Project title:	Managing ornamental plants sustainably (MOPS)
Project number:	CP 124
Work package title:	Safety of novel fungicides and insecticides for use on hardy nursery stock liners and potted cut flowers
Work package leader:	John Atwood, ADAS
Report:	Annual report, December 2015
Previous report:	None
Key staff:	Emma Worrall, ADAS Kerry Maulden, ADAS
Location of work:	ADAS, Boxworth Darby Nursery Stock, Thetford
Date work commenced:	1 June 2015
Date work completed (or expected completion date):	1 October 2015

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.

Emma Worrall
Consultant
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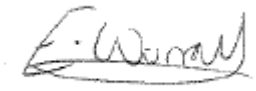


Signature Date 01/01/16

Report authorised by:

John Atwood
Project Leader
ADAS

Signature Date 26 January 2016

Contents

GROWERS SUMMARY

Headline

No significant phytotoxic damage was caused by any of the new insecticide and fungicide products that were tested in this trial on two species of potted cut flowers and six species of hardy nursery stock liners.

Background and expected deliverables

The Horticultural industry has lost, and will lose more key active ingredients due to the recent changes in legislation. Ornamental growers have been particularly badly affected and have been left with fewer options to protect their crops from pests and diseases. Through the recent AHDB – DEFRA Link funded project, Sustainable Crop & Environment Protection – Targeted Research for Edibles (SCEPTRE), a suite of new conventional pesticide and alternative biopesticide products have demonstrated efficacy against a number of key pests and pathogens of edible crops. Many of these pests and pathogens, or closely related species, also affect ornamental crops, therefore selected products from the SCEPTRE programme have been further tested for efficacy against key pests and diseases of ornamentals in the current MOPS (managing ornamental plants sustainably) project.

With the ornamentals industry utilising a diverse range of crop species the risk from crop damage or phytotoxicity is recognised as a potential issue when developing novel pesticides for the industry. It is therefore necessary to test novel treatments on some of the major crop species of ornamentals and to include some species that are thought to be sensitive to pesticide damage. From this information it is then possible to gain a ranking of the relative safety of the new treatments.

The specific objectives for this piece of work were to evaluate the safety of novel fungicides and insecticides on hardy nursery stock liners and potted cut flowers.

Materials and methods

There were 11 different treatments tested (including the untreated control) which consisted of five fungicides (products 10, 25a, 47, 77 and 105) and five insecticides (products 59, 62, 130, 179 and 200). Each product was tested at the normal rate and at double the rate giving a total of 21 treatments. The treatments were tested on two species of potted cut flowers (lily and stocks) and on six species of hardy nursery stock. The potted cut flower trial was situated at ADAS Boxworth and the hardy nursery trial was situated on a commercial nursery in Norfolk.

Potted cut flowers

The species chosen were lilies and stock plants. The lilies were planted as bulbs and the stocks were potted up from plug plants on 28 May 2015. The plants to be included in the trial were selected for uniformity on 22 June 2015 once they were 10 cm in height. The trial was set up in a poly tunnel at ADAS Boxworth.

All treatments were applied on 23 June 2015 at 600 litres per hectare which is consistent with the recommended range of volumes for each product as provided by the manufacturers. Treatments were applied using an OPS knapsack sprayer.

The potted cut flowers were assessed for phytotoxicity two weeks after the treatments had been applied on 7 July 2015. During the course of the trial the lilies started to become infected with lily botrytis and so the follow up assessment was brought forward to four weeks after treatment (originally planned for six weeks) and was carried out on 21 July 2015. As it was a phytotoxicity trial the routine use of other pesticides was avoided and the botrytis infection was unexpected. The stocks were assessed six weeks after treatment, as planned, on 4 August 2015.

Hardy nursery stock

There were six species of hardy nursery stock (*Spiraea, Hypericum, Fuchsia, Perovskia, Hebe* and *Cistus*) used in this trial, all grown as 9 cm liners. The trial was set up in a polytunnel at a commercial nursery in Norfolk.

All treatments were applied on 21 July 2015 at 600 ml per hectare which is consistent with the recommended range of volumes for each product as provided by the manufacturers. Treatments were applied using an OPS knapsack sprayer.

The hardy nursery stock trial was assessed for phytotoxicity two, six and 10 weeks after the treatments had been applied.

Results and Conclusions

- None of the treatments caused significant long lasting phytotoxic effects to the plants.
- No mean phytotoxicity scores were recorded below a commercially acceptable quality level for any of the species treated by any of the treatments.
- The most marked effect noted was temporary leaf discoloration caused by product 47 at twice normal rate on *Cistus* two weeks after treatment. Even this was not serious enough for the plants to be considered commercially unacceptable
- All of the hardy nursery stock species grew away from any initial slight phytotoxic damage and had fully recovered by the final assessment, 10 weeks after the treatments had been applied.

Action Points

- The trials work conducted has demonstrated the products to be crop-safe to the two species of potted cut flowers and the six species of nursery stock that they were tested in this study
- As different circumstances including crop species, cultivars, growth stage, environmental conditions and other factors could influence any crop responses, it is important to recognise that, should these products be approved for use, it is the user's responsibility to check the safety of any novel products, especially when used for the first time. As such, it is advisable that a few plants are tested in the first instance to provide an assurance that the product is safe in the particular circumstances it is to be used in.

Science Section

Introduction

Recent changes in legislation have meant that over 60% of active substances are no longer available for use in the horticultural industry. Ornamentals have been particularly badly affected. Further to this the gradual phasing out of the Long Term Arrangements for Extension of Use has already adversely affected the availability of many products for use on ornamentals. For these reasons growers are now in a situation where, for some pests and pathogens, they are now either over-reliant on a single mode of action product, or products available to them do not provide control an acceptable commercial level.

Through the recent AHDB funded project, Sustainable Crop & Environment Protection Targeted Research for Edibles (SCEPTRE), a suite of new conventional pesticide and alternative biopesticide products have demonstrated efficacy against a number of key pests and pathogens of edible crops. Many of these pests and pathogens, or closely related species, also affect ornamentals crops, therefore selected products from the SCEPTRE programme have been further tested for efficacy against key pests and diseases of ornamentals in the current MOPS (managing ornamental plants sustainably) project.

The ornamentals industry grow a wide range of crop species and the risk from crop damage or phytotoxicity is recognised as a potential issue when developing novel pesticides for the industry. Whilst it would be uneconomic to test novel treatments on all crop species or cultivars currently grown it is necessary to test treatments on the major crop species and to include some species that are thought to be sensitive to pesticide damage. From this information it will be possible to gain an understanding of the relative safety of the treatments tested.

Phytotoxicity tests were carried out using the most promising products against both pests and diseases from experiments completed in earlier objectives and following EPPO guidance for phytotoxicity testing PP1/135/3. Industry representatives and growers were consulted to decide on a range of host plants to test these products on. The tests on selected hardy nursery stock liners were carried out on a commercial nursery in Norfolk and the tests on potted cut flowers were carried out in a polytunnel at ADAS Boxworth

The specific objectives for this piece of work were to evaluate the safety of novel fungicides and insecticides on hardy nursery stock liners and potted cut flowers.

Materials and methods

Site and crop details

Potted cut flowers

The trial consisted of 11 products (including an untreated control) each applied at normal and two times normal rates making a total of 21 treatments, each with three replicates. Each plot consisted of two species of potted cut flowers and five plants of each species.

Stock plants were sourced by Lyndon Mason and supplied as plugs by J.A. Collison and Sons and Lilies were supplied as bulbs by Belmont Nursery, both in Norfolk. The stock plugs were potted up into 1 L pots, using M2 compost, and the Lily bulbs were planted into 2 L pots, using M2 compost, by ADAS on 28 May 2015.

The plants were selected for uniformity on 22 June 2015 once the Stocks and Lilies were around 10 cm high. The Lilies were more variable and were selected so that, as far as possible, similar heights were used in each block. The Stocks and Lilies were arranged into a randomised split plot design in a poly tunnel at ADAS Boxworth.

Hardy nursery stock

The trial consisted of the same 11 products that were used for the potted cut flowers (including an untreated control). Each treatment was applied at two different rates making a total of 21 treatments, each with three replicates). Each plot consisted of six species and five plants of each species (30 plants per plot).

Hardy nursery stock species were supplied by Darby Nursery Stock as 9 cm liners. The trial was set up in a poly tunnel at Darby Nursery Stock, Norfolk, on 21 July 2015 and was arranged as a randomised split plot design.

Table 1. Test site and plot design information

Test location:	ADAS	Darby Nursery Stock (HNS liners)
County	Cambridgeshire	Norfolk
Postcode	CB23 4NN	P26 4PW
Soil type/growing medium	Medium grade peat compost	Peat based compost
Nutrition	Solufeed	Potted into a 70 % peat 30 % pine bark mix. Incorporated at a rate of 3.5 Kg/m³, is the controlled release fertilizer Osmocote Exact standard 12 to 14 month.
Crop	Lily and Stock	*Spiraea, Hypericum, Fuchsia, Perovskia, Hebe, Cistus*
Cultivar	mixed	*Spiraea japonica* 'Firelight' *Hypericum* x *hidcoteense* 'Hidcote' *Fuchsia* 'Lady in Black' *Perovskia atriplicifolia* 'Blue Spire' *Hebe* 'Margret' *Cistus crispus* 'Sunset'
Glasshouse* or Field	Poly tunnel	Poly tunnel
Date of planting/potting	28 May 2015	Potted summer 2014 *Spiraea japonica* 'Firelight' *Hypericum* x *hidcoteense* 'Hidcote' *Perovskia atriplicifolia* 'Blue Spire' *Hebe* 'Margret' Potted early spring 2015 *Fuchsia* 'Lady in Black' *Cistus crispus* 'Sunset'
Pot size	1 L and 2 L pots	9 cm liners
Number of plants per plot	10	30
Trial design (layout in Appendix C)	Randomised split plot design	Randomised split plot design
Number of replicates	3	3
Plot size w (m), l (m), total area (m²)	0.5 m x 2.0 m	0.5 m x 0.5 m
Method of statistical analysis	ANOVA	ANOVA

*Temperature and relative humidity settings are given in Appendix B

Treatment details

All treatments were applied on one occasion for both the potted cut flowers and the hardy nursery stock species. Each product was used at the recommended rate and also at double the recommended rate (Table 2). All treatments were applied at 600 Litres per hectare which is consistent with the recommended range of volumes for each product as provided by the manufacturers. Treatments were applied using an OPS knapsack sprayer. Table 4 shows the weather conditions during each application.

Table 2. Detail of products tested

MOPS code number	Active ingredient(s)	Manufacturer	Batch number	% a.i	Formulation type
1. Untreated	-				
2. 10	N/D	N/D	N/D	N/D	N/D
3. 25a	N/D	N/D	N/D	N/D	N/D
4. 77	N/D	N/D	N/D	N/D	N/D
5. 47	N/D	N/D	N/D	N/D	N/D
6. 105	N/D	N/D	N/D	N/D	N/D
7. 200	N/D	N/D	N/D	N/D	N/D
8. 59	N/D	N/D	N/D	N/D	N/D
9. 62	N/D	N/D	N/D	N/D	N/D
10. 130	N/D	N/D	N/D	N/D	N/D
11. 179	N/D	N/D	N/D	N/D	N/D

Table 3. Treatments

Product name or MOPS code number	Application timing	Dosage rate (a.i/ha)	Spray volume (L/ha)
1. Untreated	-	-	-
2. 10	A1	1 L/ha	600
3. 10	A1	2 L/ha	600
4. 25a	A1	1 L/ha	600
5. 25a	A1	2 L/ha	600
6. 77	A1	0.8 L/ha	600
7. 77	A1	1.6 L/ha	600
8. 47	A1	0.05 kg/ha	600
9. 47	A1	0.1 kg/ha	600
10. 105	A1	2.5 L/ha	600
11. 105	A1	5 L/ha	600
12. 200	A1	0.313 kg/ha	600
13. 200	A1	0.626 kg/ha	600
14. 59	A1	0.2 L/ha	600
15. 59	A1	0.4 L/ha	600
16. 62	A1	3.9 L/ha	600
17. 62	A1	7.8 L/ha	600
18. 130	A1	1.8 L/ha	600
19. 130	A1	3.6 L/ha	600
20. 179	A1	2.4 L/ha	600
21. 179	A1	4.8 L/ha	600

Application timing	
A1	Potted cut flowers : 23 June 2015 Hardy Nursery Stock: 21 July 2015

Table 4. Application details

Application No.	**A1 for potted cut flowers**	**A1 for Hardy Nursery Stock**
Application date	23 June 2015	21 July 2015
Time of day	Late morning	Early afternoon
Application method	Foliar spray	Foliar spray
Temperature of air – max/min (°C)	20.7°C / 20.6°C	30.2°C/ 26°C
Relative humidity (%)	48.9	43.9
Cloud cover (%)	N/A as in poly tunnel	N/A as in poly tunnel
Crop growth stage	10 cm high on average	Not flowering
Crop comments	-	-
Other*:	-	-

*Includes soil temperature and moisture details where relevant

Assessments

Potted cut flowers

Both the Lilies and the Stocks were assessed two weeks after the treatments had been applied on 7 July 2015 (Table 5). During the course of the trial the Lilies started to become infected with Lily botrytis and so the follow up assessment was brought forward to four weeks after treatment application, which had originally been planned for six weeks, due to uncertainties whether the plants would survive. The four week assessment on the Lilies was carried out on 21 July 2015. The Stocks were assessed six weeks after treatment, as planned, on 4 August 2015. At each assessment all of the plants were assessed within a plot and a phytotoxicity score was given. A score of nine would indicate that the plant was as healthy as the untreated, zero meant the plant

was dead and a score of seven would mean that, although slightly damaged, the plant was considered to be commercially acceptable.

Hardy Nursery Stock

This trial was assessed two, six and 10 weeks after the treatments had been applied (Table 5). The trial was assessed for any phytotoxicity using the same scale as for the potted cut flowers. For this trial a score was given by examining each species per plot instead of giving a score for every plant in a plot.

Table 5. Assessments

Assessment no.	Date		Timing of assessment relative to last application		Assessment type(s)	
	Potted cut flowers	**Hardy nursery stock**	**Potted cut flowers**	**Hardy nursery stock**	**Potted cut flowers**	**Hardy nursery stock**
1	7 July 2015	4 August 2015	2 weeks after	2 weeks after	Phytotoxicity	Phytotoxicity
2	21 July 2015	3 September 2015	4 weeks after	6 weeks after	Phytotoxicity	Phytotoxicity
3	4 August 2015	1 October 2015	6 weeks after	10 weeks after	Phytotoxicity	Phytotoxicity

Results

Crop damage

Very little phytotoxic effects were seen throughout this trial on any of the species that the products were tested on. At two weeks after treatment the *Cistus* was the only species to show very minor damage (Table 6). The treatments that caused the damage were product 10 at the lower rate, 47 at the higher rate, 105 at the lower rate and product 62 at both rates. Out of these products it was product 47 that had the most effect on the *Cistus*, however the average phytotoxicity score for this product on *Cistus* was 7.3 and would still be considered commercially acceptable. The damage took the form of a slight discolouration to the leaves.

At the second assessment of the Lilies (four weeks after treatment) some very negligible phytotoxic effects were seen from couple of the products (Table 7). The products that caused slight damage to the leaves of the Lilies were 200 and 59 (both at the lower rate). The lowest average score was

caused by product 200 and was 8.6 out of 9 and so the plants were still considered commercially acceptable.

The previous damage seen at the first assessment (two weeks after treatment) on *Cistus* was no longer noticeable at the second assessment of the hardy nursery stock species with all the plants appearing as healthy as the untreated ones.

At the third assessment no phytotoxicity damage could be seen on any of the hardy nursery stock species.

Table 6. Effect of treatments – phytotoxicity at first assessment

Product name	Stock	Lily	*Perovskia atriplicifolia* 'Blue Spire'	*Hebe* 'Margret'	*Spiraea japonica* '*Firelight'*	*Cistus crispus* 'Sunset'	*Hypericum* x *hidcoteense* 'Hidcote'	*Fuchsia* 'Lady in Black'
10	*	*	*	*	*	8.8	*	*
25a	*	*	*	*	*	*	*	*
47	*	*	*	*	*	7.3	*	*
105	*	*	*	*	*	8.3	*	*
62	*	*	*	*	*	8.0	*	*
62	*	*	*	*	*	8.0	*	*
130	*	*	*	*	*	8.8	*	*
F value (df)	NS	NS	NS	NS	NS	NS	NS	NS

No other crop damage was observed in addition to these data presented

*No crop damage observed

Table 7. Effect of treatments – phytotoxicity at second assessment

Product name	Stock	Lily	*Perovskia atriplicifolia* 'Blue Spire'	*Hebe* 'Margret'	*Spiraea japonica* 'Firelight'	*Cistus crispus* 'Sunset'	*Hypericum* x *hidcoteense* 'Hidcote'	*Fuchsia* 'Lady in Black'
77	8.6	*	*	*	*	*	*	*
200	*	8.6	*	*	*	*	*	*
59	*	8.8	*	*	*	*	*	*
F value (df)	0.056	NS	NS	NS	NS	NS	NS	NS

No other crop damage was observed in addition to these data presented

*No crop damage observed

Formulations

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

Discussion

The majority of the crop damage was noticed to *Cistus* two weeks after the treatments had been applied and was in the form of leaf discoloration. Two of the treatments that caused some slight damage were surprisingly the lower rates only of product 10 and product 105. Since the higher rates of both these two products didn't cause any phytotoxic damage to the same species it is questionable as to whether this slight damage was actually caused by these products and not by a chance effect. The higher rates of product 47 and 130 also caused some slight phytotoxicity to *Cistus* two weeks after treatments had been applied. Product 47 is an elicitor which triggers plants to activate their own defense system. Higher rates of product 47 when previously tested on ornamentals was found to cause phytotoxicity (BCPC, 2003). Product 130 has also been known to cause phytotoxic effects (WSU, 2002). Product 62 was found to cause damage to *Cistus* two weeks after treatment at both rates. None of the phytotoxicity scores were below a seven and so all the plants were still considered to be commercially acceptable.

By six weeks after treatment the initial damage seen on the *Cistus* at two weeks after treatment was no longer apparent. The only other reduction in score noted at this stage was on the Lilies that had been treated with the lower rates of products 200 and 59. However, these scores were only marked down slightly due to the variability of the Lilies in one plot and these differences were not

statistically significant. The Lilies treated by these two products scored very close to a full score (9) and so would still be considered commercially acceptable.

At the final assessment, whether this was at an earlier stage for the potted cut flowers or at 10 weeks after treatment for the hardy nursery stock species there was no phytotoxicity recorded to any of the species caused by any of the treatments tested.

Conclusions

Overall, none of the products tested caused any significant long lasting damage to the species they were tested on. The most marked effect noted was temporary leaf discoloration caused by product 47 at twice normal rate on *Cistus* two weeks after treatment. Even this was not serious enough for the plants to be considered commercially unacceptable and the plants recovered by the next assessment four weeks later.

References

Macleod, I. L., Walker, R. and Inglis, I. M, 2003. *Evaluation of the plant defence booster, acibenzolar-S-methyl, for use in Australian agriculture.* [e-book] Alton: British Crop Protection Council. Available through: <http://www.cabdirect.org/abstracts/20033205562.html;jsessionid=D2D7ACD07B78E6CA6499278B16F7975F> [Accessed 8 December 2015].

O'Neill, T., 2015. *Sustainable Crop and Environment Protection – Target Research for Edibles (SCEPTRE)*. [pdf] AHDB. Available at: <http://horticulture.ahdb.org.uk/sites/default/files/research_papers/CP%20077_Report_Final_All%20years.pdf> [Accessed 10 December 2015].

Washington State University, 2002. *Azadirachtin: An Old Insecticide is Reborn*. [online] Available at: <http://entomology.tfrec.wsu.edu/stableipm/news060102.html> [Accessed 8 December 2015].

Appendix A – Study conduct

ADAS is officially recognised by United Kingdom Chemical Regulations Directorate as competent to carry out efficacy testing. The experiments reported were carried out according the internal ADAS operating procedures

GLP compliance 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	PP 1/152(3)
PP 1/135(3)	Phytotoxicity assessment	PP 1/135(3)
PP 1/181(3)	Conduct and reporting of efficacy evaluation trials including GEP	PP 1/181(3)

One deviation occurred from EPPO and national guidelines in that botrytis developed in one of the test crops (lily) whereas crops should be maintained pest and disease free.

The botrytis that developed in the lilies had not been anticipated and so no preventative sprays of fungicides had been applied. Additional routine fungicides were not planned for this trial to avoid the risk of phytotoxicity or synergistic effects with the test treatments. The botrytis infection developed suddenly; it was decided that fungicidal control was not viable option and the final assessment was brought forward.

Appendix B – Meteorological data

Location of the weather station	On site (ADAS Boxworth and Darby Nursery Stock)
Distance to the trial site	0 m
Origin of the weather data	Weather station for long term average Data logger for average conditions during the trial

Long-term averages from *location* Boxworth 30 year mean

Month/period	**Min temp (ºC)**	**Max temp (ºC)**	**Rainfall (mm)**
May	6.9	16.8	43.5
June	9.6	19.9	50.8
July	11.8	22.8	45.8
August	12.2	22.6	51.9

Average conditions during the trial at ADAS, Boxworth

Month/period	**Av temp (ºC)**	**Min temp (ºC)**	**Max temp (ºC)**	**Av RH (%)***	**Rainfall (mm)**
June	21.7	10.5	42.5	60.2	N/A
July	19.6	7.5	44.0	70.3	N/A
August	19.6	7.5	44.0	70.3	N/A

Average conditions during the trial at Darby Nursery Stock, Norfolk

Month/period	**Av temp (ºC)**	**Min temp (ºC)**	**Max temp (ºC)**	**Av RH (%)***	**Rainfall (mm)**
July	18.0	10.5	31.5	75.0	N/A
August	18.6	10.5	32.0	83.6	N/A
September	26.6	22.5	31.0	52.3	N/A
October	26.6	24.0	30.5	51.5	N/A

Weather at treatment application:

Month/period	Min temp (ºC)	Max temp (ºC)	Rainfall (mm)
Day of application for potted cut flowers	20.6°C	20.7°C	0 mm
Day of application for hardy nursery stock	26.0°C	30.2°C	0 mm

Appendix C – Agronomic details

Growing system

Crop	Cultivar	Planting/sowing date	Row width (m) or pot spacing
Lily and Stock	mixed	28 May 2015	0.1
Spiraea japonica *Hypericum* x *hidcoteense* *Perovskia atriplicifolia* *Hebe* *Fuchsia* *Cistus crispus*	*Spiraea japonica* 'Firelight' *Hypericum* x *hidcoteense* 'Hidcote' *Perovskia atriplicifolia* 'Blue Spire' *Hebe* 'Margret' *Fuchsia* 'Lady in Black' *Cistus crispus* 'Sunset'	Potted summer 2014 Potted early spring 2015	In trays

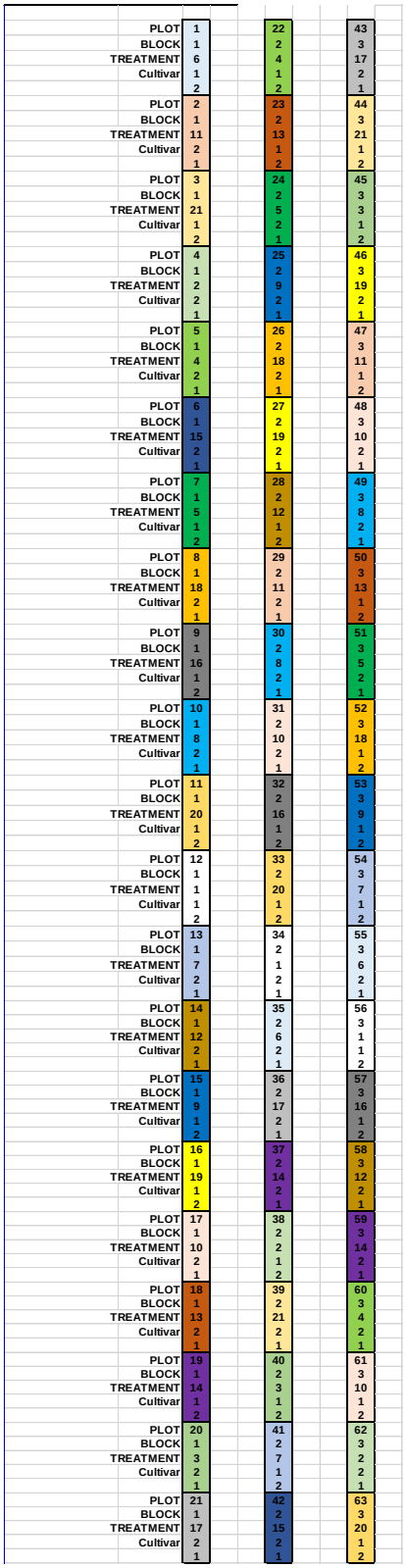
No other pesticides were applied to the trial area

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)
Plants were sat on capillary matting and hand watered every day. Quantities varied due to what was deemed necessary for the plants.

Appendix D – *Trial layout*

Potted cut flowers at ADAS Boxworth, Cambridge



PLOT	1	22	43
BLOCK	1	2	3
TREATMENT	6	4	17
Cultivar	1	1	2
	2	2	1
PLOT	2	23	44
BLOCK	1	2	3
TREATMENT	11	13	21
Cultivar	2	1	1
	1	2	2
PLOT	3	24	45
BLOCK	1	2	3
TREATMENT	21	5	3
Cultivar	1	2	1
	2	1	2
PLOT	4	25	46
BLOCK	1	2	3
TREATMENT	2	9	19
Cultivar	2	2	2
	1	1	1
PLOT	5	26	47
BLOCK	1	2	3
TREATMENT	4	18	11
Cultivar	2	2	1
	1	1	2
PLOT	6	27	48
BLOCK	1	2	3
TREATMENT	15	19	10
Cultivar	2	2	2
	1	1	1
PLOT	7	28	49
BLOCK	1	2	3
TREATMENT	5	12	8
Cultivar	1	1	2
	2	2	1
PLOT	8	29	50
BLOCK	1	2	3
TREATMENT	18	11	13
Cultivar	2	2	1
	1	1	2
PLOT	9	30	51
BLOCK	1	2	3
TREATMENT	16	8	5
Cultivar	1	2	2
	2	1	1
PLOT	10	31	52
BLOCK	1	2	3
TREATMENT	8	10	18
Cultivar	2	2	1
	1	1	2
PLOT	11	32	53
BLOCK	1	2	3
TREATMENT	20	16	9
Cultivar	1	1	1
	2	2	2
PLOT	12	33	54
BLOCK	1	2	3
TREATMENT	1	20	7
Cultivar	1	1	1
	2	2	2
PLOT	13	34	55
BLOCK	1	2	3
TREATMENT	7	1	6
Cultivar	2	2	2
	1	1	1
PLOT	14	35	56
BLOCK	1	2	3
TREATMENT	12	6	1
Cultivar	2	2	1
	1	1	2
PLOT	15	36	57
BLOCK	1	2	3
TREATMENT	9	17	16
Cultivar	1	2	1
	2	1	2
PLOT	16	37	58
BLOCK	1	2	3
TREATMENT	19	14	12
Cultivar	1	2	2
	2	1	1
PLOT	17	38	59
BLOCK	1	2	3
TREATMENT	10	2	14
Cultivar	2	1	2
	1	2	1
PLOT	18	39	60
BLOCK	1	2	3
TREATMENT	13	21	4
Cultivar	2	2	2
	1	1	1
PLOT	19	40	61
BLOCK	1	2	3
TREATMENT	14	3	10
Cultivar	1	1	1
	2	2	2
PLOT	20	41	62
BLOCK	1	2	3
TREATMENT	3	7	2
Cultivar	2	1	2
	1	2	1
PLOT	21	42	63
BLOCK	1	2	3
TREATMENT	17	15	20
Cultivar	2	2	1
	1	1	2

Hardy Nursery Stock at Darby Nursery Stock, Norfolk

	BLOCK 1				BLOCK 2				BLOCK 3			
PLOT	1	8	15	22	29	36	43	50	57
TREATMENT	5	8	14	8	17	21	13	17	15
cultivar	6	1	1	6	5	1	4	3	1
	1	5	6	1	3	6	3	5	3
	3	3	2	5	4	4	5	2	5
	4	6	5	4	6	5	2	6	2
	2	2	4	2	1	2	6	4	6
	5	4	3	3	2	3	1	1	4
PLOT	2	9	16	23	30	37	44	51	58
TREATMENT	11	7	1	13	14	11	9	21	10
cultivar	3	4	1	1	4	3	6	3	5
	2	6	2	4	1	2	5	6	2
	6	2	6	2	5	5	2	4	3
	1	1	4	6	2	6	4	1	1
	5	5	3	5	6	4	3	2	4
	4	3	5	3	3	1	1	5	6
PLOT	3	10	17	24	31	38	45	52	59
TREATMENT	15	21	18	4	7	3	7	3	2
cultivar	3	1	3	6	6	1	2	2	1
	5	5	5	1	2	5	6	5	3
	6	6	2	4	3	4	1	6	4
	1	3	6	2	4	6	5	4	5
	4	2	4	5	1	3	3	1	6
	2	4	1	3	5	2	4	3	2
PLOT	4	11	18	25	32	39	46	53	60
TREATMENT	16	4	13	10	18	20	11	4	19
cultivar	1	2	5	4	5	5	1	3	5
	3	4	6	2	3	2	6	1	4
	5	6	4	6	2	6	3	5	6
	6	5	1	1	4	1	5	6	3
	4	3	2	5	1	3	4	2	2
	2	1	3	3	6	4	2	4	1
PLOT	5	12	19	26	33	40	47	54	61
TREATMENT	19	17	6	1	6	5	14	18	8
cultivar	6	5	6	3	6	2	4	5	4
	4	3	4	6	5	5	6	2	3
	2	4	5	2	1	4	1	4	1
	1	6	3	4	3	6	5	1	5
	5	2	2	1	2	3	2	3	2
	3	1	1	5	4	1	3	6	6
PLOT	6	13	20	27	34	41	48	55	62
TREATMENT	10	3	2	12	16	19	16	5	12
cultivar	4	1	6	6	1	5	2	5	4
	1	3	1	1	6	2	1	1	5
	3	4	4	2	5	4	6	3	6
	2	2	2	4	2	1	3	6	1
	6	6	3	5	4	6	5	4	3
	5	5	5	3	3	3	4	2	2
PLOT	7	14	21	28	35	42	49	56	63
TREATMENT	20	9	12	2	15	9	6	1	20
cultivar	4	6	5	5	2	6	3	2	3
	3	1	2	4	5	1	2	5	2
	5	3	1	2	4	2	6	3	5
	1	2	4	6	3	5	4	4	6
	6	4	6	1	1	4	1	1	1
	2	5	3	3	6	3	5	6	4

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

ADAS UK Limited

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
Stored Crops
Biologicals and Semiochemicals

Date of issue: 10 May 2013
Effective date: 18 March 2013
Expiry date: 17 March 2018

Signature *Authorised signatory*

Certification Number
ORETO 339

HSE
Chemicals Regulation Directorate

Department of Agriculture and Rural Development

Appendix F – *Photographs*

Figure 1. Untreated plot 2 weeks after treatment (HNS, Norfolk)

Figure 2. Product 10 on *Spiraea* 6 weeks after treatment (HNS, Norfolk)

Figure 3. Overview of trial 6 weeks after treatment (HNS, Norfolk)

Figure 4. Untreated crops 6 weeks after treatment (potted cut flowers, Boxworth)

Figure 5. Overview of the trial 6 weeks after treatment (potted cut flowers, Boxworth)