Project title:	Managing ornamental plants sustainably (MOPS)
Project number:	CP 124
Work package title:	Efficacy of plant protection products against sucking insects - peach-potato aphid / protected ornamental
Work package leader:	Dr Tom Pope, Harper Adams University
Report:	Annual report, December 2015
Previous report:	None
Key staff:	Dr Tom Pope, Harper Adams University Grace Smith, Harper Adams University Prof Simon Edwards (Statistical advice), Harper Adams University
Location of work:	Harper Adams University
Date work commenced:	01 December 2013
Date work completed (or expected completion date):	31 January 2016

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[The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.]

AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

Dr. Tom W Pope
Lecturer in Entomology
Harper Adams University

Signature .... Date 29-01-2015.............

Report authorised by:

Prof. Peter Kettlewell
Research Co-ordinator
Harper Adams University

Signature ....Date 29.01.2015..

CONTENTS

GROWER SUMMARY

Headline

- The conventional insecticide spirotetramat (Movento) gave good control (97% reduction) of peach-potato aphid on pansy plants.
- Flonicamid (Teppeki) and the coded product 179 gave some control of aphids just three days after the first spray application. Teppeki is not authorised for ornamental plant production but similar product flonicamid (Mainman) is authorised and can be expected to give similar results.
- Plants sprayed with Teppeki or the coded product 59 were free of aphids three weeks after the first spray application.

Background and expected deliverables

The peach-potato aphid (*Myzus persicae*) is one of the most serious pests of ornamentals due to the wide range of plants it attacks. Damage caused by aphid feeding may distort leaves, buds and flowers, while the presence of the aphid themselves as well as cast skins and honeydew may make plants unmarketable. The peach-potato aphid has developed resistance to several groups of pesticides, including carbamates such as pirimicarb (e.g. Aphox) and pyrethroids such as deltamethrin (e.g. Decis).

The purpose of Objective 2 was to test the efficacy of plant protection products against sucking insects. Specifically, Objective 2.3 was to test the efficacy of products against the peach-potato aphid on a selected susceptible protected ornamental species.

Summary of the work and main conclusions

Seven plant protection products (Table 1) were tested against peach-potato aphid (*Myzus persicae*) on pansy (*Viola* x *wittrockiana*) plants grown under glasshouse conditions between August and October 2014 at Harper Adams University. The glasshouse compartment was fitted with insect-proof screens in order to minimise the risk of plants becoming infested with other insect pests. Temperature within the compartment was regulated by venting the compartment at 12°C and using additional heating if required to avoid the temperature dropping below 5°C.

Table 1. Products tested

MOPS code number	Biopesticide or conventional pesticide
Water control	-
Movento (spirotetramat)	conventional
130	biopesticide
62	biopesticide
200	conventional
59	conventional
179	biopesticide
Teppeki (flonicamid)	conventional

Plants were purchased as plugs and potted into Levington M3 Pot/Bedding Compost in 9 cm diameter pots on 8 August. Nine plants were arranged in three rows of three in each of 48 plots. Each plot was 0.5 m x 0.75 m in size and screened on three sides with horticultural fleece in order to physically separate each plot. Plants were watered from beneath using the capillary matting.

The population of aphids used was established from a population of aphids supplied by Rothamsted Research resistant to both carbamate and pyrethroid insecticides. This resistance is typical of peach-potato aphid populations found on commercial nurseries. All nine plants in each plot were artificially infested with a single adult peach-potato aphid on 17 or 18 September and three plants in each plot were infested with an additional aphid on 23 September.

All plant protection products were applied using an Oxford Precision Sprayer fitted with an HC/1.74/3 nozzle, in 600 litres of water per hectare using 3 bar pressure. A water control was applied using the same water volume and pressure. No adjuvants were used for any products tested. Each plant protection product and the water control was applied at weekly intervals for four weeks. Aphid numbers were recorded one day before the first spray application was applied on 3 October and then three and six days after this application. Aphid numbers were then recorded six days after the second (10 October), third (17 October) and fourth (24 October) spray applications. In addition, assessments of phytotoxicity were completed after each spray application.

Aphid numbers recorded one day before the first spray application were relatively low at 2-3 aphids per plant. However, aphid numbers increased more quickly over the next few weeks in the water control and 14 aphids per plant were recorded in the water control plots by 24 October.

The conventional insecticide spirotetramat (Movento) gave good control of peach-potato aphid from six days after the first spray application. The conventional insecticide flonicamid (used here as Teppeki, but an identical product, Mainman, has an EAMU (0045 of 2013) on ornamentals for the control of tobacco whitefly) gave good control from three days after the first spray application and no aphids were recorded in plots treated with this insecticide after three spray applications. All of the coded products tested, with the exception of product 200, also gave good control of peach-potato aphid (see Figure 1). The coded product 179 had reduced aphid numbers to very low levels just three days after the first spray application, while no aphids were recorded in plots treated with coded product 59 after three spray applications.

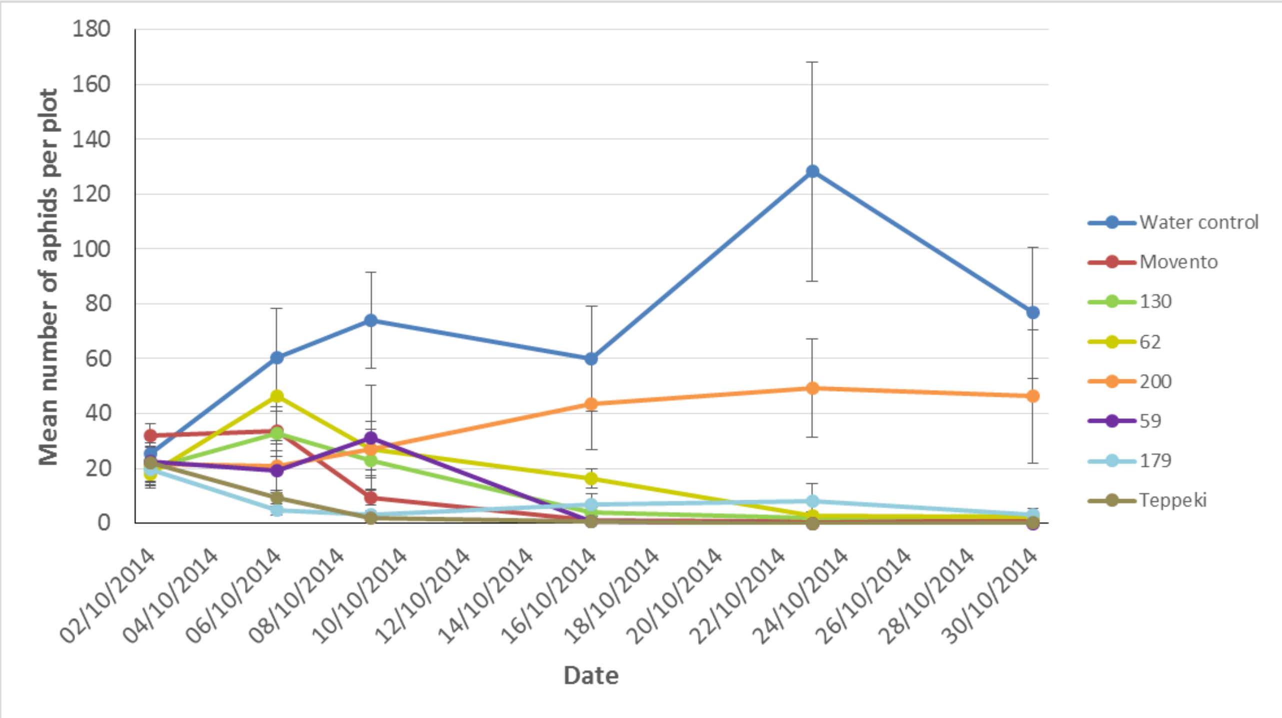


Figure 1. Mean numbers of aphids per plot on each assessment date (9 plants sampled in each plot), with standard errors.

There was little evidence of any phytotoxicity caused by any of the plant protection products tested. No effects on plant health were recorded, however, some slight colour changes in leaves or flowers were noted. These colour changes were noted for all products tested but were most apparent for product 179 and to a lesser extent 62.

Action Points

- Spirotetramat, applied as Movento, is an effective option for the control of peach-potato aphid.
- Flonicamid (here applied as Teppeki, which is used for the control of aphids on wheat and potato) also effectively controlled peach-potato aphid and therefore Mainman, an identical product which has an EAMU (0045 of 2013) for use on ornamentals, should also be effective.
- If coded product 59, a conventional insecticide, gains approval in the future, consider its use against peach-potato aphid as it showed similar levels of efficacy as Movento and Mainman. Coded product 59 works both on contact and through ingestion and displays translaminar movement (moves to the opposite leaf surface) when applied to foliage and is xylem-mobile.
- If coded product 179, a biopesticide, gains approval in the future, consider its use against peach-potato aphid as it showed similar levels of efficacy as Movento and Mainman. Coded product 179 works through contact with the pest and so good coverage will required for this product to work most effectively.

Science Section

Introduction

Various aphid species can damage ornamental plants but one of the most serious pest species is the peach-potato aphid (*Myzus persicae*) due to the wide range of plants this species of aphid attacks and because it has developed resistance to several groups of pesticides.

Myzus persicae is polyphagous and common on protected ornamental hosts including chrysanthemum, *Fuchsia*, *Impatiens*, pansy, petunia and primula. Feeding damage by this species may include distorted leaves, buds and flowers. In addition to aphid feeding damage, *M. persicae* can cause plants to be unmarketable due to the presence of the aphids themselves, together with cast skins, sticky honeydew and associated sooty moulds.

Effective chemical control of this aphid is difficult due to its resistance to many currently available chemical pesticides. Many UK populations of *M. persicae* are resistant to carbamates such as pirimicarb e.g. Aphox (Furk & Hines, 1993; Foster & Blackshaw, 2012). This type of resistance is known as Modified AcetylCholineEsterase or MACE resistance). There is also widespread resistance to pyrethroids such as deltamethrin (e.g. Decis). This type of resistance is known as knockdown resistance or kdr resistance.

Due to problems with pesticide resistance, leading growers of protected ornamentals use biological control methods within IPM programmes. Several aphid parasitoid species are now available either as single or mixed species. The most common species used for control of *M. persicae* is *Aphidius colemani*, sometimes supplemented with the predatory midge *Aphidoletes aphidimyza* whose larvae are voracious predators of many aphid species. Growers using IPM sometimes need to use an IPM-compatible aphicide e.g. immediately before dispatch or to supplement control during the summer when aphid numbers can increase rapidly.

Pesticides commonly used by growers of protected ornamentals for control of *M. persicae* within IPM programmes include pymetrozine (Chess WG) and flonicamid (Mainman). Biopesticides used include the natural plant extracts product maltodextrin (Majestik) and the plant stimulant SB Plant Invigorator. The entomopathogenic fungus, *Beauveria bassiana* (Naturalis-L) has been tried for aphid control on some nurseries but with limited success, possibly due to humidity requirements following application. Other pesticides used include spirotetramat (Movento) and the neonicotinoids thiacloprid (Calypso) and acetamiprid (Gazelle SG). However, these products are less compatible with IPM and although these particular neonicotinoids are not affected by current restrictions on use of neonicotinoids, many retailers are asking growers not to use any neonicotinoids at all on their produce. This further restricts the pesticide options for aphid control. Regardless of the future availability of neonicotinoids to growers, there are already populations of neonicotinoid-resistant *M. persicae* in southern France and northern Spain (Slater *et al*., 2013) and it is likely that resistance will develop in the future in the UK.

Materials and methods

Site and crop details

Table 2. Test site and plot design information

Test location:	Harper Adams University
County	Shropshire
Postcode	TF10 8NB
Soil type/growing medium	Levington M3 Pot/Bedding Compost
Nutrition	n/a
Crop	Pansy (*Viola* x *wittrockiana*)
Cultivar	Lubega F1 Mix
Glasshouse* or Field	Glasshouse
Date of planting/potting	Plug plants potted up on 8 August 2014
Pot size	9 cm diameter pots
Number of plants per plot	9
Trial design (layout in Appendix C)	Randomised block
Number of replicates	6
Plot size w (m), l (m), total area (m^2)	0.5 m x 0.75 m
Method of statistical analysis	ANOVA

*Temperature and relative humidity settings are given in Appendix B

Treatment details

Table 3. Detail of products tested

MOPS code number	Active ingredient(s)	Manufacturer	Batch number	a.i. conc.	Formulation type
1. Water control	-	-	-	-	-
2. Movento	spirotetramat	Bayer CropScience	ECE4101299	150 g/l	OD
3. 130	azadirachtin	Trifolio-M	140414A	1%	EC
4. 62	terpenoid	Bayer CropScience	2014-004865	16.75%	OD
5. 200	cyantranilipole	Syngenta	SMU2FP016	40%	WG
6. 59	sulfoxaflor	Dow AgroSciences	ENBK-143945-007A	120 g/l	SC
7. 179	orange oil	OroAgri	N:7579	60 g/l	SL
8. Teppeki	flonicamid	Belchim Crop Protection	1612-05	500 g/kg	WG

Table 4. Treatments

Product name or MOPS code number	Application timing	Rate of use (product)	Spray volume (L/ha)
1. Water control	Weekly x 4	-	600
2. Movento	Weekly x 4	0.5 l/ha	600
3. 130	Weekly x 4	0.3% (1.8 l/ha)	600
4. 62	Weekly x 4	0.65 l in 100 l water (3.9 l/ha)	600
5. 200	Weekly x 4	0.313 kg/ha	600
6. 59	Weekly x 4	0.2 l/ha (24 g active substance/ha)	600
7. 179	Weekly x 4	0.4% (2.4 l/ha)	600
8. Teppeki	Weekly x 4	0.14 kg/ha	600

Application timing	
A1	3 October 2014
A2	10 October 2014
A3	17 October 2014
A4	24 October 2014

Table 5. Application details

Application No.	**A1**	**A2**	**A3**	**A4**
Application date	03/10/2014	10/10/2014	17/10/2014	24/10/2014
Time of day	12:30	14:00	12:45	18:00
Application method	Oxford Precision Sprayer fitted with a HC/1.74/3 nozzle, in 600 litres of water per ha using 3 bar pressure	Oxford Precision Sprayer fitted with a HC/1.74/3 nozzle, in 600 litres of water per ha using 3 bar pressure	Oxford Precision Sprayer fitted with a HC/1.74/3 nozzle, in 600 litres of water per ha using 3 bar pressure	Oxford Precision Sprayer fitted with a HC/1.74/3 nozzle, in 600 litres of water per ha using 3 bar pressure
Temperature of air – max/min (°C)	18.6	17.3	17.2	16.5
Relative humidity (%)	42.7	39.9	42.1	40.8
Cloud cover (%)	n/a	n/a	n/a	n/a
Crop growth stage	Flowering	Flowering	Flowering	Flowering
Crop comments	-	-	-	-
Other*:	-	-	-	-

*Includes soil temperature and moisture details where relevant

The application method used was agreed upon following consultation with industry representatives, a spray application expert (David Talbot, ADAS) and product manufacturers. Efficacy of the application method was assessed before the first treatment application by attaching water-sensitive papers to spare pansy plants arranged in the same way as in the experimental plots. This allowed spray coverage on the upper and lower leaf surfaces to be determined for leaves in the upper, middle and lower crop canopy.

Target pest(s)

Table 6. Target pest(s)

Common name	Scientific Name	Infection level pre-application
Peach-potato aphid	*Myzus persicae*	Moderate, mean numbers of 18-30 aphids/plot (2-3 aphids/plant in each plot)

Each pansy plant was infested with a single adult wingless aphid on 17 or 18 September. The central three plants were infested with an additional adult wingless aphid on 23 September. Aphids used to infest pansy plants were collected from a stock culture (Rothamsted Research O-clone with MACE and kdr forms of insecticide resistance) which was maintained on pak choi plants.

Assessments

For each assessment of aphid numbers the central stem of each plant was selected and the number of aphids recorded on the leaves and flowers coming off this stem recorded as well as any aphids on the stem itself. Aphid counts were done in-situ but to aid counting of aphids each plant was carefully lifted so that the undersides of the leaves could easily be seen.

Table 6. Assessments

Assessment No.	Date	Growth stage	Timing of assessment relative to last application	Assessment type(s) (e.g. no./% LAI/crop safety)
1	02/10/2014	Flowering	1 day before first application	No. aphids/plant
2	06/10/2014	Flowering	3 day after first application	No. aphids/plant & crop safety
3	09/10/2014	Flowering	6 days after first application	No. aphids/plant
4	16/10/2014	Flowering	6 days after second application	No. aphids/plant & crop safety
5	24/10/2014	Flowering	7 days after third application	No. aphids/plant & crop safety
6	30/10/2014	Flowering	6 days after fourth application	No. aphids/plant & crop safety

Statistical analysis

Data were analysed weekly (not across weeks) using analysis of variance (ANOVA) with Ln (c=1) transformation of raw data to calculate means, variance, LSDs ($p<0.05$). Genstat 16^{th} Edition was used as advised by Prof. Simon Edwards (Harper Adams University). Graphs show a simpler representation of the data without any transformation, so that trends and dynamics over the experiment can be visualised.

Results

Spray coverage

The application method used achieved good spray coverage on the upper leaf surfaces in the upper, middle and lower crop canopies. However, spray coverage on the lower leaf surface was poor at all positions within the crop canopy (Figure 2).

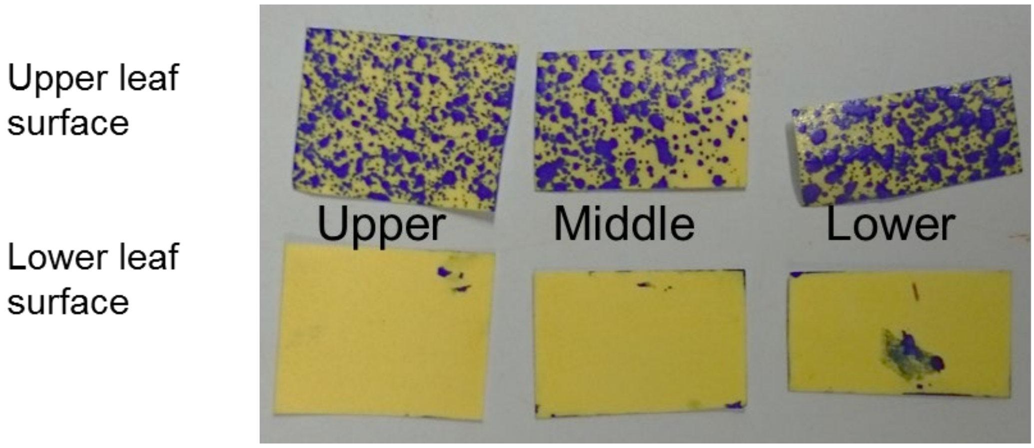


Figure 2. Spray coverage on water sensitive paper positioned on the upper and lower leaf surfaces in the upper, middle and lower crop canopy.

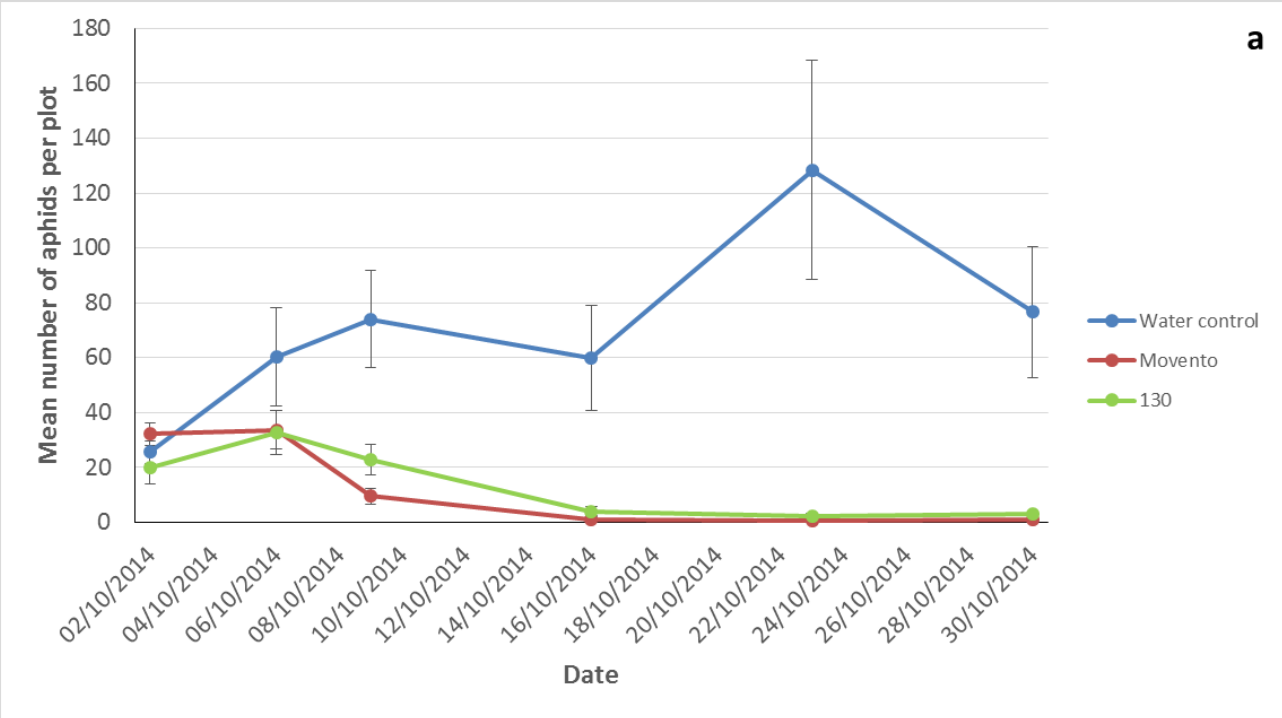
<u>Control of *Myzus persicae*</u>

Results are summarised in the Figure 3 (graphical plot) and Table 7 (with ANOVA statistics) below. The graphs clearly show that all products tested had reduced aphid numbers to zero or close to zero in each plot by the end of the experimental period. The exception was plots treated with product 200, which showed a slight increase in mean aphid numbers per plot.

Statistical analysis of the Ln (c=1) transformed aphid count data shows that there was no difference in aphid numbers between treatments before the first spray application but that there was a highly significant ($P < 0.001$) treatment effect for all assessments completed after this. No block effects were recorded on any of the assessment dates. Individual comparisons between treatment means (LSD at 5%) shows that three days after the first treatment application, Teppeki and coded products 200, 59 and 179 had significantly reduced aphid numbers compared with the water (-ve control). In addition, Teppeki and coded products 59 and 179 had significantly reduced aphid numbers compared with Movento (+ve control). Six days after the first spray application, all products except 200 and 62 had significantly reduced aphid numbers compared with the water control. Aphid numbers were again significantly lower in plots treated with Teppeki than in plots treated with Movento at this assessment. Six days after the second spray application, only product 200 had not significantly reduced aphid numbers compared with the water control. For aphid assessments completed after the third and fourth spray applications, there were no significant differences between the coded products (with the exception of product 200) and Movento in terms of aphid numbers.

Table 7. Effect of treatments on *Myzus persicae*. Raw data transformed using Ln (c=1) and presented as mean number of aphids/plot. Numbers in a column followed by the same letter are not significantly different at P <0.05 based on individual contrasts (LSD).

Product name or MOPS code	02/10/2014	06/10/2014	09/10/2014	16/10/2014	24/10/2014	30/10/2014
1. Water control	3.22^{a}	3.86^{d}	4.14^{e}	3.91^{c}	4.58^{d}	3.93^{c}
2. Movento	3.46^{a}	$3.44^{c,d}$	$2.12^{b,c,d}$	0.41^{a}	$0.23^{a,b}$	$0.38^{a,b}$
3. 130	2.80^{a}	$3.39^{c,d}$	$2.85^{c,d}$	1.31^{a}	$0.83^{a,b}$	1.31^{b}
4. 62	2.91^{a}	$3.65^{c,d}$	$3.15^{d,e}$	2.51^{b}	1.03^{b}	0.98^{a}
5. 200	2.83^{a}	$2.66^{b,c}$	$3.09^{d,e}$	$3.41^{b,c}$	3.56^{c}	2.93^{c}
6. 59	3.00^{a}	$2.09^{a,b}$	$1.86^{a,b,c}$	0.30^{a}	0^{a}	0^{a}
7. 179	2.82^{a}	1.49^{a}	$1.13^{a,b}$	1.12^{a}	1.01^{b}	0.72^{a}
8. Teppeki	2.86^{a}	$2.19^{a,b}$	0.88^{a}	0.30^{a}	0^{a}	0.12^{a}
F value (7 d.f.) Treatment	0.87 (P = n.s.)	5.84 (P <0.001)	6.93 (P <0.001)	16.77 (P <0.001)	27.03 (P <0.001)	12.94 (P <0.001)
F value (5 d.f.) Block	1.94 (P = n.s.)	1.23 (P = n.s.)	1.61 (P = n.s.)	2.44 (P = n.s.)	2.10 (P = n.s.)	0.84 (P = n.s.)
LSD (treatment)	0.72	1.02	1.21	1.01	0.95	1.13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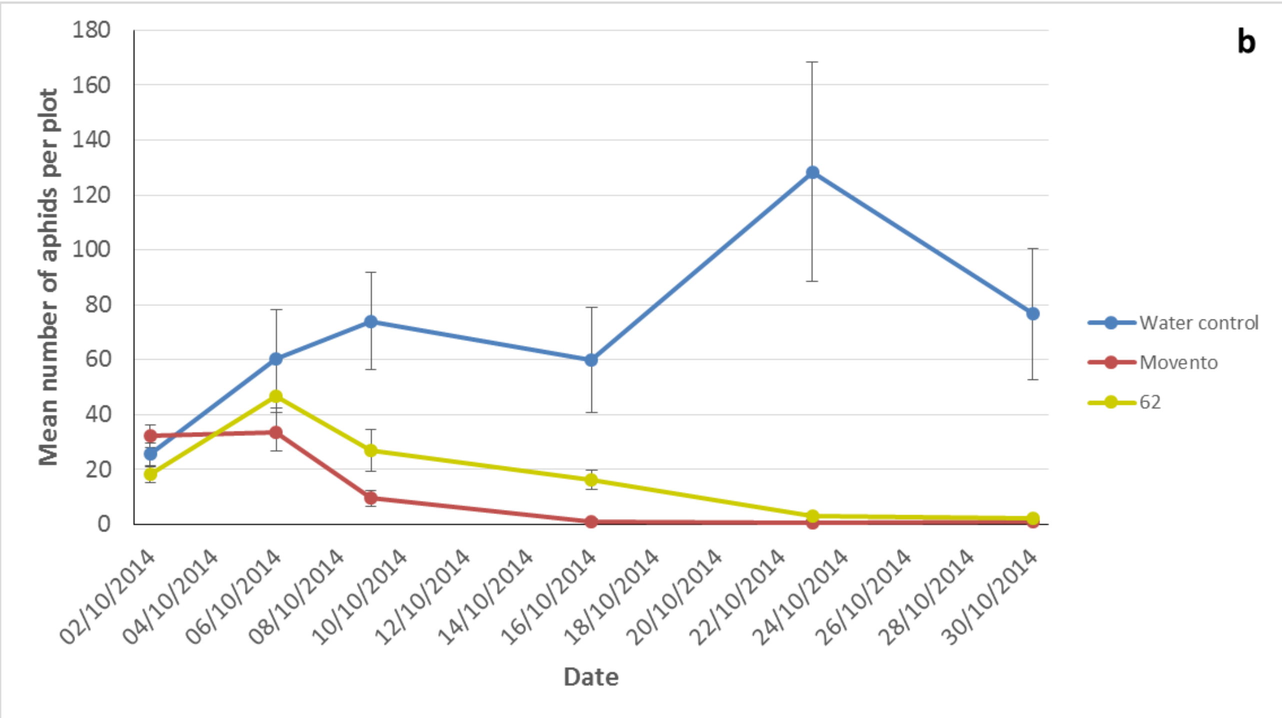
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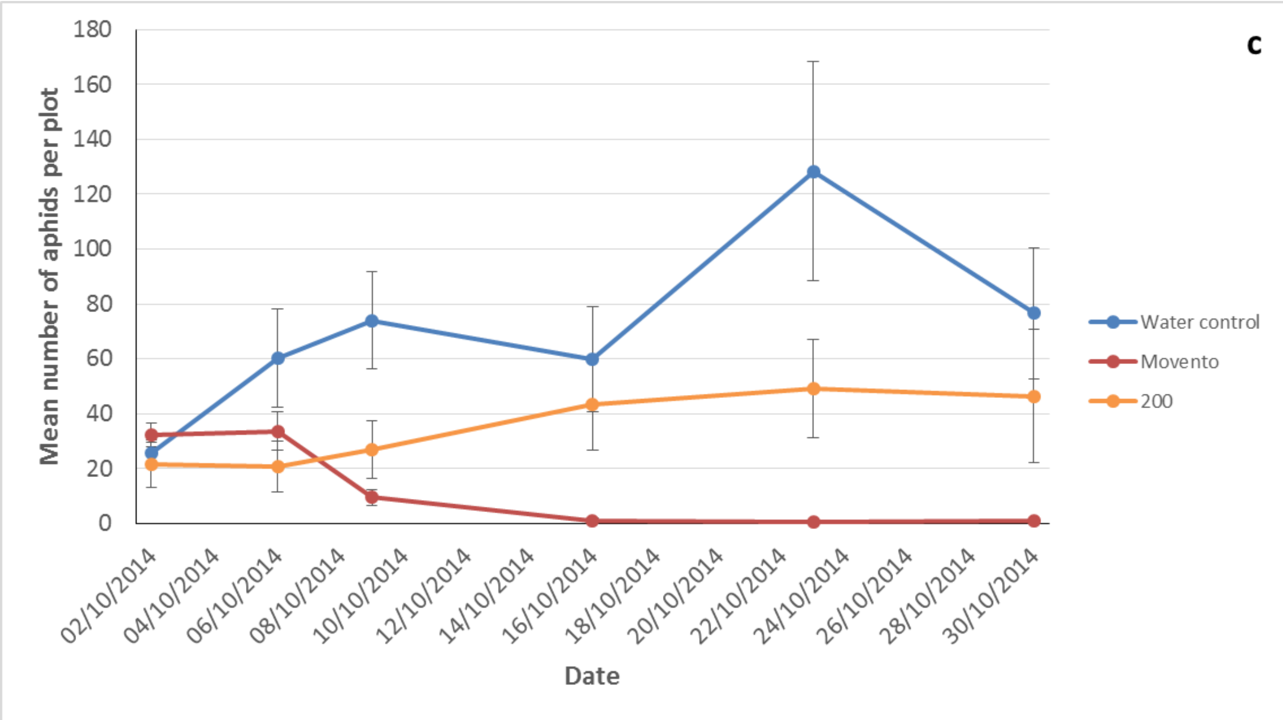
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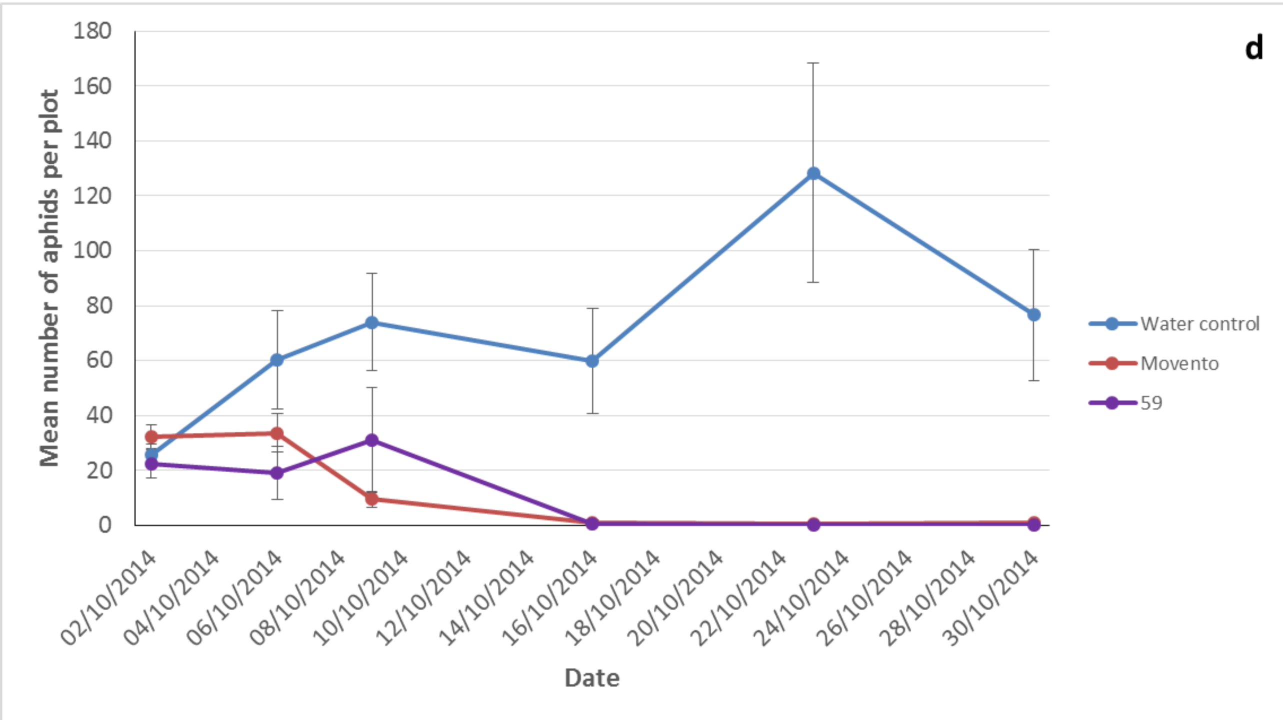
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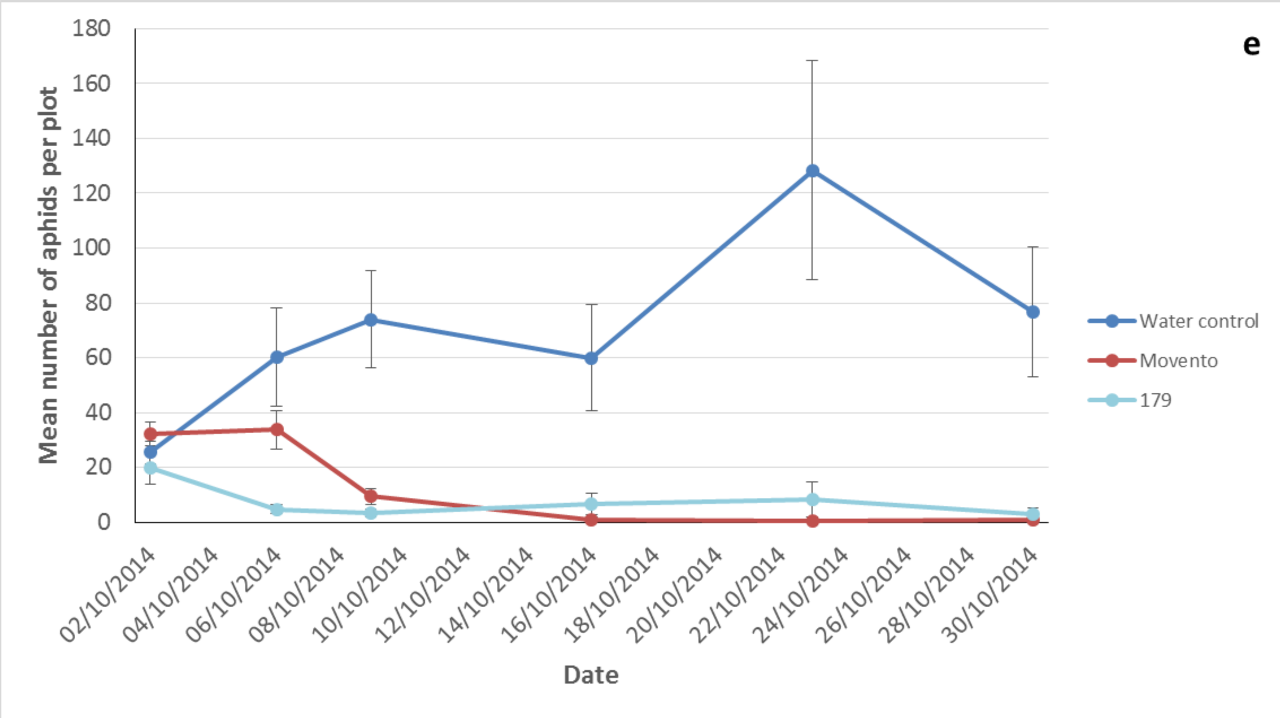
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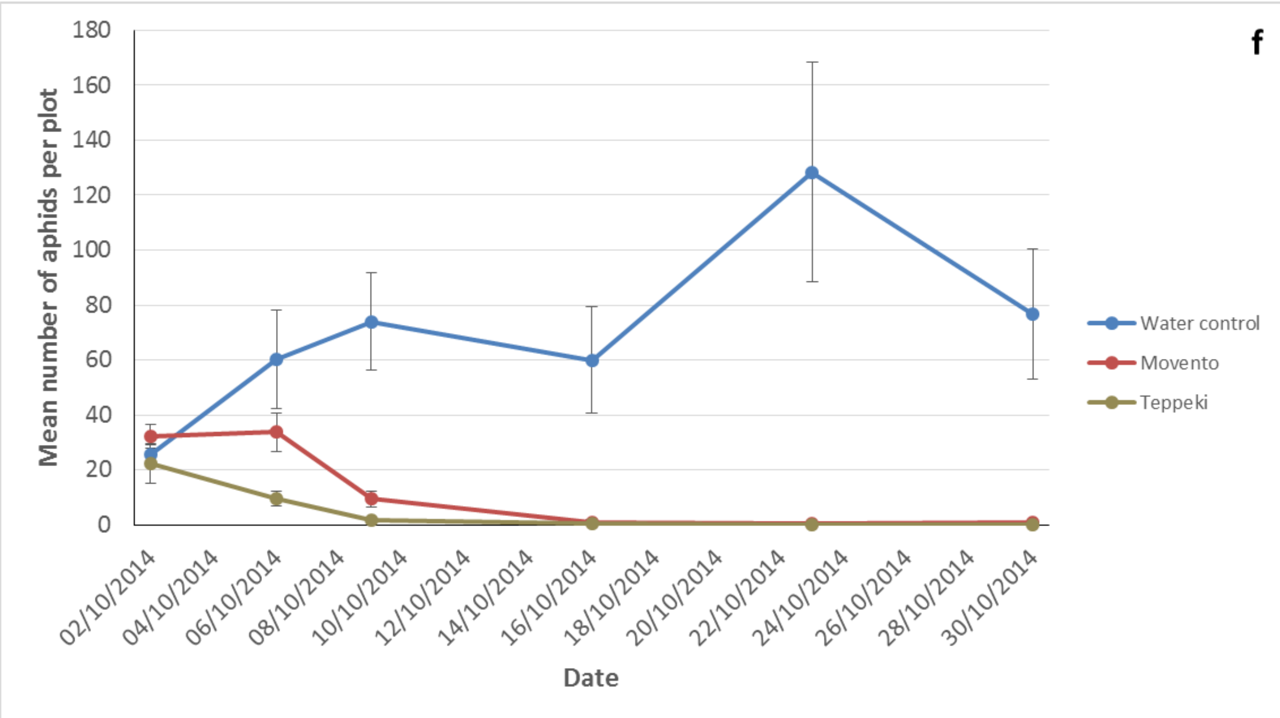
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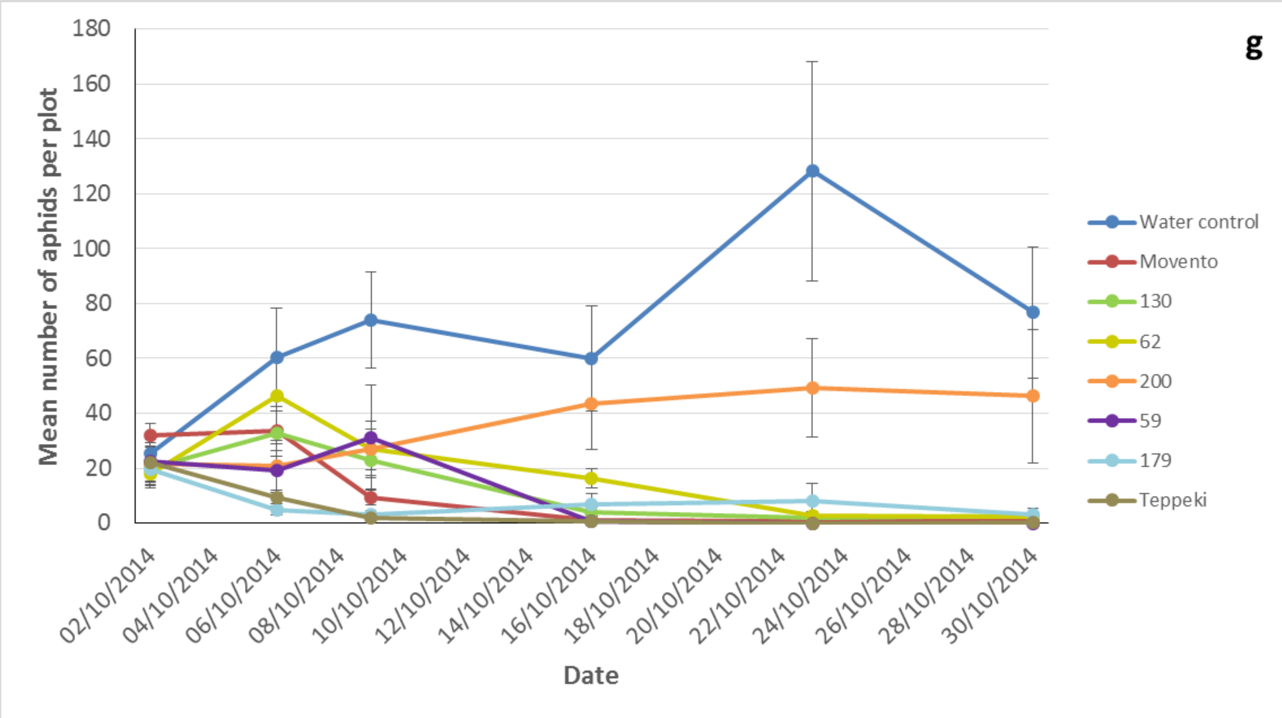

Figure 3. Mean numbers of aphids per plot on each assessment date (9 plants sampled in each plot), with standard errors. Graphs **a** to **f** present results for each coded product separately against water (-ve control) and Movento (+ve control). Graph **g** presents results for all coded products against water (-ve control) and Movento (+ve control). These graphs are complementary to Table 7 and use averages calculated from raw data, rather than the transformed data used in the statistical analysis. The graphs therefore show actual aphid counts per plot (without transformation) and trends over time in a simpler way so the dynamics of treatment effects can be visualised clearly.

<u>Crop damage</u>

Table 8. Crop damage recorded in terms of both numbers of damaged leaves and flowers in all plots and severity of damage observed (none, slight, medium, strong).

Product name or MOPS code	06/10/2014	16/10/2014	23/10/2014	30/10/2014
1. Water (-ve control)	0 leaves 0 flowers	0 leaves 0 flowers	0 leaves 0 flowers	0 leaves 0 flowers
2. Movento (+ve control)	2 leaves (slight) 0 flowers	0 leaves 1 flower (slight)	0 leaves 0 flowers	0 leaves 1 flower (slight)
3. 130	0 leaves 0 flowers	0 leaves 1 flower (slight)	0 leaves 0 flowers	0 leaves 0 flowers

4. 62	0 leaves 5 flowers (slight)	3 leaves (slight) 2 flowers (slight)	2 leaves (slight) 0 flowers	1 leaf (slight) 0 flowers
5. 200	0 leaves 2 flowers (slight)	0 leaves 0 flowers	0 leaves 0 flowers	0 leaves 0 flowers
6. 59	0 leaves 1 flower (slight)	0 leaves 0 flowers	0 leaves 0 flowers	0 leaves 0 flowers
7. 179	1 leaf (slight) 7 flower (slight)	1 leaf (slight) 3 flowers (slight)	2 leaves (slight) 0 flowers	0 leaves 0 flowers
8. Teppeki	0 leaves 3 flowers (slight)	0 leaves 0 flowers	0 leaves 0 flowers	0 leaves 0 flowers

There was little evidence of phytotoxicity in any of the treatments applied. All damage observed was associated with changes in leaf or flower colour and no effect on plant health was recorded. Changes in leaf and/or flower colour were seen for all products tested. However, product 179 and to a lesser extent product 62 were associated with slightly higher levels of damage to flowers. Overall there was insufficient crop damage to warrant statistical analysis.

Formulations

No problems were encountered during mixing or application of any of the product formulations under test.

Effect on non-target

No effects on other pests were noted during the completion of this trial. A small infestation of two-spotted spider mite (*Tetranychus urticae*) was recorded but this was effectively controlled using the predatory mite *Phytoseiulus persimilis*.

Discussion

Each pansy plant was carefully infested with one adult wingless *M. persicae* on 17 and 18 September and three plants were infested with a further adult wingless aphid on 23 September. By 2 October, one day before the first spray application, the mean number of aphids on each plant had only increased slightly to 2-3 per plant. This suggests that the aphids were relatively slow to establish on pansy plants having been initially cultured on pak choi plants. However, once established mean aphid numbers increased more quickly to 14 per plant in the water (-ve control) plots by 24 October.

No phytotoxicity symptoms related to plant health were observed. However, some slight changes in leaf or flower colour were noted. These colour changes were noted for all products tested but were most apparent for product 179 and to a lesser extent 62 (both biopesticides). The degree of colour modification was considered ‘slight’ and was typically seen as a bleaching along the leaf or petal margins. Although the pansy plants flowered throughout the experimental period the amount of colour effects observed declined. The reasons for this decline in apparent phytotoxicity symptoms are not clear but it remains possible that the colour changes seen are not directly related to the products applied.

There were highly significant (P <0.001) treatment effects at all assessment dates after the first spray application. The results obtained for Movento (+ve control) and water (-ve control) were as expected giving confidence when interpreting results for the coded products. Movento gave almost complete control but this was not apparent until two weeks after the first spray application. This reflects the fact that spirotetramat, the active ingredient of Movento, works by inhibiting insect lipid (fatty acid) biosynthesis and as such is slower acting than insecticides that target the insect nervous system. Three products, Teppeki and coded product 59 (both conventional pesticides) and 179 (biopesticide), gave good control just three days after the first spray application, which was faster than Movento. Product 59 is a neurotoxin, flonicamid (Teppeki) is a selective homopteran feeding blocker while the mode of action of coded product 179 is not fully understood. It should be noted that Teppeki (flonicamid) is used to control aphids on potatoes and winter wheat, but an identical product, Mainman, has an EAMU (0045 of 2013) on protected ornamentals for the control of tobacco whitefly).

In plots treated with Teppeki and coded product 59, no *M. persicae* were recorded after three spray applications. Interestingly both of these products have systemic activity, which may have been important in targeting all aphids on each plant and overcoming any limitations in spray coverage.

Coded product 200 (a conventional pesticide) was less effective than the other products tested. Spray coverage may have been an important factor in explaining this result as this product is not systemic. Indeed, results with water sensitive paper indicate good coverage of the upper leaf surfaces but poor coverage of lower leaf surfaces. Product 200 works when it is ingested by an insect rather than through contact with spray residues. Although not systemic, this product does have translaminar activity, which should allow effective control of insects feeding on the leaves and flowers of plants and should mean that good coverage of the upper leaf surface is sufficient for this product to be effective against aphids feeding on lower leaf surfaces. Despite this, relatively large numbers of aphids were recorded feeding on leaves, flowers and stems of pansy plants in some plots sprayed with this product.

Conclusions

- Pansy plants were successfully infested with *Myzus persicae* and after a slow start populations increased in the plots treated with the water (-ve control).
- The standard insecticide, spirotetramat (Movento) (+ve control), effectively controlled aphid populations one to two weeks after the first spray application.
- With the exception of product 200 (a conventional pesticide), all of the coded products tested showed considerable promise in reducing *M. persicae* on protected ornamentals.
- In particular, flonicamid (Teppeki) and coded product 59 (both conventional pesticides) and 179 (a biopesticide) reduced populations quicker than Movento. Teppeki and coded product 59 gave complete control (no aphids detectable within plots) after three sprays.
- Some phytotoxicity symptoms, seen as bleaching along leaf and petal margins, were recorded but this was considered ‘slight’ in terms of severity and affected relatively few leaves and flowers.

References

Foster, S. & Blackshaw, R. (2012). Sustaining the effectiveness of new insecticides against aphid pests in the UK. *Final report to Defra Project RD-2008-3471 (HDC project FV 344)*.

Furk, C. & Hines, C.M. (1993). Aspects of pirimicarb resistance in the cotton and melon aphid, *Aphis gossypii* Glover (Homoptera: Aphidiidae). *Annals of Applied Biology*. 123, 9-17.

Appendix A – Study conduct

Harper Adams University are officially recognised by United Kingdom Chemical Regulations Directorate as competent to carry out efficacy testing in the categories of agriculture, horticulture, stored crops, biologicals & semiochemicals. National regulatory guidelines were followed for the study.

GLP compliance will not be claimed in respect of this study.

Relevant EPPO/CEB 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
PP 1/23(2)	Aphids on ornamental plants	Size of the glasshouse compartment and plot dividers limited the number of plants to 9 rather than a minimum of 15. Six replicates of each treatment rather than a minimum of four. Pansy is not listed as a test crop to be used in glasshouse trials. Separate glasshouse compartments were not used for different treatments and instead plot dividers were used to effectively prevent insecticide drift.

There were no significant deviations from the EPPO and national guidelines other than those indicated above.

Appendix B – Meteorological data

Location of the weather station	52.783, -2.433		
Distance to the trial site	400 m		
Origin of the weather data	Harper Adams University met station		
Long-term averages from *location*			
Month/period	**Min temp (°C)**	**Max temp (°C)**	**Rainfall (mm)**
September (1981-2010)	9.1	17.9	57.2
October (1981-2010)	6.3	13.9	67.8

Average conditions during the trial: (datalogger within glasshouse compartment)

Month/period	Av temp (°C)	Min temp (°C)	Max temp (°C)	Av RH (%)*	Rainfall (mm)
08/08/2014 to 30/10/2014	16.5	7.9	24.5	43.1	-

***protected crops only**

Weather at treatment application: (datalogger within glasshouse compartment)

Month/period	Min temp (°C)	Max temp (°C)	Rainfall (mm)
03/10/2014	19	19	-
10/10/2014	18	18	-
17/10/2014	18	18	-
24/10/2014	16	16	-

Appendix C – Agronomic details

Growing system

Crop	Cultivar	Planting/sowing date	Row width (m) or pot spacing
Pansy (*Viola* x *wittrockiana*)	Lubega F1 Mix	Plug plants potted up on 8 August 2014	Pots arranged in three rows of three – spacing between pots 5 cm

Other pesticides - active ingredient(s) / fertiliser(s) applied to the trial area

Date	Product	Rate	Unit
08-10-2014	4000 *Phytoseiulus persimilis* applied	9/plant	Predatory mite

Details of irrigation regime (pot-grown crops)

Type of irrigation system employed (e.g. overhead sprinkler, hand watering, drip, ebb and flow, capillary sandbed or capillary matting)
Drip irrigation onto capillary matting

Appendix D – Trial layout

Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
Plot 1 Trt. 8	Plot 9 Trt. 5	Plot 17 Trt. 3	Plot 25 Trt. 7	Plot 33 Trt. 1	Plot 41 Trt. 2
Plot 2 Trt. 1	Plot 10 Trt. 3	Plot 18 Trt. 7	Plot 26 Trt. 4	Plot 34 Trt. 2	Plot 42 Trt. 5
Plot 3 Trt. 3	Plot 11 Trt. 1	Plot 19 Trt. 4	Plot 27 Trt. 5	Plot 35 Trt. 6	Plot 43 Trt. 7
Plot 4 Trt. 4	Plot 12 Trt. 7	Plot 20 Trt. 2	Plot 28 Trt. 8	Plot 36 Trt. 3	Plot 44 Trt. 6
Plot 5 Trt. 6	Plot 13 Trt. 4	Plot 21 Trt. 5	Plot 29 Trt. 3	Plot 37 Trt. 8	Plot 45 Trt. 1
Plot 6 Trt. 7	Plot 14 Trt. 6	Plot 22 Trt. 8	Plot 30 Trt. 2	Plot 38 Trt. 5	Plot 46 Trt. 4
Plot 7 Trt. 2	Plot 15 Trt. 8	Plot 23 Trt. 1	Plot 31 Trt. 6	Plot 39 Trt. 7	Plot 47 Trt. 3
Plot 8 Trt. 5	Plot 16 Trt. 2	Plot 24 Trt. 6	Plot 32 Trt. 1	Plot 40 Trt. 4	Plot 48 Trt. 8

0.5 m

0.75 m

Appendix E – Copy of the Certificate of Official Recognition of Efficacy Testing Facility or Organisation

Certificate of

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

This certifies that

CERC - Harper Adams University College

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:

Biologicals and Semiochemicals
Stored Crops
Agriculture/Horticulture

Date of issue:	26 July 2013
Effective date:	9 April 2013
Expiry date:	8 April 2018

Signature

Authorised signatory

Certification Number
ORETO 343

HSE
Chemicals Regulation Directorate

Department of Agriculture and Rural Development

Appendix F – Photographs

	
Figure 3. Plot dividers within glasshouse compartment	Figure 4. Arrangement of 9 pansy plants potted into 9 cm pots within a plot

	
Figure 5. Phytotoxicity damage to a flower treated with product 179	Figure 6. Phytotoxicity damage to a leaf treated with product 179

	
Figure 7. Peach-potato aphids on a pansy flower in a water control plot	Figure 8. Peach-potato aphids on a pansy leaf in a water control plot

