SCEPTREPLUS

Final Trial Report

Trial code:	SP30. 2019
Title:	AHDB SCEPTREplus Weed control in cut-flower production
Crop	Gladioli
Target	General broadleaf weeds and grasses, 3WEEDT
Lead researcher:	Chloe Whiteside
Organisation:	RSK ADAS Ltd, ADAS Boxworth, Cambridgeshire, CB23 4NN
Period:	June 2019 to September 2019
Report date:	06 December 2019
Report author:	Chloe Whiteside
ORETO Number: (certificate should be attached)	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

24th March 2020

Date

……

Authors signature

Trial Summary

Introduction

The demand for UK grown cut-flowers is rising, yet the lack of technical information for the wide diversity of traditional and novel species being grown is a major limiting factor behind the expansion of this sector. Included in this is the shortfall of information on herbicides. There are virtually no specific label approvals for the use of herbicides in cut-flower production, and the range of species grown and their differing sensitivities to herbicides further complicates agronomy.

The loss of linuron for residual weed control is of industry concern. Linuron was used principally in bulb cut-flower crops such as Narcissus and Gladioli and herbaceous perennials of Peony. Gladioli are an important cut-flower crop but have not been subject to a herbicide screen for many years, hence why they have been tested in 2019. Outdoor crops of gladioli are usually treated with herbicides selected from the range used on bulb crops. However, products such as Wing-P and Sunfire have been tested on other cut-flower crops, and have an EAMU for use in outdoor ornamentals, so it is worth examining those for crop safety, along with some new potentially promising coded products.

Methods

A trial was sited at a commercial cut-flower grower in Kings Lynn. Gladioli corms were planted on 24th May 2019, and treatments were applied to the soil just prior to crop emergence on the 5th June 2019. Trial plots were 1.2 m wide and 3.0 m long. Treatments were applied using an Oxford Precision Sprayer with a 1.8 m long boom fitted with 02f110 nozzles, in a water volume of 200 L/ha.

A randomised block design was used with 10 treatments including an untreated control replicated three times, totalling 30 plots. Plots were assessed for weed cover on four occasions, recording the number of weeds per plot and the species per plot. Crop damage was also assessed at two, six and 10 weeks after treatment application. Once the crop was ready to harvest in September 2019, 10 stems per plot were cut, weighed, and checked for any damage or bleaching to the flowers.

Results

Crop emergence was approximately 10 days post-treatment application, and there were no delays in emergence caused by any of the treatments in comparison to the untreated. In addition, there was no evidence of crop damage or phytotoxicity caused by any of the herbicide treatments throughout the trial period. There was no observable treatment effect on flower development or colour, and no significant effect on stem weight.

Weed control was well maintained by the majority of the treatments, and after 10 weeks, eight of the treatments had significantly less weeds than the untreated control.

Treatment	19 June 2WAT*		17 July 6WAT		14 August 10WAT	
	Mean number	Abbott's	Mean number	Abbott's	Mean number	Abbott's
Untreated	4.4		24.0		27.3	
AHDB9974	1.5	65.69	8.4	64.82	8.8	67.74
AHDB9994	0.3	94.13	5.6	76.66	7.3	73.20
Sencorex Flow	0.3	94.13	1.0	95.83	1.0	96.34
Wing-P	1.6	63.43	1.9	92.16	2.0	92.53
Sunfire	5.6	-26.41	12.4	48.52	13.5	50.49
AHDB9987	2.6	42.21	5.2	78.28	8.4	69.10
Springbok	3.5	21.44	6.9	71.40	7.3	73.34
AHDB9900 0.06 L/ha	5.6	-26.41	10.6	55.81	11.0	59.83
AHDB9900 0.1 L/ha	3.4	23.70	7.4	69.11	8.0	70.85
P value	<.001		<.001		<.001	

d.f.	18		18		18	
s.e.d.	0.1457		0.1625		0.1486	
l.s.d.	0.3060		0.3414		0.3122	
	Not significantly different from untreated control (p>0.05)					
	Significantly different from untreated control (p<0.05)					
	Positive Abbott's formula percentage reduction					

*WAT = weeks after treatment

Conclusions

- In this trial, all treatments appeared to be crop safe when applied to the soil just prior to crop emergence, and did not have any negative effect on emergence, foliage colour, flower colour or yield.
- After 10 weeks, weed control was still significantly controlled in eight of the experimental treatments.
- Although weed numbers were not significantly reduced in the plots treated with Sunfire, it must be noted that this product is predominantly for grass control, and the weeds noted in these plots were broad-leaved weeds. However it is encouraging that no crop damage was observed from this product.
- AHDB9974 is currently approved for use on outdoor bulbs and approval for use on other ornamental crops is currently being investigated.

Take home message

Sencorex Flow, Wing-P and Springbok are all worth considering as pre-emergence residual herbicides on gladioli. Sunfire can also be considered but would need to be tank-mixed with another product to ensure both broad-leaved weed and grass control was achieved. Tank mixes were not tested in this trial, any tank mix would be at the growers own risk.

Objectives

1. To evaluate the effectiveness of nine herbicide treatments, applied just prior to crop emergence, for the control of broadleaved weeds and grasses in gladioli as measured by weed control efficacy.
2. To monitor the treated crop for phytotoxicity.
3. To assess any impact on yield and flowering.

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(4)	Design and analysis of efficacy evaluation trials	None
PP 1/135(4)	Phytotoxicity assessment	None
PP 1/181(3)	Conduct and reporting of efficacy evaluation trials including good experimental practice	None
PP 1/088(3)	Weeds in flower bulbs and flower tubers	One (see below)

There was one deviation from EPPO guidance:

PP1/088(3) Section 1.4, Design and lay-out of the trial:

"Replicates: at least 4"

Study only had 3 replicates – the larger number of treatments provides an acceptable number of residual degrees of freedom.

Test site

Item	**Details**
Location address	Belmont Nursery, Clenchwarton Road, Kings Lynn 52.74457, 0381173
Crop	Gladioli
Cultivar	
Soil or substrate type	Sandy clay loam
Agronomic practice	See appendix
Prior history of site	See appendix

Trial design

Item	**Details**
Trial design:	Fully randomised block
Number of replicates:	3
Row spacing:	0.2 m
Plot size: (w x l)	1.2 m x 3 m
Plot size: (m^2)	3.6
Number of plants per plot:	Approx. 120
Leaf Wall Area calculations	N/A

Treatment details

AHDB Code	Active substance	Product name/ manufacturers code	Formulation batch number	Content of active substance in product	Formulation type	Adjuvant
Untreated	N/A	N/A	N/A	N/A	N/A	N/A
AHDB9974	N/A	N/A	N/A	N/A	N/A	N/A
AHDB9994	N/A	N/A	N/A	N/A	N/A	N/A
N/A	metribuzin	Sencorex Flow	EM4H002443	600	Suspension Concentrate	N/A
N/A	pendimethalin + dimethenamid-P	Wing P	0014243535	250 + 212.5	Emulsifiable Concentrate	N/A
N/A	flufenacet	Sunfire	321969	500	Suspension Concentrate	N/A
AHDB9987	N/A	N/A	N/A	N/A	N/A	N/A
N/A	dimethenamid-P & metazachlor	Springbok	BAS76900H	200 + 200	Emulsifiable Concentrate	N/A
AHDB9900	N/A	N/A	N/A	N/A	N/A	N/A

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	Untreated	N/A	N/A	A
2	AHDB9974	1000	2.0	A
3	AHDB9994	1050	1.75	A
4	Sencorex Flow	450	0.75	A
5	Wing-P	875 + 743.75	3.5	A
6	Sunfire	240	0.48	A
7	AHDB9987	1200	2.0	A
8	Springbok	500 + 500	2.5	A
9	AHDB9900	30	0.06	A
10	AHDB9900	50	0.1	A

Application details

	Application A
Application date	05/06/2019
Time of day	09:30
Crop growth stage (Max, min average BBCH)	N/A (pre-emergence)
Crop height (cm)	N/A
Crop coverage (%)	N/A
Application Method	Spray
Application Placement	Onto soil
Application equipment	Oxford Precision Sprayer (knapsack)
Nozzle pressure	2 bar
Nozzle type	Flat fan
Nozzle size	02f110
Application water volume/ha	200 L/ha
Temperature of air - shade (°C)	15.8
Relative humidity (%)	77.0
Wind speed range (m/s)	0.9 – 1.2

Dew presence (Y/N)	N
Temperature of soil - 2-5 cm (°C)	12.4
Wetness of soil - 2-5 cm	Dry
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	3.3 total count *(untreated average)*	3.3 total count *(untreated average)*	27.3 total count *(untreated average)*

Assessment details

One herbicide application was planned just prior to crop emergence on a newly planted crop of gladioli (planted 24th May 2019). An initial weed assessment was carried out in all plots, with the total weed cover and weed species present in each plot being recorded before the herbicide treatments were applied. At each subsequent assessment date these criteria were recorded as well as a phytotoxicity score from 0 to 10, with 0 being 'no damage' and 10 being 'dead' (**Table 1**). Plots scoring 2 or below were deemed to have commercially acceptable level of damage. A sub-sample of plants were assessed for yield and observations were made on the quality of the flowers at the end of the trial in September 2019.

	Evaluation Timing (DA)*				
Evaluation date	**After conventional herbicides**	**After Bio-herbicides**	**Crop Growth Stage (BBCH)**	**Evaluation type (efficacy, phytotox)**	**Assessment**
03/06/19	-2	N/A	PRE-EM	Efficacy	Total number of weeds per plot
19/06/19	+14	N/A		Efficacy and phytotox	Total number of weeds per plot Phytotox (scale 0-10, 10 = dead)
17/07/19	+42	N/A		Efficacy and phytotox	Total number of weeds per plot Phytotox (scale 0-10, 10 = dead)
14/08/19	+70	N/A		Efficacy and phytotox	Total number of weeds per plot Phytotox (scale 0-10, 10 = dead)
10/09/19	+97	N/A		Yield	Weight of 10 flowering stems per plot recorded

* DA – days after application

Phytotoxicity was recorded using the following scale:

Table 1. Scale used to assess the extent of phytotoxic damage in treated plots

Crop tolerance score	Equivalent to crop damage (% phytotoxicity)
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%

* ≤ 2 = acceptable damage, i.e. damage unlikely to reduce yield and acceptable to the grower.

Statistical analysis

The trial design was a randomised block design with three replicates of 10 treatments, including an untreated control.

As the distribution of weeds was uneven across the trial – which is not unexpected in field situations – there was a need to transform these variables prior to analysis; an angular transformation was used.

All data were analysed by ANOVA using Genstat 18.4 by Chris Dyer at RSK ADAS. *Post hoc* analyses were performed on the data using Duncan's multiple range test. For the % efficacy data calculated by Abbotts formula, an angular transformation was carried out and then the back transformed means are presented, from which Abbotts Formula was used to calculate the % reduction in weeds.

Results

Phytotoxicity

Throughout the trial period, there was no evidence of crop damage or phytotoxicity caused by any of the herbicide treatments.

Crop emergence was approximately 10 days post-treatment application, and there were no delays in emergence caused by any of the treatments in comparison to the untreated. All plots emerged at the same time, and there was no evidence of foliar bleaching, stunting or crop death.

At each assessment date two, six and 10 week's post-application, there was no evidence of any phytotoxicity in any of the plots. The crop was growing well, there were no markings on the leaves, and foliage colour was the same as the commercial crop. Crop damage scores for all treatments was 0 at each assessment date.

In September, the trial had begun to flower, and stems could be harvested from the trial. There was no treatment effect on flower development or colour (**Appendix C**). There was also no significant effect on stem weight. Stems in the untreated plots weighed 87.6 g on average, the lightest stems were treated with Sencorex Flow and weighed 79.5 g on average. The greatest stem weight was 95.2 g, these plants were treated with AHDB9900 at 0.06 L/ha.

Efficacy

At the start of the trial the weed population was relatively low, with between 0.7 and 4.3 weeds per plot.

The overall weed cover in the majority of the treated plots was lower than the untreated control at the two week assessment. Of these treatments, both AHDB9994 and Sencorex Flow had significantly lower weed numbers than the untreated control ($p<.001$).

At the six week assessment, the weed cover was highest in the untreated, and all treatments apart from Sunfire and AHDB9900 at 0.06 L/ha were significantly lower than the untreated control ($p<.001$). Sencorex Flow was still giving the greatest level of weed control, closely followed by Wing-P.

At the final assessment 10 weeks post-treatment, all treatments apart from Sunfire gave significant weed control (p<.001) with the lowest number of weeds in the plots treated with Sencorex Flow (**Figure 1**).

Table 2 shows the mean number of weeds per plot at each assessment date, and the % reduction compared to the untreated control.

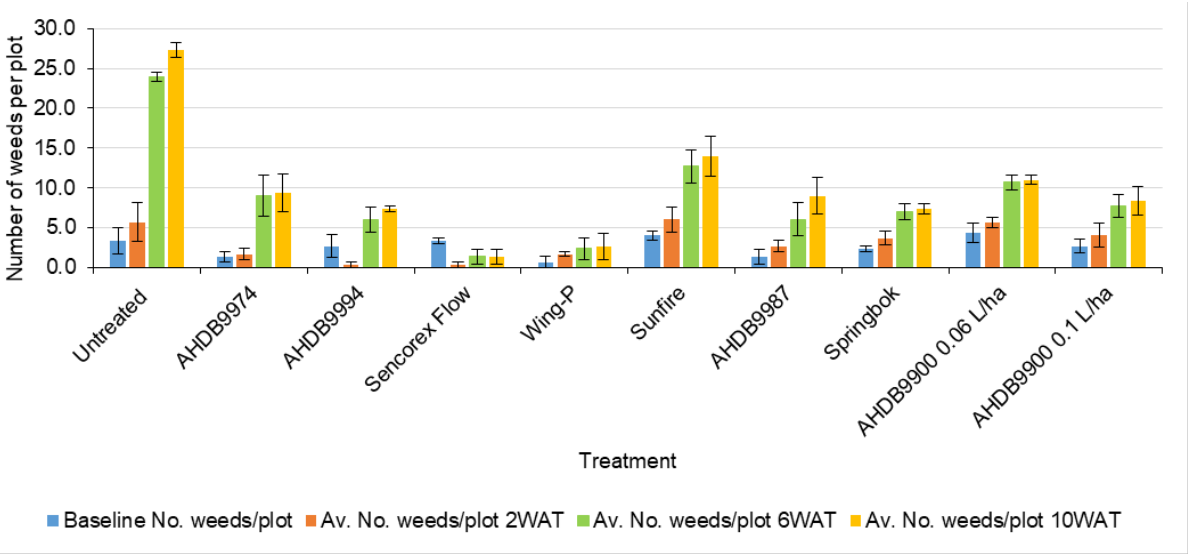

Figure 1: Mean number of weeds per plot at each assessment date.

Table 2. Mean number of weeds per plot at each assessment date.

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	Not significantly different from untreated control (p>0.05)					
	Significantly different from untreated control (p<0.05)					
	Positive Abbott's formula percentage reduction					

Discussion

In terms of crop safety and phytotoxicity, none of the treatments caused any adverse effect to the crop. At the rates used, none of the products caused delayed emergence, stunting, foliar bleaching or damage, or flower bleaching or damage. There was also no effect on stem weight and yield at the end of the trial. From a crop safety perspective, all treatments, including the experimental products, were successful.

At the start of the trial, weed distribution across the plots was relatively even. At the first assessment two weeks after application, only AHDB9994 and Sencorex Flow had significantly lower weeds per plot than the untreated control. Both these products appeared to have killed off the young weeds that were present at the pre-treatment assessment, as well as preventing any new weeds from germinating. Whilst Sencorex Flow is predominantly a residual herbicide, it does have some contact action, which explains the reduction in weeds at the start of the trial. AHDB9994 also has a little contact action on very small weeds, as its mode of action is to be absorbed through the hypocotyl and cotyledons.

At the second assessment six weeks after application, a number of products had significantly lower weeds per plot than the untreated control; AHDB9974, AHDB9994, Sencorex Flow, Wing-P, AHDB9987, Springbok and AHDB9900 0.1 L/ha. AHDB9974 is already approved for use on outdoor bulbs through an EAMU, so it is encouraging to see that this product gave effective weed control and did not cause any crop damage to the gladioli.

At the final assessment 10 weeks after application, all products apart from Sunfire had significantly lower weeds per plot than the untreated control. However, it should be noted that Sunfire primarily controls grasses and some broad-leaved weeds (chickweed, cleavers, field pansy, mayweeds and shepherd's purse). The weed species within the trial were; blackgrass, redshank, groundsel, fat hen, bindweed, smooth sowthistle, annual meadow grass and speedwell, so it is unsurprising that weed populations were higher in the Sunfire treated plots. Whilst tank mixes were not tested in this trial, Sunfire would generally be mixed with another product such as Sencorex Flow (at a low rate) to provide adequate weed control, although this is an off-label use at growers risk.

Overall, all treatments performed well, with no crop damage observed, and successful weed control. However these results are from one trial, on one soil type in one year, which was relatively dry. Sencorex Flow can leach and cause damage by root uptake to some plant species, especially on light soils and after heavy rainfall. For products which currently have an EAMU, growers are advised to test the product on a small area first prior to wide-scale use and adhere to the EAMU. Any use is at the growers own risk.

Conclusions

- In this trial, all treatments appeared to be crop safe when applied to the soil just prior to crop emergence, and did not have any negative effect on emergence, foliage colour, flower colour or yield.
- After 10 weeks, weed control was still significantly controlled in eight of the experimental treatments.
- Although weed numbers were not significantly reduced in the plots treated with Sunfire, it must be noted that this product is predominantly for grass control, and the weeds noted in these plots were broad-leaved weeds. However it is encouraging that no crop damage was observed from this product.
- AHDB9974 is currently approved for use on outdoor bulbs and approval for use on other ornamental crops is currently being investigated.

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 Mark Eves, the grower who provided the site and crop for the trial as well as technical input.

Appendix

a. Crop diary – events related to growing crop

b. Trial diary

Date	Event
24/05/2019	Crop planted. Trial marked out and routine soil sample collected. Weed levels assessed.
03/06/2019	Pre-treatment weed assessment completed.
05/06/2019	Spray treatments applied 2 weeks post planting. No crop emergence yet.
19/06/2019	2 week weed assessment and phytotoxicity completed.
17/07/2019	6 week weed assessment and phytotoxicity completed. No apparent phytotox present within the plots. The most predominant weeds within the plot are Redshank, Grasses, Groundsel, Bindweed and Fat Hen. There are quite a few redshank in the plots which have remained untouched by many of the herbicide treatments.
14/08/2019	10 week weed assessment and phytotoxicity completed.
10/09/2019	Crop is now in flower and commercial crop is being harvested. 10 stems from each plot harvested and weighed, photos taken of flowers within each plot.

c. Photographs

	
Untreated	AHDB9974 2.0 L/ha
	
AHDB9994 1.75 L/ha	Sencorex Flow 0.75 L/ha
	
Wing-P 3.5 L/ha	Sunfire 0.48 L/ha
	
AHDB9987 2.0 L/ha	Springbok 2.5 L/ha
	
AHDB9900 0.06 L/ha	AHDB9900 0.1 L/ha

d. Climatological data during study period

Date	Temperature °C (maximum)	Temperature °C (minimum)	Temperature °C (average)
24/05/2019	23.5	15.0	20.0
25/05/2019	23.5	8.5	15.7
26/05/2019	20.5	12.5	16.6
27/05/2019	17.5	8.0	12.5
28/05/2019	16.0	9.0	12.3
29/05/2019	18.5	6.5	12.1
30/05/2019	23.5	13.0	17.9
31/05/2019	21.5	10.0	17.1
01/06/2019	27.5	10.5	19.4
02/06/2019	27.5	15.5	21.3
03/06/2019	22.0	9.5	16.1
04/06/2019	20.5	7.0	13.7
05/06/2019	20.0	10.0	14.9
06/06/2019	22.0	10.5	16.2
07/06/2019	20.0	6.5	14.2
08/06/2019	13.0	11.0	12.0
09/06/2019	21.5	6.5	14.5
10/06/2019	13.5	11.0	11.7
11/06/2019	12.0	10.5	11.6
12/06/2019	15.5	11.0	12.3
13/06/2019	14.0	10.5	12.2
14/06/2019	20.0	11.5	15.0
15/06/2019	21.5	8.5	15.2
16/06/2019	21.5	8.5	15.5
17/06/2019	23.5	11.5	17.4
18/06/2019	22.0	9.0	15.7
19/06/2019	21.0	13.0	15.7
20/06/2019	20.0	12.0	15.9
21/06/2019	22.5	6.5	15.0
22/06/2019	24.0	9.5	16.5
23/06/2019	26.0	10.5	17.5
24/06/2019	29.0	17.0	22.6
25/06/2019	20.0	14.5	17.0
26/06/2019	17.0	13.0	14.5
27/06/2019	21.5	10.5	15.8
28/06/2019	24.0	12.5	17.3
29/06/2019	32.0	10.5	22.0
30/06/2019	26.0	15.0	20.6
01/07/2019	23.0	11.5	16.9
02/07/2019	22.0	10.5	16.9
03/07/2019	27.5	7.0	17.1
04/07/2019	29.0	6.0	18.4
05/07/2019	30.5	12.5	21.0
06/07/2019	19.0	11.5	15.6
07/07/2019	26.5	10.0	18.1
08/07/2019	23.5	12.0	16.6
09/07/2019	22.5	13.0	16.4
10/07/2019	25.0	15.0	19.7

Date	Temperature °C (maximum)	Temperature °C (minimum)	Temperature °C (average)
11/07/2019	26.5	15.5	20.5
12/07/2019	27.0	14.5	19.0
13/07/2019	25.5	14.5	18.2
14/07/2019	23.5	13.5	17.1
15/07/2019	27.5	12.5	17.6
16/07/2019	33.0	7.0	19.4
17/07/2019	33.0	13.5	22.6
18/07/2019	25.0	15.0	18.8
19/07/2019	20.0	8.5	15.4
20/07/2019	25.5	16.0	19.0
21/07/2019	24.5	9.5	17.8
22/07/2019	33.5	15.5	22.6
23/07/2019	40.5	13.0	25.4
24/07/2019	36.5	19.0	26.0
25/07/2019	41.0	16.5	27.9
26/07/2019	35.5	18.5	25.3
27/07/2019	19.0	15.5	17.3
28/07/2019	18.0	15.0	16.1
29/07/2019	29.5	13.0	19.7
30/07/2019	25.5	16.0	19.7
31/07/2019	19.5	15.0	16.7
01/08/2019	26.0	15.0	18.7
02/08/2019	25.0	15.0	19.6
03/08/2019	26.5	11.5	18.6
04/08/2019	26.0	12.5	19.5
05/08/2019	24.5	14.5	18.9
06/08/2019	23.5	12.5	17.4
07/08/2019	22.5	13.5	17.2
08/08/2019	25.5	11.5	18.0
09/08/2019	25.5	16.0	19.5
10/08/2019	21.5	15.5	17.8
11/08/2019	20.5	13.0	16.4
12/08/2019	20.0	11.0	14.7
13/08/2019	19.5	6.5	13.5
14/08/2019	18.5	8.5	13.4
15/08/2019	20.0	11.0	15.9
16/08/2019	18.5	8.5	13.5
17/08/2019	22.0	12.5	16.8
18/08/2019	20.5	13.0	15.9
19/08/2019	20.5	11.0	14.6
20/08/2019	19.0	8.0	13.3
21/08/2019	23.0	9.0	15.5
22/08/2019	23.0	11.0	16.8
23/08/2019	27.0	11.5	19.0
24/08/2019	27.0	10.0	18.6
25/08/2019	29.5	10.0	19.3
26/08/2019	30.5	11.0	20.4
27/08/2019	31.5	13.0	21.5
28/08/2019	27.5	15.0	20.0
29/08/2019	24.0	13.0	17.3

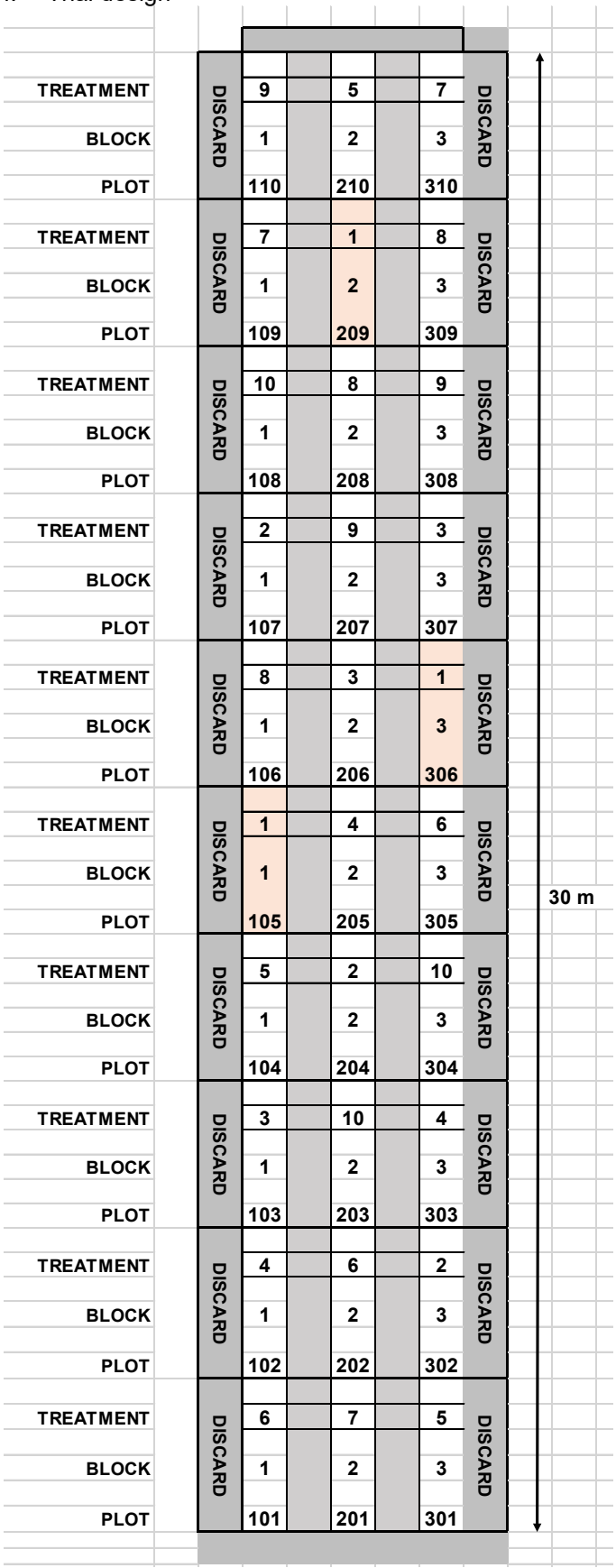
Date	Temperature °C (maximum)	Temperature °C (minimum)	Temperature °C (average)
30/08/2019	24.5	12.5	17.7
31/08/2019	25.0	12.0	17.0
01/09/2019	22.0	6.0	13.3
02/09/2019	23.5	6.5	14.4
03/09/2019	26.5	12.0	18.2
04/09/2019	19.0	13.0	16.0
05/09/2019	19.0	8.5	13.6
06/09/2019	15.5	8.0	11.5
07/09/2019	16.5	5.5	11.3
08/09/2019	17.5	6.5	11.8
09/09/2019	14.5	4.0	10.3
10/09/2019	18.5	9.0	13.0

e. Raw data from assessments

Plot number	Block	Treatment	Total weeds/plot 2WAT	Total weeds/plot 6WAT	Total weeds/plot 10WAT	Av weight per plant 14WAT
101	1	6	3	13	17	*
102	1	4	0	3	3	91.96
103	1	3	0	3	7	98.18
104	1	5	2	1	1	84.38
105	1	1	1	24	26	90.36
106	1	8	2	5	6	90.84
107	1	2	1	7	8	87.68
108	1	10	1	10	11	95.24
109	1	7	4	7	9	92.26
110	1	9	5	9	10	92.24
201	2	7	2	2	5	*
202	2	6	7	9	9	86.46
203	2	10	6	8	9	86.52
204	2	2	3	14	14	83.02
205	2	4	0	0	0	82.68
206	2	3	0	8	8	98.62
207	2	9	7	12	12	100.22
208	2	8	5	8	8	96.5
209	2	1	9	25	29	84.6
210	2	5	2	5	6	110.4
301	3	5	1	1	1	*
302	3	2	1	6	6	84.04
303	3	4	1	1	1	63.94
304	3	10	5	5	5	85
305	3	6	8	16	16	85.96
306	3	1	7	23	27	87.84
307	3	3	1	7	7	75.3
308	3	9	5	11	11	93.06
309	3	8	4	8	8	92.66
310	3	7	2	9	13	89.86

*plots were cleared by nursery staff, therefore yield could not be assessed on these plots

f. Trial design



g. 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