SCEPTREPLUS

Final Trial Report

Trial code:	2019-20. SP18
Title:	**Narcissus post-cropping herbicide screen**
Crop	Bulbs and outdoor flowers (Narcissus)
Target	General broadleaf weeds and grasses, 3WEEDT PP1/088(3) Weeds in flower bulbs and flower tubers
Lead researcher:	Angela Huckle
Organisation:	RSK ADAS UK Ltd
Period:	1st March 2019 – 30th September 2020
Report date:	30th November 2020
Report author:	Angela Huckle Guy Johnson
ORETO Number: (certificate should be attached)	ORETO 409

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

26th November 2020
Date

……
Authors signature

Trial Summary

Introduction

The limited range of herbicides available to narcissus growers for safe application over the crop after flowers have been harvested, leaves gaps in the weed control spectrum. Weeds such as mayweed (*Tripleurospermum inodorum*), willowherb (*Epilobium spp.*) and shepherds purse (*Capsella bursa*-pastoris) are becoming challenging to control. . Post-cropping is an important time for weed control in narcissus, and where postharvest weed control is neglected, significant reductions in flower yields can be seen the year following harvest. The risk posed by a narrower list of available actives is that weeds may build resistance to them, with the consequent reduction in their efficacy. This further compounds the issue of loss of actives for effective weed control.

While narcissus is a small sector in area, this crop is high value, so the control of weeds—which can host pests and disease, interfere with harvest, and reduce yield and quality—is of high importance to the industry.

The search for new actives for weed control in narcissus has been driven most notably by the recent loss of linuron. This active has been a key component of narcissus herbicide programmes, used widely by commercial growers, including in tank mixes to complement the weed control spectrums of other actives. Since the withdrawal of linuron in June 2018, finding new actives offering similar efficacy has been a priority for the sector.

The objective of this trial is to identify effective herbicides that are safe for post-cropping application to narcissus.

Methods

The trial was sited and marked out in a one year old narcissus crop, var. Lowan, at a commercial grower holding near Penzance, Cornwall on the 12th of March 2019. The trial was set out as a randomised block design replicated four times. Fifteen treatments were applied at a growth stage equivalent to a post-cropping timing on 19th of March 2019, and included two untreated controls. The treatments were applied with an Oxford precision sprayer using 200 L/ha water volume and a two metre boom. The plots were assessed for weed cover, species present and crop phytotoxicity. Assessments were carried out at two, six and ten weeks after treatments were applied on 2nd April, 1st May and 29th May respectively. An additional assessment for phytotoxicity only was carried out on 16th April at four weeks after application.

Results and Discussion

Wing-P 3.5 L/ha + Lector 0.1 L/ha, AHDB 9865, or AHDB 9900 applied inter-row combine effective weed control with being safe to apply over narcissus at a post-cropping timing, causing no adverse effects to foliage in the year of application or to flowers in the following spring. AHDB 9864 was safe to use over the narcissus but did not give significant control of weed species in the trial. It was included for its activity on groundsel, but levels of groundsel in the trial were low. However, useful information on crop safety has been obtained.

All treatments with the exception of AHDB 9921, did not have significantly greater phytotoxicity scores compared with the untreated control at four weeks after application (**Table 1**). The crop effect caused by AHDB 9921 was a marked wilting and collapse of the narcissus leaves. At six weeks after application, further significant crop effects are observed on plots treated with tank-mixes containing Butryflow, or products AHDB 9994 or AHDB 9900. These effects are exhibited as early senescence or drooping, with associated yellowing. The wilting symptoms in plots treated with AHDB 9921 also persisted throughout the assessment period.

The untreated control was not scored as zero as the plots were blind scored, and the yellow flecking from the hot water treatment was scored as a crop effect. Therefore any treatments which have a score of three or under are deemed safe as this is equivalent to the control plots. At 10 weeks after treatment application the untreated score rises to 4.5 as natural senescence of the narcissus further confounded crop effect scores and clear separation of treatment effects.

Despite this, by ten weeks after application, three treatments were not significantly different to the untreated controls and had an equivalent or lower crop effect score. These were; Wing-P 3.5 L/ha + Lector 0.1 L/ha, Wing-P 3.5 L/ha + Lector 0.1 L/ha + Centium 0.25 L/ha, or AHDB 9865.

Table 1. Mean phytotoxicity scores at two, four, six and ten weeks after the final assessment. WAA = weeks after application. Phytotoxicity scores range from 0 = no effect to 10 = crop death.

		Mean Phytotoxicity scores (0-10)			
	Date	**02-Apr 2 WAA**	**16-Apr 4 WAA**	**01-May 6 WAA**	**29-May 10 WAA**
Treat no	Treatment				
1+ 2	Untreated control	0.4	3.0	3.0	4.5
3	Kerb 3.0 L/ha + Stomp Aqua 2.9 L/ha	2.8	2.3	3.0	6.5
4	Kerb 3.0 L/ha + Stomp Aqua 2.9 L/ha + AHDB 9987	3.5	2.0	4.0	5.8
5	Wing-P 3.5 L/ha + Lector 0.1 L/ha	2.3	2.3	4.3	4.8
6	Wing-P 3.5 L/ha + Lector 0.1 L/ha + Centium 0.25 L/ha	2.8	2.8	3.0	4.0
7	Butryflow 1.0 L/ha + Stomp Aqua 2.9 L/ha	2.8	2.3	5.5	6.5
8	Butryflow 1.0 L/ha + Stomp Aqua 2.9 L/ha + AHDB 9987	3.8	3.8	6.0	5.3
9	AHDB 9921	9.0	8.5	8.3	7.3
10	AHDB 9865	2.8	2.5	3.3	3.8
11	AHDB 9864	4.0	2.3	3.0	6.3
12	AHDB 9994	2.8	1.5	4.8	7.8
13	AHDB 9900 lower rate	4.5	3.0	5.0	6.3
14	AHDB 9900 label rate	3.8	2.3	5.3	7.3
15	AHDB 9900 inter-row	4.5	2.0	3.3	5.8
P-value		<0.001	<0.001	<0.001	<0.001
d.f		43	43	43	43
L.S.D		1.512	1.502	1.39	1.263
	Not significantly different from untreated control				
	Significantly different from untreated control				

Ten treatments had significantly lower percentage weed cover compared with the untreated control plots at ten weeks after application, reducing weed cover by at least 40% (**Table 2**). The best performing treatments contained product AHDB 9900 applied at label rate over the row or inter-row with an average of 5.75% and 8.25% weed cover respectively at ten weeks after the final treatment application. Both treatments eliminated volunteer potatoes and shepherds purse by the final assessment. Treatments containing Wing-P 3.5 L/ha + Lector 0.1 L/ha also performed well reducing the percentage weed cover by at least 75% to just 16.25 to 21.25% mean weed cover per plot.

In addition to significantly reducing weed cover compared to the untreated control, treatments including AHDB 9900, AHDB 9865 and Wing-P + Lector also gave a significantly greater reduction in percentage weed cover than the standard, Kerb Flo 3.0 L/ha + Stomp Aqua 2.9 L/ha.

Table 2. Mean percentage of weed cover values (back transformed means) and the Abbotts reduction percentage at two and ten weeks after the final treatment. WAA = weeks after application

		Mean weed cover (%)		Abbots reduction (%)	
Treat no	**Date**	**02-Apr 2 WAA**	**29-May 10 WAA**	**02-Apr 2 WAA**	**29-May 10 WAA**
1+2	Untreated control	61.12	82.62		
3	Kerb 3.0 L/ha + Stomp Aqua 2.9 L/ha	54.25	55.00	11.24	33.43
4	Kerb 3.0 L/ha + Stomp Aqua 2.9 L/ha + AHDB 9987	61.00	47.50	0.20	42.51
5	Wing-P 3.5 L/ha + Lector 0.1 L/ha	48.50	16.25	20.65	80.33
6	Wing-P 3.5 L/ha + Lector 0.1 L/ha + Centium 0.25 L/ha	56.00	21.25	8.38	74.28
7	Butryflow 1.0 L/ha + Stomp Aqua 2.9 L/ha	37.50	65.00	38.65	21.33
8	Butryflow 1.0 L/ha + Stomp Aqua 2.9 L/ha + AHDB 9987	41.75	50.00	31.69	39.48
9	AHDB 9921	42.50	31.25	30.46	62.18
10	AHDB 9865	51.75	25.75	15.33	68.83
11	AHDB 9864	57.00	56.25	6.74	31.92
12	AHDB 9994	50.75	38.00	16.97	54.01
13	AHDB 9900 lower rate	40.50	16.75	33.74	79.73
14	AHDB 9900 label rate	41.75	5.75	31.69	93.04
15	AHDB 9900 inter-row	41.75	8.25	31.69	90.01
	p-value	0.18	<0.001		
	d.f.	43	43		
	L.S.D	20.66	28.08		
		Not significantly different from untreated control (p>0.05)			
		Significantly different from untreated control (p<0.05)			

Conclusions

- Wing-P 3.5 L/ha + Lector 0.1 L/ha, AHDB 9865, or AHDB 9900 applied inter-row combine effective weed control with being safe to apply over narcissus at a post-cropping timing,
- Ten treatments had significantly lower percentage weed cover than the untreated control plots for up to ten weeks after application, reducing weed by at least 40%, but those containing AHDB 9900, AHDB 9994 or Butryflow caused the crop to senesce earlier than the untreated plots, or the commercial standard.
- AHDB 9900 is a promising product for post-cropping weed control in narcissus and was the most effective at reducing total percentage of weed cover. But it did cause the crop to senesce earlier and would be safer to apply between the rows.
- AHDB 9921 is not safe to use over narcissus.

Take home message:

Wing-P 3.5 L/ha + Lector 0.1 L/ha provided a greater level of efficacy than the standard, Kerb Flo 3.0 L/ha + Stomp Aqua 2.9 L/ha and provides a useful alternative. However, Kerb Flo should be included where willowherb is a problem weed species. An EAMU for AHDB 9865 and AHDB 9900 or AHDB 9994 applied as an inter-row application would further improve weed control and options available to growers.

Objectives

To screen new products to be used post cropping for weed control in narcissus production.

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**
EPPO PP1/135(4)	Phytotoxicity assessment	None
EPPO PP1/152(4)	Guideline on design and analysis of efficacy evaluation trials	None
EPPO PP1/225 (2)	Minimum effective dose	None
EPPO PP1/181 (4)	Conduct and reporting of efficacy evaluation trials including good experimental practice	None
EPPO PP 1/214(3)	Principles of acceptable efficacy	None
EPPO PP 1/224(2)	Principles of efficacy evaluation for minor uses	None

There were no deviations from EPPO guidance.

Test site

Item	**Details**
Location address	Field site: Rose an Grouse Greenyard Flowers, Varfell Farm, Longrock, Penzance
Crop	Narcissus
Cultivar	Lowan
Soil or substrate type	Sandy clay loam
Agronomic practice	Not available
Prior history of site	2018 - Potatoes

Trial design

Item	**Details**
Trial design:	Randomised block design
Number of replicates:	4
Row spacing:	1m
Plot size: (w x l)	2m x 6m (2 rows per plot)
Plot size: (m^2)	$12m^2$
Number of plants per plot:	N/K
Leaf Wall Area calculations	

Treatment details

AHDB Code	Active substance	Product name/ manufacturers code	Formulation batch number	Content of active substance in product	Formulation type
Untreated	-	-	-	-	-
N/A	propyzamide (400g/L)	Kerb flo	F470H9G014	400g/L	Suspension concentrate
N/A	pendimethalin (455g/L)	Stomp aqua	N/K	455g/L	Capsule Suspension
AHDB9987	N/D	N/D	N/D	N/D	N/D
N/A	florasulam (50g/L)	Lector	102187706	50g/L	Suspension concentrate
N/A	dimethenamid-P (212.5g/L)	Wing-P	N/K	212.5g/L	Emulsifiable concentrate
N/A	clomazone (360g/L)	Centium 360 CS	173113	360g/L	Capsule suspension
N/A	bromoxynil (401.58g/L)	Butryflow	317110408	401.58g/L	Capsule suspension
AHDB9921	N/D	N/D	N/D	N/D	N/D
AHDB 9865	N/D	N/D	N/D	N/D	N/D
AHDB 9864	N/D	N/D	N/D	N/D	N/D
AHDB9994	N/D	N/D	N/D	N/D	N/D
AHDB9900	N/D	N/D	N/D	N/D	N/D

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+2	Untreated			A
3	Kerb Flo Stomp Aqua	1200 g/ha 1160 g/ha	3.0 L/ha 2.9 L/ha	A
4	Kerb Flo Stomp Aqua AHDB 9987	1200 g/ha 1319.5 g/ha 1200 g/ha	3.0 L/ha 2.9 L/ha 2.0 L/ha	A
5	Lector Wing-P	5 g/ha 743.73 as/ha	0.1 L/ha 3.5 L/ha	A
6	Lector Wing-P Centium 360 CS	5 g/ha 743.73 g/ha 90 g/ha	0.1 L/ha 3.5 L/ha 0.25 L/ha	A
7	Butryflow Stomp Aqua	401.58 g/ha 1160 g/ha	1.0 L/ha 2.9 L/ha	A
8	Butryflow Stomp Aqua AHDB 9987	401.58 g/ha 1319.5 g/ha 1200 g/ha	1.0 L/ha 2.9 L/ha 2.0 L/ha	A
9	AHDB 9921	3.125 g/ha 2.5 g/ha	0.5 L/ha	A
10	AHDB 9865	18.762 g/ha 3.763 g/ha	0.265 kg/ha	A
11	AHDB 9864	1600 g/ha	4.0 L/ha	A
12	AHDB 9994	1050 g/ha	1.75 L/ha	A
13	AHDB 9900 rate 1	12 g/ha	0.06 L/ha	A
14	AHDB 9900 rate 2	20 g/ha	0.1 L/ha	A
15	AHDB 9900 rate 2 inter-row	20 g/ha	0.1 L/ha	A

Application details

	Application A
Application date	19/03/2019
Time of day	14:40
Crop growth stage (Max, min average BBCH)	Post-flowering BBCH 69
Crop height (cm)	45
Crop coverage (%)	65
Application Method	Spray
Application Placement	Soil
Application equipment	Oxford precision sprayer
Nozzle pressure	1.9
Nozzle type	Flat fan
Nozzle size	02F110
Application water volume/ha	200
Temperature of air - shade (°C)	15.15
Relative humidity (%)	75.65
Wind speed range (m/s)	3.85
Dew presence (Y/N)	N
Temperature of soil - 2-5 cm (°C)	11.1
Wetness of soil - 2-5 cm	Damp
Cloud cover (%)	85

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

Common name	Scientific Name	EPPO Code	Infestation level pre-application	Infestation level at start of assessment period	Infestation level at end of assessment period
Broad leaved weeds and grasses	*N/A*	3WEEDT	23 weeds per m^2	76 weeds per m^2	88.6 weeds per m^2

Assessment details

Evaluation date	Evaluation timing (DA)*	Crop Growth Stage (BBCH)	Evaluation type (efficacy, phytotox)	Assessment
02/04/2019	14	69 End of flowering	efficacy, phyto	Phytotoxicity (scale 0-10; 10 = dead), percentage of weed cover (whole plot score) and

				weed species count per 3 quadrats.
16/04/2019	28	79 Start of seed head formation	efficacy, phyto	Phytotoxicity (scale 0-10; 10 = dead), percentage of weed cover (whole plot score).
02/05/2019	44	92 Beginning of senescence	efficacy, phyto	Phytotoxicity (scale 0-10; 10 = dead), weed species counts per 3 quadrats).
29/05/2019	71	93 Continued senescence	efficacy, phyto	Phytotoxicity (scale 0-10; 10 = dead), percentage of weed cover (whole plot score) and weed species count per 3 quadrats.

* DA – days after application

Statistical analysis

The trial design was a fully randomised block design, with three replicates of fifteen treatments including two untreated controls.

The percentage reduction in weed control was calculated from the back transformed means. As the distribution of weeds was uneven across each trial—which is not unexpected in field situations—there was a need to transform the data prior to analysis. To determine treatment efficacy, an angular transformation was performed then the back transformed means presented, from which the % reduction in weeds was calculated using Abbotts formula.

All data was analysed by ANOVA using Genstat (18th edition) by Chris Dyer at RSK ADAS UK Ltd.

Results

Phytotoxicity

The results of phytotoxicity assessments from four dates are presented in **Table 1**, these were scored on a scale from 0 to 10, with 0 being 'no effect', and 10 being 'dead'. Plots scored 2 or less were deemed to have a commercially acceptable level of damage.

Phytotoxicity was recorded using the following scale:

Crop tolerance score	(% phytotoxicity) Equivalent to crop damage
0	*(no damage)* 0%
1	10%
***2**	20%
3	30%
4	40%
5	50%
6	60%
7	70%
8	80%
9	90%
10	*(complete crop kill)* 100%

All treatments with the exception of AHDB 9921, did not have significantly greater phytotoxicity scores compared to the untreated control at four weeks after application. The crop effect caused by AHDB 9921 was a marked wilting and collapse of the narcissus foliage.

The untreated control was not scored as zero as the plots were blind scored, and the yellow flecking from the hot water treatment was scored as a crop effect. Therefore any treatments which have a score of three or under are deemed safe as this is equivalent to the control plots.

At 10 weeks after treatment application the untreated score rises to 4.5 as the narcissus had started to senesce.

At six weeks after application, further significant crop effects are observed on plots treated with tank-mixes containing Butryflow, or products AHDB 9994 or AHDB 9900. These effects are exhibited as early senescence or drooping, with associated yellowing. The wilting symptoms in plots treated with AHDB 9921 also persisted.

By ten weeks after application, further senescence of the narcissus crop confounded crop scores, but three treatments were not significantly different to the untreated controls and had an equivalent or lower crop effect score. These were; Wing-P 3.5 L/ha + Lector 0.1 L/ha, Wing-P 3.5 L/ha + Lector 0.1 L/ha + Centium 0.25 L/ha, or AHDB 9865.

Table 1. Mean phytotoxicity scores at two, four, six and ten weeks after the final assessment. WAA = weeks after application

		Mean Phytotoxicity scores (0-10)			
	Date	**02-Apr 2 WAA**	**16-Apr 4 WAA**	**01-May 6 WAA**	**29-May 10 WAA**
Treat no	Treatment				
1+ 2	Untreated control	0.4	3.0	3.0	4.5
3	Kerb 3.0 L/ha + Stomp Aqua 2.9 L/ha	2.8	2.3	3.0	6.5
4	Kerb 3.0 L/ha + Stomp Aqua 2.9 L/ha + AHDB 9987	3.5	2.0	4.0	5.8
5	Wing-P 3.5 L/ha + Lector 0.1 L/ha	2.3	2.3	4.3	4.8
6	Wing-P 3.5 L/ha + Lector 0.1 L/ha + Centium 0.25 L/ha	2.8	2.8	3.0	4.0
7	Butryflow 1.0 L/ha + Stomp Aqua 2.9 L/ha	2.8	2.3	5.5	6.5
8	Butryflow 1.0 L/ha + Stomp Aqua 2.9 L/ha + AHDB 9987	3.8	3.8	6.0	5.3
9	AHDB 9921	9.0	8.5	8.3	7.3
10	AHDB 9865	2.8	2.5	3.3	3.8
11	AHDB 9864	4.0	2.3	3.0	6.3
12	AHDB 9994	2.8	1.5	4.8	7.8
13	AHDB 9900 lower rate	4.5	3.0	5.0	6.3
14	AHDB 9900 label rate	3.8	2.3	5.3	7.3
15	AHDB 9900 inter-row	4.5	2.0	3.3	5.8
P-value		<0.001	<0.001	<0.001	<0.001
d.f		43	43	43	43
L.S.D		1.512	1.502	1.39	1.263
	Not significantly different from untreated control				
	Significantly different from untreated control				

Efficacy

Total weed cover

The results for the mean percentage weed cover and percentage of weed cover by Abbotts reduction are presented in **Table 2**. Results are given for two and ten weeks after treatment application.

Table 2. Mean percentage of weed cover values (back transformed means) and the Abbotts reduction percentage at two and ten weeks after the final treatment. WAA = weeks after application

		Mean weed cover (%)		Abbots reduction (%)	
	Date	**02-Apr 2 WAA**	**29-May 10 WAA**	**02-Apr 2 WAA**	**29-May 10 WAA**
Treat no					
1+2	Untreated control	61.12	82.62		
3	Kerb 3.0 L/ha + Stomp Aqua 2.9 L/ha	54.25	55.00	11.24	33.43
4	Kerb 3.0 L/ha + Stomp Aqua 2.9 L/ha + AHDB 9987	61.00	47.50	0.20	42.51
5	Wing-P 3.5 L/ha + Lector 0.1 L/ha	48.50	16.25	20.65	80.33
6	Wing-P 3.5 L/ha + Lector 0.1 L/ha + Centium 0.25 L/ha	56.00	21.25	8.38	74.28
7	Butryflow 1.0 L/ha + Stomp Aqua 2.9 L/ha	37.50	65.00	38.65	21.33
8	Butryflow 1.0 L/ha + Stomp Aqua 2.9 L/ha + AHDB 9987	41.75	50.00	31.69	39.48
9	AHDB 9921	42.50	31.25	30.46	62.18
10	AHDB 9865	51.75	25.75	15.33	68.83
11	AHDB 9864	57.00	56.25	6.74	31.92
12	AHDB 9994	50.75	38.00	16.97	54.01
13	AHDB 9900 lower rate	40.50	16.75	33.74	79.73
14	AHDB 9900 label rate	41.75	5.75	31.69	93.04
15	AHDB 9900 inter-row	41.75	8.25	31.69	90.01
	p-value	0.18	<0.001		
	d.f.	43	43		
	L.S.D	20.66	28.08		
		Not significantly different from untreated control (p>0.05)			
		Significantly different from untreated control (p<0.05)			

Ten treatments had significantly lower percentage weed cover than the untreated control plots at ten weeks after application, reducing weed by at least 40% (**Table 2 and Figure 1**). The best performing treatments contained product AHDB 9900 applied at label rate over the row or inter-row with an average of 5.75% and 8.25% weed cover respectively at ten weeks after the final treatment application. Both treatments eliminated shepherds purse by the final assessment. Treatments containing Wing-P 3.5 L/ha + Lector 0.1 L/ha also performed well reducing the percentage weed cover by at least 75% to just 16.25 to 21.25% mean weed cover per plot.

In addition to significantly reducing weed cover compared to the untreated control, treatments including AHDB 9900, AHDB 9865 and Wing-P + Lector also gave a significantly greater reduction in percentage weed cover than the standard, Kerb Flo 3.0 L/ha + Stomp Aqua 2.9 L/ha.

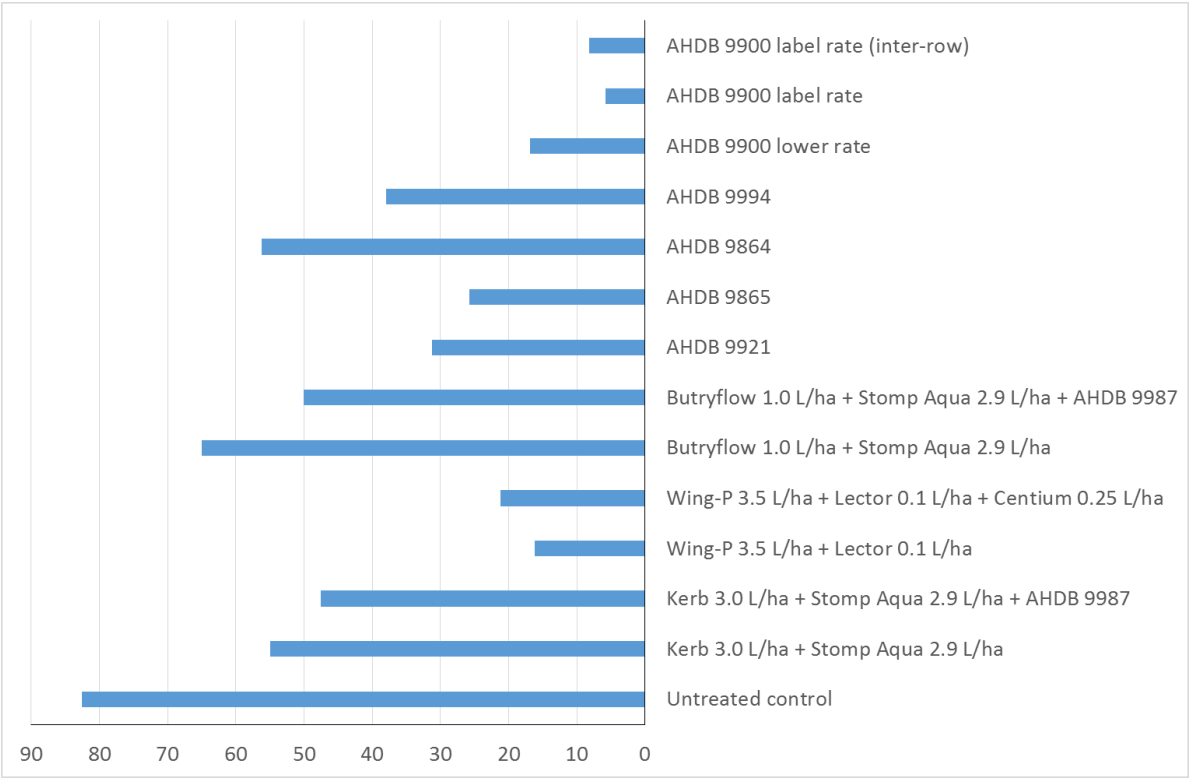


Figure 1. Mean percentage of weed cover values (back transformed means) at ten weeks after the final treatment. F pr. <0.001, L.S.D = 28.08.

Total weed counts

Overall weed counts were completed at two, six and ten weeks after treatment application and results from these are presented in **Table 3**. As the distribution of weeds was uneven across each trial—which is not unexpected in field situations—there was a need to transform this data prior to analysis. To determine treatment efficacy, an angular transformation was performed then the back transformed means presented, from which the % reduction in weeds was calculated using Abbotts formula.

All treatments significantly reduced weed numbers compared to the untreated control at six and ten weeks after application. There is a fluctuation in the numbers of weeds in the untreated control as the trial progresses, this is because the quadrats were placed at random, and may have covered a different area of the plot between assessments. However, in all the treated plots, the weed numbers are significantly and consistently lower than the untreated and therefore this can be attributed to treatment effects.

In these assessments Kerb Flo + Stomp Aqua reduced weed numbers greater than Wing-P and Lector at six and ten weeks after application. This is the opposite result to the % weed cover assessment results. Therefore, although Wing-P + Lector didn't reduce weed numbers as much as the standard, those weeds which remained were smaller in size and covered less area of the plot.

Weed species present were mainly shepherds purse and willowherb, with some mayweed, sowthistle and volunteer potatoes.

Table 3. Mean percentage of weed count values and the Abbotts reduction percentage at two and ten weeks after the final treatment. WAA = weeks after application

		Mean weed count per m^2 – all weeds			Abbots reduction (%)		
	Date	02-Apr 2 WAA	2-May 6 WAA	29-May 10 WAA	02-Apr 2 WAA	2-May 6 WAA	29-May 10 WAA
Treat no	Treatment						
1+2	Untreated control	98.67	76.00	88.64			
3	Kerb 3.0 L/ha + Stomp Aqua 2.9 L/ha	90.67	52.00	38.67	8.11	31.58	56.37
4	Kerb 3.0 L/ha + Stomp Aqua 2.9 L/ha + AHDB 9987	96.00	52.00	28.00	2.71	31.58	68.41
5	Wing-P 3.5 L/ha + Lector 0.1 L/ha	90.67	34.67	49.33	8.11	54.38	44.35
6	Wing-P 3.5 L/ha + Lector 0.1 L/ha + Centium 0.25 L/ha	74.67	25.33	42.67	24.32	66.67	51.86
7	Butryflow 1.0 L/ha + Stomp Aqua 2.9 L/ha	69.33	45.33	37.33	29.74	40.36	57.89
8	Butryflow 1.0 L/ha + Stomp Aqua 2.9 L/ha + AHDB 9987	69.33	50.67	28.00	29.74	33.33	68.41
9	AHDB 9921	74.67	34.67	58.67	24.32	54.38	33.81
10	AHDB 9865	69.33	44.00	44.00	29.74	42.11	50.36
11	AHDB 9864	112.00	52.00	50.67	-13.51	31.58	42.84
12	AHDB 9994	48.00	33.33	37.33	51.35	56.14	57.89
13	AHDB 9900 lower rate	58.67	28.00	34.67	40.54	63.16	60.89
14	AHDB 9900 label rate	90.67	21.33	52.00	8.11	71.93	41.34
15	AHDB 9900 inter-row	42.67	28.00	34.67	56.75	63.16	60.89
	p-value	<0.001	<0.001	<0.001			
	d.f.	43	43	43			
	L.S.D	11.475	16.283	16.881			
		Not significantly different from untreated control (p>0.05)					
		Significantly different from untreated control (p<0.05)					

Weed species counts

All treatments significantly reduced shepherds purse at ten weeks after application (**Table 4**) with treatments containing AHDB 9900, AHDB 9994, AHDB 9865, AHDB 9921, AHDB 9987 or Wing-P + Lector eliminating this weed species completely. The level of weed in the plots treated with Kerb Flo and Stomp Aqua reduces dramatically between the six week and the ten week assessments, this may have been due to greater soil moisture after an increase in rainfall later in May increasing the activity of these residual herbicides.

Only five treatments significantly reduced the level of willowherb in the plots at ten weeks after application, these were those where Kerb Flo + Stomp Aqua were included, Butryflow + Stomp Aqua + AHDB9987 or AHDB 9900. AHDB 9994 reduced willowherb numbers for up to six weeks, but did not have the longevity of control of the best performing treatments and at ten weeks after application no longer offered significant control.

Table 1. Mean willow herb and shepherds purse counts at six and ten weeks after the final treatment application. WAA = weeks after application.

		Mean weed count per m^2			
		Willowherb		Shepherds purse	
Treat no	Treatment	2-May 6 WAA	29-May 10 WAA	2-May 6 WAA	29-May 10 WAA
1	Untreated control	24.64	13.33	31.36	29.33
3	Kerb 3.0 L/ha + Stomp Aqua 2.9 L/ha	2.67	0.00	32.00	8.00
4	Kerb 3.0 L/ha + Stomp Aqua 2.9 L/ha + AHDB 9987	0.00	1.33	34.67	0.00
5	Wing-P 3.5 L/ha + Lector 0.1 L/ha	16.00	36.00	0.00	0.00
6	Wing-P 3.5 L/ha + Lector 0.1 L/ha + Centium 0.25 L/ha	10.67	33.33	4.00	0.00
7	Butryflow 1.0 L/ha + Stomp Aqua 2.9 L/ha	16.00	9.33	5.33	10.67
8	Butryflow 1.0 L/ha + Stomp Aqua 2.9 L/ha + AHDB 9987	26.67	0.00	1.33	0.00
9	AHDB 9921	10.67	32.00	0.00	0.00
10	AHDB 9865	12.00	12.00	4.00	0.00
11	AHDB 9864	16.00	17.33	20.00	12.00
12	AHDB 9994	2.67	17.33	5.33	0.00
13	AHDB 9900 lower rate	0.00	1.33	1.33	0.00
14	AHDB 9900 label rate	0.00	0.00	0.00	0.00
15	AHDB 9900 inter-row	2.67	16.00	2.67	0.00
	p-value	<0.001	<0.001	<0.001	<0.001
	d.f	43	43	43	43
	L.S.D	14.261	10.475	9.968	4.654
	Not significantly different from control (p>0.05)				
	Significantly different from control (p>0.05)				

Discussion

Wing-P 3.5 L/ha + Lector 0.1 L/ha, AHDB 9865, or AHDB 9900 applied inter-row combine effective weed control with being safe to apply over narcissus at a post-cropping timing, causing no adverse effects to foliage in the year of application or to flowers in the following spring. AHDB 9864 was safe to use over the narcissus but did not give significant control of the weed species in the trial. It was included for its activity on groundsel, but levels of groundsel in the trial were low. However, useful information on crop safety has been obtained for this product.

Ten treatments had significantly lower percentage weed cover than the untreated control plots at ten weeks after application, reducing weed by at least 40%. The best performing treatments contained product AHDB 9900 applied at label rate over the row or inter-row with an average of 5.75% and 8.25% weed cover respectively at ten weeks after the final treatment application. Whether applied over the row or inter-row, AHDB 9900 eliminated shepherds purse by the final assessment. Treatments containing Wing-P 3.5 L/ha + Lector 0.1 L/ha also performed well reducing the percentage weed cover by at least 75% to just 16.25 to 21.25% mean weed cover per plot.

Although AHDB 9900, AHDB 9994 and AHDB 9921 significantly reduced the percentage mean weed cover, they also caused adverse effects to the crop, and therefore may not be safe to use at this timing. AHDB 9921 caused the crop to lose turgor and collapse dramatically at two weeks after application. While AHDB 9994, AHDB 9900, and plots where Butryflow was applied caused the crop to senesce earlier than the untreated control. Despite the crop collapse, or early senescence, bud emergence or flower quality was unaffected in the following year after

treatment. However, long term effects of the early senescence are unknown, and other products in the trial were as effective as well as safe over the crop so would be better choices. An alternative approach would be to apply products such as AHDB 9994 or AHDB 9900 between the rows only.

In addition to significantly reducing weed cover compared to the untreated control, treatments including AHDB 9900, AHDB 9865 and Wing-P + Lector also gave a significantly greater reduction in percentage weed cover than the standard, Kerb Flo 3.0 L/ha + Stomp Aqua 2.9 L/ha. But, it should be noted that Kerb Flo was one of the few products to control willowherb in the trials.

Conclusions

- Wing-P 3.5 L/ha + Lector 0.1 L/ha, AHDB 9865, or AHDB 9900 applied inter-row combine effective weed control with being safe to apply over narcissus at a post-cropping timing,
- Ten treatments had significantly lower percentage weed cover than the untreated control plots for up to ten weeks after application, reducing weed by at least 40%, but those containing AHDB 9900, AHDB 9994 or Butryflow caused the crop to senesce earlier than the untreated plots, or the commercial standard.
- AHDB 9900 is a promising product for post-cropping weed control in narcissus and was the most effective at reducing total percentage of weed cover. But it did cause the crop to senesce earlier and would be safer to apply between the rows.
- AHDB 9921 is not safe to use over narcissus.

Acknowledgements

AHDB for funding the work, and also the crop protection companies for their financial contributions as well as providing samples for the trials. Thanks should also be given to Greenyard Flowers who provided sites and crops for the trials as well as Simon Gardner, Sylvie Pearson and Andrew Richards for technical input.

Appendix

a. Crop diary – events related to growing crop

Crop	**Cultivar**	**Planting date**	**Row width** (m)
Narcissus	Lowan	Autumn 2018	1 m

Previous cropping

Year	**Crop**
2018	Potatoes
2017	N/K
2016	N/K

Cultivations

Date	**Description**
	None as the crop is perennial and not cultivated once ridged

Active ingredients(s)/fertiliser(s) applied to trial area

Date	**Product**	**Rate** (kg/ha)
	N/K	

Pesticides applied to trial area

Date	**Product**	**Rate** (L/ha)
November 2019	Sencorex	0.25 L/ha
	Stomp	2.9 L/ha
	Roundup	3.0 L/ha

b. Table showing sequence of events by date – this relates to treatments and assessments.

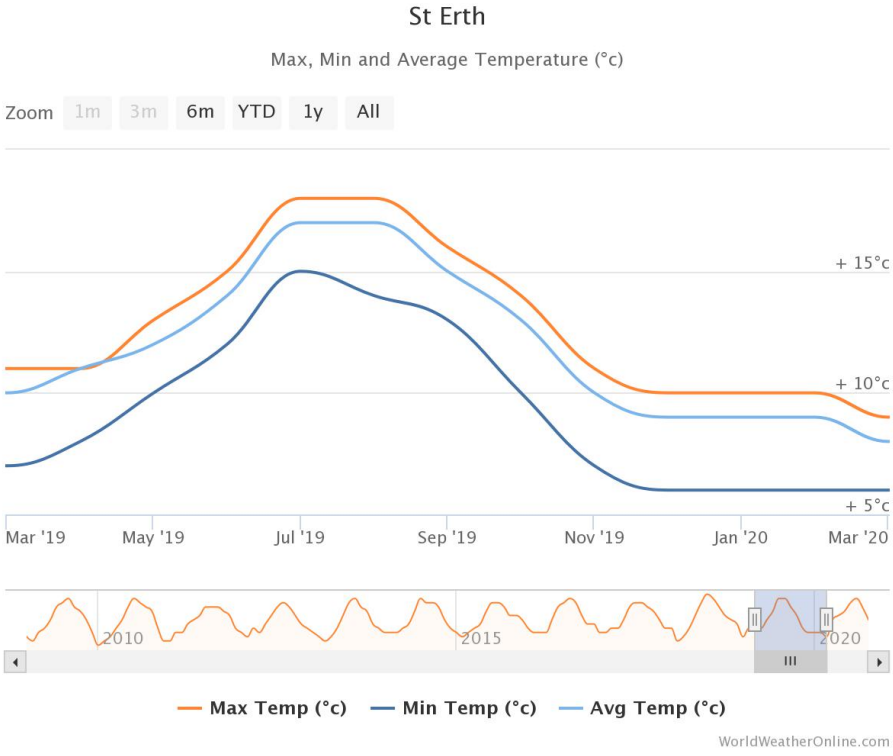
Date	**Event**
12/03/2019	Trial area marked out.
19/03//2019	Baseline weed count assessment completed
02/04/2019	Assessment, two weeks after treatment (phyto/ % weed cover and counts).
16/04/2019	Assessment, four weeks after treatment (phyto).
02/05/2019	Assessment, six weeks after treatment (phyto/weed counts).
29/05/2019	Assessment, ten weeks after treatment (phyto/ % weed cover and counts).
30/01/2020	Assessment, flower quality

c. Photographs.

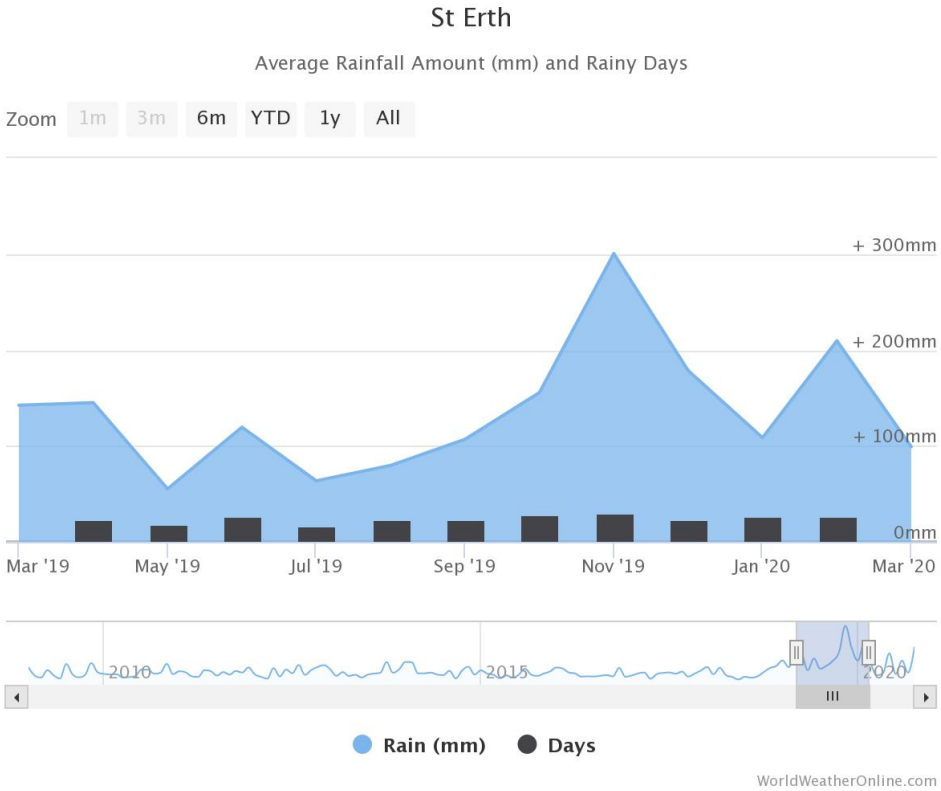
<table>
<tr><td>  </td><td>  </td><td>  </td></tr>
<tr><td>Untreated control</td><td>Kerb 3.0 L/ha + Stomp Aqua 2.9 L/ha</td><td>Wing-P 3.5 L/ha + Lector 0.1 L/ha + Centium 0.25 L/ha</td></tr>
<tr><td>  </td><td colspan="2">  </td></tr>
<tr><td>AHDB 9900 label rate</td><td colspan="2">Loss of turgor, wilting and collapsed foliage at 2 weeks after application in plot treated with AHDB 9921</td></tr>
</table>

d. Climatological data during study period – Weather taken from World Weather Online due to loss of USB logger - https://www.worldweatheronline.com/' title='Historical average weather'> Data provided by WorldWeatherOnline.com

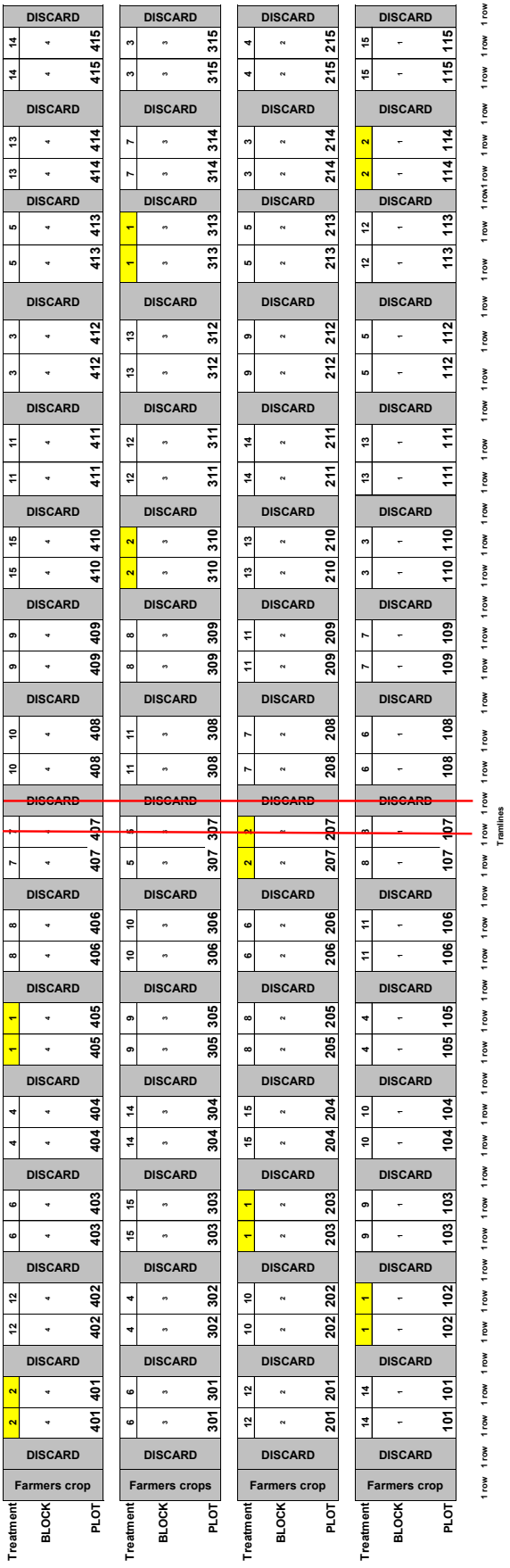
Max, Min and Average temperature through the trial period



Rainfall through the trial period



e. Trial design



f. ORETO certificate.

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
Stored Crops
Biologicals and Semiochemicals

Date of issue: 1 June 2018
Effective date: 18 March 2018
Expiry date: 17 March 2023

Signature Alison Richardson
Authorised signatory

Certification Number
ORETO 409

HSE
Chemicals Regulation Division

Department of Agriculture and Rural Development