SCEPTREPLUS

Final Trial Report

Trial code:	SP15
Title:	Efficacy of plant protection products against western flower thrips (WFT) on protected ornamentals
Crop	Protected ornamentals (verbena), trial data also applicable to other flowering protected ornamentals and flowering protected hardy nursery stock
Target	western flower thrips – *Frankliniella occidentalis* - FRANOC
Lead researcher:	Jude Bennison
Organisation:	ADAS Boxworth, Battlegate Road, Boxworth, Cambridge, CB23 4NN
Period:	June to December 2017
Report date:	4 January 2018
Report author:	Jude Bennison
ORETO Number: (certificate should be attached)	374

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

3/2/2018

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Date Authors signature

Trial Summary

Introduction

Western flower thrips (*Frankliniella occidentalis*) causes feeding damage to flowers and leaves that can make plants unmarketable. The pest is widely resistant to many chemical plant protection products. Biological control methods are widely used within Integrated Pest Management (IPM) programmes but sometimes these need supplementing with a compatible plant protection product therefore new effective actives need development.

Control measures for Western Flower Thrips were investigated in CP 124 Managing Ornamental Plants Sustainably (MOPS) and the inclusion of *Neoseiulus cucumeris* in an IPM based approach warranted further investigation with other conventional and biopesticide products in SCEPTREplus.

Methods

Verbena (cv Quartz) plants were grown in thrips-proof cages in two glasshouse compartments at ADAS Boxworth between June and September 2017. Once the plants were flowering 20 WFT adults were released to each cage the day before the first treatments were applied. There were six replicate cages (plots) for each of eight treatments. Five treatments (four biopesticides and one conventional insecticide) were tested as foliar sprays as supplements to the predatory mite Neoseiulus cucumeris, compared with two control treatments and the standard treatment Actara (thiamethoxam). The two controls were a water foliar spray used with or without N. cucumeris. Neoseiulus cucumeris were released weekly to all cages except the water controls from potting to the week before the end of the trial at 50/m2/week. All foliar treatments were applied using a knapsack sprayer (Oxford Precision sprayer) in 600 l/ha water. Treatments were applied over a 14-day period at time intervals recommended by each manufacturer. These varied from once only, twice at 7-day intervals and three times at 5-day intervals. Assessment of percentage flower and leaf damage and numbers of WFT adults and larvae per flower and leaves were made one day before the first application and three, six, 14 and 36 days after the first application.

Results

Mean numbers of live WFT adults and larvae per flower were significantly reduced compared with the water controls by all treatments on the final two assessment dates and mean numbers on leaves and mean percentage leaf area damaged were significantly reduced by all treatments on the final three assessment dates. All treatments were equally effective. Mean percentage flower area damaged was significantly reduced compared with both the water control and the water plus N. cucumeris control by both Actara and Botanigard WP plus Majestik, both in combination with N. cucumeris on the first three assessment dates, by AHDB9970 in combination with N. cucumeris on the second and third assessment dates and by AHDB9971 in combination with N. cucumeris on the first, second and fourth assessment dates. Botanigard WP without the addition of Majestik and Mainman were the only treatments used in combination with N. cucumeris that did not significantly reduce mean percentage flower area damaged compared with the water plus N. cucumeris control.

Mean percentage flower area damaged 3, 6, 14 and 36 days after the first treatment are presented in the table below (angular transformation was used before data analysis but back-transformed data are presented).

Date	3 Sep	6 Sep	14 Sep	4 Oct
Treatment				
Water control	1.31 c	2.48 c	2.22 c	10.67 c
Water + *N. cucumeris* control	0.99 bc	1.61 bc	0.81 b	0.87 b
Actara + *N. cucumeris*	0.19 a	0.10 a	0.05 a	0.28 ab
AHDB9970 + *N. cucumeris*	0.37 ab	0.29 a	0.05 a	0.57 b
Botanigard WP + *N. cucumeris*	0.53 abc	0.48 ab	0.63 b	0.79 b
Botanigard WP + Majestik +	0.19 a	0.20 a	0.10 a	1.19 b

N. cucumeris				
AHDB9971 + *N. cucumeris*	0.24 a	0.14 a	0.73 b	0 a
Mainman + *N. cucumeris*	0.42 ab	0.51 ab	0.51 b	0.59 b

Significantly fewer than in water controls ($P<0.05$). Significantly fewer than in both water and water plus *Neoseiulus cucumeris controls* ($P<0.05$). Values sharing the same letters are not significantly different, those with different letters are significantly different.

Conclusions

The results indicate that the reduction in mean numbers of WFT adults and larvae per leaf and percentage leaf area damaged compared with the water controls are likely to have been mainly due to the use of N. cucumeris in combination with all treatments. Neoseiulus cucumeris predates first instar WFT larvae and thus would reduce subsequent numbers of second instar larvae and adults. However, there were significant reductions in mean percentage flower area damaged compared with the N. cucumeris and water control by the standard treatment Actara and also by AHDB9970, Botanigard WP tank mixed with Majestik and AHDB9971, all used in combination with N. cucumeris. This result indicates that these treatments improved control of WFT flower damage when used as a supplement to N. cucumeris in an IPM programme. However, WFT pressure remained low in the controls during the first 14 days when treatments were applied. The final assessment 36 days after the first application was added as an 'extra' assessment when numbers of WFT were higher but no further treatments were applied after the 14-day period.

Further work is needed to confirm the robustness of treatment efficacy under higher WFT pressure, either with or without N. cucumeris. Treatments might continue for longer than the 14-day period used in the experiment reported here.

Take-home message: Two coded biopesticides and a tank mix of Botanigard WP with Majestik significantly reduced percentage flower damage when used in combination with *N. cucumeris* compared with using *N. cucumeris* in combination with water as a control.

Objectives

1. To evaluate the effectiveness of conventional insecticides and biopesticides against western flower thrips on protected ornamentals as measured by numbers of live adults and larvae per flower and leaves and percentage damaged flower and leaf area.
2. To monitor the treated crop for phytotoxicity

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
PP 1/160(2)	Thrips on glasshouse crops	Size of cages and flowering stage of plants limited the number of plants per plot to 4 rather than a minimum of 15. Six replicates of each treatment used rather than the minimum of four.

Deviations from EPPO guidance: as in table above.

Test site

Item	**Details**
Location address	ADAS Boxworth, Boxworth, Cambridge, CB23 4NN
Crop	Verbena
Cultivar	Quartz
Soil or substrate type	M2 growing media
Agronomic practice	See Appendix A
Prior history of site	Glasshouse compartments used for evaluating control methods for pests and diseases on various crops

Trial design

Item	**Details**
Trial design:	Randomised blocks in two glasshouse compartments
Number of replicates:	6
Row spacing:	1L pots arranged in two rows of two
Plot size: (w x l)	0.5x0.5x0.5m thrips-proof cage
Plot size: (m^2)	0.125 m^2
Number of plants per plot:	Four
Leaf Wall Area calculations	N/A

Treatment details

AHDB Code	Active substance	Product name or manufacturers code	Formulation batch number	Content of active substance in product	Formulation type
-	Water (-ve control)	-	-	-	-
-	*Neoseiulus cucumeris* + water (control)	Amblyline	-	-	loose predators in bran carrier
-	thiamethoxam + *N. cucumeris* (+ve control)	Actara	0855555/0855557	250 g/kg	WG
AHDB 9970	N/D	N/D	N/D	N/D	N/D
-	*Beauveria bassiana* + *N. cucumeris*	Botanigard WP	42821	200 g/kg	WP
-	*Beauveria bassiana* + maltodextrin + *N. cucumeris*	Botanigard WP + Majestik	42821 +11916	598 g/L	SL
AHDB 9971	N/D	N/D	N/D	N/D	N/D
-	flonicamid + *N. cucumeris*	Mainman	C3350-09	500 g/kg	WG

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	Water	-	-	AD
2	*Neoseiulus cucumeris* + water	-	50 per m2 per week from potting	AD
3	Actara	250g/kg	0.4	AD
4	AHDB9970	479.8g/L	6.0	AD
5	Botanigard WP	220g/kg	0.375	BCE
6	Botanigard WP + Majestik	220g/kg + 598 g/L	0.375 + 15	BCE
7	AHDB9971	26g/L	0.84	AD
8	Mainman	500g/kg	0.14	A

Application details

	Application A	Application B	Application C	Application D	Application E
Application date	01/09/2017	01/09/2017	06/09/2017	08/09/2017	11/09/2017
Treatments	1,2,3,4,7,8	5,6	5,6	1,2,3,4,7	5,6
Time of day	09.00 Treatment 4 16:35 other Treatments		15:10	09.00 Treatment 4, 14:30 other Treatments	16:40
Crop growth stage (Max, min average BBCH)	flowering	flowering	flowering	flowering	flowering
Crop height (cm)					
Crop coverage (%)					
Application Method	spray	spray	spray	spray	spray
Application Placement	foliar	foliar	foliar	foliar	foliar
Application equipment	Oxford Precision sprayer (knapsack)	Oxford Precision sprayer (knapsack)	Oxford Precision sprayer (knapsack)	Oxford Precision sprayer (knapsack)	Oxford Precision sprayer (knapsack)
Nozzle pressure	2.9 bar	2.9 bar	2.9 bar	2.9 bar	2.9 bar
Nozzle type	Hollow cone	Flat fan	Flat fan	Hollow cone	Flat fan
Nozzle size	HC/1.74/3	03F80	03F80	HC/1.74/3	03F80
Application water volume/ha	600	600	600	600	600
Temperature of air - shade (°C)	28.1	26.5	25.3	24.6	25.6
Relative humidity (%)	34.4	39.9	37.4	71.1	53.4
Wind speed range (m/s)	N/A	N/A	N/A	N/A	N/A
Dew presence (Y/N)	N/A	N/A	N/A	N/A	N/A
Temperature of soil - 2-5 cm (°C)	N/A	N/A	N/A	N/A	N/A
Wetness of soil - 2-5 cm	Damp	Damp	Damp	Damp	Damp
Cloud cover (%)	N/A	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	Infection level pre-application	Infection level at start of assessment period	Infection level at end of assessment period
western flower thrips	*Frankliniella occidentalis*	FRANOC	0[1]	1.63 (1.31)[1]	11.33 (10.67)[1]
Peach potato aphid	*Myzus persicae*	MYZUPE	Low[2]	Low[2]	Low[2]

[1] Mean percentage flower area damaged (back-transformed data in brackets)

[2] Non target pest treated with the parasitoid *Aphidius colemani*

Assessment details

Prior to the application of treatments, water-sensitive paper was used to demonstrate spray coverage, using water one day before the release of WFT. Papers were attached to the upper and lower sides of top, middle and lower leaves using paper clips and were balanced on the top of a flower. Western flower thrips adults (18 females and two males) from the ADAS laboratory culture were added to each plot (thrips-proof cage) one day before first treatments were applied.

Assessments of WFT numbers and damage were done one day before the first treatments were applied and three, six and 14 days after first treatments. An additional assessment was made 36 days after the first treatment as WFT numbers were still low at the 14-day assessment. On each assessment date numbers of flowers, live WFT adults and larvae on all the flowers and leaves in each cage, and percentage flower and leaf damage caused by WFT were recorded. Each flower head was tapped onto a white plastic tray and any thrips dropping to the tray were recorded, followed by tapping the thrips back onto the assessed flower. Leaf assessments were done by examining the upper and lower surfaces of each leaf. The assessments were done in-situ using a headband magnifier, to avoid removing flowers, leaves and thrips from the cages.

Evaluation date	Evaluation Timing (DA)*	Crop Growth Stage (BBCH)	Evaluation type (efficacy, phytotox)	What was assessed and how (e.g. dead or live pest; disease incidence and severity; yield, marketable quality)
3/9/17	3	flowering	Efficacy and phytotoxicity	numbers of live WFT adults and larvae per flower and leaves, % flower and leaf damage, numbers of live *N. cucumeris*
6/9/17	6	flowering	Efficacy and phytotoxicity	numbers of live WFT adults and larvae per flower and leaves, % flower and leaf damage, numbers of live *N. cucumeris*
14/9/17	14	flowering	Efficacy and phytotoxicity	numbers of live WFT adults and larvae per flower and leaves, % flower and leaf damage, numbers of live *N. cucumeris*
6/10/17	36	flowering	Efficacy and phytotoxicity	numbers of live WFT adults and larvae per flower and leaves, % flower and leaf damage, numbers of live *N. cucumeris*

* DA – days after first application

Statistical analysis

The data were analysed using Analysis of Variance (ANOVA). Angular transformation was used for data recorded as percentage flower or leaf area damaged. Abbott's formula was used to calculate percentage reduction in numbers of WFT or percentage of flower or leaf area damaged where there was a significant treatment effect.

Results

Spray coverage

Spray coverage was good on the flower and the upper side of the top and middle leaves (Figure 4, Appendix 1). Coverage was less good on the upper side of the lower leaves and very little spray reached the lower leaf side in all leaf positions.

Numbers of WFT adults per flower

No WFT were recorded in flowers or on leaves on the first assessment completed the day before WFT were released to the cages. Mean numbers of live WFT adults per flower three, six, 14 and 36 days after the first treatments were applied are presented in Table 1 and Figure 1. On the first assessment date three days after first treatments, only Botanigard tank mixed with Majestik significantly reduced mean numbers of WFT adults per flower compared with the water controls. On the second assessment date, six days after first treatments, no treatments significantly reduced numbers of WFT adults compared with the water controls. On the third and fourth assessment dates, 14 and 36 days after first treatment, all treatments significantly reduced numbers of WFT adults per flower compared with water controls and all were equally effective. No treatment significantly reduced numbers of WFT adults compared with the *Neoseiulus cucumeris* plus water controls on any assessment date.

Table 1. Mean numbers of live WFT adults per flower 3, 6, 14 and 36 days after the first treatment. Significantly fewer than in water controls (P<0.05). Values sharing the same letters are not significantly different, those with different letters are significantly different. N.S.= not significant P value.

Date	3 Sep	6 Sep	14 Sep	4 Oct
Treatment				
Water control	1.21 b	1.08	0.5 b	2.76 b
Water + *N. cucumeris* control	0.64 ab	0.45	0.13 a	0.14 a
Actara + *N. cucumeris*	1.19 b	0.31	0.08 a	0.24 a
AHDB9970 + *N. cucumeris*	0.50 ab	0.28	0 a	0.25 a
Botanigard WP + *N. cucumeris*	0.63 ab	0.42	0.10 a	0.15 a
Botanigard WP + Majestik + *N. cucumeris*	0.25 a	0.53	0.04 a	0.32 a
AHDB9971 + *N. cucumeris*	0.58 ab	0.20	0.08 a	0 a
Mainman + *N. cucumeris*	1.13 b	0.49	0.13 a	0.21 a
F value	2.29	1.87	3.47	19.49
P value	0.05	0.10 (N.S.)	0.006	<0.001
d.f.	35	35	35	35
s.e.d.	0.338	0.283	0.117	0.294
l.s.d.	0.687	0.574	0.238	0.596

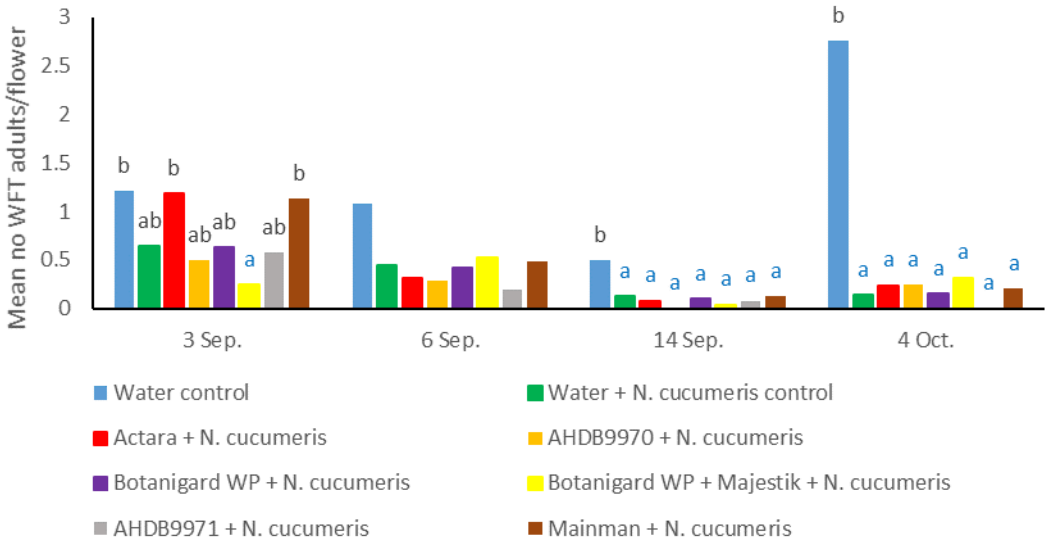

Figure 1. Mean numbers of live WFT adults per flower 3, 6, 14 and 36 days after the first treatment. Blue letters indicate significantly fewer than in water controls (P<0.05). Values sharing the same letters are not significantly different, those with different letters are significantly different.

Abbotts formula was used to calculate percentage reduction in mean numbers of WFT adults per flower and are presented in Table 2.

Table 2. Percentage reduction in mean numbers of WFT adults per flower compared with Treatment 1 (water control) and T2 (water + *N. cucumeris* control) 3, 6, 14 and 36 days after the first treatment (Abbotts formula). Significantly fewer than in water controls (P<0.05). No figure is given compared with T1 or T2 if there was no significant treatment effect on that date.

Date	3 Sep		6 Sep		14 Sep		4 Oct	
	cf. T1	cf.T2	cf. T1	cf. T2	cf. T1	cf. T2	cf. T1	cf. T2
Treatment								
Water control								
Water + *N. cucumeris* control	47.10				75.0		94.97	
Actara + *N. cucumeris*	1.16				83.40		91.46	
AHDB9970 + *N. cucumeris*	58.16				100		90.96	
Botanigard WP + *N. cucumeris*	48.26				80.60		94.46	
Botanigard WP + Majestik + *N. cucumeris*	79.30				91.66		88.46	
AHDB9971 + *N. cucumeris*	51.74				83.40		100	
Mainman + *N. cucumeris*	6.87				75.0		92.47	

Numbers of WFT larvae per flower

Mean numbers of live WFT larvae per flower three, six, 14 and 36 days after the first treatments were applied are presented in Table 3 and Figure 2. No WFT larvae were recorded three days after first treatment. There were no significant effects of treatment on numbers of larvae six days after treatment. On the third and fourth assessment dates, 14 and 36 days after first treatment, all treatments significantly reduced numbers of WFT larvae per flower compared with water controls and all were equally effective. No treatment significantly reduced numbers of WFT larvae compared with the *Neoseiulus cucumeris* plus water controls on any assessment date.

Table 3. Mean numbers of live WFT larvae per flower 3, 6, 14 and 36 days after the first treatment. Significantly fewer than in water controls (P<0.05). Values sharing the same letters are not significantly different, those with different letters are significantly different. N.S.= not significant P value.

Date	3 Sep	6 Sep	14 Sep	4 Oct
Treatment				
Water control	0	0.88	1.21 b	46.64 b
Water + *N. cucumeris* control	0	0.08	0.10 a	2.93 a
Actara + *N. cucumeris*	0	0	0.13 a	1.68 a
AHDB9970 + *N. cucumeris*	0	0.08	0.04 a	1.13 a
Botanigard WP + *N. cucumeris*	0	0.17	0.21 a	0.99 a
Botanigard WP + Majestik + *N. cucumeris*	0	0.04	0.08 a	0.96 a
AHDB9971 + *N. cucumeris*	0	0.04	0 a	0.13 a
Mainman + *N. cucumeris*	0	0.08	0.13 a	1.32 a
F value	-	1.51	4.64	18.21
P value	-	0.20 (N.S.)	<0.001	<0.001
d.f.	-	35	35	35
s.e.d.	-	0.332	0.261	5.32
l.s.d.	-	0.673	0.529	10.80

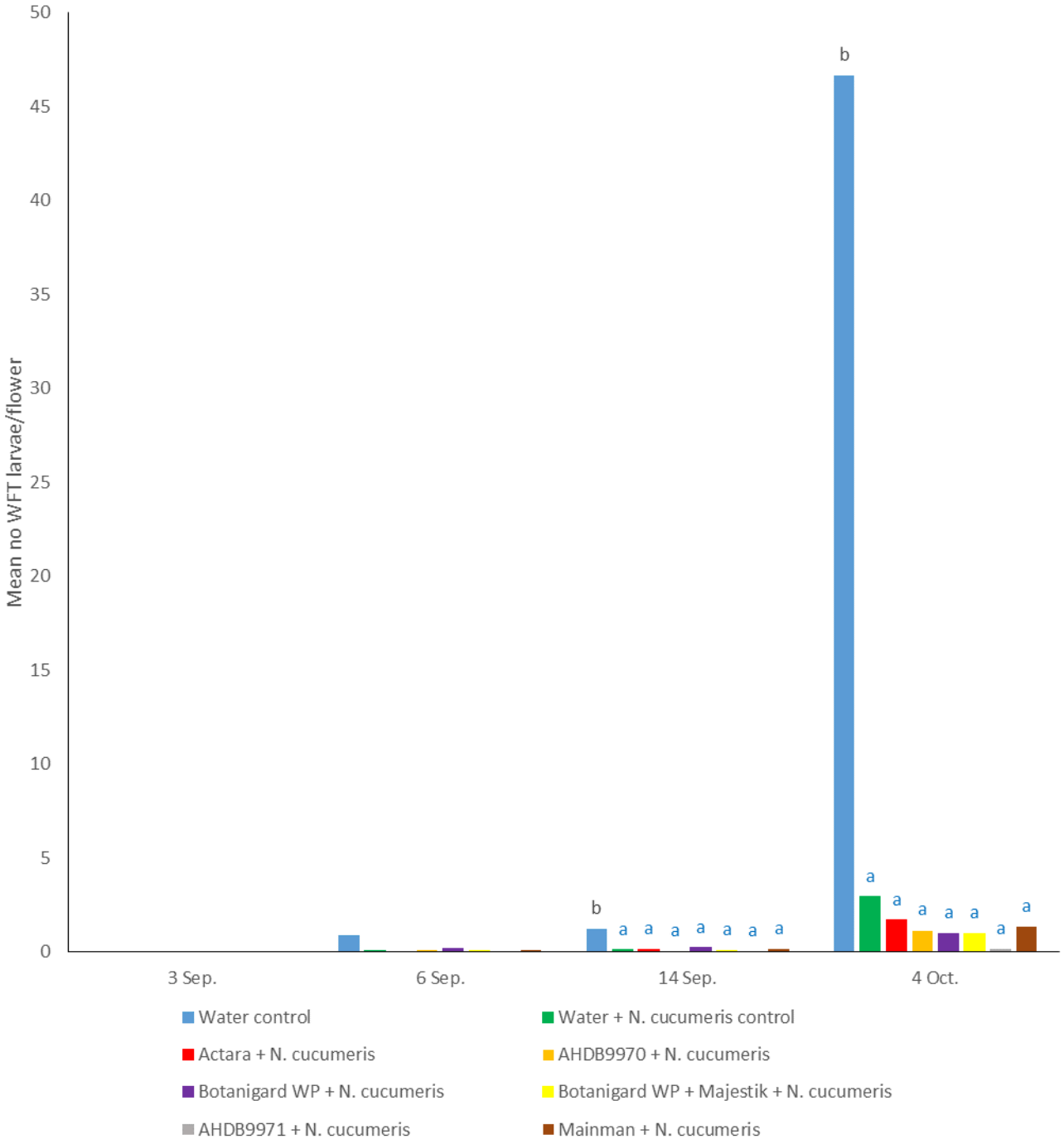

Figure 2. Mean numbers of live WFT larvae per flower 3, 6, 14 and 36 days after the first treatment. Blue letters indicate significantly fewer than in water controls ($P<0.05$). Values sharing the same letters are not significantly different, those with different letters are significantly different.

Table 4. Percentage reduction in mean numbers of WFT larvae per flower compared with Treatment 1 (water control) and T2 (water + *N. cucumeris* control) 3, 6, 14 and 36 days after the first treatment (Abbotts formula). Significantly fewer than in water controls (P<0.05). No figure given if there was no significant treatment effect on that date.

Date	3 Sep		6 Sep		14 Sep		4 Oct	
	cf. T1	cf.T2	cf. T1	cf. T2	cf. T1	cf. T2	cf. T1	cf. T2
Treatment								
Water control								
Water + *N. cucumeris* control					91.39		86.59	
Actara + *N. cucumeris*					89.32		97.67	
AHDB9970 + *N. cucumeris*					96.52		97.67	
Botanigard WP + *N. cucumeris*					82.78		97.67	
Botanigard WP + Majestik + *N. cucumeris*					93.13		92.71	
AHDB9971 + *N. cucumeris*					100		98.83	
Mainman + *N. cucumeris*					89.65		94.46	

Percentage of flower area damaged

Mean percentage flower area damaged three, six, 14 and 36 days after the first treatments were applied are presented in Table 5 and Figure 3. The analysis was done on the angular transformed data and back-transformed data is also presented. On the first assessment, three days after the first treatments, all treatments except for the *N. cucumeris* plus water control and Botanigard WP plus *N. cucumeris* significantly reduced percentage flower area damaged compared with the water controls. Actara, Botanigard WP tank mixed with Majestik and AHDB9971, all used in combination with *N, cucumeris* significantly reduced percentage flower area compared with the *N. cucumeris* plus water control and all were equally effective. On the second assessment date six days after first treatments, all treatments except for the *N. cucumeris* plus water control significantly reduced percentage flower area damaged compared with the water control. Actara, AHDB9970, Botanigard tank mixed with Majestik and AHDB9971, all used in combination with *N. cucumeris* significantly reduced percentage flower area damaged compared with the *N. cucumeris* plus water control and all were equally effective. On the third and fourth assessment dates, 14 and 36 days after first treatments, all treatments significantly reduced percentage flower area damaged compared with the water controls. On the third assessment date, Actara, AHDB9970 and Botanigard WP tank mixed with Majestik, all used in combination with *N. cucumeris* significantly reduced percentage flower area damaged compared with the *N. cucumeris* plus water control and all were equally effective. On the final assessment date, only AHDB9971 used in combination with *N. cucumeris* significantly reduced percentage flower area damaged compared with the *N. cucumeris* plus water control.

Table 5 Mean percentage flower area damaged 3, 6, 14 and 36 days after the first treatment. Ang= angular transformed data, Back=back-transformed data. Significantly fewer than in water controls (P<0.05). Significantly fewer than in both water and water plus *Neoseiulus cucumeris controls* (P<0.05). Values sharing the same letters are not significantly different, those with different letters are significantly different. N.S.= not significant P value.

Date	3 Sep		6 Sep		14 Sep		4 Oct	
	Ang	Back	Ang	Back	Ang	Back	Ang	Back
Treatment								
Water control	6.57 c	1.31	9.07 c	2.48	8.57 c	2.22	19.07 c	10.67
Water + *N. cucumeris* control	5.72 bc	0.99	7.28 bc	1.61	5.18 b	0.81	5.36 b	0.87
Actara + *N. cucumeris*	2.50 a	0.19	1.85 a	0.10	1.29 a	0.05	3.01 ab	0.28
AHDB9970 + *N. cucumeris*	3.47 ab	0.37	3.06 a	0.29	1.31 a	0.05	4.33 b	0.57
Botanigard WP + *N. cucumeris*	4.18 abc	0.53	3.96 ab	0.48	4.56 b	0.63	5.09 b	0.79
Botanigard WP + Majestik + *N. cucumeris*	2.50 a	0.19	2.56 a	0.20	1.78 a	0.10	6.27 b	1.19
AHDB9971 + *N. cucumeris*	2.78 a	0.24	2.13 a	0.14	4.90 b	0.73	0.15 a	0
Mainman + *N. cucumeris*	3.70 ab	0.42	4.08 ab	0.51	4.08 b	0.51	4.39 b	0.59
F value	3.37		5.23		10.98		17.32	
P value	0.007		<0.001		<0.001		<0.001	
d.f.	35		35		35		35	
s.e.d.	1.161		1.602		1.056		1.907	
l.s.d.	2.358		3.252		2.143		3.872	

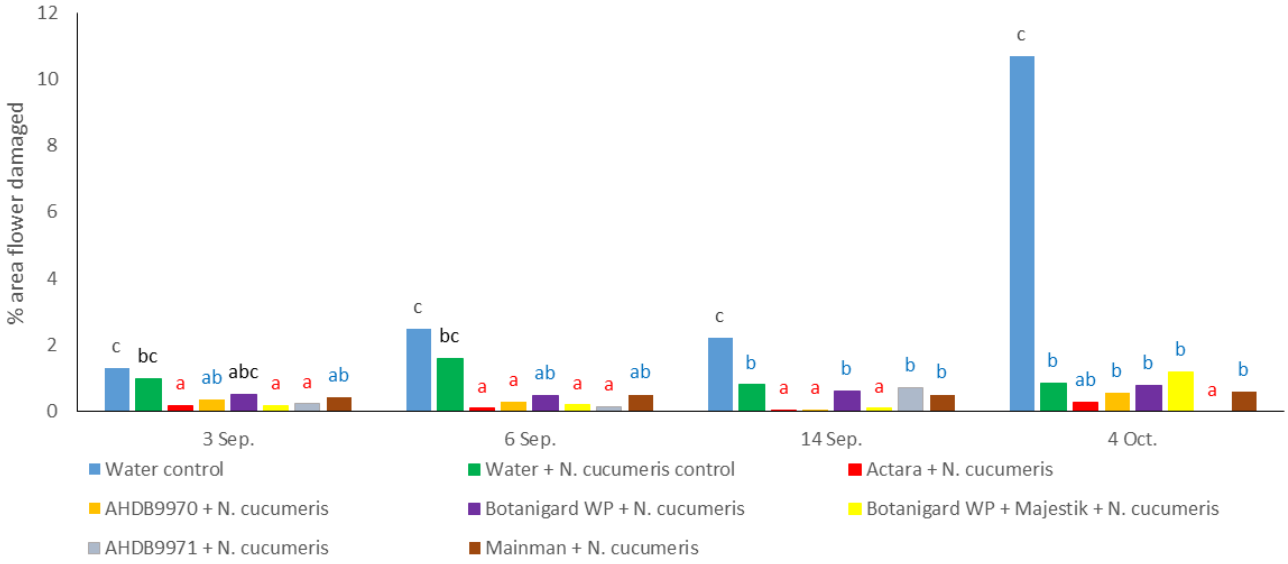

Figure 3. Mean percentage flower area damaged 3, 6, 14 and 36 days after the first treatment. Blue letters indicate significantly fewer than in water controls (P<0.05). Red letters indicate significantly fewer than in both water and water plus *Neoseiulus cucumeris controls* (P<0.05). Values sharing the same letters are not significantly different, those with different letters are significantly different. Analysis done on angular transformed data but back-transformed data presented.

Table 6. Percentage reduction in mean back-transformed percentage flower area damaged compared with Treatment 1 (water control) and T2 (water + *N. cucumeris* control) 3, 6, 14 and 36 days after the first treatment (Abbotts formula). Significantly fewer than in water controls (P<0.05). Significantly fewer than in both water and water plus *Neoseiulus cucumeris controls* (P<0.05). No figure given if there was no significant treatment effect on that date.

Date	3 Sep		6 Sep		14 Sep		4 Oct	
	cf. T1	cf.T2	cf. T1	cf. T2	cf. T1	cf. T2	cf. T1	cf. T2
Treatment								
Water control								
Water + *N. cucumeris* control	24.19		35.34		63.35		91.81	
Actara + *N. cucumeris*	85.43	80.81	95.81	93.52	97.71	93.74	97.42	68.54
AHDB9970 + *N. cucumeris*	72.12	62.63	88.52	82.25	97.63	93.55	94.65	34.67
Botanigard WP + *N. cucumeris*	59.43	46.46	80.84	70.37	71.46	22.14	92.62	9.95
Botanigard WP + Majestik + *N. cucumeris*	85.42	80.81	91.96	87.56	95.66	88.15	88.64	-36.27
AHDB9971 + *N. cucumeris*	82.05	75.76	94.42	91.37	67.12	10.28	99.99	99.89
Mainman + *N. cucumeris*	68.25	57.58	79.62	68.48	77.25	37.91	94.51	32.95

Numbers of WFT adults on leaves

Mean numbers of live WFT adults on all leaves per plot, three, six, 14 and 36 days after the first treatments were applied are presented in Table 7 and Figure 4. On the first assessment date three days after first treatment there were no significant effects of treatment. On the remaining three assessment dates, six, 14 and 36 days after first treatment, all treatments significantly reduced mean numbers of WFT adults on leaves compared with the water control and all were equally effective. None of the treatments significantly reduced numbers of WFT adults on leaves compared with the *N. cucumeris* plus water control.

Table 7. Mean numbers of live WFT adults on leaves 3, 6, 14 and 36 days after the first treatment. Significantly fewer than in water controls (P<0.05). Values sharing the same letters are not significantly different, those with different letters are significantly different. N.S.= not significant P value

Date	3 Sep	6 Sep	14 Sep	4 Oct
Treatment				
Water control	0.71	1.54 b	1.88 b	9.64 b
Water + *N. cucumeris* control	0.38	**0.71 a**	**0.75 a**	**0.96 a**
Actara + *N. cucumeris*	0.38	**0.46 a**	**0.08 a**	**0.10 a**
AHDB9970 + *N. cucumeris*	0.58	**0.33 a**	**0.18 a**	**0.69 a**
Botanigard WP + *N. cucumeris*	0.63	**0.25 a**	**0.29 a**	**0.72 a**
Botanigard WP + Majestik + *N. cucumeris*	0.25	**0.21 a**	**0.43 a**	**0.76 a**
AHDB9971 + *N. cucumeris*	0.42	**0.33 a**	**0.18 a**	**0.35 a**
Mainman + *N. cucumeris*	0.54	**0.19 a**	**0.13 a**	**0.82 a**
F value	0.98	4.25	7.75	27.87
P value	0.46 (N.S.)	0.002	<0.001	<0.001
d.f.	35	35	35	35
s.e.d.	0.221	0.310	0.305	0.857
l.s.d.	0.448	0.629	0.619	1.739

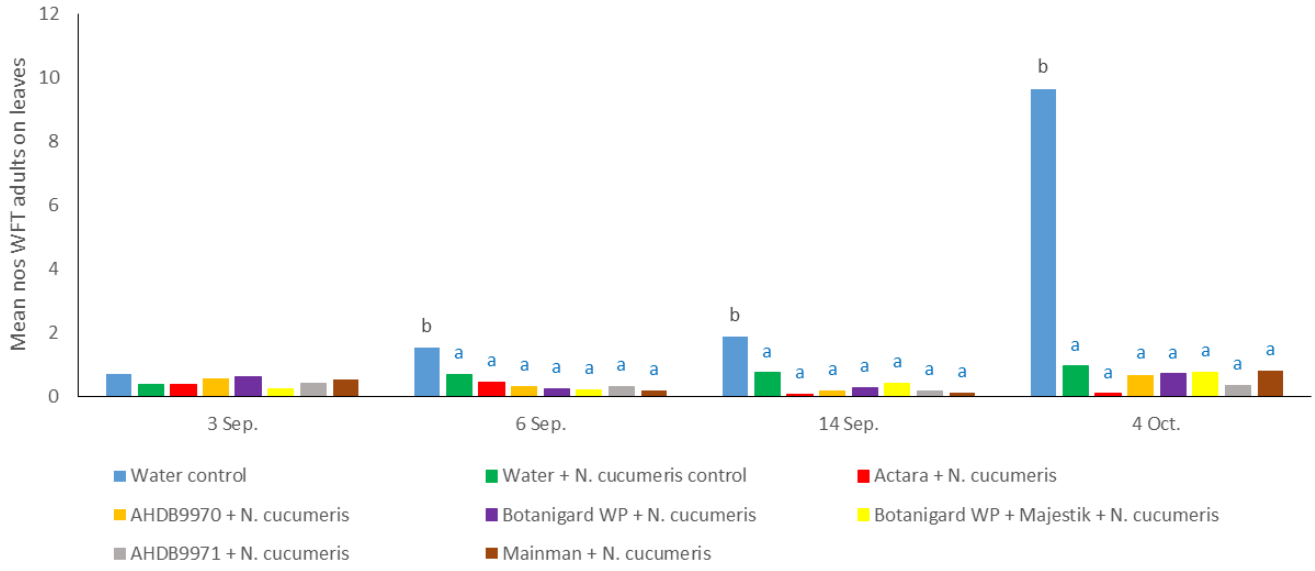

Figure 4. Mean numbers of live WFT adults on leaves 3, 6, 14 and 36 days after the first treatment. Blue letters indicate **significantly fewer than in water controls (P<0.05).** Values sharing the same letters are not significantly different, those with different letters are significantly different.

Table 8. Percentage reduction in mean numbers of WFT adults on leaves compared with Treatment 1 (water control) and T2 (water + *N. cucumeris* control) 3, 6, 14 and 36 days after the first treatment (Abbotts formula). **Significantly fewer than in water controls (P<0.05).** No figure given if there was no significant treatment effect on that date.

Date	3 Sep		6 Sep		14 Sep		4 Oct	
	cf. T1	cf.T2	cf. T1	cf. T2	cf. T1	cf. T2	cf. T1	cf. T2
Treatment								
Water control								
Water + *N. cucumeris* control			54.15		60.0		90.04	
Actara + *N. cucumeris*			70.30		95.57		98.96	
AHDB9970 + *N. cucumeris*			78.40		90.35		92.84	
Botanigard WP + *N. cucumeris*			83.79		84.43		92.53	
Botanigard WP + Majestik + *N. cucumeris*			86.51		76.80		92.12	
AHDB9971 + *N. cucumeris*			78.40		90.35		96.37	
Mainman + *N. cucumeris*			87.42		93.33		91.49	

Numbers of WFT larvae on leaves

Mean numbers of live WFT larvae on all leaves per plot, three, six, 14 and 36 days after the first treatments were applied are presented in Table 9 and Figure 5. No WFT larvae were recorded on leaves on the first assessment date, three days after treatment. On the remaining three assessment dates, all treatments significantly reduced mean numbers of WFT larvae on leaves compared with the water control and all were equally effective. None of the treatments significantly reduced numbers of WFT adults on leaves compared with the *N. cucumeris* plus water control.

Table 9. Mean numbers of live WFT larvae on leaves 3, 6, 14 and 36 days after the first treatment. Ang= angular transformed data, Back=backtransformed data. Significantly fewer than in water controls (P<0.05). Significantly fewer than in both water and water plus *Neoseiulus cucumeris controls* (P<0.05). Values sharing the same letters are not significantly different, those with different letters are significantly different. N.S.= not significant P value

Date	3 Sep	6 Sep	14 Sep	4 Oct
Treatment				
Water control	0	1.68 b	6.96 b	46.64 b
Water + *N. cucumeris* control	0	0.08 a	0.67 a	2.93 a
Actara + *N. cucumeris*	0	0.54 a	0.38 a	1.68 a
AHDB9970 + *N. cucumeris*	0	0.25 a	0.39 a	1.13 a
Botanigard WP + *N. cucumeris*	0	0.08 a	0.39 a	0.99 a
Botanigard WP + Majestik + *N. cucumeris*	0	0 a	0.26 a	0.96 a
AHDB9971 + *N. cucumeris*	0	0.08 a	0.10 a	0.13 a
Mainman + *N. cucumeris*	0	0.04 a	0.29 a	1.32 a
F value	-	2.95	6.55	18.21
P value	-	0.015	<0.001	<0.001
d.f.	-	35	35	35
s.e.d.	-	0.466	1.294	5.32
l.s.d.	-	0.947	2.626	10.80

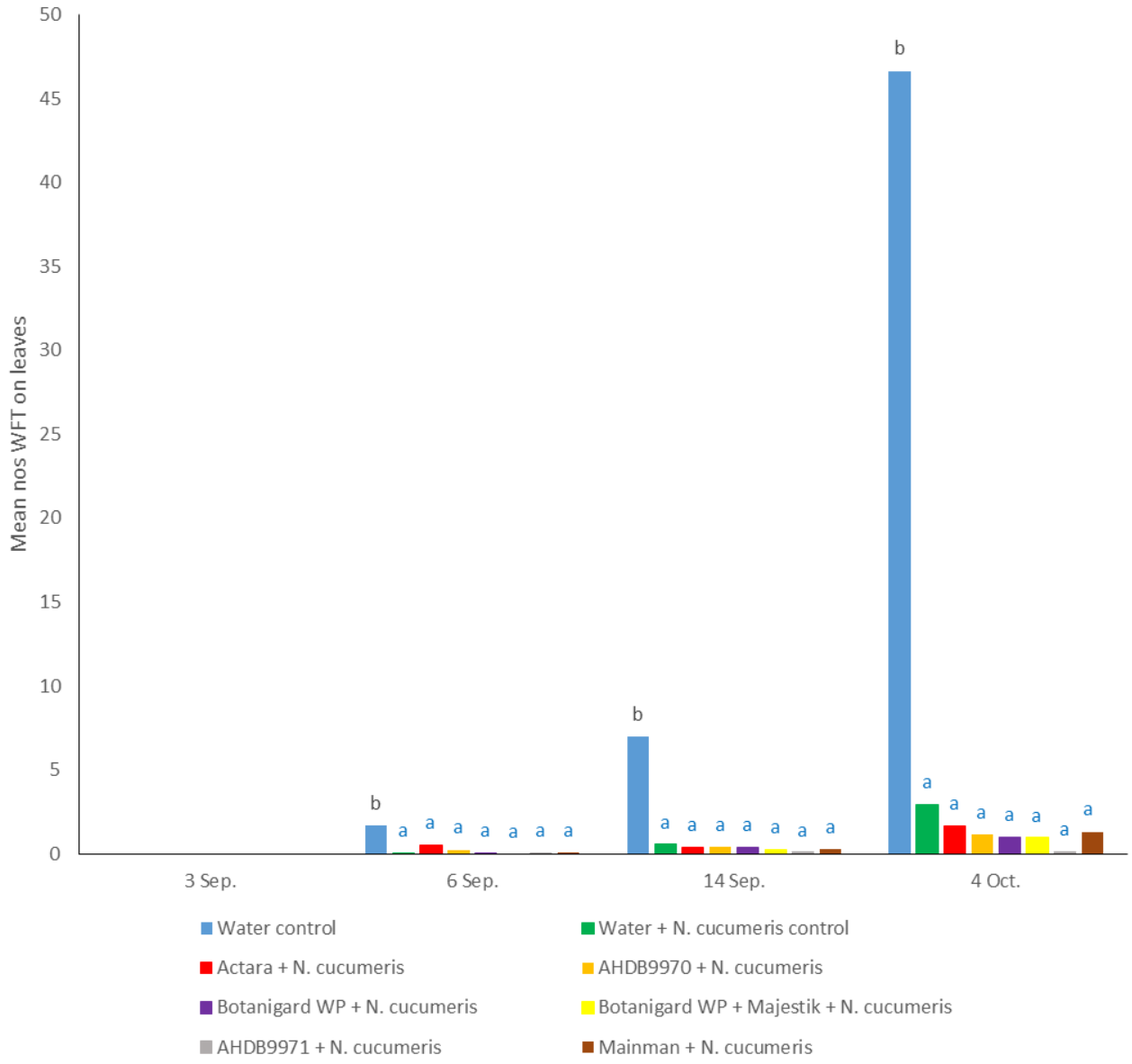

Figure 5. Mean numbers of live WFT larvae on leaves 3, 6, 14 and 36 days after the first treatment. Blue letters indicate **significantly fewer than in water controls (P<0.05).** Values sharing the same letters are not significantly different, those with different letters are significantly different.

Table 10. Percentage reduction in mean numbers of WFT larvae on leaves compared with Treatment 1 (water control) and T2 (water + *N. cucumeris* control) 3, 6, 14 and 36 days after the first treatment (Abbotts formula). Significantly fewer than in water controls (P<0.05). No figure given if there was no significant treatment effect on that date.

Date	3 Sep		6 Sep		14 Sep		4 Oct	
	cf. T1	cf.T2	cf. T1	cf. T2	cf. T1	cf. T2	cf. T1	cf. T2
Treatment								
Water control								
Water + *N. cucumeris* control			95.0		90.37		93.78	
Actara + *N. cucumeris*			67.76		94.54		96.35	
AHDB9970 + *N. cucumeris*			85.13		94.40		97.64	
Botanigard WP + *N. cucumeris*			95.06		94.40		97.85	
Botanigard WP + Majestik + *N. cucumeris*			100		96.26		97.85	
AHDB9971 + *N. cucumeris*			95.06		98.56		99.79	
Mainman + *N. cucumeris*			97.52		95.83		97.21	

Percentage of leaf area damaged

Mean percentage leaf area damaged three, six, 14 and 36 days after the first treatments were applied are presented in Table 11 and Figure 6. The analysis was done on the angular transformed data and back-transformed data is also presented. On the first assessment date three days after first treatment, there was no significant treatment effect. On the remaining three assessment dates three, 14 and 36 days after the first treatment, all treatments significantly reduced mean percentage leaf area damaged compared with the water control and all were equally effective. None of the treatments significantly reduced mean percentage leaf area damaged compared with the *N. cucumeris* plus water control.

Table 11. Mean percentage leaf area damaged 3, 6, 14 and 36 days after the first treatment. Ang= angular transformed data, Back=backtransformed data. Significantly fewer than in water controls (P<0.05). Significantly fewer than in both water and water plus *Neoseiulus cucumeris controls* (P<0.05). Values sharing the same letters are not significantly different, those with different letters are significantly different. N.S.= not significant P value.

Date	3 Sep		6 Sep		14 Sep		4 Oct	
	Ang	Back	Ang	Back	Ang	Back	Ang	Back
Treatment								
Water control	3.96	0.48	5.78 b	1.01	15.05 b	6.74	29.99 b	24.98
Water + *N. cucumeris* control	1.35	0.06	**2.13 a**	0.14	**5.58 a**	0.95	**7.37 a**	1.65
Actara + *N. cucumeris*	1.13	0.04	**1.37 a**	0.06	**3.56 a**	0.39	**3.23 a**	0.32
AHDB9970 + *N. cucumeris*	1.83	0.10	**0.54 a**	0.01	**3.28 a**	0.33	**4.37 a**	0.58
Botanigard WP + *N. cucumeris*	1.46	0.07	**1.10 a**	0.04	**2.84 a**	0.25	**3.85 a**	0.45
Botanigard WP + Majestik + *N. cucumeris*	1.52	0.07	**1.58 a**	0.08	**4.53 a**	0.63	**6.07 a**	1.12
AHDB9971 + *N. cucumeris*	1.06	0.03	**0.42 a**	0.01	**2.57 a**	0.20	**2.31 a**	0.16
Mainman + *N. cucumeris*	0.25	0	**0.32 a**	0	**2.75 a**	0.23	**3.99 a**	0.49
F value	1.14		2.82		16.14		15.52	
P value	0.36 (N.S.)		0.02		<0.001		<0.001	
d.f.	35		35		35		35	
s.e.d.	1.419		1.501		1.471		3.291	
l.s.d.	2.881		3.047		2.987		6.680	

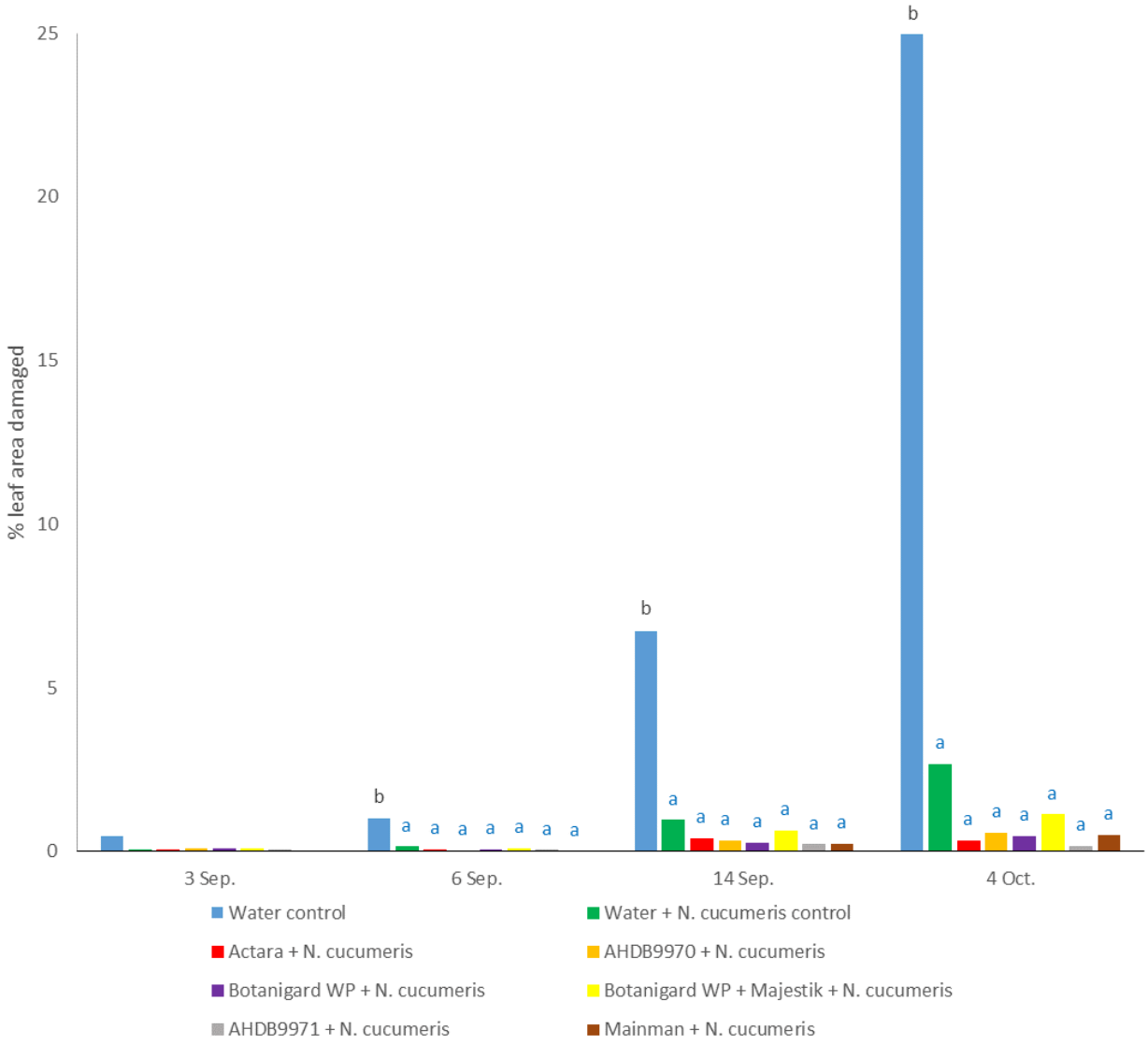

Figure 6. Mean percentage leaf area damaged 3, 6, 14 and 36 days after the first treatment. Blue letters indicate significantly fewer than in water controls ($P<0.05$). Values sharing the same letters are not significantly different, those with different letters are significantly different. Analysis done on angular transformed data but back-transformed data presented.

Table 12. Percentage reduction in mean back-transformed percentage leaf area damaged compared with Treatment 1 (water control) and T2 (water + *N. cucumeris* control) 3, 6, 14 and 36 days after the first treatment (Abbotts formula). Significantly fewer than in water controls (P<0.05). Significantly fewer than in both water and water plus *Neoseiulus cucumeris controls* (P<0.05). No figure given if there was no significant treatment effect on that date.

Date	3 Sep		6 Sep		14 Sep		4 Oct	
	cf. T1	cf.T2	cf. T1	cf. T2	cf. T1	cf. T2	cf. T1	cf. T2
Treatment								
Water control								
Water + *N. cucumeris* control			86.35		85.99		93.41	
Actara + *N. cucumeris*			94.34		94.29		98.73	
AHDB9970 + *N. cucumeris*			99.11		95.15		97.68	
Botanigard WP + *N. cucumeris*			96.36		96.37		98.20	
Botanigard WP + Majestik + *N. cucumeris*			92.54		90.73		95.53	
AHDB9971 + *N. cucumeris*			99.47		97.0		99.35	
Mainman + *N. cucumeris*			99.70		96.6		98.06	

Numbers of *Neoseiulus cucumeris*

Mean numbers of live *N. cucumeris* per plant, three, six, 14 and 36 days after the first treatments were applied are presented in Table 13 and Figure 7. Numbers of *N. cucumeris* were not recorded until the second assessment date onwards. *Neoseiulus cucumeris* were not recorded on the water control plants on any assessment date. There was no significant treatment effect on the second assessment date, six days after treatment. On the third assessment date, 14 days after the first treatment, all treatments significantly reduced mean numbers of *N. cucumeris* per plant compared with the *N. cucumeris* plus water control and all treatments had a similar effect. On the final assessment date, 36 days after the first treatment, all treatments except for Actara and Mainman, both in combination with *N. cucumeris* significantly reduced numbers of *N. cucumeris* per plant compared with the *N. cucumeris* plus water control and all treatments had a similar effect.

Table 13. Mean numbers of live *Neoseiulus cucumeris* per plant 3, 6, 14 and 36 days after the first treatment. Ang= angular transformed data, Back=backtransformed data. Significantly fewer than in water plus *Neoseiulus cucumeris* controls (P<0.05). Values sharing the same letters are not significantly different, those with different letters are significantly different. N.S.= not significant P value

Date	3 Sep	6 Sep	14 Sep	4 Oct
Treatment				
Water control	-	0	0	0
Water + *N. cucumeris* control	-	0.71	1.5 b	3.57 d
Actara + *N. cucumeris*	-	0.25	0.71 a	2.89 cd
AHDB9970 + *N. cucumeris*	-	0.46	0.26 a	1.06 ab
Botanigard WP + *N. cucumeris*	-	0.50	0.67 a	1.65 abc
Botanigard WP + Majestik + *N. cucumeris*	-	0.42	0.56 a	1.49 abc
AHDB9971 + *N. cucumeris*	-	0.46	0.63 a	1.67 abc
Mainman + *N. cucumeris*	-	0.82	0.75 a	2.35 bcd
F value	-	0.72	3.06	4.02
P value	-	0.66 (N.S.)	0.013	0.003
d.f.	-	35	35	35
s.e.d.	-	0.422	0.351	0.779
l.s.d.	-	0.857	0.712	1.582

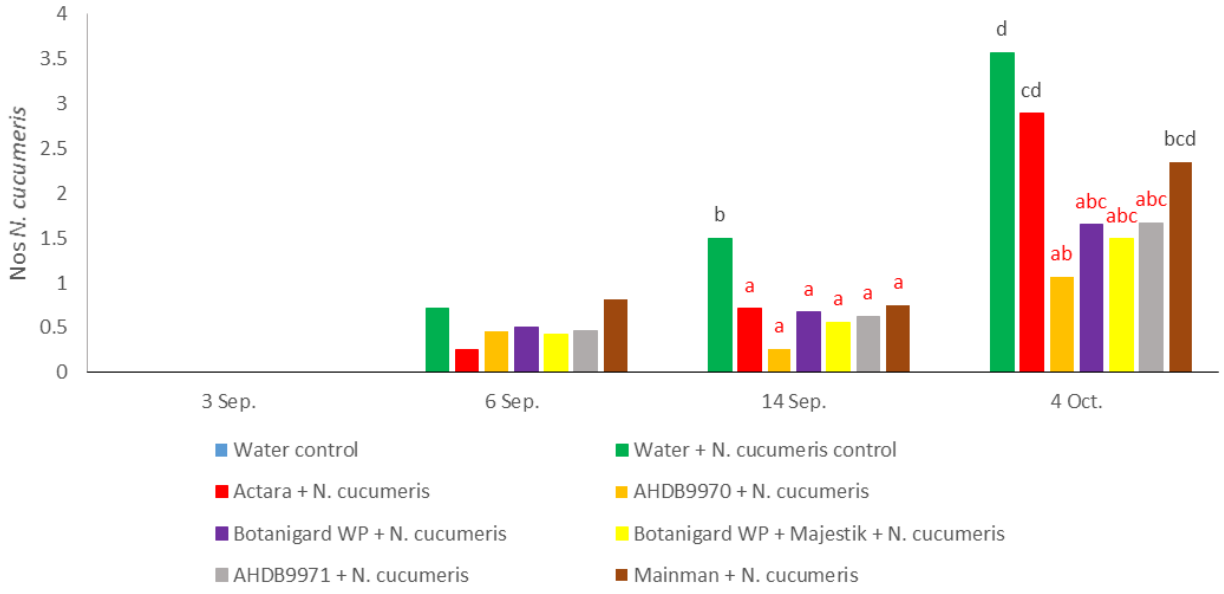

Figure 7. Mean numbers of live *N. cucumeris* per plant 3, 6, 14 and 36 days after the first treatment. Red letters indicate significantly fewer than in *N. cucumeris* plus water controls (P<0.05). Values sharing the same letters are not significantly different, those with different letters are significantly different.

Table 14. Percentage reduction in mean numbers of *N, cucumeris* per plant compared with T2 (water + *N. cucumeris* control) 3, 6, 14 and 36 days after the first treatment (Abbotts formula). Significantly fewer than in water plus *Neoseiulus cucumeris* controls (P<0.05). No figure given if there was no significant treatment effect on that date.

Date	3 Sep cf. T2	6 Sep cf. T2	14 Sep cf. T2	4 Oct cf. T2
Treatment				
Water control				
Water + *N. cucumeris* control				
Actara + *N. cucumeris*			52.80	19.05
AHDB9970 + *N. cucumeris*			82.40	70.31
Botanigard WP + *N. cucumeris*			55.53	53.78
Botanigard WP + Majestik + *N. cucumeris*			62.93	58.26
AHDB9971 + *N. cucumeris*			58.33	53.22
Mainman + *N. cucumeris*			50.0	34.17

Phytotoxicity
No phytotoxicity symptoms were recorded on any assessment date.

Discussion

- The results indicate that the reduction in mean numbers of WFT adults and larvae per leaf and percentage leaf area damaged by all treatments compared with the water controls are likely to have been mainly due to the use of *N. cucumeris* in combination with all treatments. *Neoseiulus cucumeris* predates first instar WFT larvae and thus would reduce subsequent numbers of second instar larvae and adults.
- However, there were significant reductions in mean percentage flower area damaged compared with the *N. cucumeris* and water control by the standard treatment Actara and also by AHDB9970, Botanigard tank mixed with Majestik and AHDB9971, all used in combination with *N. cucumeris.* This result indicates that these treatments improved control of WFT flower damage when used as a supplement to *N, cucumeris* in an IPM programme.
- The addition of Majestik to Botanigard WP improved reduction in percentage flower area damaged. It would be useful to test the efficacy of Majestik as a single biopesticide rather than as a tank mix with Botanigard WP in any future work.
- The results indicated that all treatments may have had some adverse effects on *N. cucumeris*. However more detailed work would be needed to confirm these effects as the numbers of *N. cucumeris* were not assessed using standard side effects methods in this experiment as the main objective was to test the effect of the candidate treatments on WFT control. Thiamethoxam (used as Actara in this experiment) is reported as 'slightly harmful' to *N. cucumeris* i.e. killing 25-50% on the Biobest side effects list (http://www.biobestgroup.com/en/side-effect-manual) but 'harmful' to *N. cucumeris* i.e. killing over 75% on the Koppert side effects list (https://www.koppert.com/side-effects/). Flonicamid (used as Mainman in this experiment) is reported as 'safe' i.e. killing up to 25% *N. cucumeris* on both the Biobest and Koppert side effects lists.
- The standard insecticide Actara performed against WFT as expected thus confirming it to be a valid experiment. Actara has an EAMU for use on protected ornamentals but is not currently used by growers for control of WFT as it is one of the neonicotinoids currently subject to EC restrictions on use on flowering plants.
- Majestik caused foaming when added to water in the spray tank.
- There were no phytotoxicity effects of treatment.

Conclusions

- The results indicate that the reduction in mean numbers of WFT adults and larvae per leaf and percentage leaf area damaged by all treatments compared with the water controls are likely to have been mainly due to the use of *N. cucumeris* in combination with all treatments. *Neoseiulus cucumeris* predates first instar WFT larvae and thus would reduce subsequent numbers of second instar larvae and adults.
- However, there were significant reductions in mean percentage flower area damaged compared with the *N. cucumeris* and water control by the standard treatment Actara and also by AHDB9970, Botanigard tank mixed with Majestik and AHDB9971, all used in combination with *N. cucumeris.* This result indicates that these treatments improved control of WFT flower damage when used as a supplement to *N, cucumeris* in an IPM programme.
- The addition of Majestik to Botanigard WP improved reduction in percentage flower area damaged. It would be useful to test the efficacy of Majestik as a single biopesticide rather than as a tank mix with Botanigard WP in any future work, after checking known efficacy data with the manufacturer.
- Further work is needed to confirm treatment efficacy, either when used in combination with *N. cucumeris* in an IPM programme under higher WFT pressure, or when used without *N. cucumeris*. Treatments might continue for longer than the 14-day period used in the experiment reported here.
- The results indicated that all treatments may have had some adverse effects on *N. cucumeris*, however more detailed work would be needed to confirm these effects after discussion of available information with the product manufacturers.

Take-home message: Two coded biopesticides and a tank mix of Botanigard WP with Majestik significantly reduced percentage flower damage when used in combination with *N. cucumeris* compared with using *N. cucumeris* in combination with water as a control.

Acknowledgements

Thanks to AHDB and crop protection company funding and to Bioline AgroSciences for providing the *N. cucumeris* free of charge.

Appendix

a. Crop diary – events related to growing crop

Crop	Cultivar	Potting up date	Pots per cage
Verbena	Quartz	10/5/17	4

Biological control agents applied for other pests

Date	Product	Rate per cage	Pest
01-Sep	*Aphidius colemani*	20	*Myzus persicae*
07-Sep	*Aphidius colemani*	20	*Myzus persicae*
15-Sep	*Aphidius colemani*	20	*Myzus persicae*
20-Sep	*Aphidius colemani*	20	*Myzus persicae*
27-Sep	*Aphidius colemani*	20	*Myzus persicae*

Fungicides applied to trial plants

Date	Product	Rate	Unit
16-Jun	Topsin	1.1	Kg/ha
22-Jun	Rovral	0.67	Kg/ha

Growth regulators applied to trial plants

Date	Product	Rate	Unit
27-Jun	Bonsai	2	ml/L

Details of irrigation regime
Plant were irrigated using automatic irrigation to capillary matting beneath the cages. The matting was kept damp throughout the trial.

b. Trial diary

Date	Event
05-Jun	Seeds sown
13-Jul	Plants potted on
26-Jul;	*Neoseiulus cucumeris* added to all treatments except water control
02-Aug	*Neoseiulus cucumeris* added to all treatments except water control
10 Aug	*Neoseiulus cucumeris* added to all treatments except water control
17-Aug	*Neoseiulus cucumeris* added to all treatments except water control
25-Aug	*Neoseiulus cucumeris* added to all treatments except water control
31-Aug	Thrips damage assessment
31-Aug	20 WFT (18 female, 2 male) added to each cage
01-Sep	*Neoseiulus cucumeris* added to all treatments except water control
01-Sep	All treatments sprayed
04-Sep	Thrips numbers and damage assessment
06-Sep	Botanigard and Botanigard + Majestik sprays applied
07-Sep	Thrips numbers and damage assessment
07-Sep	*Neoseiulus cucumeris* added to all treatments except water control
08-Sep	Actara, AHDB9970 and AHDB9971 sprays applied
11-Sep	Botanigard and Botanigard + Majestik sprays applied
15-Sep	*Neoseiulus cucumeris* added to all treatments except water control
18-Sep	Thrips numbers and damage assessment
20-Sep	*Neoseiulus cucumeris* added to all treatments except water control
27-Sep	*Neoseiulus cucumeris* added to all treatments except water control
05-Oct	Thrips numbers and damage assessment

c. Climatological data during study period

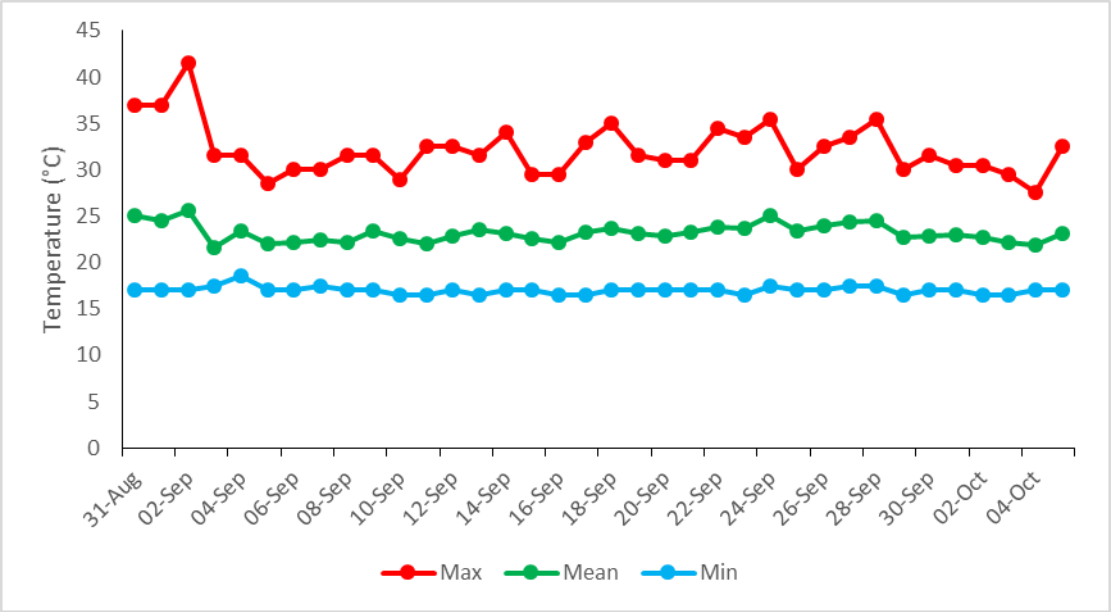

Figure 1. Mean daily mean, maximum and minimum temperatures inside plot cages during the trial period

	Temperature	
Date	Max	Min
31/08/2017	37	17
01/09/2017	37	17
02/09/2017	41.5	17
03/09/2017	31.5	17.5
04/09/2017	28.5	18.5
05/09/2017	30	17
06/09/2017	30	17
07/09/2017	31.5	17.5
08/09/2017	31.5	17
09/09/2017	29	17
10/09/2017	32.5	16.5
11/09/2017	32.5	16.5
12/09/2017	31.5	17
13/09/2017	34	16.5
14/09/2017	29.5	17
15/09/2017	29.5	17
16/09/2017	33	16.5
17/09/2017	35	16.5
18/09/2017	31.5	17
19/09/2017	31	17
20/09/2017	31	17
21/09/2017	34.5	17
22/09/2017	33.5	17

23/09/2017	35.5	16.5
24/09/2017	30	17.5
25/09/2017	32.5	17
26/09/2017	32.5	17
27/09/2017	33.5	17.5
28/09/2017	30	17.5
29/09/2017	31.5	16.5
30/09/2017	30.5	17
01/10/2017	30.5	17
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04/10/2017	32.5	17
05/10/2017	32.5	17

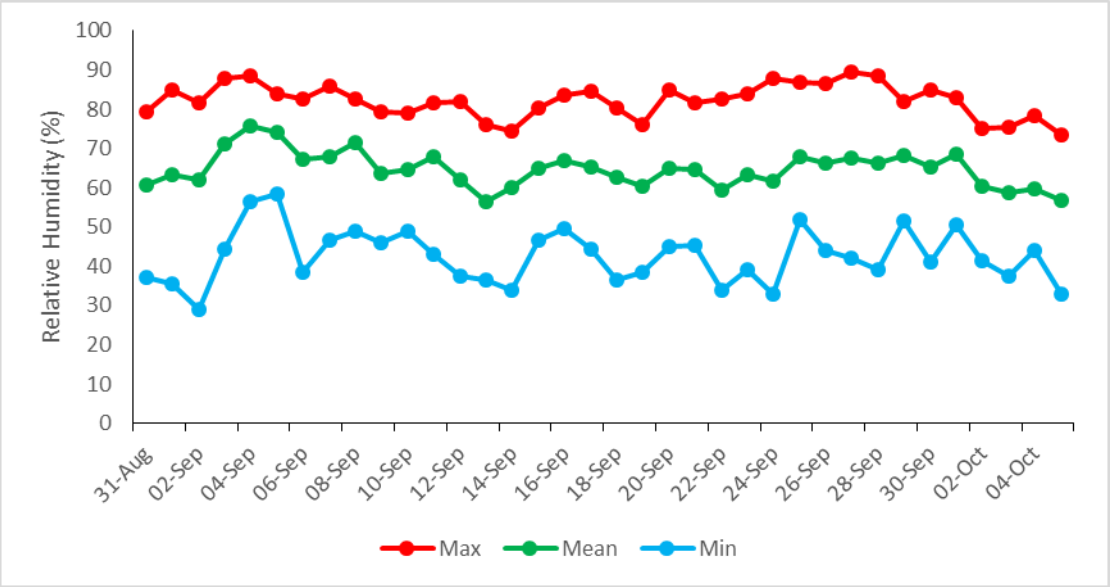

Figure 2. Mean daily mean, maximum and minimum relative humidities (%) inside plot cages during the trial period

	Relative Humidity (%)	
Date	Max	Min
31/08/2017	79.5	37
01/09/2017	85	35.5
02/09/2017	81.5	29
03/09/2017	88	44.5
04/09/2017	88.5	56.5
05/09/2017	84	58.5
06/09/2017	82.5	38.5
07/09/2017	86	46.5
08/09/2017	82.5	49
09/09/2017	79.5	46

10/09/2017	79	49
11/09/2017	81.5	43
12/09/2017	82	37.5
13/09/2017	76	36.5
14/09/2017	74.5	34
15/09/2017	80.5	46.5
16/09/2017	83.5	49.5
17/09/2017	94.5	44.5
18/09/2017	90.5	36.5
19/09/2017	76	38.5
20/09/2017	85	45
21/09/2017	81.5	45.5
22/09/2017	82.5	34
23/09/2017	84	39
24/09/2017	85	33
25/09/2017	87	52
26/09/2017	86.5	44
27/09/2017	89.5	42
28/09/2017	88.5	39
29/09/2017	82	51.5
30/09/2017	85	41
01/10/2017	83	50.5
02/10/2017	75	41.5
03/10/2017	75.5	37.5
04/10/2017	78.5	44
05/10/2017	73.5	33

d. Raw data from assessments

Percentage flower area damaged before angular transformation

Date	3 Sep	6 Sep	14 Sep	4 Oct
Treatment				
Water control	1.63	3.0	2.31	11.33
Water + *N. cucumeris* control	1.36	3.93	0.88	1.30
Actara + *N. cucumeris*	0.34	0.28	0.10	0.49
AHDB9970 + *N. cucumeris*	0.80	0.54	0.11	0.79
Botanigard WP + *N. cucumeris*	1.01	1.10	0.74	0.97
Botanigard WP + Majestik + *N. cucumeris*	0.51	0.67	0.32	1.52
AHDB9971 + *N. cucumeris*	0.37	0.28	0.77	0
Mainman + *N. cucumeris*	1.23	1.32	0.83	0.9

Percentage leaf area damaged before angular transformation

Date	3 Sep	6 Sep	14 Sep	4 Oct
Treatment				
Water control	1.35	2.10	7.34	28.0
Water + *N. cucumeris* control	0.22	0.40	1.06	1.9
Actara + *N. cucumeris*	0.21	0.37	0.61	0.3
AHDB9970 + *N. cucumeris*	0.31	0.05	0.42	0.8
Botanigard WP + *N. cucumeris*	0.19	0.13	0.33	0.5
Botanigard WP + Majestik + *N. cucumeris*	0.29	0.31	0.81	1.3
AHDB9971 + *N. cucumeris*	0.16	0.05	0.27	0.2
Mainman + *N. cucumeris*	0.01	0.05	0.26	0.6

e. Trial design

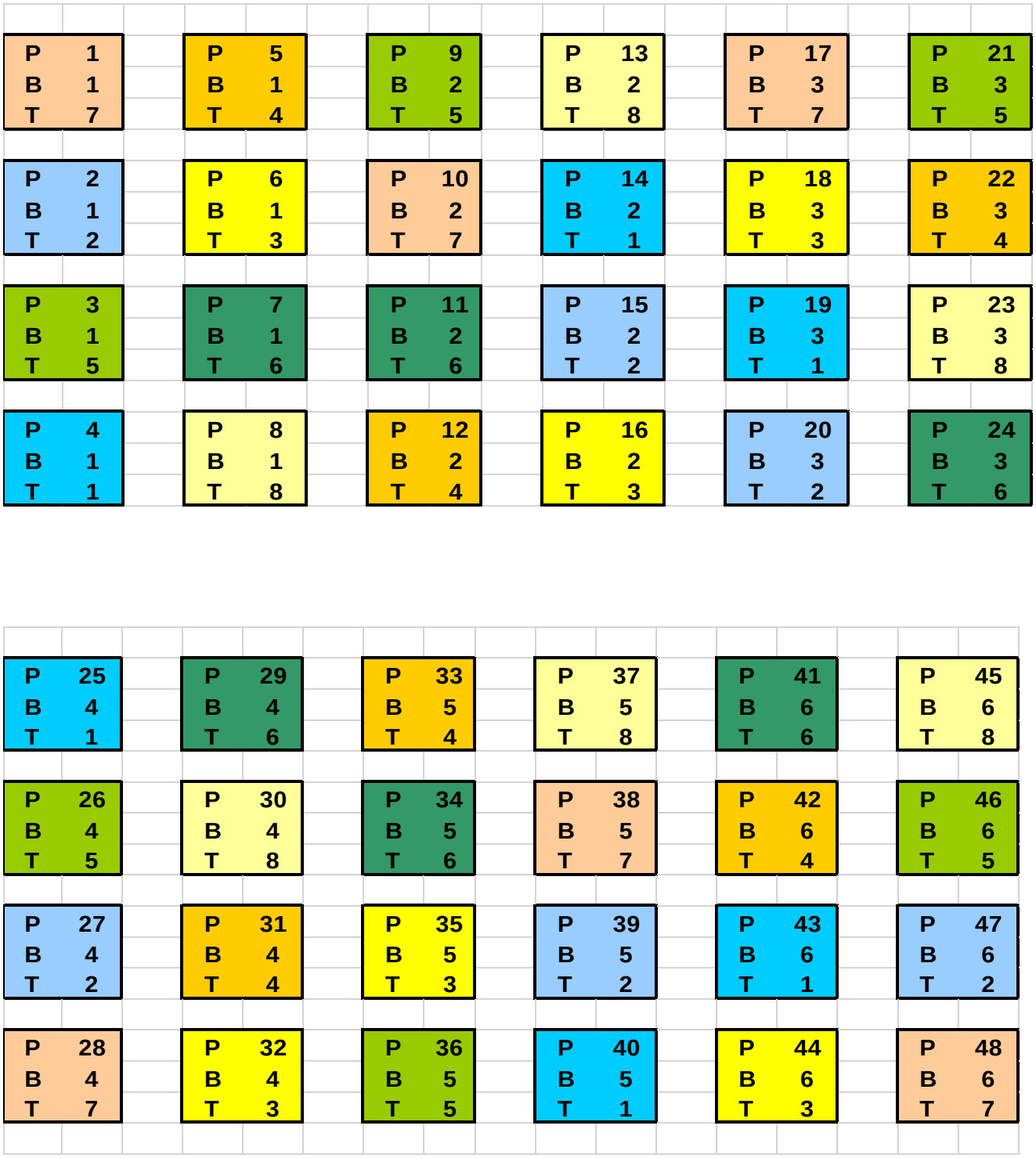

Figure 3. Trial plan in two adjacent glasshouse compartments. P= plot, B= block, T= treatment number, figures indicate plot numbers.

f. Spray deposition

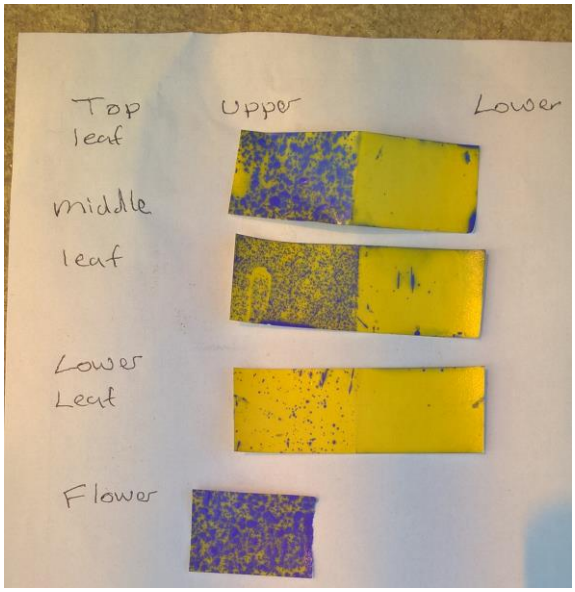

Figure 4. Water spray deposition on water-sensitive paper attached to flower and upper and lower leaf surfaces on top, middle and bottom leaves one day before WFT release.

Certificate of

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

This certifies that

RSK ADAS Ltd

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
Stored Crops

Date of issue: 16 December 2016
Effective date: 5 December 2016
Expiry date: 17 March 2018

Certification Number
ORETO 374

Signature R Brown

Authorised signatory

HSE
Chemicals Regulation Division

Department of Agriculture and Rural Development