figure 4a *Cavariella aegopodii* – survival after inoculation/treatment with insecticide and bio-insecticide products shown as mean number of aphids per plant. Insecticides applied on Day 0 and bio-insecticides applied on Day 0 and Day 7.

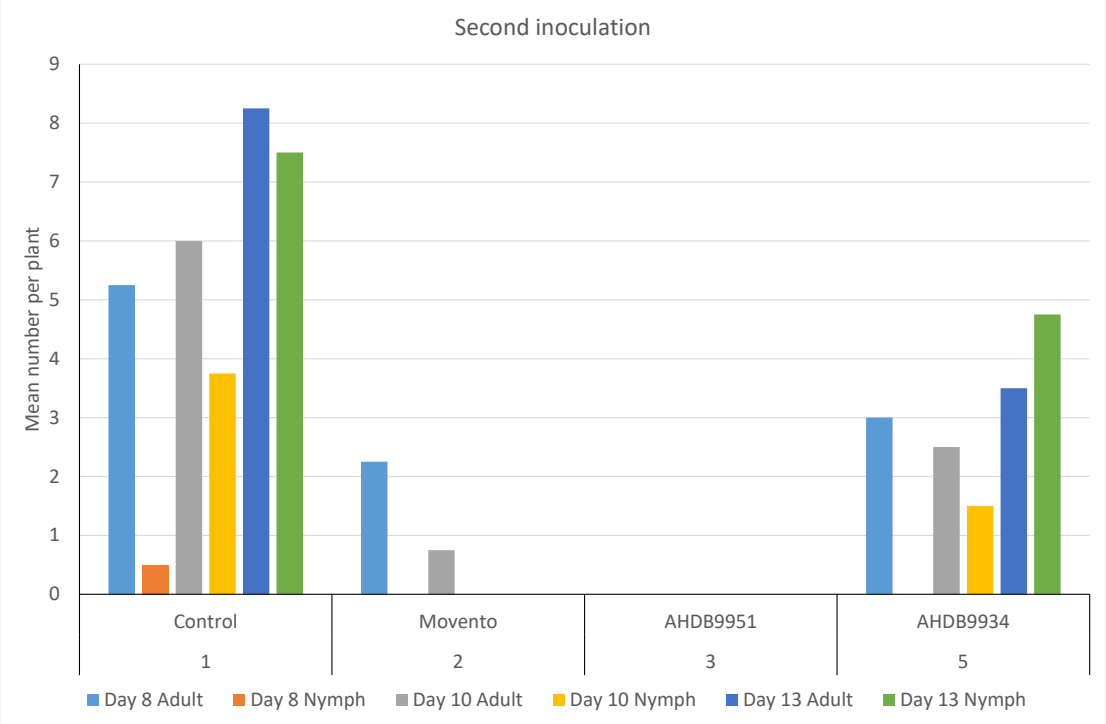

Figure 4b *Cavariella aegopodii* – survival after inoculation/treatment with insecticide and bio-insecticide products shown as mean number of aphids per plant. Insecticides applied on Day 0 and bio-insecticides applied on Day 0 and Day 7.

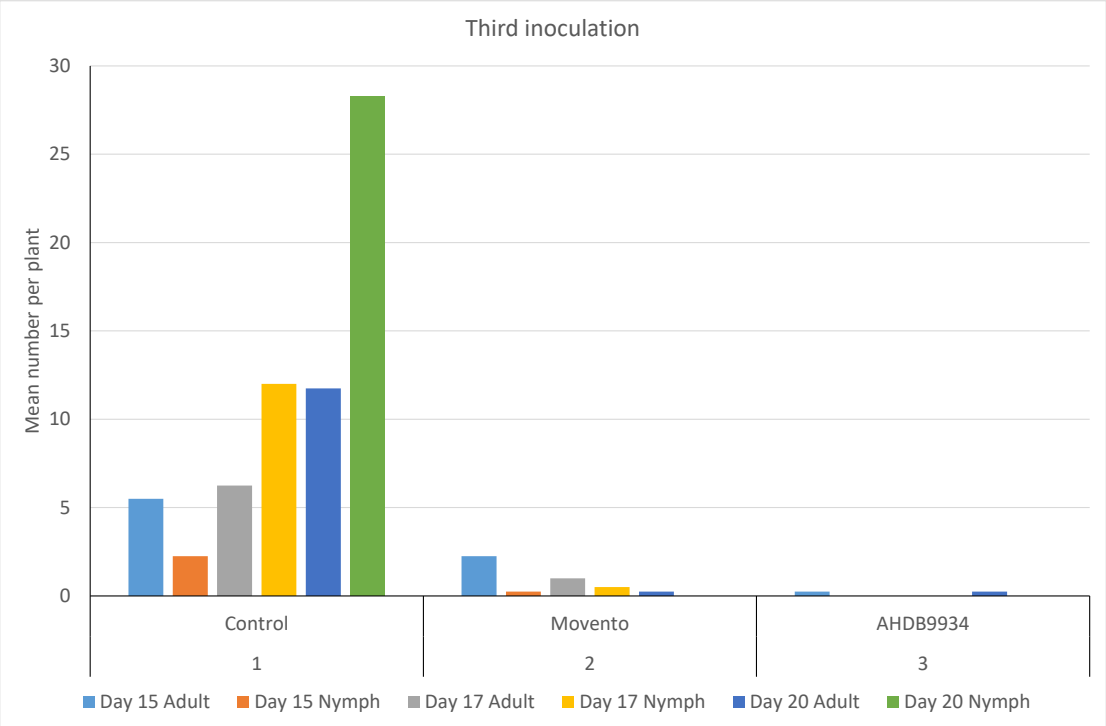

Figure 4c *Cavariella aegopodii* – survival after inoculation/treatment with insecticide and bio-insecticide products shown as mean number of aphids per plant. Insecticides applied on Day 0 and bio-insecticides applied on Day 0 and Day 7.

D *Nasonovia ribisnigri* (Currant lettuce aphid) on lettuce

Trial conduct

UK regulatory guidelines were followed but EPPO guidelines took precedence. The following EPPO guidelines were followed:

Relevant EPPO guideline(s)		Variation from EPPO
PP 1/152(3)	Design and analysis of efficacy evaluation trials	None
PP 1/135(3)	Phytotoxicity assessment	None
PP 1/181(3)	Conduct and reporting of efficacy evaluation trials including GEP	None

There were no deviations from EPPO guidance.

Test site

Item	Details
Location address	University of Warwick Wellesbourne Campus Wellesbourne Warwick CV35 9EF
Crop	Lettuce
Cultivar	Lobjoits Green Cos
Soil or substrate type	Levingtons M2
Agronomic practice	See Appendix A
Prior history of site	n/a

Trial design

Item	Details
Trial design:	Replication in time
Number of replicates:	4
Row spacing:	n/a
Plot size: (w x l)	n/a
Plot size: (m^2)	n/a
Number of plants per plot:	1
Leaf Wall Area calculations	n/a

Treatment details

Conventional and bio-insecticides

AHDB Code	Active substance	Product name/ manufacturers code	Formulation batch number	Content of active substance in product	Formulation type	Adjuvant
Untreated						
Authorized	Spirotetramat	Movento	ECE4101299	150g/l	OD	None
AHDB9951	N/D	N/D	N/D	N/D	N/D	None
AHDB9935	N/D	N/D	N/D	N/D	N/D	None
AHDB9934	N/D	N/D	N/D	N/D	N/D	None
AHDB9933	N/D	N/D	N/D	N/D	N/D	None
AHDB9946	N/D	N/D	N/D	N/D	N/D	None
AHDB9928	N/D	N/D	N/D	N/D	N/D	None
AHDB9971	N/D	N/D	N/D	N/D	N/D	None
AHDB9932	N/D	N/D	N/D	N/D	N/D	None
AHDB9967	N/D	N/D	N/D	N/D	N/D	None
Not needed	Maltodextrin	Majestik		49%	SC	None

Application schedule

Conventional and bio-insecticides

Treatment number	Treatment: product name or AHDB code	Rate of active substance (ml or g a.s./ha)	Rate of product (l or kg/ha)	Application code
1	Control			
2	Movento	75g	0.5l	A
3	AHDB9951	125g	0.625l	A
4	AHDB9935	30g	0.3l	A
5	AHDB9934		0.8334kg	A
6	AHDB9933	75g	0.1875kg	A
7	AHDB9946	9.3g	1l	A B
8	AHDB9928	55g	0.25kg	A B
9	AHDB9971	16.8g	0.56l	A B
10	AHDB9932		0.6l	A B
11	AHDB9967	192ml	3.2l	A B
12	Majestic	4900g	10l	A B

Application details

Conventional and bio-insecticides

	Application			
	A1	B1	A2	B2
	Reps 1 and 2		Reps 3 and 4	
Application date	15/1/19	22/1/19	29/1/19	5/2/19
Time of day	11.00	13.30	11.00	13.30
Crop growth stage (Max, min average BBCH)	16	16	16	16
Crop height (cm)	15	15	15	15
Crop coverage (%)	N/A	N/A	N/A	N/A
Application Method	Spray			
Application Placement	Foliar			
Application equipment	Berthoud Vermorel 2000HP			
Nozzle pressure	2 Bar			
Nozzle type	02F110			
Nozzle size	02			
Application water volume/ha	300 (conventional) and 400 (bio-insecticides)			
Temperature of air - shade (°C)	9	5	4	8
Relative humidity (%)	N/A	N/A	N/A	N/A
Wind speed range (m/s)	N/A	N/A	N/A	N/A
Dew presence (Y/N)	N/A	N/A	N/A	N/A
Temperature of soil - 2-5 cm (°C)	N/A	N/A	N/A	N/A
Wetness of soil - 2-5 cm	N/A	N/A	N/A	N/A
Cloud cover (%)	N/A	N/A	N/A	N/A

Untreated levels of pests/pathogens at application and through the assessment period

Common name	Scientific Name	EPPO Code	Infestation level pre-application	Infestation level at start of assessment period	Infestation level at end of assessment period
Currant lettuce aphid	*Nasonovia ribisnigri*	NASORN	10/plant	10/plant	>50/plant

Method

Lettuce (cv Lobjoits green cos) seeds (1 per pot) were sown in FP7 pots filled with Levingtons M2 compost on 2 occasions (conventional insecticides bio-insecticides were included in a single trial). Plants were allowed to develop to around the 6 true leaf stage. As lettuce do not have a waxy leaf surface it was decided that no adjuvants would be required to aid adhesion to the leaf surface. One day before spraying the plants were inoculated with 10 aphids/plant and kept in insect cages in controlled environment rooms (20°C, 16 hours light, 8 hours dark). The plants were removed from the cages and taken outdoors to be sprayed. After spraying they were returned to the cages in the controlled environment room. Conventional insecticides were sprayed once, bio-insecticides were re-applied 1 week after the first application using the same techniques. Where there was 100% mortality of aphids 6 days after

spraying plants were re-inoculated with 10 aphids as before. If 100% mortality of aphids was achieved again plants were re-inoculated with a further 10 aphids 13 days after spraying. Aphid numbers were counted at the times described below.

Assessment details

Conventional and bio-insecticides

Evaluation date	Evaluation Timing (DA)[1]	Crop Growth Stage (BBCH)	Evaluation type (efficacy, phytotox)	Assessment
16/1/19 29/1/19	1	16	Efficacy	Aphid count
18/1/19 1/2/19	3	16	Efficacy	Aphid count
21/1/19 [2] 4/2/19 [2]	6	16	Efficacy	Aphid count
23/1/19 6/2/19	8	16	Efficacy Phytotoxicity	Aphid count Leaf damage
25/1/19 8/2/19	10	17	Efficacy	Aphid count
28/1/19 [3] 11/2/19 [3]	13	17	Efficacy	Aphid count
30/1/19 13/2/19	14	17	Efficacy	Aphid count
1/2/19 15/2/19	17	17	Efficacy	Aphid count
4/2/19 18/2/19	20	17	Efficacy	Aphid count

[1] DA – days after application
[2] First re-infestation in treatments where there were no surviving aphids
[3] Second re-infestation in treatments where there were no surviving aphids

Statistical analysis

The data were subjected to Analysis of Variance in EXCEL. They were not transformed prior to analysis. The output should be interpreted with care as there are a large number of zeros in the data set and some of the comparisons are based on small numbers of aphids (e.g. nymphs soon after infestation).

Results

Phytotoxicity

There was no evidence of phytoxicity from any of the treatments.

Aphid counts

Table 6 and Figure 5 a-c summarise aphid survival after treatment. Movento and AHDB9951 treatments led to 100% mortality within 6 days (first inoculation). Plants treated with Movento, AHDB9951 and AHDB9934 were re-inoculated on Day 6 and all aphids had died by Day 13 on plants treated with Movento and AHDB9951 (second inoculation). None of the analyses were significantly different at this point, however, due to the low numbers of aphids overall. These plants were re-inoculated

on Day 13 and again all aphids had died by Day 20 (third inoculation). Again none of the analyses were significantly different at this point, due to the low numbers of aphids overall.

Table 6 *Nasonovia ribisnigri* – survival after inoculation/treatment with insecticide and bio-insecticide products shown as mean number of aphids per plant. Insecticides applied on Day 0 and bio-insecticides applied on Day 0 and Day 7. Highlighted means are significantly lower than the untreated control (one-sided LSD).

First inoculation		Day 1		Day 3		Day 6	
Treatment		Adult	Nymph	Adult	Nymph	Adult	Nymph
1	Control	7.5	0.25	5.75	3	6.75	9.75
2	Movento	2.5	0.25	0.75	0.25	0	0
3	AHDB9951	2.25	0.75	0	0	0	0
4	AHDB9935	5.25	0.75	4.5	1	4	2.5
5	AHDB9934	3.25	0.5	1.5	0	0.25	0
6	AHDB9933	4.25	1.25	5.5	2	5.75	10.5
7	AHDB9946	4.25	0.5	3	2.5	4.25	4
8	AHDB9928	6.5	2.25	7.75	10	10.75	18.25
9	AHDB9971	4	1.75	5	3.25	5.25	15
10	AHDB9932	5	1	3.75	3.75	5.25	16
11	AHDB9967	5.25	0.75	3.75	2.5	4.5	2.75
12	Majestik	5.5	0	4.75	2.75	4.25	7.25
F		2.799	0.764	4.554	2.346	2.531	2.567
P		<0.001	0.672	<0.001	0.027	0.018	0.016
SED		1.304	1.054	1.479	2.469	2.746	5.863
LSD (5%) (two-sided)		2.645	2.138	3.000	5.008	5.570	11.891
LSD (5%) (one-sided)		2.202	1.780	2.497	4.169	4.636	9.899
df		36	36	36	36	36	36

First inoculation		Day 8		Day 10		Day 13	
Treatment		Adult	Nymph	Adult	Nymph	Adult	Nymph
1	Control	7.5	12.75	7.75	13	6.75	10.25
2	Movento	0	0	0	0	0	0
3	AHDB9951	0	0	0	0	0	0
4	AHDB9935	3.5	4.5	3.5	1.75	2.75	5.5
5	AHDB9934	0	0	0	0	4.25	4
6	AHDB9933	7	10.75	6	10	10.5	12.5
7	AHDB9946	3.25	7	1.75	3.75	2	1.75
8	AHDB9928	12.75	21.75	12.75	16.5	15	17.75
9	AHDB9971	10	13.75	10.5	18.25	10	20
10	AHDB9932	2.75	12	7.5	7.5	6	7.25
11	AHDB9967	3.75	1.75	2.25	0.25	1.5	2
12	Majestik	3.75	9.75	6	11.25	4	12.25
F		2.927	2.538	2.979	3.192	2.799	4.154
P		0.007	0.017	0.007	0.004	0.01	<0.001
SED		3.354	6.075	3.504	5.393	3.920	4.714
LSD (5%) (two-sided)		6.801	12.321	7.106	10.937	7.950	9.560
LSD (5%) (one-sided)		5.662	10.257	5.916	9.104	6.618	7.958
df		36	36	36	36	36	36

First inoculation		Day 15		Day 17		Day 20	
Treatment		Adult	Nymph	Adult	Nymph	Adult	Nymph
1	Control	8.5	8.25	5.5	9.5	9.25	11.25
2	Movento	0	0	0	0	0	0
3	AHDB9951	0	0	0	0	0	0
4	AHDB9935	2	4.5	3	1.25	2.25	1.75
5	AHDB9934	4.25	5.75	5	8	6.75	9
6	AHDB9933	9.5	8.75	11.25	7.75	12.25	7.75
7	AHDB9946	1.5	0.5	0.75	0.75	0.75	0.5
8	AHDB9928	11.25	10.75	10.75	13.25	14.75	9.25
9	AHDB9971	6.75	15.5	4.75	6.25	8.25	8.75
10	AHDB9932	7.5	8	7.5	10.75	8	15.5
11	AHDB9967	2.25	4.25	1.75	7.5	2.75	9.5
12	Majestik	4.75	10.25	4.75	7	4.75	9.5
F		3.317	2.593	2.076	1.263	1.933	1.092
P		0.003	0.015	0.049	0.284	0.067	0.395
SED		2.962	4.216	3.735	5.625	4.956	6.866
LSD (5%) (two-sided)		6.008	8.550	7.575	11.409	10.052	13.924
LSD (5%) (one-sided)		5.001	7.117	6.306	9.497	8.368	11.591
df		36	36	36	36	36	36

Second inoculation		Day 8		Day 10		Day 13	
Treatment		Adult	Nymph	Adult	Nymph	Adult	Nymph
1	Control	5	0.5	2	1	2.5	3.5
2	Movento	4.25	0.25	0.25	0	0	0
3	AHDB9951	3.5	0	0.5	0	0	0
5	AHDB9934	6.75	1	3	2	4.25	4
F		1.370	0.548	3.655	0.724	3.540	1.716
P		0.308	0.661	0.052	0.560	0.056	0.226
SED		1.681	0.814	0.942	1.581	1.537	2.219
LSD (5%) (two-sided)		3.745	1.814	2.099	3.523	3.425	4.945
LSD (5%) (one-sided)		3.046	1.475	1.707	2.866	2.786	4.022
df		10	10	10	10	10	10

Third inoculation		Day 15		Day 17		Day 20	
Treatment		Adult	Nymph	Adult	Nymph	Adult	Nymph
1	Control	4	0.25	1.5	0.25	2	1.5
2	Movento	1.5	0	0.75	0	0	0
3	AHDB9951	1.75	0	0.25	0	0	0
F		2.150	1	1.14	1	4.8	1
P		0.173	0.405	0.362	0.405	0.038	0.405
SED		1.328	0.204	0.833	0.204	0.745	1.225
LSD (5%) (two-sided)		3.004	0.462	1.885	0.462	1.686	2.771
LSD (5%) (one-sided)		2.435	0.374	1.528	0.374	1.366	2.245
df		9	9	9	9	9	9

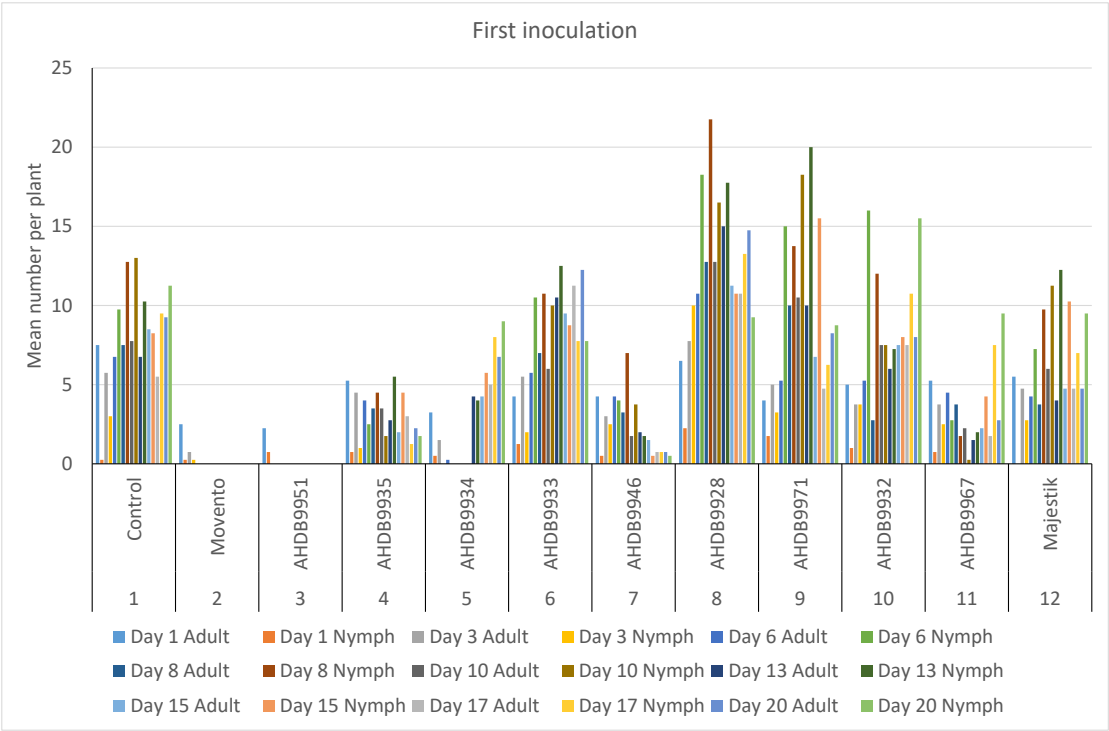

Figure 5a *Nasonovia ribisnigri* – survival after inoculation/treatment with insecticide and bio-insecticide products shown as mean number of aphids per plant. Insecticides applied on Day 0 and bio-insecticides applied on Day 0 and Day 7.

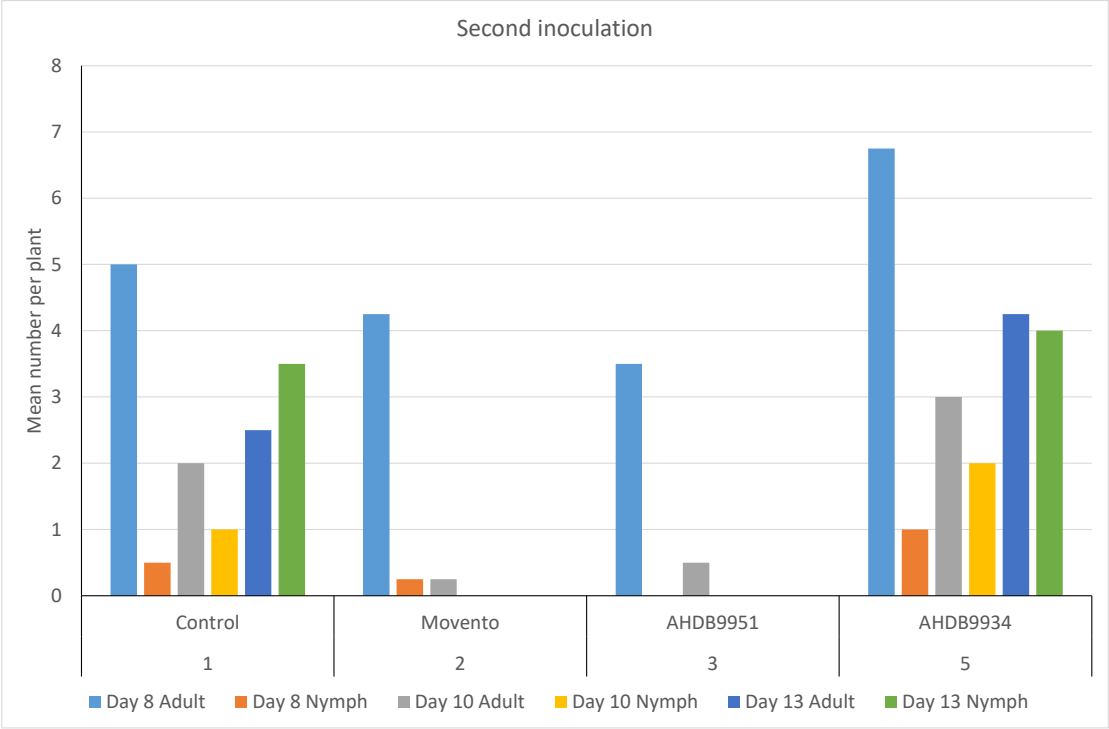

Figure 5b *Nasonovia ribisnigri* – survival after inoculation/treatment with insecticide and bio-insecticide products shown as mean number of aphids per plant. Insecticides applied on Day 0 and bio-insecticides applied on Day 0 and Day 7.

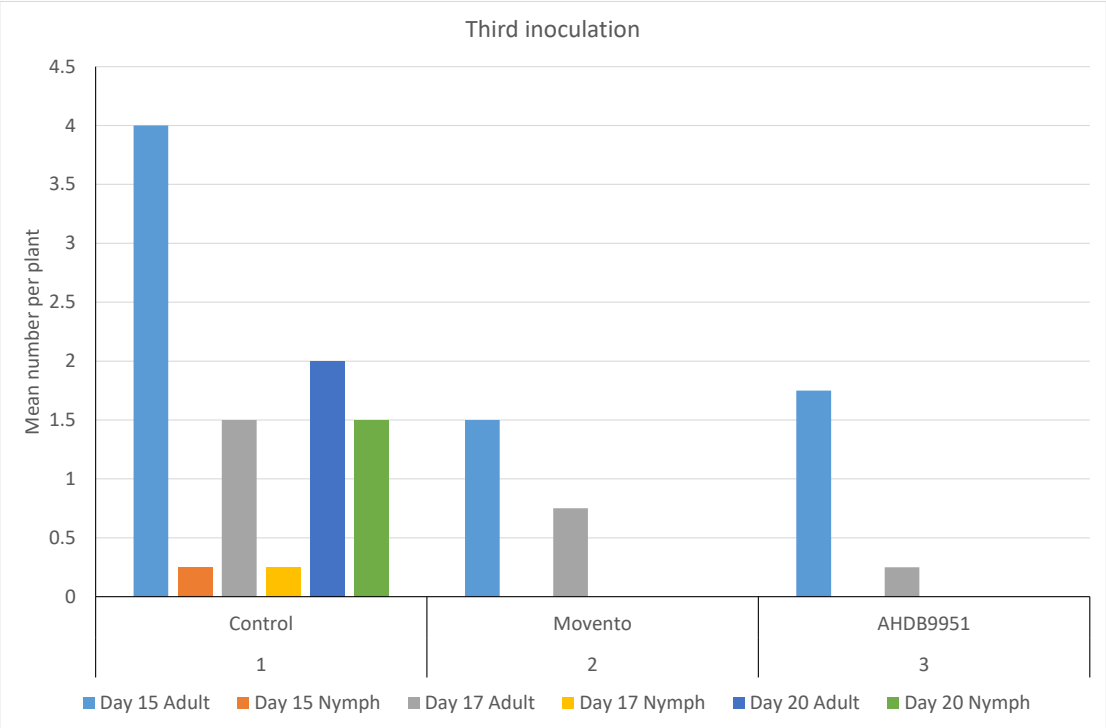

Figure 5c *Nasonovia ribisnigri* – survival after inoculation/treatment with insecticide and bio-insecticide products shown as mean number of aphids per plant. Insecticides applied on Day 0 and bio-insecticides applied on Day 0 and Day 7.

E *Nasonovia ribisnigri* (currant lettuce aphid) on lettuce – supplementary trial to test treatments used against *Pemphigus bursarius* (Lettuce root aphid) in a field trial

Trial conduct

UK regulatory guidelines were followed but EPPO guidelines took precedence. The following EPPO guidelines were followed:

Relevant EPPO guideline(s)		Variation from EPPO
PP 1/152(3)	Design and analysis of efficacy evaluation trials	None
PP 1/135(3)	Phytotoxicity assessment	None
PP 1/181(3)	Conduct and reporting of efficacy evaluation trials including GEP	None

There were no deviations from EPPO guidance.

Test site

Item	Details
Location address	University of Warwick Wellesbourne Campus Wellesbourne Warwick CV35 9EF
Crop	Lettuce
Cultivar	Challenge
Soil or substrate type	Levingtons M2
Agronomic practice	See Appendix A
Prior history of site	n/a

Trial design

Item	Details
Trial design:	
Number of replicates:	4
Row spacing:	n/a
Plot size: (w x l)	n/a
Plot size: (m^2)	n/a
Number of plants per plot:	1
Leaf Wall Area calculations	n/a

Treatment details

AHDB Code	Active substance	Product name/ manufacturers code	Formulation batch number	Content of active substance in product	Formulation type	Adjuvant
Untreated						
Authorized (2018)	Thiamethoxam	Cruiser 70WS	Not known	70%	WS	None
Authorized	Spirotetramat	Movento	ECE4101299	150 g/l	OD	None
AHDB9966	N/D	N/D	N/D	N/D	N/D	None
AHDB9951	N/D	N/D	N/D	N/D	N/D	None
AHDB9948	N/D	N/D	N/D	N/D	N/D	None
AHDB9948	N/D	N/D	N/D	N/D	N/D	None
AHDB9943	N/D	N/D	N/D	N/D	N/D	None

Application schedule

Treatment number	Treatment: product name or AHDB code	Rate of active substance (ml or g a.s./ha)	Rate of product (l or kg/ha)	Application code
1	Control			
2	Cruiser	80 g/100,000 seeds	114 g/100,000 seeds	A
3	Movento	75 g	0.5 l	C
5	AHDB9966	24 g	0.2 l	C
6	AHDB9951	125 g	0.625 l	C
7	AHDB9948	75 g	0.75 l	C
8	AHDB9948	0.75 g/1000 plants	3.75 ml/1000 plants [1]	B
9	AHDB9943	1 g/1000 plants	2 g/1000 plants [2]	A
10	AHDB9966	0.24 g/1000 plants	2 ml/1000 plants [1]	A
11	AHDB9951	1.25 g/1000 plants	6.25 ml/1000 plants [1]	A
12	AHDB9948	0.75 g/1000 plants	3.75 ml/1000 plants [1]	A

[1] Calculated from spray rate assuming 100,000 plants/ha
[2] Manufacturer recommendation

Application details

	Application A	Application B	Application C
Application date	22/5/18	12/6/18	15/6/18
Time of day	11.00	9.00	10.00
Crop growth stage (Max, min average BBCH)	Seed	14	14
Crop height (cm)	N/A	8	8
Crop coverage (%)	N/A	N/A	15
Application Method	"Phytodrip"	Drench	Spray
Application Placement	Block	Block	Foliar
Application equipment	Pipette	Pipette	Berthoud Vermorel 2000HP
Nozzle pressure	N/A	N/A	2 bar
Nozzle type	N/A	N/A	02F110
Nozzle size	N/A	N/A	02
Application water volume/ha	0.2 ml/block	1 ml/block	300
Temperature of air - shade (°C)	N/A	N/A	20
Relative humidity (%)	N/A	N/A	63
Wind speed range (m/s)	N/A	N/A	Light
Dew presence (Y/N)	N/A	N/A	N
Temperature of soil - 2-5 cm (°C)	N/A	N/A	Not recorded
Wetness of soil - 2-5 cm	N/A	N/A	Damp
Cloud cover (%)	N/A	N/A	Not recorded

Untreated levels of pests/pathogens at application and through the assessment period

Common name	Scientific Name	EPPO Code	Infestation level pre-application	Infestation level at start of assessment period	Infestation level at end of assessment period
Currant lettuce aphid [1]	*Nasonovia ribisnigri*	NASORN	0	10 wingless/plant and 10 winged/cage	

[1] Non-target pests

Method

Lettuce (cv Challenge) seeds were sown into peat blocks on 29 August 2018. The trial consisted of 11 treatments and each replicate consisted of 5 plants transplanted into FP9 pots on 26 September 2018. The plots were 1 cage in size. Treatments were applied at sowing (Seed treatment or "Phytodrip"), pre-planting (drench) or as post-planting sprays (on 17 October 2018). The "Phytodrip" treatments were applied directly to the seed after sowing in a small volume of water (0.2 ml) and the drench treatment was applied before transplanting in 1 ml of water (which equates to a similar volume to that applied to brassica transplants). Due to the compaction of the blocks at this stage the 1 ml had to be applied in 2 x 0.5 ml portions with the first 0.5 ml being allowed to soak in before the second was added.

Plants were inoculated with 10 wingless aphids immediately after spraying and transferred to an insect-proof cage (5 plants/cage to give a total of 10 plants/treatment) then a further 10 winged aphids were added to each cage.

Assessment details

	Evaluation Timing (DA)*				
Evaluation date	**After sowing**	**After sprays**	**Crop Growth Stage (BBCH)**	**Evaluation type (efficacy, phytotox)**	**Assessment**
25/10/18	57	8	19	Efficacy	Aphid numbers

* DA – days after application

Statistical analysis

No formal analysis was undertaken as there were only enough cages to replicate the treatment twice.

Results

Phytotoxicity

There was no evidence of phytotoxicity due to any of the treatments.

Aphid counts

Figure 6 shows the mean number of winged and wingless aphids per plant on lettuce plants treated 1) at sowing with seed or phytodrip treaments, with foliar sprays or with a pre-planting drench treatment (2 replicates only). With the exception of the AHDB9948 drench and phytodrip treatments all other treatments appeared to be effective.

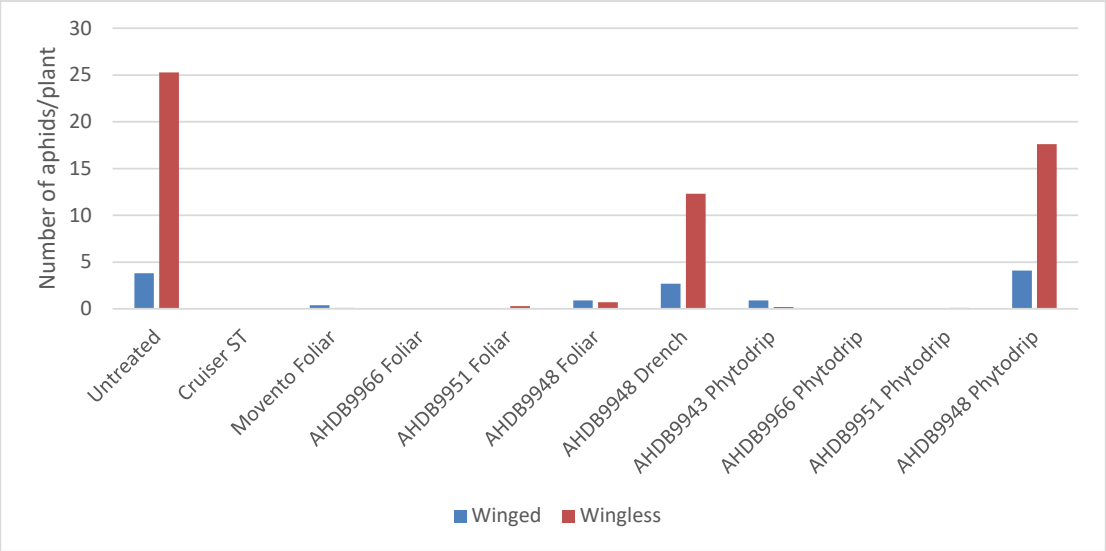

Figure 6 *Nasonovia ribisnigri* – mean number of winged and wingless aphids per plant on lettuce plants treated 1) at sowing with seed or phytodrip treatments, with foliar sprays or with a pre-planting drench treatment (2 replicates only).

Discussion

The original aim was to determine the efficacy of treatments over a period of two weeks following treatment. However, it seemed that there might be more information to obtain by following some of the tests for longer and in particular by re-infesting plants where all the aphids had died within 6 days to determine the persistence of the treatments. This appeared to work very well and showed that some of the treatments (mainly conventional insecticides) were persistent for at least 2 weeks and continued to be very effective. Overall, the bio-insecticides were less effective than the conventional insecticides but some products were very effective against one or more species.

For two of the species (*C. aegopodii* and *N. ribisnigri*), development of infestations was followed for a period of 3 weeks from the first treatment. There was no evidence that any of the products 'started to work' later on. However, it is possible that this is not the best approach for understanding how best to use microbial bio-insecticides which, as living organisms, may be more dependent on environmental conditions and the growth stage of the target pest than conventional insecticides and bio-insecticides based on plant extracts or other non-living substances.

Tables A and B summarise the performance of products screened in laboratory tests, expressed as a percentage of the aphids remaining on the untreated control plants 6 days after treatment. Of the conventional insecticides, most were rapidly effective, with the exception of AHDB9933 and AHDB9935 versus *N. ribisnigri* and *C. aegopodii*. This may suggest that this is related to formulation, as both of these products were applied with adjuvant against the other two species (*Myzus persicae, Brevicoryne brassicae*). A similar pattern can be observed with some of the bio-insecticides. Adjuvants were applied with AHDB9928, AHDB9931, AHDB9932 and AHDB9946 on brassicas (*Myzus persicae, Brevicoryne brassicae*) but not with AHDB9929.

Once the effect of adjuvants on *B. brassicae* was suspected, an additional treatment of Phase II on its own as included in the last two replicates and it was toxic to *B. brassicae*. As the plants were infested prior to treatment this was likely to have been through direct contact action. Survival of aphids following re-infestation did not appear to be affected by Phase II.

Table A. Performance of conventional insecticides screened in laboratory tests expressed as a percentage of the aphids remaining on untreated control plants 6 days after treatment compared with the untreated control.

Species	**Product**	**% remaining of control after 6 days**
Myzus persicae	AHDB9933	0
Brevicoryne brassicae	AHDB9933	0
Nasonovia ribisnigri	AHDB9933	98
Cavariella aegopodii	AHDB9933	109
Myzus persicae	AHDB9934	0
Brevicoryne brassicae	AHDB9934	0
Cavariella aegopodii	AHDB9934	2
Nasonovia ribisnigri	AHDB9934	2
Myzus persicae	AHDB9935	0
Brevicoryne brassicae	AHDB9935	0
Cavariella aegopodii	AHDB9935	17
Nasonovia ribisnigri	AHDB9935	39
Myzus persicae	AHDB9943	0
Myzus persicae	AHDB9948	0
Myzus persicae	AHDB9951	0
Brevicoryne brassicae	AHDB9951	0
Cavariella aegopodii	AHDB9951	0
Nasonovia ribisnigri	AHDB9951	0
Myzus persicae	AHDB9966	0
Cavariella aegopodii	Movento	0
Myzus persicae	Movento	0
Brevicoryne brassicae	Movento	0
Nasonovia ribisnigri	Movento	0
Myzus persicae	Plenum	0

Table B. Performance of Phase II and bio-insecticides screened in laboratory tests expressed as a percentage of the aphids remaining on untreated control plants 6 days after treatment compared with the untreated control.

Species	Product	% remaining of control after 6 days
Brevicoryne brassicae	Phase II	9
Brevicoryne brassicae	AHDB9928	18
Myzus persicae	AHDB9928	53
Nasonovia ribisnigri	AHDB9928	176
Myzus persicae	AHDB9929	23
Cavariella aegopodii	AHDB9929	94
Brevicoryne brassicae	AHDB9931	2
Myzus persicae	AHDB9931	9
Cavariella aegopodii	AHDB9931	114
Brevicoryne brassicae	AHDB9932	0
Myzus persicae	AHDB9932	26
Nasonovia ribisnigri	AHDB9932	129
Brevicoryne brassicae	AHDB9946	0
Myzus persicae	AHDB9946	9
Nasonovia ribisnigri	AHDB9946	50
Cavariella aegopodii	AHDB9946	114
Myzus persicae	AHDB9964	53
Brevicoryne brassicae	AHDB9967	24
Nasonovia ribisnigri	AHDB9967	44
Myzus persicae	AHDB9967	92
Myzus persicae	AHDB9968	12
Brevicoryne brassicae	AHDB9970	17
Myzus persicae	AHDB9970	17
Myzus persicae	AHDB9971	72
Cavariella aegopodii	AHDB9971	77
Nasonovia ribisnigri	AHDB9971	123
Myzus persicae	Majestik	44
Nasonovia ribisnigri	Majestik	70
Myzus persicae	SB Plant Invigorator	61
Cavariella aegopodii	SB Plant Invigorator	103
Cavariella aegopodii	Spruzit	41
Myzus persicae	Spruzit	70

Analysis of these data sets was problematical because of the large number of zeros and also the low numbers on some occasions (e.g. of nymphs soon after inoculation/re-infestation) so levels of significance should only be taken as a guide.

Conclusions

The study showed that a number of ‘novel’ insecticides and a few bio-insecticides were effective against one or more species of aphid. It also highlighted the importance of product formulation and adjuvants in increasing levels of control.

Acknowledgements

We would like to thank the AHDB for funding and supporting this project and for the financial and in kind contributions from the crop protection manufactures and distributors involved with the SCEPTREplus programme as listed below:
Agrii, Alpha Biocontrol Ltd, Andermatt, Arysta Lifescience, BASF, Bayer, Belchim, Bionema Limited, Certis Europe, Dow, DuPont, Eden Research, Fargro Limited, FMC, Gowan, Interfarm, Lallemand Plant Care, Novozymes, Oro Agri, Russell IPM, Sumitomo Chemicals, Syngenta, UPL. We would also like to thank G’s for providing lettuce seed and for their technical advice.

Appendix

a. Raw data from assessments

Myzus persicae - Conventional insecticides - First inoculation

			Number of aphids	
Days after spraying	Treatment	Rep	Adults	Nymphs
0	C1	1	10	0
0	2	1	10	0
0	3	1	10	0
0	4	1	10	0
0	5	1	10	0
0	6	1	10	0
0	7	1	10	0
0	8	1	10	0
0	9	1	10	0
0	C1	2	10	0
0	2	2	10	0
0	3	2	10	0
0	4	2	10	0
0	5	2	10	0
0	6	2	10	0
0	7	2	10	0
0	8	2	10	0
0	9	2	10	0
0	C1	3	10	0
0	2	3	10	0
0	3	3	10	0
0	4	3	10	0
0	5	3	10	0
0	6	3	10	0
0	7	3	10	0
0	8	3	10	0
0	9	3	10	0
0	C1	4	10	0
0	2	4	10	0
0	3	4	10	0
0	4	4	10	0
0	5	4	10	0
0	6	4	10	0
0	7	4	10	0
0	8	4	10	0
0	9	4	10	0
1	C1	1	5	12
1	2	1	3	0
1	3	1	0	0
1	4	1	0	0
1	5	1	1	0
1	6	1	0	0
1	7	1	1	4
1	8	1	0	0

1	9	1	0	0
1	C1	2	7	2
1	2	2	1	0
1	3	2	0	0
1	4	2	0	0
1	5	2	0	0
1	6	2	0	0
1	7	2	2	0
1	8	2	1	1
1	9	2	0	0
1	C1	3	5	2
1	2	3	1	0
1	3	3	0	0
1	4	3	1	1
1	5	3	0	0
1	6	3	0	0
1	7	3	6	4
1	8	3	4	2
1	9	3	2	0
1	C1	4	5	8
1	2	4	1	0
1	3	4	1	0
1	4	4	0	0
1	5	4	0	0
1	6	4	0	0
1	7	4	0	0
1	8	4	0	0
1	9	4	0	0
3	C1	1	5	12
3	2	1	0	0
3	3	1	0	0
3	4	1	0	0
3	5	1	0	0
3	6	1	0	0
3	7	1	0	0
3	8	1	0	0
3	9	1	0	0
3	C1	2	8	14
3	2	2	0	0
3	3	2	0	0
3	4	2	0	0
3	5	2	0	0
3	6	2	0	0
3	7	2	0	0
3	8	2	0	0
3	9	2	0	0
3	C1	3	5	22
3	2	3	0	0
3	3	3	0	0
3	4	3	0	0
3	5	3	0	0

3	6	3	0	0
3	7	3	0	0
3	8	3	0	0
3	9	3	0	0
3	C1	4	4	8
3	2	4	0	0
3	3	4	0	0
3	4	4	0	0
3	5	4	0	0
3	6	4	0	0
3	7	4	0	0
3	8	4	0	0
3	9	4	0	0
6	C1	1	5	13
6	2	1	0	0
6	3	1	0	0
6	4	1	0	0
6	5	1	0	0
6	6	1	0	0
6	7	1	0	0
6	8	1	0	0
6	9	1	0	0
6	C1	2	14	46
6	2	2	0	0
6	3	2	0	0
6	4	2	0	0
6	5	2	0	0
6	6	2	0	0
6	7	2	0	0
6	8	2	0	0
6	9	2	0	0
6	C1	3	6	17
6	2	3	0	0
6	3	3	0	0
6	4	3	0	0
6	5	3	0	0
6	6	3	0	0
6	7	3	0	0
6	8	3	0	0
6	9	3	0	0
6	C1	4	4	7
6	2	4	0	0
6	3	4	0	0
6	4	4	0	0
6	5	4	0	0
6	6	4	0	0
6	7	4	0	0
6	8	4	0	0
6	9	4	0	0

Myzus persicae - Conventional insecticides - Second inoculation

			Number of aphids	
Days after spraying	Treatment	Rep	Adults	Nymphs
6	C2	1	10	0
6	2	1	10	0
6	3	1	10	0
6	4	1	10	0
6	5	1	10	0
6	6	1	10	0
6	7	1	10	0
6	8	1	10	0
6	9	1	10	0
6	C2	2	10	0
6	2	2	10	0
6	3	2	10	0
6	4	2	10	0
6	5	2	10	0
6	6	2	10	0
6	7	2	10	0
6	8	2	10	0
6	9	2	10	0
6	C2	3	10	0
6	2	3	10	0
6	3	3	10	0
6	4	3	10	0
6	5	3	10	0
6	6	3	10	0
6	7	3	10	0
6	8	3	10	0
6	9	3	10	0
6	C2	4	10	0
6	2	4	10	0
6	3	4	10	0
6	4	4	10	0
6	5	4	10	0
6	6	4	10	0
6	7	4	10	0
6	8	4	10	0
6	9	4	10	0
7	C2	1	4	2
7	2	1	5	3
7	3	1	4	0
7	4	1	3	3
7	5	1	6	7
7	6	1	2	1
7	7	1	8	1
7	8	1	7	6
7	9	1	2	0
7	C2	2	7	3
7	2	2	5	0

7	3	2	3	0
7	4	2	8	1
7	5	2	6	6
7	6	2	6	2
7	7	2	9	5
7	8	2	5	4
7	9	2	2	0
7	C2	3	8	4
7	2	3	5	0
7	3	3	4	3
7	4	3	2	0
7	5	3	9	0
7	6	3	7	0
7	7	3	9	1
7	8	3	4	5
7	9	3	1	0
7	C2	4	10	0
7	2	4	9	0
7	3	4	0	0
7	4	4	4	0
7	5	4	5	3
7	6	4	8	1
7	7	4	7	0
7	8	4	5	3
7	9	4	0	0
9	C2	1	4	7
9	2	1	3	0
9	3	1	0	0
9	4	1	0	0
9	5	1	7	4
9	6	1	2	2
9	7	1	3	1
9	8	1	4	1
9	9	1	0	0
9	C2	2	6	13
9	2	2	4	0
9	3	2	0	0
9	4	2	2	1
9	5	2	2	8
9	6	2	4	7
9	7	2	3	2
9	8	2	0	7
9	9	2	0	0
9	C2	3	7	6
9	2	3	1	0
9	3	3	0	0
9	4	3	0	0
9	5	3	4	2
9	6	3	5	1
9	7	3	5	3
9	8	3	3	4

9	9	3	0	0
9	C2	4	9	4
9	2	4	6	0
9	3	4	0	0
9	4	4	0	0
9	5	4	2	2
9	6	4	8	2
9	7	4	3	0
9	8	4	4	6
9	9	4	0	0
13	C2	1	6	18
13	2	1	0	0
13	3	1	0	0
13	4	1	0	0
13	5	1	1	5
13	6	1	0	0
13	7	1	0	0
13	8	1	0	2
13	9	1	0	0
13	C2	2	9	34
13	2	2	0	0
13	3	2	0	0
13	4	2	0	0
13	5	2	6	6
13	6	2	6	15
13	7	2	1	0
13	8	2	3	1
13	9	2	0	0
13	C2	3	14	9
13	2	3	0	0
13	3	3	0	0
13	4	3	0	0
13	5	3	0	2
13	6	3	2	1
13	7	3	0	0
13	8	3	1	4
13	9	3	0	0
13	C2	4	9	21
13	2	4	0	0
13	3	4	0	0
13	4	4	0	0
13	5	4	0	2
13	6	4	6	6
13	7	4	0	0
13	8	4	4	9
13	9	4	0	0

Myzus persicae - Conventional insecticides - Third inoculation

			Number of aphids

Days after spraying	Treatment	Rep	Adults	Nymphs
13	C3	1	10	0
13	2	1	0	0
13	3	1	0	0
13	4	1	0	0
13	5	1	1	5
13	6	1	0	0
13	7	1	0	0
13	8	1	0	2
13	9	1	0	0
13	C3	2	9	34
13	2	2	0	0
13	3	2	0	0
13	4	2	0	0
13	5	2	6	6
13	6	2	6	15
13	7	2	1	0
13	8	2	3	1
13	9	2	0	0
13	C3	3	14	9
13	2	3	0	0
13	3	3	0	0
13	4	3	0	0
13	5	3	0	2
13	6	3	2	1
13	7	3	0	0
13	8	3	1	4
13	9	3	0	0
13	C3	4	9	21
13	2	4	0	0
13	3	4	0	0
13	4	4	0	0
13	5	4	0	2
13	6	4	6	6
13	7	4	0	0
13	8	4	4	9
13	9	4	0	0
14	C3	1	9	2
14	2	1	7	4
14	3	1	5	1
14	4	1	4	3
14	5	1		
14	6	1	7	6
14	7	1		
14	8	1	0	2
14	9	1	7	0
14	C3	2	6	0
14	2	2	6	0
14	3	2	8	1
14	4	2	10	1
14	5	2		

14	6	2		
14	7	2	5	1
14	8	2		
14	9	2	8	0
14	C3	3		
14	2	3	7	0
14	3	3	8	6
14	4	3	6	1
14	5	3		
14	6	3		
14	7	3	9	5
14	8	3		
14	9	3	5	2
14	C3	4	8	4
14	2	4	10	0
14	3	4	2	2
14	4	4	7	4
14	5	4	4	1
14	6	4		
14	7	4	8	3
14	8	4		
14	9	4	5	0
16	C3	1	7	9
16	2	1	4	1
16	3	1	0	0
16	4	1	3	6
16	5	1		
16	6	1	5	11
16	7	1		
16	8	1	0	1
16	9	1	2	0
16	C3	2	5	2
16	2	2	1	0
16	3	2	3	9
16	4	2	9	3
16	5	2		
16	6	2		
16	7	2	4	0
16	8	2		
16	9	2	6	2
16	C3	3	6	5
16	2	3	5	0
16	3	3	4	8
16	4	3	4	2
16	5	3		
16	6	3		
16	7	3	5	2
16	8	3		
16	9	3	2	0
16	C3	4	8	16
16	2	4	7	1

16	3	4	0	0
16	4	4	5	2
16	5	4	4	4
16	6	4		
16	7	4	6	2
16	8	4		
16	9	4	0	0
20	C3	1	7	19
20	2	1	0	0
20	3	1	0	0
20	4	1	2	6
20	5	1		
20	6	1	2	12
20	7	1		
20	8	1	0	0
20	9	1	0	0
20	C3	2	5	6
20	2	2	0	0
20	3	2	5	2
20	4	2	5	6
20	5	2		
20	6	2		
20	7	2	0	0
20	8	2		
20	9	2	4	3
20	C3	3	10	15
20	2	3	0	0
20	3	3	2	10
20	4	3	2	0
20	5	3		
20	6	3		
20	7	3	0	0
20	8	3		
20	9	3	1	0
20	C3	4	14	36
20	2	4	0	0
20	3	4	0	0
20	4	4	2	2
20	5	4	5	5
20	6	4		
20	7	4	0	0
20	8	4		
20	9	4	0	0

Myzus persicae - Bio-insecticides - First inoculation

			Number of aphids	
Days after spraying	Treatment	Rep	Adults	Nymphs
0	C1	1	0	10
0	2	1	0	10

0	3	1	0	10
0	4	1	0	10
0	5	1	0	10
0	6	1	0	10
0	7	1	0	10
0	8	1	0	10
0	9	1	0	10
0	10	1	0	10
0	11	1	0	10
0	12	1	0	10
0	13	1	0	10
0	14	1	0	10
0	15	1	0	10
0	C1	2	0	10
0	2	2	0	10
0	3	2	0	10
0	4	2	0	10
0	5	2	0	10
0	6	2	0	10
0	7	2	0	10
0	8	2	0	10
0	9	2	0	10
0	10	2	0	10
0	11	2	0	10
0	12	2	0	10
0	13	2	0	10
0	14	2	0	10
0	15	2	0	10
0	C1	3	0	10
0	2	3	0	10
0	3	3	0	10
0	4	3	0	10
0	5	3	0	10
0	6	3	0	10
0	7	3	0	10
0	8	3	0	10
0	9	3	0	10
0	10	3	0	10
0	11	3	0	10
0	12	3	0	10
0	13	3	0	10
0	14	3	0	10
0	15	3	0	10
0	C1	4	0	10
0	2	4	0	10
0	3	4	0	10
0	4	4	0	10
0	5	4	0	10
0	6	4	0	10
0	7	4	0	10
0	8	4	0	10
0	9	4	0	10

0	10	4	0	10
0	11	4	0	10
0	12	4	0	10
0	13	4	0	10
0	14	4	0	10
0	15	4	0	10
1	C1	1	11	4
1	2	1	1	3
1	3	1	6	4
1	4	1	5	3
1	5	1	4	0
1	6	1	0	0
1	7	1	6	7
1	8	1	7	5
1	9	1	9	4
1	10	1	4	7
1	11	1	6	4
1	12	1	6	4
1	13	1	3	2
1	14	1	5	14
1	15	1	2	4
1	C1	2	2	7
1	2	2	0	0
1	3	2	6	8
1	4	2	6	14
1	5	2	2	1
1	6	2	1	0
1	7	2	1	6
1	8	2	4	8
1	9	2	2	8
1	10	2	3	8
1	11	2	8	15
1	12	2	5	2
1	13	2	2	1
1	14	2	3	7
1	15	2	9	6
1	C1	3	8	7
1	2	3	3	1
1	3	3	5	9
1	4	3	3	3
1	5	3	6	16
1	6	3	4	3
1	7	3	0	0
1	8	3	3	8
1	9	3	2	6
1	10	3	9	10
1	11	3	4	7
1	12	3	5	0
1	13	3	3	3
1	14	3	6	7
1	15	3	1	0

1	C1	4	8	2
1	2	4	3	0
1	3	4	1	1
1	4	4	2	2
1	5	4	1	1
1	6	4	2	2
1	7	4	0	0
1	8	4	5	1
1	9	4	3	4
1	10	4	5	2
1	11	4	5	1
1	12	4	2	2
1	13	4	3	4
1	14	4	4	2
1	15	4	3	1
3	C1	1	11	16
3	2	1	0	0
3	3	1	6	18
3	4	1	2	0
3	5	1	0	0
3	6	1	0	0
3	7	1	7	38
3	8	1	4	13
3	9	1	5	9
3	10	1	9	26
3	11	1	4	11
3	12	1	3	5
3	13	1	1	2
3	14	1	8	22
3	15	1	1	3
3	C1	2	7	23
3	2	2	0	0
3	3	2	2	11
3	4	2	1	3
3	5	2	0	0
3	6	2	1	5
3	7	2	1	4
3	8	2	5	11
3	9	2	2	6
3	10	2	9	21
3	11	2	4	18
3	12	2	0	2
3	13	2	0	2
3	14	2	5	22
3	15	2	2	4
3	C1	3	4	10
3	2	3	1	0
3	3	3	6	5
3	4	3	1	0
3	5	3	2	15
3	6	3	0	0

3	7	3	0	0
3	8	3	2	4
3	9	3	3	11
3	10	3	4	5
3	11	3	2	6
3	12	3	0	0
3	13	3	2	0
3	14	3	3	12
3	15	3	1	1
3	C1	4	6	15
3	2	4	0	0
3	3	4	0	0
3	4	4	2	1
3	5	4	1	0
3	6	4	1	0
3	7	4	0	0
3	8	4	2	2
3	9	4	4	5
3	10	4	4	2
3	11	4	4	6
3	12	4	0	0
3	13	4	3	3
3	14	4	1	1
3	15	4	0	3
6	C1	1	11	20
6	2	1	0	0
6	3	1	7	32
6	4	1	1	0
6	5	1	0	0
6	6	1	0	0
6	7	1	20	62
6	8	1	11	12
6	9	1	5	12
6	10	1	3	16
6	11	1	5	17
6	12	1	9	19
6	13	1	3	5
6	14	1	21	44
6	15	1	1	3
6	C1	2	7	37
6	2	2	0	0
6	3	2	3	9
6	4	2	3	1
6	5	2	0	0
6	6	2	3	9
6	7	2	2	6
6	8	2	5	33
6	9	2	1	8
6	10	2	9	50
6	11	2	3	17
6	12	2	0	2

6	13	2	4	8
6	14	2	6	27
6	15	2	0	1
6	C1	3	5	17
6	2	3	0	0
6	3	3	6	4
6	4	3	1	1
6	5	3	6	15
6	6	3	0	0
6	7	3	0	0
6	8	3	0	3
6	9	3	7	12
6	10	3	5	7
6	11	3	2	4
6	12	3	0	0
6	13	3	2	1
6	14	3	4	15
6	15	3	0	3
6	C1	4	9	23
6	2	4	0	0
6	3	4	3	5
6	4	4	5	3
6	5	4	1	0
6	6	4	0	0
6	7	4	0	0
6	8	4	2	3
6	9	4	9	3
6	10	4	2	1
6	11	4	14	17
6	12	4	0	0
6	13	4	5	5
6	14	4	1	1
6	15	4	1	2
8	C1	1	17	48
8	2	1	0	0
8	3	1	1	6
8	4	1	0	0
8	5	1	0	0
8	6	1	0	0
8	7	1	41	86
8	8	1	11	22
8	9	1	14	21
8	10	1	9	11
8	11	1	6	16
8	12	1	13	19
8	13	1	5	10
8	14	1	24	76
8	15	1	0	0
8	1	2	5	40
8	2	2	0	0
8	3	2	3	19

8	4	2	1	0
8	5	2	0	0
8	6	2	3	3
8	7	2	1	3
8	8	2	8	23
8	9	2	2	9
8	10	2	12	40
8	11	2	3	19
8	12	2	0	1
8	13	2	16	37
8	14	2	6	41
8	15	2	0	1
8	C1	3	11	11
8	2	3	0	0
8	3	3	7	7
8	4	3	1	2
8	5	3	7	12
8	6	3	0	0
8	7	3	0	0
8	8	3	0	0
8	9	3	5	14
8	10	3	5	7
8	11	3	1	2
8	12	3	0	0
8	13	3	0	0
8	14	3	4	11
8	15	3	0	2
8	C1	4	20	9
8	2	4	0	0
8	3	4	8	4
8	4	4	7	5
8	5	4	1	0
8	6	4	0	0
8	7	4	0	0
8	8	4	1	2
8	9	4	10	8
8	10	4	1	0
8	11	4	14	17
8	12	4	0	0
8	13	4	2	1
8	14	4	1	1
8	15	4	1	0
10	C1	1	29	71
10	2	1	0	0
10	3	1	0	5
10	4	1	0	0
10	5	1	0	0
10	6	1	0	0
10	7	1	76	146
10	8	1	14	16
10	9	1	18	35

10	10	1	8	18
10	11	1	4	13
10	12	1	23	42
10	13	1	7	28
10	14	1	37	136
10	15	1	2	1
10	1	2	7	51
10	2	2	0	0
10	3	2	11	19
10	4	2	1	0
10	5	2	0	0
10	6	2	3	4
10	7	2	4	7
10	8	2	12	40
10	9	2	1	4
10	10	2	15	63
10	11	2	4	13
10	12	2	1	0
10	13	2	17	46
10	14	2	5	28
10	15	2	0	0
10	C1	3	16	20
10	2	3	0	0
10	3	3	7	15
10	4	3	2	1
10	5	3	24	28
10	6	3	0	0
10	7	3	0	0
10	8	3	0	0
10	9	3	11	14
10	10	3	5	11
10	11	3	2	3
10	12	3	0	0
10	13	3	0	0
10	14	3	6	5
10	15	3	0	1
10	C1	4	18	6
10	2	4	0	0
10	3	4	9	15
10	4	4	4	5
10	5	4	1	0
10	6	4	0	0
10	7	4	0	0
10	8	4	1	2
10	9	4	9	9
10	10	4	0	0
10	11	4	19	19
10	12	4	0	0
10	13	4	2	1
10	14	4	1	0
10	15	4	0	0

13	C1	1	29	109
13	2	1	0	0
13	3	1	1	7
13	4	1	0	0
13	5	1	0	0
13	6	1	0	0
13	7	1	87	525
13	8	1	24	70
13	9	1	27	86
13	10	1	13	24
13	11	1	8	26
13	12	1	17	84
13	13	1	7	36
13	14	1	65	219
13	15	1	3	7
13	1	2	9	57
13	2	2	0	0
13	3	2	21	23
13	4	2	2	0
13	5	2	0	0
13	6	2	2	8
13	7	2	7	7
13	8	2	18	56
13	9	2	8	11
13	10	2	37	113
13	11	2	17	19
13	12	2	1	0
13	13	2	32	105
13	14	2	21	46
13	15	2	0	0
13	C1	3	21	42
13	2	3	0	0
13	3	3	13	34
13	4	3	1	0
13	5	3	24	28
13	6	3	3	6
13	7	3	1	7
13	8	3	0	0
13	9	3	20	21
13	10	3	5	12
13	11	3	2	4
13	12	3	29	62
13	13	3	0	0
13	14	3	3	2
13	15	3	0	0
13	C1	4	26	35
13	2	4	0	0
13	3	4	10	20
13	4	4	7	2
13	5	4	1	0
13	6	4	9	13
13	7	4	3	2

13	8	4	1	2
13	9	4	12	18
13	10	4	0	0
13	11	4	29	31
13	12	4	4	9
13	13	4	1	1
13	14	4	1	0
13	15	4	0	0

Myzus persicae - Bio-insecticides - Second inoculation

			Number of aphids	
Days after spraying	Treatment	Rep	Adults	Nymphs
7	C2	1	10	0
7	2	1	10	0
7	5	1	10	0
7	6	1	10	0
7	7	1		
7	12	1		
7	C2	2	10	0
7	2	2	10	0
7	5	2	10	0
7	6	2		
7	7	2		
7	12	2		
7	C2	3	10	0
7	2	3	10	0
7	5	3		
7	6	3	10	0
7	7	3	10	0
7	12	3	10	0
7	C2	4	10	0
7	2	4	10	0
7	5	4		
7	6	4	10	0
7	7	4	10	0
7	12	4	10	0
8	C2	1	4	2
8	2	1	0	0
8	5	1	7	11
8	6	1	2	4
8	7	1		
8	12	1		
8	C2	2	7	3
8	2	2	0	0
8	5	2	6	14
8	6	2		
8	7	2		
8	12	2		
8	C2	3	8	4

8	2	3	0	0
8	5	3		
8	6	3	3	2
8	7	3	3	6
8	12	3	10	13
8	C2	4	10	0
8	2	4	0	0
8	5	4		
8	6	4	7	3
8	7	4	6	1
8	12	4	6	3
10	C2	1	4	7
10	2	1	0	0
10	5	1	4	18
10	6	1	1	1
10	7	1		
10	12	1		
10	C2	2	6	13
10	2	2	0	0
10	5	2	4	17
10	6	2		
10	7	2		
10	12	2		
10	C2	3	7	6
10	2	3	0	0
10	5	3		
10	6	3	5	1
10	7	3	4	11
10	12	3	24	25
10	C2	4	9	4
10	2	4	0	0
10	5	4		
10	6	4	8	8
10	7	4	4	3
10	12	4	4	6
13	C2	1	6	18
13	2	1	0	0
13	5	1	25	14
13	6	1	1	4
13	7	1		
13	12	1	17	84
13	C2	2	9	34
13	2	2	0	0
13	5	2	9	30
13	6	2		
13	7	2		
13	12	2		
13	C2	3	14	9
13	2	3	0	0
13	5	3		

13	6	3	3	6
13	7	3	1	7
13	12	3	29	62
13	C2	4	9	21
13	2	4	0	0
13	5	4		
13	6	4	9	13
13	7	4	3	2
13	12	4	4	9

Brevicoryne brassicae - First inoculation

			Number of aphids	
Days after spraying	Treatment	Rep	Adults	Nymphs
0	C1	1	10	0
0	2	1	10	0
0	3	1	10	0
0	4	1	10	0
0	5	1	10	0
0	6	1	10	0
0	7	1	10	0
0	8	1	10	0
0	9	1	10	0
0	10	1	10	0
0	11	1	10	0
0	12	1	10	0
0	13	1	10	0
0	C1	2	10	0
0	2	2	10	0
0	3	2	10	0
0	4	2	10	0
0	5	2	10	0
0	6	2	10	0
0	7	2	10	0
0	8	2	10	0
0	9	2	10	0
0	10	2	10	0
0	11	2	10	0
0	12	2	10	0
0	13	2	10	0
0	C1	3	10	0
0	2	3	10	0
0	3	3	10	0
0	4	3	10	0
0	5	3	10	0
0	6	3	10	0
0	7	3	10	0
0	8	3	10	0
0	9	3	10	0
0	10	3	10	0
0	11	3	10	0
0	12	3	10	0
0	13	3	10	0

0	C1	4	10	0
0	2	4	10	0
0	3	4	10	0
0	4	4	10	0
0	5	4	10	0
0	6	4	10	0
0	7	4	10	0
0	8	4	10	0
0	9	4	10	0
0	10	4	10	0
0	11	4	10	0
0	12	4	10	0
0	13	4	10	0
1	C1	1	8	15
1	2	1	3	2
1	3	1	3	2
1	4	1	1	1
1	5	1	1	1
1	6	1	3	1
1	7	1	2	3
1	8	1	2	2
1	9	1	0	0
1	10	1	5	4
1	11	1	0	0
1	12	1	5	3
1	13	1		
1	C1	2	6	6
1	2	2	1	0
1	3	2	0	0
1	4	2	0	0
1	5	2	0	0
1	6	2	0	0
1	7	2	0	0
1	8	2	0	0
1	9	2	1	0
1	10	2	3	3
1	11	2	2	1
1	12	2	5	6
1	13	2		
1	C1	3	9	2
1	2	3	0	2
1	3	3	2	0
1	4	3	2	0
1	5	3	0	0
1	6	3	0	0
1	7	3	1	0
1	8	3	0	0
1	9	3	2	1
1	10	3	1	0
1	11	3	1	0
1	12	3	2	0

1	13	3	2	1
1	C1	4	6	9
1	2	4	0	0
1	3	4	3	1
1	4	4	0	1
1	5	4	0	0
1	6	4	0	0
1	7	4	2	1
1	8	4	0	0
1	9	4	4	1
1	10	4	2	0
1	11	4	0	0
1	12	4	0	1
1	13	4	2	0
3	C1	1	9	25
3	2	1	0	0
3	3	1	0	0
3	4	1	0	0
3	5	1	0	0
3	6	1	0	0
3	7	1	2	8
3	8	1	0	0
3	9	1	0	0
3	10	1	2	1
3	11	1	0	0
3	12	1	4	6
3	13	1		
3	C1	2	8	11
3	2	2	0	0
3	3	2	0	0
3	4	2	0	0
3	5	2	0	0
3	6	2	0	0
3	7	2	0	0
3	8	2	0	0
3	9	2	1	0
3	10	2	1	3
3	11	2	2	2
3	12	2	3	12
3	13	2		
3	C1	3	8	15
3	2	3	0	0
3	3	3	0	0
3	4	3	0	0
3	5	3	0	0
3	6	3	0	0
3	7	3	0	0
3	8	3	0	0
3	9	3	1	3
3	10	3	1	1
3	11	3	0	0

3	12	3	0	0
3	13	3	0	2
3	C1	4	5	13
3	2	4	0	0
3	3	4	0	0
3	4	4	0	0
3	5	4	0	0
3	6	4	0	0
3	7	4	2	5
3	8	4	0	0
3	9	4	3	9
3	10	4	0	0
3	11	4	0	0
3	12	4	0	0
3	13	4	2	3
6	C1	1	9	31
6	2	1	0	0
6	3	1	0	0
6	4	1	0	0
6	5	1	0	0
6	6	1	0	0
6	7	1	3	4
6	8	1	0	0
6	9	1	0	0
6	10	1	1	0
6	11	1	0	0
6	12	1	4	11
6	13	1		
6	C1	2	8	23
6	2	2	0	0
6	3	2	0	0
6	4	2	0	0
6	5	2	0	0
6	6	2	0	0
6	7	2	0	0
6	8	2	0	0
6	9	2	0	0
6	10	2	0	0
6	11	2	0	0
6	12	2	3	17
6	13	2		
6	C1	3	8	43
6	2	3	0	0
6	3	3	0	0
6	4	3	0	0
6	5	3	0	0
6	6	3	0	0
6	7	3	0	0
6	8	3	0	0
6	9	3	1	3
6	10	3	1	1

6	11	3	0	0
6	12	3	0	0
6	13	3	0	0
6	C1	4	5	21
6	2	4	0	0
6	3	4	0	0
6	4	4	0	0
6	5	4	0	0
6	6	4	0	0
6	7	4	2	16
6	8	4	0	0
6	9	4	5	17
6	10	4	0	0
6	11	4	0	0
6	12	4	0	0
6	13	4	1	6
8	C1	1	13	40
8	2	1	0	0
8	3	1	0	0
8	4	1	0	0
8	5	1	0	0
8	6	1	0	0
8	7	1	3	1
8	8	1	0	0
8	9	1	0	0
8	10	1	0	0
8	11	1	0	0
8	12	1	6	8
8	13	1		
8	C1	2	5	19
8	2	2	0	0
8	3	2	0	0
8	4	2	0	0
8	5	2	0	0
8	6	2	0	0
8	7	2	0	0
8	8	2	0	0
8	9	2	0	0
8	10	2	0	0
8	11	2	0	0
8	12	2	4	11
8	13	2		
8	C1	3	8	64
8	2	3	0	0
8	3	3	0	0
8	4	3	0	0
8	5	3	0	0
8	6	3	0	0
8	7	3	0	0
8	8	3	0	0
8	9	3	1	2

8	10	3	1	1
8	11	3	0	0
8	12	3	0	0
8	13	3	0	0
8	C1	4	20	16
8	2	4	0	0
8	3	4	0	0
8	4	4	0	0
8	5	4	0	0
8	6	4	0	0
8	7	4	18	7
8	8	4	0	0
8	9	4	5	16
8	10	4	0	0
8	11	4	0	0
8	12	4	0	0
8	13	4	4	9
10	C1	1	16	55
10	2	1	0	0
10	3	1	0	0
10	4	1	0	0
10	5	1	0	0
10	6	1	0	0
10	7	1	1	0
10	8	1	0	0
10	9	1	0	0
10	10	1	0	0
10	11	1	0	0
10	12	1	3	11
10	13	1		
10	C1		10	32
10	2	2	0	0
10	3	2	0	0
10	4	2	0	0
10	5	2	0	0
10	6	2	0	0
10	7	2	0	0
10	8	2	0	0
10	9	2	0	0
10	10	2	0	0
10	11	2	0	0
10	12	2	4	8
10	13	2		
10	C1	3	12	63
10	2	3	0	0
10	3	3	0	0
10	4	3	0	0
10	5	3	0	0
10	6	3	0	0
10	7	3	0	0
10	8	3	0	0

10	9	3	0	0
10	10	3	0	0
10	11	3	0	0
10	12	3	0	0
10	13	3	0	0
10	C1	4	21	29
10	2	4	0	0
10	3	4	0	0
10	4	4	0	0
10	5	4	0	0
10	6	4	0	0
10	7	4	18	18
10	8	4	0	0
10	9	4	5	16
10	10	4	0	0
10	11	4	0	0
10	12	4	0	0
10	13	4	4	17
13	C1	1	34	64
13	2	1	0	0
13	3	1	0	0
13	4	1	0	0
13	5	1	0	0
13	6	1	0	0
13	7	1	0	0
13	8	1	0	0
13	9	1	0	0
13	10	1	0	0
13	11	1	0	0
13	12	1	4	11
13	13			
13	C1	2	18	50
13	2	2	0	0
13	3	2	0	0
13	4	2	0	0
13	5	2	0	0
13	6	2	0	0
13	7	2	0	0
13	8	2	0	0
13	9	2	0	0
13	10	2	0	0
13	11	2	0	0
13	12	2	4	6
13	13			
13	C1	3	32	74
13	2	3	0	0
13	3	3	0	0
13	4	3	0	0
13	5	3	0	0
13	6	3	0	0
13	7	3	0	0

13	8	3	0	0
13	9	3	0	0
13	10	3	3	8
13	11	3	0	0
13	12	3	0	0
13	13	3	0	0
13	C1	4	24	48
13	2	4	0	0
13	3	4	0	0
13	4	4	0	0
13	5	4	0	0
13	6	4	0	0
13	7	4	20	64
13	8	4	0	0
13	9	4	14	32
13	10	4	0	0
13	11	4	0	0
13	12	4	0	0
13	13	4	7	17

Brevicoryne brassicae - second inoculation

			Number of aphids	
Days after spraying	Treatment	Rep	Adults	Nymphs
6	C2	1	10	0
6	2	1	10	0
6	3	1	10	0
6	4	1	10	0
6	5	1	10	0
6	6	1	10	0
6	7	1		
6	8	1	10	0
6	9	1	10	0
6	10	1	10	0
6	11	1	10	0
6	12	1		
6	13	1		
6	C2	2	10	0
6	2	2	10	0
6	3	2	10	0
6	4	2	10	0
6	5	2	10	0
6	6	2	10	0
6	7	2	10	0
6	8	2	10	0
6	9	2	10	0
6	10	2	10	0
6	11	2	10	0
6	12	2		
6	13	2		
6	C2	3	10	0
6	2	3	10	0
6	3	3	10	0

6	4	3	10	0
6	5	3	10	0
6	6	3	10	0
6	7	3	10	0
6	8	3	10	0
6	9	3		
6	10	3		
6	11	3	10	0
6	12	3	10	0
6	13	3	10	0
6	C2	4	10	0
6	2	4	10	0
6	3	4	10	0
6	4	4	10	0
6	5	4	10	0
6	6	4	10	0
6	7	4		
6	8	4	10	0
6	9	4		
6	10	4	10	0
6	11	4	10	0
6	12	4	10	0
6	13	4		
8	C2	1	2	5
8	2	1	0	1
8	3	1	2	0
8	4	1	0	0
8	5	1	2	4
8	6	1	1	2
8	7	1		
8	8	1	3	5
8	9	1	4	7
8	10	1	5	0
8	11	1	4	15
8	12	1		
8	13	1		
8	C2	2	6	7
8	2	2	1	1
8	3	2	0	1
8	4	2	0	0
8	5	2	1	0
8	6	2	1	0
8	7	2	4	9
8	8	2	3	8
8	9	2	2	9
8	10	2	9	7
8	11	2	4	3
8	12	2		
8	13	2		
8	C2	3	7	7
8	2	3	2	0

8	3	3	1	0
8	4	3	8	4
8	5	3	1	0
8	6	3	1	0
8	7	3	7	9
8	8	3	4	7
8	9	3		
8	10	3		
8	11	3	6	5
8	12	3	9	6
8	13	3	7	10
8	C2	4	6	11
8	2	4	2	0
8	3	4	0	0
8	4	4	2	1
8	5	4	0	0
8	6	4	0	0
8	7	4		
8	8	4	3	1
8	9	4		
8	10	4	5	0
8	11	4	3	0
8	12	4	6	4
8	13	4		
10	C2	1	0	4
10	2	1	0	0
10	3	1	0	0
10	4	1	0	0
10	5	1	0	0
10	6	1	0	0
10	7	1		
10	8	1	2	5
10	9	1	2	9
10	10	1	4	1
10	11	1	3	7
10	12	1		
10	13	1		
10	C2	2	6	19
10	2	2	1	0
10	3	2	0	0
10	4	2	0	0
10	5	2	0	0
10	6	2	0	0
10	7	2	4	16
10	8	2	4	13
10	9	2	2	14
10	10	2	7	23
10	11	2	3	7
10	12	2		
10	13	2		
10	C2	3	7	13
10	2	3	0	0

10	3	3	0	0
10	4	3	2	0
10	5	3	0	0
10	6	3	0	0
10	7	3	5	13
10	8	3	5	19
10	9	3		
10	10	3		
10	11	3	6	11
10	12	3	8	24
10	13	3	6	19
10	C2	4	5	18
10	2	4	0	0
10	3	4	0	0
10	4	4	0	0
10	5	4	0	0
10	6	4	0	0
10	7	4		
10	8	4	3	1
10	9	4		
10	10	4	4	3
10	11	4	2	0
10	12	4	6	19
10	13	4		
13	C2	1	0	2
13	2	1	0	0
13	3	1	0	0
13	4	1	0	0
13	5	1	0	0
13	6	1	0	0
13	7	1		
13	8	1	2	7
13	9	1	2	11
13	10	1	5	2
13	11	1	4	9
13	12	1		
13	13	1		
13	C2	2	5	20
13	2	2	0	0
13	3	2	0	0
13	4	2	0	0
13	5	2	0	0
13	6	2	0	0
13	7	2	7	28
13	8	2	2	11
13	9	2	2	18
13	10	2	12	52
13	11	2	4	11
13	12	2		
13	13	2		
13	C2	3	7	26
13	2	3	0	0

13	3	3	0	0
13	4	3	0	0
13	5	3	0	0
13	6	3	0	0
13	7	3	5	25
13	8	3	5	39
13	9	3		
13	10	3		
13	11	3	5	14
13	12	3	7	55
13	13	3	9	39
13	C2	4	13	47
13	2	4	0	0
13	3	4	0	0
13	4	4	0	0
13	5	4	0	0
13	6	4	0	0
13	7	4		
13	8	4	3	0
13	9	4		
13	10	4	5	14
13	11	4	2	11
13	12	4	8	27
13	13	4		

Brevicoryne brassicae - third inoculation

			Number of aphids	
Days after spraying	Treatment	Rep	Adults	Nymphs
13	2	1	10	0
13	3	1	10	0
13	4	1	10	0
13	5	1	10	0
13	6	1	10	0
13	C3	2	10	0
13	2	2	10	0
13	3	2	10	0
13	4	2	10	0
13	5	2	10	0
13	6	2	10	0
13	C3	3	10	0
13	2	3	10	0
13	3	3	10	0
13	4	3	10	0
13	5	3	10	0
13	6	3	10	0
13	C3	4	10	0
13	2	4	10	0
13	3	4	10	0
13	4	4	10	0
13	5	4	10	0
13	6	4	10	0

14	C3	1	9	10
14	2	1	3	4
14	3	1	4	2
14	4	1	0	0
14	5	1	5	3
14	6	1	0	0
14	C3	2	4	0
14	2	2	4	1
14	3	2	7	0
14	4	2	1	0
14	5	2	7	5
14	6	2	6	0
14	C3	3	10	0
14	2	3	7	0
14	3	3	4	2
14	4	3	8	6
14	5	3	6	2
14	6	3	2	0
14	C3	4	7	3
14	2	4	5	1
14	3	4	8	3
14	4	4	5	0
14	5	4	3	1
14	6	4	3	0
17	C3	1	8	29
17	2	1	0	0
17	3	1	1	3
17	4	1	0	0
17	5	1	1	1
17	6	1	0	0
17	C3	2	4	4
17	2	2	1	0
17	3	2	2	0
17	4	2	0	0
17	5	2	0	0
17	6	2	1	1
17	C3	3	10	31
17	2	3	1	0
17	3	3	0	0
17	4	3	0	0
17	5	3	0	0
17	6	3	0	0
17	C3	4	7	17
17	2	4	0	0
17	3	4	0	0
17	4	4	1	1
17	5	4	0	0
17	6	4	0	0
20	C3	1	9	40

20	2	1	0	0
20	3	1	0	0
20	4	1	0	0
20	5	1	0	0
20	6	1	0	0
20	C3	2	3	17
20	2	2	0	0
20	3	2	0	0
20	4	2	0	0
20	5	2	0	0
20	6	2	2	2
20	C3	3	7	45
20	2	3	1	0
20	3	3	0	0
20	4	3	0	0
20	5	3	0	0
20	6	3	0	0
20	C3	4	7	31
20	2	4	0	0
20	3	4	0	0
20	4	4	0	0
20	5	4	0	0
20	6	4	0	0

Cavariella aegopodii - First inoculation

			Number of aphids	
Days after spraying	Treatment	Rep	Adults	Nymphs
0	C1	1	10	0
0	2	1	10	0
0	3	1	10	0
0	4	1	10	0
0	5	1	10	0
0	6	1	10	0
0	7	1	10	0
0	8	1	10	0
0	9	1	10	0
0	10	1	10	0
0	11	1	10	0
0	12	1	10	0
0	C1	2	10	0
0	2	2	10	0
0	3	2	10	0
0	4	2	10	0
0	5	2	10	0
0	6	2	10	0
0	7	2	10	0
0	8	2	10	0
0	9	2	10	0
0	10	2	10	0
0	11	2	10	0
0	12	2	10	0
0	C1	3	10	0

0	2	3	10	0
0	3	3	10	0
0	4	3	10	0
0	5	3	10	0
0	6	3	10	0
0	7	3	10	0
0	8	3	10	0
0	9	3	10	0
0	10	3	10	0
0	11	3	10	0
0	12	3	10	0
0	C1	4	10	0
0	2	4	10	0
0	3	4	10	0
0	4	4	10	0
0	5	4	10	0
0	6	4	10	0
0	7	4	10	0
0	8	4	10	0
0	9	4	10	0
0	10	4	10	0
0	11	4	10	0
0	12	4	10	0
1	C1	1	6	4
1	2	1	1	0
1	3	1	1	0
1	4	1	5	0
1	5	1	6	1
1	6	1	5	0
1	7	1	6	1
1	8	1	2	0
1	9	1	4	1
1	10	1	8	0
1	11	1	4	2
1	12	1	7	0
1	C1	2	4	0
1	2	2	2	0
1	3	2	1	0
1	4	2	3	0
1	5	2	1	0
1	6	2	4	0
1	7	2	4	0
1	8	2	6	0
1	9	2	3	0
1	10	2	5	0
1	11	2	5	0
1	12	2	6	0
1	C1	3	7	0
1	2	3	1	0
1	3	3	0	0
1	4	3	3	0

1	5	3	3	0
1	6	3	5	3
1	7	3	5	3
1	8	3	1	0
1	9	3	6	1
1	10	3	2	0
1	11	3	8	3
1	12	3	4	1
1	C1	4	4	1
1	2	4	1	0
1	3	4	0	0
1	4	4	5	1
1	5	4	0	0
1	6	4	3	3
1	7	4	4	0
1	8	4	2	1
1	9	4	6	0
1	10	4	7	4
1	11	4	4	2
1	12	4	7	4
3	C1	1	7	5
3	2	1	0	0
3	3	1	0	0
3	4	1	3	2
3	5	1	1	0
3	6	1	2	6
3	7	1	3	1
3	8	1	2	2
3	9	1	4	4
3	10	1	6	3
3	11	1	5	5
3	12	1	8	1
3	C1	2	6	1
3	2	2	0	0
3	3	2	0	0
3	4	2	3	1
3	5	2	0	0
3	6	2	3	0
3	7	2	0	3
3	8	2	5	1
3	9	2	3	2
3	10	2	4	1
3	11	2	4	0
3	12	2	3	1
3	C1	3	5	2
3	2	3	0	0
3	3	3	0	0
3	4	3	3	0
3	5	3	3	1
3	6	3	7	10
3	7	3	8	12

3	8	3	2	0
3	9	3	6	9
3	10	3	5	0
3	11	3	8	4
3	12	3	7	2
3	C1	4	4	1
3	2	4	0	0
3	3	4	0	0
3	4	4	4	0
3	5	4	0	0
3	6	4	5	3
3	7	4	5	3
3	8	4	2	2
3	9	4	6	7
3	10	4	7	7
3	11	4	2	0
3	12	4	7	6
6	C1	1	9	12
6	2	1	0	0
6	3	1	0	0
6	4	1	3	1
6	5	1	0	0
6	6	1	6	3
6	7	1	3	1
6	8	1	4	3
6	9	1	6	11
6	10	1	7	17
6	11	1	11	10
6	12	1	9	11
6	C1	2	4	4
6	2	2	0	0
6	3	2	0	0
6	4	2	2	1
6	5	2	0	0
6	6	2	2	3
6	7	2	1	4
6	8	2	6	3
6	9	2	3	2
6	10	2	8	3
6	11	2	4	4
6	12	2	14	10
6	C1	3	12	20
6	2	3	0	0
6	3	3	0	0
6	4	3	1	0
6	5	3	0	1
6	6	3	9	36
6	7	3	8	23
6	8	3	2	0
6	9	3	4	10
6	10	3	5	1

6	11	3	7	16
6	12	3	7	13
6	C1	4	3	2
6	2	4	0	0
6	3	4	0	0
6	4	4	3	0
6	5	4	0	0
6	6	4	5	8
6	7	4	12	23
6	8	4	6	3
6	9	4	7	8
6	10	4	6	21
6	11	4	4	6
6	12	4	4	7
8	C1	1	12	14
8	2	1	0	0
8	3	1	0	0
8	4	1	5	0
8	5	1	0	0
8	6	1	11	4
8	7	1	5	4
8	8	1	1	1
8	9	1	11	22
8	10	1	26	9
8	11	1	11	8
8	12	1	11	6
8	C1	2	5	9
8	2	2	0	0
8	3	2	0	0
8	4	2	2	0
8	5	2	0	0
8	6	2	2	3
8	7	2	1	0
8	8	2	3	3
8	9	2	0	2
8	10	2	11	7
8	11	2	8	6
8	12	2	15	18
8	C1	3	23	33
8	2	3	0	0
8	3	3	0	0
8	4	3	1	2
8	5	3	0	0
8	6	3	36	51
8	7	3	10	19
8	8	3	2	0
8	9	3	13	17
8	10	3	4	10
8	11	3	10	16
8	12	3	11	16
8	C1	4	2	5

8	2	4	0	0
8	3	4	0	0
8	4	4	4	0
8	5	4	0	0
8	6	4	25	27
8	7	4	7	8
8	8	4	4	4
8	9	4	16	20
8	10	4	20	17
8	11	4	4	3
8	12	4	15	17
10	C1	1	27	12
10	2	1	0	0
10	3	1	0	0
10	4	1	2	0
10	5	1	0	0
10	6	1	19	9
10	7	1	4	4
10	8	1	2	1
10	9	1	12	19
10	10	1	27	17
10	11	1	11	10
10	12	1	20	24
10	C1	2	21	17
10	2	2	0	0
10	3	2	0	0
10	4	2	4	2
10	5	2	0	0
10	6	2	7	4
10	7	2	1	0
10	8	2	4	3
10	9	2	3	5
10	10	2	10	4
10	11	2	10	6
10	12	2	19	18
10	C1	3	29	40
10	2	3	0	0
10	3	3	0	0
10	4	3	2	2
10	5	3	0	0
10	6	3	41	70
10	7	3	11	20
10	8	3	2	0
10	9	3	10	28
10	10	3	9	10
10	11	3	20	29
10	12	3	16	15
10	C1	4	7	15
10	2	4	0	0
10	3	4	0	0
10	4	4	4	0

10	5	4	0	0
10	6	4	40	43
10	7	4	9	4
10	8	4	4	3
10	9	4	12	8
10	10	4	22	40
10	11	4	6	3
10	12	4	15	18
13	C1	1	26	21
13	2	1	0	0
13	3	1	0	0
13	4	1	1	0
13	5	1	0	0
13	6	1	24	26
13	7	1	7	1
13	8	1	2	2
13	9	1	22	18
13	10	1	31	47
13	11	1	18	7
13	12	1	30	35
13	C1	2	35	10
13	2	2	0	0
13	3	2	0	0
13	4	2	2	3
13	5	2	0	0
13	6	2	18	24
13	7	2	3	1
13	8	2	5	4
13	9	2	12	7
13	10	2	14	13
13	11	2	16	24
13	12	2	59	41
13	C1	3	38	50
13	2	3	0	0
13	3	3	0	0
13	4	3	4	1
13	5	3	0	0
13	6	3	63	80
13	7	3	17	25
13	8	3	1	0
13	9	3	22	38
13	10	3	17	15
13	11	3	23	45
13	12	3	20	27
13	C1	4	10	20
13	2	4	0	0
13	3	4	0	0
13	4	4	3	0
13	5	4	0	0
13	6	4	45	51
13	7	4	9	11

13	8	4	14	10
13	9	4	14	6
13	10	4	25	45
13	11	4	12	11
13	12	4	33	27
15	C1	1	53	70
15	2	1	0	0
15	3	1	0	0
15	4	1	1	0
15	5	1	0	0
15	6	1	22	43
15	7	1	7	4
15	8	1	4	8
15	9	1	18	20
15	10	1	37	90
15	11	1	19	4
15	12	1	30	80
15	C1	2	40	50
15	2	2	0	0
15	3	2	0	0
15	4	2	5	8
15	5	2	0	0
15	6	2	30	47
15	7	2	5	6
15	8	2	9	5
15	9	2	19	13
15	10	2	40	40
15	11	2	29	30
15	12	2	81	83
15	C1	3	40	55
15	2	3	0	0
15	3	3	0	0
15	4	3	2	3
15	5	3	0	0
15	6	3	45	130
15	7	3	36	45
15	8	3	0	1
15	9	3	22	47
15	10	3	24	16
15	11	3	35	80
15	12	3	32	35
15	C1	4	16	20
15	2	4	0	0
15	3	4	0	0
15	4	4	4	0
15	5	4	0	0
15	6	4	42	105
15	7	4	8	22
15	8	4	13	18
15	9	4	13	10
15	10	4	24	55
15	11	4	12	40

15	12	4	30	50
17	C1	1	50	120
17	2	1	0	0
17	3	1	0	0
17	4	1	1	0
17	5	1	0	0
17	6	1	28	105
17	7	1	10	5
17	8	1	5	8
17	9	1	18	34
17	10	1	53	90
17	11	1	15	30
17	12	1	40	95
17	C1	2	45	55
17	2	2	0	0
17	3	2	0	0
17	4	2	6	10
17	5	2	0	0
17	6	2	56	99
17	7	2	7	6
17	8	2	9	6
17	9	2	18	12
17	10	2	56	65
17	11	2	55	94
17	12	2	87	100
17	C1	3	38	110
17	2	3	0	0
17	3	3	0	0
17	4	3	2	1
17	5	3	0	0
17	6	3	42	220
17	7	3	38	100
17	8	3	0	0
17	9	3	26	70
17	10	3	23	20
17	11	3	27	105
17	12	3	31	70
17	C1	4	20	65
17	2	4	0	0
17	3	4	0	0
17	4	4	3	1
17	5	4	0	0
17	6	4	46	140
17	7	4	16	24
17	8	4	18	20
17	9	4	13	7
17	10	4	39	75
17	11	4	30	52
17	12	4	59	80
20	C1	1	95	200

20	2	1	0	0
20	3	1	0	0
20	4	1	0	0
20	5	1	0	0
20	6	1	47	230
20	7	1	13	26
20	8	1	6	16
20	9	1	14	30
20	10	1	70	200
20	11	1	23	45
20	12	1	70	190
20	C1	2	80	116
20	2	2	0	0
20	3	2	0	0
20	4	2	8	12
20	5	2	0	0
20	6	2	140	160
20	7	2	14	32
20	8	2	17	35
20	9	2	17	11
20	10	2	75	95
20	11	2	110	200
20	12	2	135	192
20	C1	3	47	130
20	2	3	0	0
20	3	3	0	0
20	4	3	5	3
20	5	3	0	0
20	6	3	97	360
20	7	3	74	230
20	8	3	1	0
20	9	3	32	140
20	10	3	25	65
20	11	3	69	200
20	12	3	40	90
20	C1	4	40	91
20	2	4	0	0
20	3	4	0	0
20	4	4	3	6
20	5	4	0	0
20	6	4	90	240
20	7	4	32	54
20	8	4	25	55
20	9	4	13	10
20	10	4	91	150
20	11	4	43	81
20	12	4	80	117

Cavariella aegopodii - Second inoculation

			Number of aphids	
Days after spraying	Treatment	Rep	Adults	Nymphs

6	C2	1	10	0
6	2	1	10	0
6	3	1	10	0
6	5	1	10	0
6	C2	2	10	0
6	2	2	10	0
6	3	2	10	0
6	5	2	10	0
6	C2	3	10	0
6	2	3	10	0
6	3	3	10	0
6	5	3	10	0
6	C2	4	10	0
6	2	4	10	0
6	3	4	10	0
6	5	4	10	0
8	C2	1	5	2
8	2	1	0	0
8	3	1	0	0
8	5	1	2	0
8	C2	2	3	0
8	2	2	1	0
8	3	2	0	0
8	5	2	2	0
8	C2	3	7	0
8	2	3	4	0
8	3	3	0	0
8	5	3	3	0
8	C2	4	6	0
8	2	4	4	0
8	3	4	0	0
8	5	4	5	0
10	C2	1	5	2
10	2	1	0	0
10	3	1	0	0
10	5	1	2	1
10	C2	2	5	8
10	2	2	0	0
10	3	2	0	0
10	5	2	1	2
10	C2	3	7	3
10	2	3	1	0
10	3	3	0	0
10	5	3	3	0
10	C2	4	7	2
10	2	4	2	0
10	3	4	0	0
10	5	4	4	3
13	C2	1	9	9

13	2	1	0	0
13	3	1	0	0
13	5	1	2	0
13	C2	2	11	5
13	2	2	0	0
13	3	2	0	0
13	5	2	3	11
13	C2	3	6	10
13	2	3	0	0
13	3	3	0	0
13	5	3	5	0
13	C2	4	7	6
13	2	4	0	0
13	3	4	0	0
13	5	4	4	8

Cavariella aegopodii - Third inoculation

			Number of aphids	
Days after spraying	Treatment	Rep	Adults	Nymphs
13	C3	1	10	0
13	2	1	10	0
13	3	1	10	0
13	C3	2	10	0
13	2	2	10	0
13	3	2	10	0
13	C3	3	10	0
13	2	3	10	0
13	3	3	10	0
13	C3	4	10	0
13	2	4	10	0
13	3	4	10	0
15	C3	1	5	6
15	2	1	1	0
15	3	1	0	0
15	C3	2	3	1
15	2	2	3	0
15	3	2	1	0
15	C3	3	8	2
15	2	3	4	0
15	3	3	0	0
15	C3	4	6	0
15	2	4	1	1
15	3	4	0	0
17	C3	1	6	7
17	2	1	0	0
17	3	1	0	0
17	C3	2	4	11
17	2	2	0	0
17	3	2	0	0

17	C3	3	8	27
17	2	3	3	2
17	3	3	0	0
17	C3	4	7	3
17	2	4	1	0
17	3	4	0	0
20	C3	1	12	25
20	2	1	0	0
20	3	1	0	0
20	C3	2	14	21
20	2	2	1	0
20	3	2	0	0
20	C3	3	14	50
20	2	3	0	0
20	3	3	1	0
20	C3	4	7	17
20	2	4	0	0
20	3	4	0	0

Nasonovia ribisnigri - First inoculation

			Number of aphids			
Days after spraying	Treatment	Rep	Winged	Wingless	Total adults	Nymphs
0	C1	1	0	10	10	0
0	2	1	0	10	10	0
0	3	1	0	10	10	0
0	4	1	0	10	10	0
0	5	1	0	10	10	0
0	6	1	0	10	10	0
0	7	1	0	10	10	0
0	8	1	0	10	10	0
0	9	1	0	10	10	0
0	10	1	0	10	10	0
0	11	1	0	10	10	0
0	12	1	0	10	10	0
0	C1	2	0	10	10	0
0	2	2	0	10	10	0
0	3	2	0	10	10	0
0	4	2	0	10	10	0
0	5	2	0	10	10	0
0	6	2	0	10	10	0
0	7	2	0	10	10	0
0	8	2	0	10	10	0
0	9	2	0	10	10	0
0	10	2	0	10	10	0
0	11	2	0	10	10	0
0	12	2	0	10	10	0
0	C1	3	0	10	10	0
0	2	3	0	10	10	0
0	3	3	0	10	10	0
0	4	3	0	10	10	0
0	5	3	0	10	10	0

0	6	3	0	10	10	0
0	7	3	0	10	10	0
0	8	3	0	10	10	0
0	9	3	0	10	10	0
0	10	3	0	10	10	0
0	11	3	0	10	10	0
0	12	3	0	10	10	0
0	C1	4	0	10	10	0
0	2	4	0	10	10	0
0	3	4	0	10	10	0
0	4	4	0	10	10	0
0	5	4	0	10	10	0
0	6	4	0	10	10	0
0	7	4	0	10	10	0
0	8	4	0	10	10	0
0	9	4	0	10	10	0
0	10	4	0	10	10	0
0	11	4	0	10	10	0
0	12	4	0	10	10	0
1	C1	1	4	2	6	0
1	2	1	0	0	0	0
1	3	1	0	4	4	1
1	4	1	0	6	6	3
1	5	1	1	4	5	2
1	6	1	2	3	5	4
1	7	1	1	6	7	2
1	8	1	2	4	6	7
1	9	1	0	5	5	4
1	10	1	2	2	4	1
1	11	1	4	5	9	3
1	12	1	0	5	5	0
1	C1	2	2	6	8	1
1	2	2	2	2	4	1
1	3	2	1	0	1	0
1	4	2	2	3	5	0
1	5	2	0	1	1	0
1	6	2	2	3	5	0
1	7	2	1	4	5	0
1	8	2	0	7	7	1
1	9	2	1	3	4	0
1	10	2	0	5	5	2
1	11	2	1	5	6	0
1	12	2	4	4	8	0
1	C1	3	0	8	8	0
1	2	3	1	3	4	0
1	3	3	3	0	3	0
1	4	3	2	3	5	0
1	5	3	1	3	4	0
1	6	3	0	4	4	0
1	7	3	1	0	1	0
1	8	3	0	3	3	1

1	9	3	0	4	4	3
1	10	3	0	4	4	1
1	11	3	2	1	3	0
1	12	3	1	5	6	0
1	C1	4	0	8	8	0
1	2	4	0	2	2	0
1	3	4	0	1	1	2
1	4	4	1	4	5	0
1	5	4	2	1	3	0
1	6	4	0	3	3	1
1	7	4	1	3	4	0
1	8	4	3	7	10	0
1	9	4	0	3	3	0
1	10	4	0	7	7	0
1	11	4	0	3	3	0
1	12	4	0	3	3	0
3	C1	1	5	2	7	6
3	2	1	0	0	0	0
3	3	1	0	0	0	0
3	4	1	2	5	7	4
3	5	1	1	2	3	0
3	6	1	3	4	7	4
3	7	1	1	1	2	9
3	8	1	3	9	12	22
3	9	1	1	5	6	7
3	10	1	1	3	4	8
3	11	1	3	3	6	6
3	12	1	0	7	7	8
3	C1	2	1	7	8	5
3	2	2	0	1	1	1
3	3	2	0	0	0	0
3	4	2	2	2	4	0
3	5	2	0	0	0	0
3	6	2	2	3	5	0
3	7	2	0	4	4	0
3	8	2	1	8	9	10
3	9	2	3	4	7	3
3	10	2	0	5	5	4
3	11	2	0	4	4	4
3	12	2	3	3	6	2
3	C1	3	1	6	7	1
3	2	3	2	0	2	0
3	3	3	0	0	0	0
3	4	3	1	3	4	0
3	5	3	1	1	2	0
3	6	3	1	4	5	2
3	7	3	1	0	1	1
3	8	3	0	2	2	4
3	9	3	1	3	4	3
3	10	3	1	1	2	2
3	11	3	1	1	2	0

3	12	3	2	3	5	0
3	C1	4	1	0	1	0
3	2	4	0	0	0	0
3	3	4	0	0	0	0
3	4	4	1	2	3	0
3	5	4	0	1	1	0
3	6	4	1	4	5	2
3	7	4	1	4	5	0
3	8	4	4	4	8	4
3	9	4	1	2	3	0
3	10	4	2	2	4	1
3	11	4	2	1	3	0
3	12	4	1	0	1	1
6	C1	1	4	7	11	11
6	2	1	0	0	0	0
6	3	1	0	0	0	0
6	4	1	1	6	7	4
6	5	1	1	0	1	0
6	6	1	3	4	7	21
6	7	1	0	9	9	5
6	8	1	1	25	26	30
6	9	1	0	5	5	10
6	10	1	0	3	3	16
6	11	1	6	4	10	6
6	12	1	1	4	5	9
6	C1	2	1	7	8	17
6	2	2	0	0	0	0
6	3	2	0	0	0	0
6	4	2	1	2	3	3
6	5	2	0	0	0	0
6	6	2	3	4	7	2
6	7	2	1	3	4	11
6	8	2	0	8	8	30
6	9	2	3	4	7	38
6	10	2	0	12	12	38
6	11	2	1	4	5	2
6	12	2	3	2	5	7
6	C1	3	2	2	4	5
6	2	3	0	0	0	0
6	3	3	0	0	0	0
6	4	3	2	2	4	2
6	5	3	0	0	0	0
6	6	3	2	1	3	10
6	7	3	0	0	0	0
6	8	3	0	5	5	4
6	9	3	1	3	4	9
6	10	3	1	1	2	3
6	11	3	1	1	2	2
6	12	3	4	1	5	12
6	C1	4	4	0	4	6
6	2	4	0	0	0	0

6	3	4	0	0	0	0
6	4	4	1	1	2	1
6	5	4	0	0	0	0
6	6	4	3	3	6	9
6	7	4	3	1	4	0
6	8	4	2	2	4	9
6	9	4	1	4	5	3
6	10	4	0	4	4	7
6	11	4	1	0	1	1
6	12	4	2	0	2	1
8	C1	1	3	7	10	13
8	2	1	0	0	0	0
8	3	1	0	0	0	0
8	4	1	0	2	2	7
8	5	1	0	0	0	0
8	6	1	3	9	12	19
8	7	1	0	9	9	8
8	8	1	3	29	32	31
8	9	1	0	7	7	18
8	10	1	1	1	2	14
8	11	1	2	4	6	3
8	12	1	3	2	5	24
8	C1	2	1	6	7	15
8	2	2	0	0	0	0
8	3	2	0	0	0	0
8	4	2	2	3	5	4
8	5	2	0	0	0	0
8	6	2	3	3	6	4
8	7	2	0	3	3	16
8	8	2	0	9	9	45
8	9	2	3	18	21	26
8	10	2	0	3	3	28
8	11	2	1	3	4	2
8	12	2	2	2	4	8
8	C1	3	1	6	7	3
8	2	3	0	0	0	0
8	3	3	0	0	0	0
8	4	3	0	4	4	4
8	5	3	0	0	0	0
8	6	3	1	4	5	9
8	7	3	0	0	0	0
8	8	3	0	8	8	2
8	9	3	2	5	7	8
8	10	3	0	2	2	1
8	11	3	1	3	4	2
8	12	3	4	1	5	7
8	C1	4	4	2	6	20
8	2	4	0	0	0	0
8	3	4	0	0	0	0
8	4	4	2	1	3	3
8	5	4	0	0	0	0

8	6	4	2	3	5	11
8	7	4	0	1	1	4
8	8	4	1	1	2	9
8	9	4	1	4	5	3
8	10	4	0	4	4	5
8	11	4	1	0	1	0
8	12	4	1	0	1	0
10	C1	1	2	6	8	12
10	2	1	0	0	0	0
10	3	1	0	0	0	0
10	4	1	1	3	4	1
10	5	1	0	0	0	0
10	6	1	4	6	10	8
10	7	1	0	4	4	4
10	8	1	5	25	30	20
10	9	1	0	5	5	21
10	10	1	0	3	3	8
10	11	1	0	1	1	0
10	12	1	3	6	9	26
10	C1	2	1	5	6	16
10	2	2	0	0	0	0
10	3	2	0	0	0	0
10	4	2	1	3	4	1
10	5	2	0	0	0	0
10	6	2	2	3	5	5
10	7	2	0	2	2	9
10	8	2	1	5	6	39
10	9	2	1	20	21	36
10	10	2	0	18	18	18
10	11	2	1	1	2	0
10	12	2	2	3	5	5
10	C1	3	3	2	5	6
10	2	3	0	0	0	0
10	3	3	0	0	0	0
10	4	3	0	2	2	3
10	5	3	0	0	0	0
10	6	3	1	5	6	11
10	7	3	0	0	0	0
10	8	3	2	8	10	0
10	9	3	4	9	13	9
10	10	3	0	3	3	0
10	11	3	2	4	6	1
10	12	3	3	5	8	9
10	C1	4	4	8	12	18
10	2	4	0	0	0	0
10	3	4	0	0	0	0
10	4	4	2	2	4	2
10	5	4	0	0	0	0
10	6	4	0	3	3	16
10	7	4	1	0	1	2
10	8	4	3	2	5	7

10	9	4	0	3	3	7
10	10	4	2	4	6	4
10	11	4	0	0	0	0
10	12	4	2	0	2	5
13	C1	1	0	4	4	12
13	2	1	0	0	0	0
13	3	1	0	0	0	0
13	4	1	0	3	3	18
13	5	1	3	7	10	11
13	6	1	3	10	13	13
13	7	1	0	2	2	0
13	8	1	17	22	39	25
13	9	1	3	4	7	19
13	10	1	0	5	5	13
13	11	1	0	0	0	0
13	12	1	2	2	4	18
13	C1	2	0	10	10	7
13	2	2	0	0	0	0
13	3	2	0	0	0	0
13	4	2	1	3	4	0
13	5	2	1	2	3	1
13	6	2	0	16	16	17
13	7	2	0	5	5	6
13	8	2	0	7	7	31
13	9	2	0	15	15	32
13	10	2	2	10	12	11
13	11	2	0	0	0	0
13	12	2	0	2	2	5
13	C1	3	4	1	5	5
13	2	3	0	0	0	0
13	3	3	0	0	0	0
13	4	3	0	2	2	0
13	5	3	2	1	3	4
13	6	3	0	10	10	8
13	7	3	0	0	0	0
13	8	3	3	6	9	11
13	9	3	2	7	9	17
13	10	3	1	3	4	1
13	11	3	3	3	6	8
13	12	3	3	6	9	24
13	C1	4	3	5	8	17
13	2	4	0	0	0	0
13	3	4	0	0	0	0
13	4	4	1	1	2	4
13	5	4	1	0	1	0
13	6	4	1	2	3	12
13	7	4	0	1	1	1
13	8	4	1	4	5	4
13	9	4	1	8	9	12
13	10	4	2	1	3	4
13	11	4	0	0	0	0

13	12	4	1	0	1	2
15	C1	1	0	4	4	9
15	2	1	0	0	0	0
15	3	1	0	0	0	0
15	4	1	1	0	1	14
15	5	1	2	7	9	15
15	6	1	3	9	12	11
15	7	1	0	2	2	0
15	8	1	11	10	21	23
15	9	1	0	3	3	18
15	10	1	2	5	7	11
15	11	1	0	0	0	0
15	12	1	1	2	3	14
15	C1	2	1	11	12	2
15	2	2	0	0	0	0
15	3	2	0	0	0	0
15	4	2	0	0	0	0
15	5	2	0	3	3	1
15	6	2	3	9	12	9
15	7	2	0	3	3	2
15	8	2	2	3	5	3
15	9	2	1	4	5	14
15	10	2	8	8	16	14
15	11	2	0	0	0	0
15	12	2	0	1	1	0
15	C1	3	1	2	3	8
15	2	3	0	0	0	0
15	3	3	0	0	0	0
15	4	3	0	2	2	1
15	5	3	3	1	4	7
15	6	3	0	9	9	10
15	7	3	0	0	0	0
15	8	3	3	6	9	11
15	9	3	5	8	13	20
15	10	3	0	2	2	4
15	11	3	3	6	9	17
15	12	3	3	9	12	23
15	C1	4	6	9	15	14
15	2	4	0	0	0	0
15	3	4	0	0	0	0
15	4	4	2	3	5	3
15	5	4	1	0	1	0
15	6	4	1	4	5	5
15	7	4	1	0	1	0
15	8	4	3	7	10	6
15	9	4	0	6	6	10
15	10	4	3	2	5	3
15	11	4	0	0	0	0
15	12	4	1	2	3	4
17	C1	1	1	1	2	9

17	2	1	0	0	0	0
17	3	1	0	0	0	0
17	4	1	1	8	9	1
17	5	1	2	8	10	20
17	6	1	3	8	11	6
17	7	1	1	0	1	0
17	8	1	16	10	26	30
17	9	1	0	2	2	5
17	10	1	7	6	13	17
17	11	1	0	0	0	0
17	12	1	0	0	0	1
17	C1	2	0	5	5	3
17	2	2	0	0	0	0
17	3	2	0	0	0	0
17	4	2	0	0	0	0
17	5	2	1	1	2	0
17	6	2	7	14	21	10
17	7	2	0	0	0	3
17	8	2	3	0	3	0
17	9	2	0	0	0	1
17	10	2	3	7	10	23
17	11	2	0	0	0	0
17	12	2	0	0	0	1
17	C1	3	3	0	3	8
17	2	3	0	0	0	0
17	3	3	0	0	0	0
17	4	3	0	1	1	0
17	5	3	2	5	7	12
17	6	3	2	8	10	10
17	7	3	0	0	0	0
17	8	3	3	6	9	16
17	9	3	2	6	8	11
17	10	3	1	1	2	1
17	11	3	2	5	7	30
17	12	3	5	11	16	20
17	C1	4	7	5	12	18
17	2	4	0	0	0	0
17	3	4	0	0	0	0
17	4	4	1	1	2	4
17	5	4	1	0	1	0
17	6	4	1	2	3	5
17	7	4	1	1	2	0
17	8	4	3	2	5	7
17	9	4	3	6	9	8
17	10	4	5	0	5	2
17	11	4	0	0	0	0
17	12	4	0	3	3	6
20	C1	1	1	2	3	7
20	2	1	0	0	0	0
20	3	1	0	0	0	0
20	4	1	1	4	5	4
20	5	1	3	15	18	26

20	6	1	11	8	19	13
20	7	1	1	0	1	0
20	8	1	6	29	35	11
20	9	1	0	2	2	8
20	10	1	2	15	17	30
20	11	1	0	0	0	0
20	12	1	0	0	0	1
20	C1	2	3	11	14	5
20	2	2	0	0	0	0
20	3	2	0	0	0	0
20	4	2	0	0	0	0
20	5	2	0	0	0	0
20	6	2	11	5	16	7
20	7	2	0	0	0	0
20	8	2	2	1	3	0
20	9	2	0	3	3	3
20	10	2	3	7	10	30
20	11	2	0	0	0	0
20	12	2	0	0	0	1
20	C1	3	2	2	4	13
20	2	3	0	0	0	0
20	3	3	0	0	0	0
20	4	3	0	1	1	0
20	5	3	1	8	9	10
20	6	3	3	9	12	11
20	7	3	0	0	0	0
20	8	3	2	5	7	15
20	9	3	2	6	8	10
20	10	3	0	1	1	0
20	11	3	3	8	11	38
20	12	3	5	11	16	30
20	C1	4	4	12	16	20
20	2	4	0	0	0	0
20	3	4	0	0	0	0
20	4	4	1	2	3	3
20	5	4	0	0	0	0
20	6	4	2	0	2	0
20	7	4	1	1	2	2
20	8	4	6	8	14	11
20	9	4	3	17	20	14
20	10	4	3	1	4	2
20	11	4	0	0	0	0
20	12	4	0	3	3	6

Nasonovia ribisnigri - Second inoculation

			Number of aphids			
Days after spraying	Treatment	Rep	Winged	Wingless	Total adults	Nymphs
6	C2	1				
6	2	1	10	0	10	0
6	3	1	10	0	10	0
6	5	1	10	0	10	0

6	C2	2				
6	2	2	10	0	10	0
6	3	2	10	0	10	0
6	5	2	10	0	10	0
6	C2	3	10	0	10	0
6	2	3	10	0	10	0
6	3	3	10	0	10	0
6	5	3	10	0	10	0
6	C2	4	10	0	10	0
6	2	4	10	0	10	0
6	3	4	10	0	10	0
6	5	4	10	0	10	0
8	C2	1				
8	2	1	0	3	3	1
8	3	1	0	0	0	0
8	5	1	1	6	7	4
8	C2	2				
8	2	2	0	2	2	0
8	3	2	0	4	4	0
8	5	2	0	5	5	0
8	C2	3	1	4	5	1
8	2	3	0	5	5	0
8	3	3	0	3	3	0
8	5	3	0	5	5	0
8	C2	4	1	5	6	0
8	2	4	0	0	0	0
8	3	4	0	1	1	0
8	5	4	1	0	1	0
10	C2	1				
10	2	1	0	1	1	0
10	3	1	0	0	0	0
10	5	1	2	3	5	8
10	C2	2				
10	2	2	0	0	0	0
10	3	2	1	0	1	0
10	5	2	1	3	4	0
10	C2	3	2	1	3	2
10	2	3	0	0	0	0
10	3	3	0	1	1	0
10	5	3	2	1	3	0
10	C2	4	1	0	1	0
10	2	4	0	0	0	0
10	3	4	0	0	0	0
10	5	4	0	0	0	0
13	C2	1				
13	2	1	0	0	0	0
13	3	1	0	0	0	0
13	5	1	3	7	10	11
13	C2	2				

13	2	2	0	0	0	0
13	3	2	0	0	0	0
13	5	2	1	2	3	1
13	C2	3	1	2	3	7
13	2	3	0	0	0	0
13	3	3	0	0	0	0
13	5	3	2	1	3	4
13	C2	4	1	1	2	0
13	2	4	0	0	0	0
13	3	4	0	0	0	0
13	5	4	1	0	1	0

Nasonovia ribisnigri - Third inoculation

			Number of aphids			
Days after spraying	Treatment	Rep	Winged	Wingless	Total adults	Nymphs
13	C3	1	10	0	10	0
13	2	1	10	0	10	0
13	3	1	10	0	10	0
13	C3	2	10	0	10	0
13	2	2	10	0	10	0
13	3	2	10	0	10	0
13	C3	3	10	0	10	0
13	2	3	10	0	10	0
13	3	3	10	0	10	0
13	C3	4	10	0	10	0
13	2	4	10	0	10	0
13	3	4	10	0	10	0
15	C3	1	1	3	4	1
15	2	1	3	0	3	0
15	3	1	0	1	1	0
15	C3	2	2	2	4	0
15	2	2	0	0	0	0
15	3	2	0	0	0	0
15	C3	3	2	4	6	0
15	2	3	1	2	3	0
15	3	3	0	5	5	0
15	C3	4	0	2	2	0
15	2	4	0	0	0	0
15	3	4	1	0	1	0
17	C3	1	2	1	3	1
17	2	1	0	0	0	0
17	3	1	0	0	0	0
17	C3	2	1	0	1	0
17	2	2	0	0	0	0
17	3	2	0	0	0	0
17	C3	3	1	1	2	0
17	2	3	2	1	3	0
17	3	3	1	0	1	0

17	C3	4	0	0	0	0
17	2	4	0	0	0	0
17	3	4	0	0	0	0
20	C3	1	2	2	4	6
20	2	1	0	0	0	0
20	3	1	0	0	0	0
20	C3	2	2	1	3	0
20	2	2	0	0	0	0
20	3	2	0	0	0	0
20	C3	3	1	0	1	0
20	2	3	0	0	0	0
20	3	3	0	0	0	0
20	C3	4	0	0	0	0
20	2	4	0	0	0	0
20	3	4	0	0	0	0

Nasonovia ribisnigri – lettuce root aphid treatments

Treatment	Cage	Plant	Live aphids			
	Number		Winged	Wingless	Nymphs	Total wingless
1	19	1	3	5	6	11
1	19	2	1	0	2	2
1	19	3	0	11	24	35
1	19	4	4	5	16	21
1	19	5	9	3	15	18
1	19	Cage	1	0	0	0
1	12	1	2	8	11	19
1	12	2	14	6	39	45
1	12	3	1	14	4	18
1	12	4	0	12	40	52
1	12	5	4	5	27	32
1	12	Cage	4	0	0	0
2	18	1	0	0	0	0
2	18	2	0	0	0	0
2	18	3	0	0	0	0
2	18	4				
2	18	5				
2	18	Cage	0	0	0	0
2	17	1	0	0	0	0
2	17	2	0	0	0	0
2	17	3	0	0	0	0
2	17	4	0	0	0	0
2	17	5				
2	17	Cage	0	0	0	0
3	21	1	0	0	0	0
3	21	2	0	0	0	0
3	21	3	2	0	0	0
3	21	4	0	0	0	0
3	21	5	0	0	0	0
3	21	Cage	0	0	0	0
3	22	1	0	0	0	0
3	22	2	0	0	0	0

3	22	3	2	1	0	1
3	22	4	0	0	0	0
3	22	5	0	0	0	0
3	22	Cage	0	0	0	0
5	3	1	0	0	0	0
5	3	2	0	0	0	0
5	3	3	0	0	0	0
5	3	4	0	0	0	0
5	3	5	0	0	0	0
5	3	Cage	0	0	0	0
5	4	1	0	0	0	0
5	4	2	0	0	0	0
5	4	3	0	0	0	0
5	4	4	0	0	0	0
5	4	5	0	0	0	0
5	4	Cage	0	0	0	0
6	2	1	0	0	0	0
6	2	2	0	0	0	0
6	2	3	0	0	0	0
6	2	4	0	0	0	0
6	2	5	0	0	2	2
6	2	Cage	0	0	0	0
6	1	1	0	0	1	1
6	1	2	0	0	0	0
6	1	3	0	0	0	0
6	1	4	0	0	0	0
6	1	5	0	0	0	0
6	1	Cage	0	0	0	0
7	5	1	1	0	0	0
7	5	2	1	1	0	1
7	5	3	0	0	0	0
7	5	4	2	0	5	5
7	5	5	0	0	0	0
7	5	Cage	0	0	0	0
7	8	1	0	0	0	0
7	8	2	0	0	0	0
7	8	3	0	0	0	0
7	8	4	1	0	0	0
7	8	5	4	1	0	1
7	8	Cage	0	0	0	0
8	9	1	10	15	37	52
8	9	2	5	4	2	6
8	9	3	1	3	14	17
8	9	4	3	3	16	19
8	9	5	0	5	8	13
8	9	Cage	6	0	0	0
8	20	1	2	0	5	5
8	20	2	1	1	3	4
8	20	3	4	1	0	1
8	20	4	0	1	2	3
8	20	5	1	0	3	3
8	20	Cage	5	0	0	0

9	6	1	0	0	0	0
9	6	2	0	0	0	0
9	6	3	1	0	0	0
9	6	4	0	0	0	0
9	6	5	4	0	2	2
9	6	Cage	0	0	0	0
9	15	1	0	0	0	0
9	15	2	0	0	0	0
9	15	3	2	0	0	0
9	15	4	1	0	0	0
9	15	5	1	0	0	0
9	15	Cage	0	0	0	0
10	11	1	0	0	0	0
10	11	2	0	0	0	0
10	11	3	0	0	0	0
10	11	4	0	0	0	0
10	11	5				
10	11	Cage	0	0	0	0
10	16	1	0	0	0	0
10	16	2	0	0	0	0
10	16	3	0	0	0	0
10	16	4	0	0	0	0
10	16	5	0	0	0	0
10	16	Cage	0	0	0	0
11	14	1	0	0	0	0
11	14	2	0	0	0	0
11	14	3	0	0	0	0
11	14	4	0	0	0	0
11	14	5	0	0	1	1
11	14	Cage	0	0	0	0
11	13	1	0	0	0	0
11	13	2	0	0	0	0
11	13	3	0	0	0	0
11	13	4	0	0	0	0
11	13	5	0	0	0	0
11	13	Cage	0	0	0	0
12	10	1	7	4	12	16
12	10	2	6	7	14	21
12	10	3	4	7	13	20
12	10	4	0	1	4	5
12	10	5	1	3	8	11
12	10	Cage	1	0	0	0
12	7	1	2	3	1	4
12	7	2	0	2	6	8
12	7	3	3	1	4	5
12	7	4	9	5	19	24
12	7	5	9	10	52	62
12	7	Cage	0	0	0	0

Certificate of

Official Recognition of Efficacy Testing Facilities or Organisations in the United Kingdom

This certifies that

Warwick Crop Centre, School of Life Sciences

complies with the minimum standards laid down in Regulation (EC) 1107/2009 for efficacy testing.

The above Facility/Organisation has been officially recognised as being competent to carry out efficacy trials/tests in the United Kingdom in the following categories:

Agriculture/Horticulture
Biologicals and Semiochemicals

Date of issue: **6 October 2017**
Effective date: **20 March 2017**
Expiry date: **19 March 2022**

Signature Alison Richardson
Authorised signatory

Certification Number
ORETO 381

HSE
Chemicals Regulation Division

Department of Agriculture and Rural Development