

SCEPTREPLUS

Final Trial Report

Trial code:	2019.SP01
Title:	AHDB SCEPTREplus carrot herbicide screen
Crop	Group: Field vegetables – Carrot (apiaceae), other umbelliferous root vegetables
Target	General broadleaf weeds and grasses, 3WEEDT EPPO1/99(3) Weeds in root vegetables
Lead researcher:	Angela Huckle
Organisation:	RSK ADAS
Period:	1 st April 2019 – 31 st March 2020
Report date:	29 th February 2020
Report author:	Angela Huckle Emily Lawrence
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



14th April 2020
Date

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Authors signature

Trial Summary

Introduction

This trial was a continuation of work carried out in 2018, looking at products with the potential to partly or fully replace the linuron—a key component of herbicide programmes for carrots, and no longer approved—with a focus on finding options for post-emergence weed control and understanding how they are best included in current programmes.

Carrot growers require new products to supplement their short list of currently available actives. While extensions of authorisation for use of aclonifen, diflufenican and metribuzin were issued in 2019 (note: aclonifen and diflufenican EAMUs only for pre-emergence use), finding different weed control options is always a priority. This trial screened the crop safety and efficacy of novel products in post-emergence herbicide programmes in addition to examining these recently approved actives when applied to carrots as post-emergence tank-mixes.

Method

Two separate trials were sited in commercial carrot fields on sandy loam soils; one in Norfolk (Site 1) and one in South Yorkshire (Site 2). A randomised block design was used for the trial layout, with three replicates of seven treatments, including an untreated control and grower standard treatment. There were twenty-one plots in total at each site, with plots measuring 2 m x 6 m.

Site 1

Treatments were applied at three timings. The first were applied on 23rd April 2019 (BBCH00-03), with subsequent applications on 24th May (BBCH10-12), and 5th June (BBCH11-14).

Site 2

Treatments were applied at three timings. The first were applied on 12th May (BBCH00-03), with subsequent application on 20th June (BBCH13-14), and 2nd July (BBCH14-15).

All treatments were applied with a 2m boom, using a knapsack sprayer at 200 L/ha water volume.

The plots were assessed on at least five occasions (see 'Assessment details'), focusing on weed cover and species presence, and crop phytotoxicity (i.e. treatment safety). Assessments were carried out at treatment application timings B and C, and at approximately two, four and eight weeks after the final treatment application.

Results and discussion

The differences in phytotoxic effects between the two sites was notable in this trial, with few treatments displaying phytotoxic damage at Site 2, despite some clear treatment effects at Site 1 (**Table 1**). This can be attributed to a delay in application at Site 2, meaning a larger crop at the time of treatment which was less vulnerable to phytotoxic damage. This highlights the importance of timing applications for crop safety; with treatment efficacy similar at both sites (**Table 2**)—in spite of the difference in application timing—treatment of a slightly larger crop is recommended, as long as weeds are not too large.

At the final assessment at Site 1, none of the treatments showed statistically significant differences in terms of crop quality compared to the untreated control, though most treatments still received a higher damage score than is commercially acceptable. The apparent heightened effect of treatments at Site 1 is likely due to the hot and dry conditions the crop endured. The warm weather during the application of the Timing B treatments is notable, with the maximum temperature on the application day 6.5°C higher at Site 1 (24/05/2019; 23.5°C) than Site 2 (20/06/2019; 17°C). At the final assessment, the crop had been recently subject to exceptionally high temperatures, with a week-long heatwave peaking at 41°C four days before assessment. There was also little precipitation or opportunity to irrigate this site, with the only supplementary irrigation applied 50 days before the final assessment. It is likely that these conditions impacted

crop vigour which may have had a confounding effect on the following phytotoxicity assessment.

Taking the challenging weather into account, four treatments assessed in these trials gave statistically significant weed control and appeared crop safe—**Anthem, then Sencorex** (grower standard); **Anthem, then AHDB9981**; **Anthem, then AHDB9993**; and **Anthem, then Sencorex + Hurricane**. By the conclusion of the trial, eight weeks after the final treatment application, all these treatments offered a significant reduction in weed cover compared to the untreated control, with no significant phytotoxic symptoms.

Hurricane SC is authorised under EAMU 0180/19 for pre-emergence use on carrots. A post-emergence EAMU authorisation for this product would also be very useful as its performance was promising in these trials.

The use of **AHDB9981** and **AHDB9993** on carrots is not currently approved, though these products also showed promise in this trial. Applied post-emergence, both showed persistent efficacy throughout these trials with no significant phytotoxic damage. These products would be valuable additions to carrot growers' weed control options, and pursual of EAMUs would be useful.

Table 1. Mean phytotoxicity scores at two, four, and eight weeks (nine weeks for Site 2) after Timing C treatment application.

Treatment	Mean crop damage scores (0-10)					
	Site 1			Site 2		
	+ 2 weeks	+ 4 weeks	+ 8 weeks	+ 2 weeks	+ 4 weeks	+ 9 weeks
Untreated	0.0	0.0	0.3	0.0	0.0	0.0
Anthem, then Sencorex (x2)	2.0	0.3	3.0	0.3	0.3	1.0
Anthem, then AHDB9981 (x2)	2.0	0.7	2.7	0.0	0.3	1.3
Anthem, then AHDB9993 (x2)	*3.3	1.0	2.7	0.0	0.0	1.0
Anthem, then Sencorex + Emerger (x2)	*6.0	*3.3	2.7	0.0	0.0	1.0
Anthem, then Sencorex + Gamit (x2)	*3.3	1.7	2.3	*3.0	*3.0	*3.0
Anthem, then Sencorex + Hurricane (x2)	*4.3	0.7	1.7	0.3	0.3	1.0
p-value	<0.001	0.002	0.392	0.012	<0.001	<0.001
d.f.	12	11	12	12	12	12
L.S.D.	1.430	1.3500	2.642	1.098	0.5714	0.3882

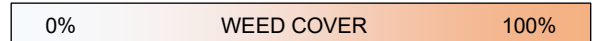
* significantly higher than untreated control AND >2.

Table 2. Mean percentage weed cover values (back-transformed) at two, four, and eight weeks (nine weeks for Site 2) after Timing C treatment application.

Trt. No.	Mean weed cover (%)											
	Site 1						Site 2					
	+ 2 weeks		+ 4 weeks		+ 8 weeks		+ 2 weeks		+ 4 weeks		+ 9 weeks	
	Ang.	Back-trans	Ang.	Back-trans	Ang.	Back-trans	Ang.	Back-trans	Ang.	Back-trans	Ang.	Back-trans
UTC	57.8	71.6	66.0	83.4	41.2	43.3	55.1	67.2	63.4	80.0	63.4	80.0

2	10.1	*3.1	8.1	*2.0	7.7	*1.8	3.8	*0.5	3.8	*0.5	3.8	*0.5
3	12.9	*5.0	11.9	*4.3	13.3	*5.3	3.8	*0.5	4.6	*0.2	4.6	*0.7
4	16.2	*7.8	20.5	*12.3	24.3	*17.0	6.5	*1.3	5.7	*1.0	5.7	*1.0
5	7.3	*1.6	6.5	*1.3	2.7	*0.2	0.0	*0.0	1.9	*0.1	1.9	*0.1
6	8.1	*2.0	6.5	*1.3	5.7	*1.0	3.8	*0.5	5.7	*1.0	5.7	*1.0
7	11.3	*3.9	7.2	*1.6	3.8	*0.4	3.8	*0.5	5.7	*1.0	5.7	*1.0
p-value	<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	
d.f.	12		12		12		12		12		12	
L.S.D.	10.55		10.15		9.62		8.098		4.642		4.413	

* significantly lower than untreated control.



Conclusion

- **Hurricane SC, AHDB9981, and AHDB9993** are promising products for post-emergence weed control in carrots, observed to be effective and crop safe by the conclusion of the trial. EAMU authorisation for post-emergence use of these products in carrots would be useful.
- Post-emergence **Anthem, then Sencorex + Emerger** caused significant stunting after application, though the crop did grow through this effect, and post-emergence **Anthem, then Sencorex + Gamit 36 CS** treated carrots showed persistent foliar blanching.

Take home message

EAMU authorisations for post-emergence use of **Hurricane SC, AHDB9981, and AHDB9993** should be applied for, to expand the range of actives available to parsnip growers. This would improve weed control and reduce the risk of resistance development.

Objective

To compare a number of herbicide tank-mixes with the commercial standards at one pre-emergence application timing and three post-emergence application timings for selectivity (crop safety) and efficacy in carrots.

Trial conduct

UK regulatory guidelines were followed but EPPO guideline 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

Deviations from EPPO guidance:

Test sites

Item	Details	
Location address	Site 1 Field: C60 Alan Bartlett & Sons Pentney, King's Lynn PE32 1JL Norfolk Grid reference: TF 73178 13777	Site 2 Field: Jackson Spetch Camella M H Poskitt Camblesforth, Selby YO8 8HA Yorkshire Grid reference: SE 64615 26605
Crop	Carrot	
Cultivar	Octavo F1	Stanhey
Soil or substrate type	Freely draining slightly acid sandy soil	
Agronomic practice	See Appendix A	
Prior history of site	See Appendix A	

Trial design

Item	Details
Trial design:	Randomised block
Number of replicates:	3
Row spacing:	80" beds (4 triple lines, 13" row spacing)
Plot size: (w x l)	2m x 6m
Plot size: (m ²)	12m ²
Number of plants per plot:	Approx. 3000
<i>Leaf Wall Area calculations</i>	N/A

Treatment details

AHDB Code	Product name	Active substance	Content of active substance in product (g/L)	Formulation batch number	Formulation type
N/A*	Anthem	pendimethalin	400	N/K	Suspension Concentrate
N/A*	Gamit 36 CS	clomazone	360	160344	Capsule Suspension

N/A†	Sencorex Flow	metribuzin	600	EV56005563	Suspension Concentrate
N/A†	Hurricane SC	diflufenican	500	17118244	Suspension Concentrate
AHDB9981	N/D	N/D	N/D	N/D	N/D
AHDB9993	N/D	N/D	N/D	N/D	N/D
N/A†	Emerger	aclonifen	160	EV5600	Suspension concentrate

* label approval

† EAMU approval

Application schedule

Treatment number	Treatment: product name or AHDB code	Application timing code	Rate of active substance (g/ha)	Rate of product (L/ha)
1	Untreated	-	-	-
2*	Anthem	A		3.30
	Sencorex Flow	B	180	0.30
	Sencorex Flow	C	300	0.50
3	Anthem	A	1320	3.30
	AHDB9981	B, C	225	0.50
4	Anthem	A	1320	3.30
	AHDB9993	B	160	1.00
	AHDB9993	C	220	2.00
5	Anthem	A	1320	3.30
	Sencorex Flow Emerger	B, C	180 80	0.30 0.50
6	Anthem	A	1320	3.30
	Sencorex Flow	B, C	180	0.30
	Gamit 36 CS		18	0.05
7	Anthem	A	1320	3.30
	Sencorex Flow Hurricane SC	B, C	180 25	0.30 0.05

* Grower standard

Application details

Site 1

	Timing A	Timing B	Timing C
Application date	23/04/2019	24/05/2019	05/06/2019
Time of day	17:00 – 18:00	10:00 – 11:00	13:00 – 15:00
Crop growth stage (min., max. BBCH)	BBCH00-03	BBCH10-12	BBCH11-14
Crop height (cm)	N/A	2.0 – 7.0	5
Crop coverage (%)	N/A	10.0	N/K
Application Method	spray	spray	spray
Application Placement	soil	foliar	foliar
Application equipment	Oxford Precision Sprayer (knapsack)	Oxford precision sprayer (knapsack)	Oxford Precision Sprayer (knapsack)
Nozzle pressure (bar)	2.0	2.0	2.0

Nozzle type	Flat fan	Flat fan	Flat fan
Nozzle size	02F110	02F110	02F110
Application water (L/ha)	200	200	200
Temperature of air – shade (°C)	19.0 – 18.0	18.4 – 24.5	11.8 – 18.7
Relative humidity (%)	54.3 – 55.3	51.1 – 30.6	48.9 – 44.7
Wind speed range (mph)	4.6 – 4.2	5.2 – 2.5	6.2 – 7.1
Dew presence (Y/N)	N/K	N	N
Temperature of soil – 10cm (°C)	18.7 – 18.1	N/K	N/K
Wetness of soil (2-5 cm)	dry	dry	N/K
Cloud cover (%)	50	1	70

Site 2

	Timing A	Timing B	Timing C
Application date	12/05/2019	20/06/2019	03/07/2019
Time of day	09:00 – 10:00	11:00 – 11:45	11:00 – 13:00
Crop growth stage (min., max. BBCH)	BBCH00-03	BBCH13-14	BBCH14-15
Crop height (cm)	N/A	3.0	15.0
Crop coverage (%)	N/A	10.0	35.0
Application Method	spray	spray	spray
Application Placement	soil	soil	foliar
Application equipment	Oxford Precision Sprayer (knapsack)	Oxford Precision Sprayer (knapsack)	Oxford Precision Sprayer (knapsack)
Nozzle pressure (bar)	2.0	2.0	2.0
Nozzle type	Flat fan	Flat fan	Flat fan
Nozzle size	03F110	03F110	03F110
Application water (L/ha)	200	200	200
Temperature of air – shade (°C)	14.2 – 14.0	14.2 – 13.4	17.1 – 18.9
Relative humidity (%)	74.2 – 76.8	56.2 – 46.9	56.4 – 69.2
Wind speed range (mph)	2.4 – 1.0	7.6 – 5.9	2.3 – 3.5
Dew presence (Y/N)	N	N	N
Temperature of soil – 10cm (°C)	10.2	14.3	17.1
Wetness of soil (2-5 cm)	damp	damp	dry
Cloud cover (%)	5	75	30

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

Common name	Scientific Name	EPPO Code	Infection level* at start of assessment period (2 WAT)	Infection level* mid-assessment period (4 WAT)	Infection level* at end of assessment period (8-9 WAT)
Broad leaved	N/A	3WEEDT	SITE 1 71.6%	83.4%	43.3% (8wks)

weeds and grasses			SITE 2	67.2%	80.0%	80.0% (9wks)
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WAT = weeks after Timing D treatment application

* average weed cover (back-transformed)

Assessment details

Site 1

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)
24/05/2019	31	10-12	efficacy, phytotox	Phytotox (scale 0-10, 10 = Dead), percent weed cover (whole plot score), plant population count.
05/06/2019	43	11-14	efficacy, phytotox	Phytotox (scale 0-10, 10 = Dead), percent weed cover (whole plot score), plant population count.
17/06/2019	55	12-15	efficacy, phytotox	Phytotox (scale 0-10, 10 = Dead), percent weed cover (whole plot score, plus percent cover by species), plant population count.
01/07/2019	69	14-16	efficacy, phytotox	Phytotox (scale 0-10, 10 = Dead), percent weed cover (whole plot score, plus percent cover by species).
29/07/2019	97	17	efficacy, phytotox	Phytotox (scale 0-10, 10 = Dead), percent weed cover (whole plot score, plus percent cover by species).

* DA – days after Timing A application

Site 2

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)
20/06/2019	39	13-14	efficacy	Percent weed cover (whole plot score and per species)
02/07/2019	52	14-15	efficacy, phytotox	Phytotox (scale 0-10, 10 = Dead), percentage of weed cover (whole plot score and per species), plant population count.
15/07/2019	64	15-16	efficacy, phytotox	Phytotox (scale 0-10, 10 = Dead), percentage of weed cover (whole plot score and per species).
29/07/2019	78	N/K	efficacy, phytotox	Phytotox (scale 0-10, 10 = Dead), percentage of weed cover (whole plot score and per species).
15/08/2019	95	N/K	efficacy, phytotox	Phytotox (scale 0-10, 10 = Dead), percentage of weed cover (whole plot score and per species).
06/09/2019	117	N/K	efficacy, phytotox	Phytotox (scale 0-10, 10 = Dead), percentage of weed cover (whole plot score and per species).

* DA – days after Timing A application

Statistical analysis

The trials had randomised block designs, each comprising seven treatments, including an untreated control and grower standard treatment. Treatments were replicated three times.

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 and the back transformed means presented, from which the % reduction in weeds was calculated using Abbotts formula.

All data were analysed by ANOVA using Genstat (18th edition) by Emily Lawrence (ADAS).

Results

Phytotoxicity

The results of phytotoxicity assessments from three dates are presented in **Table 1** and **Figure 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%

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

At Site 1, treatments of **Anthem, then Sencorex** or **Anthem, then AHDB9981** did not show any statistically significant damage to the crop at any point during the assessment period.

From two weeks after the application of the final treatment, phytotoxic treatment effects were evident at Site 1 for the remaining four treatments. Most notable was the effect of **Anthem, then Sencorex + Emerger**, leaving the crop yellow and scorched. By the four-week assessment, most treatment effects had been grown through, and while the foliar damage from **Anthem, then Sencorex + Emerger** did not persist, crop that received this treatment was notably stunted. At the final assessment—eight weeks after the final treatment application—there were no statistically significant differences in quality between any treatments and the untreated crop, though only crop treated with **Anthem, then Sencorex + Hurricane** was of commercially acceptable quality at this assessment.

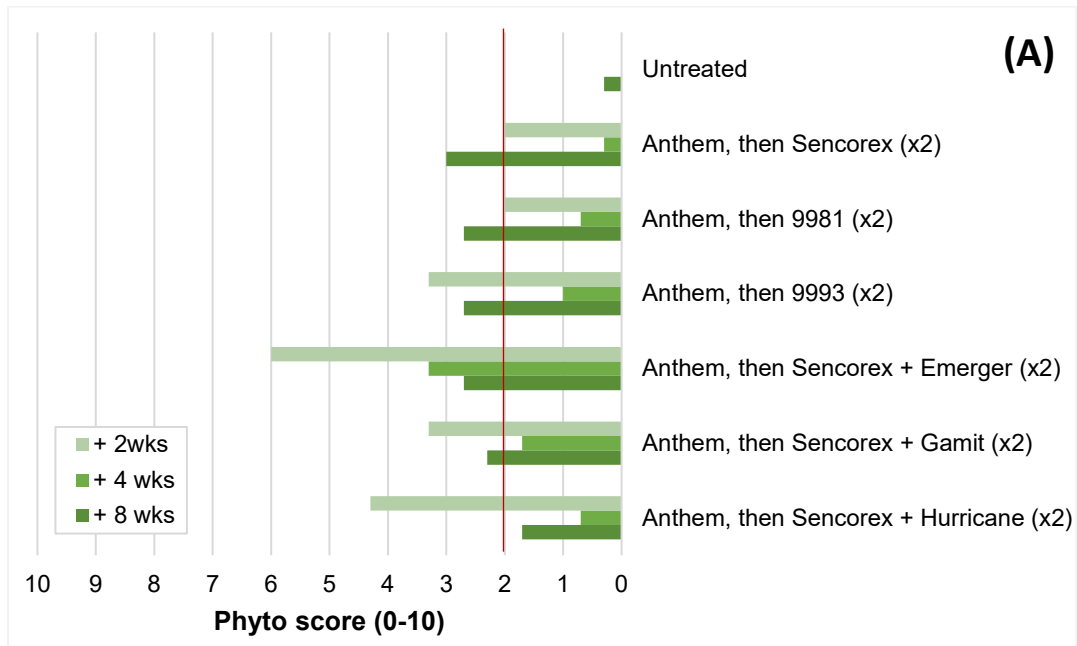
There were few phytotoxic effects recorded at Site 2, with five of the six treatments showing no significant differences between the treatments and the untreated crop at any assessment. The remaining treatment—**Anthem, then Sencorex + Gamit 36 CS**—did show some significant phytotoxic symptoms, with persistent blanching of the carrot foliage noted across the assessments.

Table 1. Mean phytotoxicity scores at two, four, and eight weeks (nine weeks for Site 2) after Timing C treatment application.

Treatment	Mean crop damage scores (0-10)					
	Site 1			Site 2		
	+ 2 weeks	+ 4 weeks	+ 8 weeks	+ 2 weeks	+ 4 weeks	+ 9 weeks
Untreated	0.0	0.0	0.3	0.0	0.0	0.0

Anthem, then Sencorex (x2)	2.0	0.3	3.0	0.3	0.3	1.0
Anthem, then AHDB9981 (x2)	2.0	0.7	2.7	0.0	0.3	1.3
Anthem, then AHDB9993 (x2)	*3.3	1.0	2.7	0.0	0.0	1.0
Anthem, then Sencorex + Emerger (x2)	*6.0	*3.3	2.7	0.0	0.0	1.0
Anthem, then Sencorex + Gamit (x2)	*3.3	1.7	2.3	*3.0	*3.0	*3.0
Anthem, then Sencorex + Hurricane (x2)	*4.3	0.7	1.7	0.3	0.3	1.0
p-value	<0.001	0.002	0.392	0.012	<0.001	<0.001
d.f.	12	11	12	12	12	12
L.S.D.	1.430	1.3500	2.642	1.098	0.5714	0.3882

* significantly higher than untreated control AND >2.



d.f.	12	12	12	12	12	12
L.S.D.	10.55	10.15	9.62	8.098	4.642	4.413

* significantly lower than untreated control.

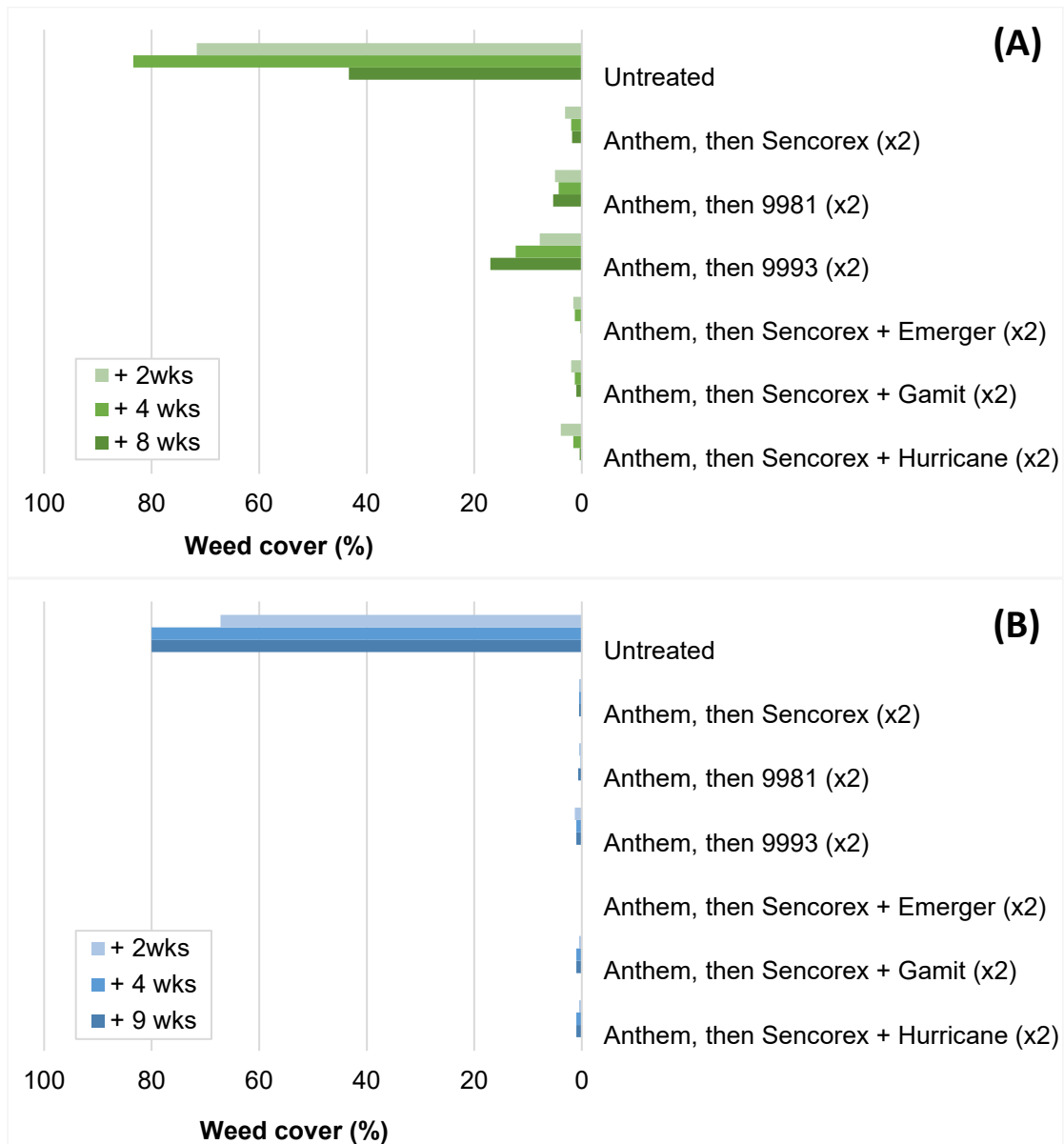
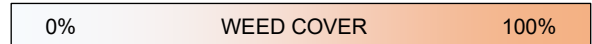


Figure 2. Mean weed cover (%; back-transformed values) at two, four, and eight weeks (nine weeks for Site 2) after Timing C treatment application (Site 1 **(A)** and Site 2 **(B)**).

Table 3. Percentage reduction in weed cover two, four, and eight weeks (nine weeks for Site 2) after Timing C treatment application (calculated using Abbott's formula).

Treatment	Mean weed cover reduction (%)					
	Site 1			Site 2		
	+ 2 weeks	+ 4 weeks	+ 8 weeks	+ 2 weeks	+ 4 weeks	+ 9 weeks
Anthem, then Sencorex (x2)	95.7	97.6	95.9	99.3	99.4	99.4
Anthem, then AHDB9981 (x2)	93.0	94.9	87.8	99.3	99.7	99.2

Anthem, then AHDB9993 (x2)	89.1	85.3	60.8	98.1	98.8	98.8
Anthem, then Sencorex + Emerger (x2)	97.7	98.4	99.5	100.0	99.9	99.9
Anthem, then Sencorex + Gamit (x2)	97.2	98.4	97.7	99.3	98.8	98.8
Anthem, then Sencorex + Hurricane (x2)	94.6	98.1	99.0	99.3	98.8	98.8

Plant population

Results from carrot plant counts are presented in **Table 4**. There were no significant reductions in plant population by any of the treatments applied at either site.

Table 4. Plant population counts from each trial site; values are treatment averages of the number of carrot plants present in a 0.5m length of a single central row.

Trt. No.	Mean plant population (No plants in 0.5 m of single row)		
	Site 1		Site 2
	Timing C	Timing C + 2 weeks	Timing C
Untreated	34.3	36.8	34.5
Anthem, then Sencorex (x2)	38.2	39.3	35.0
Anthem, then AHDB9981 (x2)	38.0	38.5	36.0
Anthem, then AHDB9993 (x2)	39.0	38.0	36.0
Anthem, then Sencorex + Emerger (x2)	37.3	32.1	36.0
Anthem, then Sencorex + Gamit (x2)	37.5	37.8	33.0
Anthem, then Sencorex + Hurricane (x2)	38.0	44.5	39.5
p-value	0.808	0.312	0.278
d.f.	12	11	12
L.S.D.	6.580	9.76	5.132

Discussion

The differences in phytotoxic effects between the two sites was notable in this trial, with few treatments displaying phytotoxic damage at Site 2, despite some clear treatment effects at Site 1. This can be attributed to a delay in application at Site 2, meaning a larger crop at the time of treatment which was less vulnerable to phytotoxic damage. This highlights the importance of timing applications for crop safety; with treatment efficacy similar at both sites—in spite of the

difference in application timing—treatment of a slightly larger crop is recommended, as long as weeds are not too large.

At the final assessment at Site 1, none of the treatments showed statistically significant differences in terms of crop quality compared to the untreated control, though most treatments still received a higher damage score than is commercially acceptable. The apparent heightened effect of treatments at Site 1 is likely due to the hot and dry conditions the crop endured. The warm weather during the application of the Timing B treatments is notable, with the maximum temperature on the application day 6.5°C higher at Site 1 (24/05/2019; 23.5°C) than Site 2 (20/06/2019; 17°C). At the final assessment, the crop had been recently subject to exceptionally high temperatures, with a week-long heatwave peaking at 41°C four days before assessment. There was also little precipitation or opportunity to irrigate this site, with the only supplementary irrigation applied 50 days before the final assessment. It is likely that these conditions impacted crop vigour which may have had a confounding effect on the following phytotoxicity assessment.

Taking the challenging weather into account, four treatments assessed in these trials gave statistically significant weed control and appeared crop safe—**Anthem, then Sencorex** (grower standard); **Anthem, then AHDB9981**; **Anthem, then AHDB9993**; and **Anthem, then Sencorex + Hurricane**. By the conclusion of the trial, eight weeks after the final treatment application, all these treatments offered a significant reduction in weed cover compared to the untreated control, with no significant phytotoxic symptoms.

Hurricane SC is authorised under EAMU 0180/19 for pre-emergence use on carrots. A post-emergence EAMU authorisation for this product would also be very useful as its performance was promising in these trials.

The use of **AHDB9981** and **AHDB9993** on carrots is not currently approved, though these products also showed promise in this trial. Applied post-emergence, both showed persistent efficacy throughout these trials with no significant phytotoxic damage. These products would be valuable additions to carrot growers' weed control options, and pursuit of EAMUs would be useful.

Conclusions

- **Hurricane SC, AHDB9981, and AHDB9993** are promising products for post-emergence weed control in carrots, observed to be effective and crop safe by the conclusion of the trial. EAMU authorisation for post-emergence use of these products in carrots would be useful.
- Post-emergence **Anthem, then Sencorex + Emerger** caused significant stunting after application, though the crop did grow through this effect, and post-emergence **Anthem, then Sencorex + Gamit 36 CS** treated carrots showed persistent foliar blanching.

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 those who provided sites and crops for the trials as well as technical input, particularly Peter Saunders of Alan Bartlett & Sons, and James Bramley of MH Poskitt Ltd.

Appendix

Crop diary – events related to growing crop

a. Site 1

Crop	Cultivar	Drilling date	Bed width
Carrots	Octavo F1	18/04/19	80", 4 triple lines, 13" row spacing

Previous cropping

Year	Crop
2018	Winter wheat
2017	Beet
2016	Potatoes

Cultivations

Year	Crop
16/04/19	Subsoil/plough/ridge/destone

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

Date	Product	Rate	Unit
20/02/19	Laws 0N-60P-80K-160NaO-40MgO-2B-60SO ₃ -80 CaO	875.000	kg/ha
04/06/19	Master Manganese Plus	1.500	kg/ha
27/06/19	Laws Top Dressing C: N-13 P-0 K-11 2Mg	375.000	kg/ha
04/07/19	Nutrel Fastmix K-Mag	5.000	kg/ha
	OptE B	1.500	L/ha
	Master Manganese Plus	2.500	kg/ha
24/07/19	Master Manganese Plus	2.500	kg/ha
	Nutrel Fastmix K-Mag	4.000	kg/ha
	Zinic	2.000	L/ha

Pesticides applied to trial area

Date	Product	Rate	Unit
18/04/19	Vydate 10G	30.000	kg/ha
04/06/19	Clayton Cayman	0.400	L/ha
	Decis Protech	0.500	L/ha
27/06/19	SL 567A	1.300	L/ha
04/07/19	Minecto One	0.185	kg/ha
24/07/19	Signum	0.750	kg/ha
	Hallmark with Zeon Technology	0.150	L/ha
	Teppeki	0.140	kg/ha

Details of irrigation regime

Date	Type, rate and duration	Amount applied (mm)
09/06/19	Overhead gun	25.0

b. Site 2

Crop	Cultivar	Drilling date	Bed width
Carrots	Stanhey	06/05/19	72", 4 triple lines

Previous cropping

Year	Crop
2018	Maize
2017	Swede
2016	Sugar beet

Cultivations

Date	Description	Depth (cm)
04/05/19	Sumo	30
	Plough	24
	Ridge	45
05/05/19	Destone	30
06/06/19	Bedform	18

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

Date	Product	Rate	Unit
23/06/2019	Yara Axan	225	kg/ha

c. Table showing sequence of events by date – this relates to treatments and assessments.**Site 1:**

Date	Event
23/04/2019	Timing A treatment application.
24/05/2019	Timing B treatment application. Trial assessment; crop phyto, weed cover, population counts.
05/06/2019	Timing C treatment application. Trial assessment; crop phyto, weed cover, population counts.
17/06/2019	Trial assessment; crop phyto, weed cover, population counts.
01/07/2019	Trial assessment; crop phyto, weed cover.
29/07/2019	Trial assessment; crop phyto, weed cover.

Site 2:

Date	Event
12/05/2019	Timing A treatment application.
20/06/2019	Timing B treatment application. Trial assessment; weed cover.
02/07/2019	Timing C treatment application. Trial assessment; crop phyto, weed cover, population counts.
15/07/2019	Trial assessment; crop phyto, weed cover.
29/07/2019	Trial assessment; crop phyto, weed cover.
15/08/2019	Trial assessment; crop phyto, weed cover.
06/09/2019	Trial assessment; crop phyto, weed cover.

d. Climatological data during study period.

Site 1

Date	Min. temp. (°C)	Max. temp. (°C)	Precip. (mm)
24/04/2019	11.5	25.0	0
25/04/2019	8.0	18.5	2
26/04/2019	3.0	20.5	0
27/04/2019	7.0	11.0	2
28/04/2019	4.5	14.0	0
29/04/2019	0.5	15.0	0
30/04/2019	-0.5	18.0	0
01/05/2019	1.0	20.5	1
02/05/2019	9.5	16.0	1
03/05/2019	6.0	10.0	0
04/05/2019	1.5	10.5	6
05/05/2019	5.0	13.0	1
06/05/2019	2.0	13.5	0
07/05/2019	5.5	17.0	0
08/05/2019	8.0	12.5	20
09/05/2019	7.5	12.0	0
10/05/2019	6.5	14.0	4
11/05/2019	7.0	14.0	6
12/05/2019	1.5	17.5	0
13/05/2019	2.0	20.0	0
14/05/2019	3.0	21.0	0
15/05/2019	4.0	21.0	0
16/05/2019	5.0	20.0	0
17/05/2019	10.0	15.5	1
18/05/2019	10.0	16.0	2
19/05/2019	5.0	20.0	0
20/05/2019	10.0	20.5	1
21/05/2019	8.0	21.0	0
22/05/2019	4.5	22.0	0

23/05/2019	6.5	24.0	0
24/05/2019	5.0	23.5	0
25/05/2019	8.5	23.5	0
26/05/2019	12.5	20.5	1
27/05/2019	8.0	17.5	2
28/05/2019	9.0	16.0	7
29/05/2019	6.5	18.5	7
30/05/2019	13.0	23.5	1
31/05/2019	10.0	21.5	0
01/06/2019	10.5	27.5	0
02/06/2019	15.5	27.5	0
03/06/2019	9.5	22.0	0
04/06/2019	7.0	20.5	1
05/06/2019	10.0	20.0	0
06/06/2019	10.5	22.0	0
07/06/2019	6.5	20.0	2
08/06/2019	11.0	13.0	14
09/06/2019	6.5	21.5	0
10/06/2019	11.0	13.5	33
11/06/2019	10.5	12.0	23
12/06/2019	11.0	15.5	6
13/06/2019	10.5	14.0	13
14/06/2019	11.5	20.0	5
15/06/2019	8.5	21.5	0
16/06/2019	8.5	21.5	0
17/06/2019	11.5	23.5	0
18/06/2019	9.0	22.0	8
19/06/2019	13.0	21.0	14
20/06/2019	12.0	20.0	4
21/06/2019	6.5	22.5	0
22/06/2019	9.5	24.0	0
23/06/2019	10.5	26.0	0
24/06/2019	17.0	29.0	0
25/06/2019	14.5	20.0	16
26/06/2019	13.0	17.0	0
27/06/2019	10.5	21.5	0
28/06/2019	12.5	24.0	0
29/06/2019	10.5	32.0	0
30/06/2019	15.0	26.0	0
01/07/2019	11.5	23.0	0
02/07/2019	10.5	22.0	0
03/07/2019	7.0	27.5	0
04/07/2019	6.0	29.0	0
05/07/2019	12.5	30.5	0
06/07/2019	11.5	19.0	1

07/07/2019	10.0	26.5	0
08/07/2019	12.0	23.5	0
09/07/2019	13.0	22.5	0
10/07/2019	15.0	25.0	0
11/07/2019	15.5	26.5	0
12/07/2019	14.5	27.0	2
13/07/2019	14.5	25.5	0
14/07/2019	13.5	23.5	1
15/07/2019	12.5	27.5	0
16/07/2019	7.0	33.0	0
17/07/2019	13.5	33.0	0
18/07/2019	15.0	25.0	6
19/07/2019	8.5	20.0	3
20/07/2019	16.0	25.5	7
21/07/2019	9.5	24.5	0
22/07/2019	15.5	33.5	0
23/07/2019	13.0	40.5	0
24/07/2019	19.0	36.5	2
25/07/2019	16.5	41.0	0
26/07/2019	18.5	35.5	1
27/07/2019	15.5	19.0	27
28/07/2019	15.0	18.0	10
29/07/2019	13.0	29.5	0

Site 2

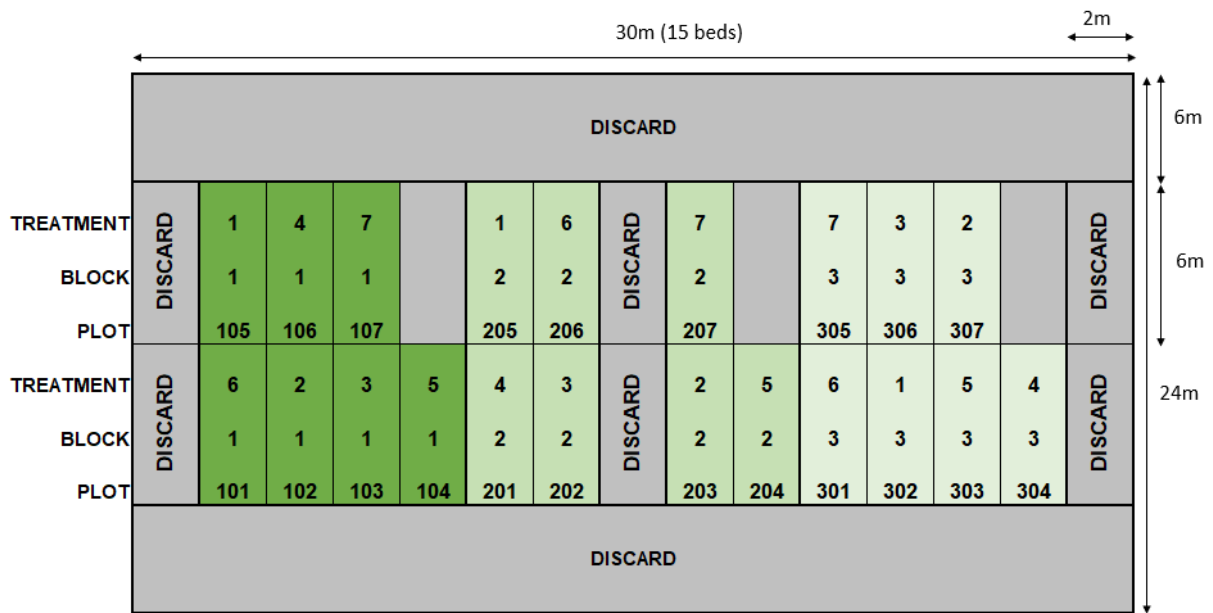
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14/05/2019	7	20	0
15/05/2019	6	20	0
16/05/2019	4	17	0
17/05/2019	9	19	1
18/05/2019	10	16	0
19/05/2019	10	19	0
20/05/2019	8	20	0
21/05/2019	9	20	0
22/05/2019	9	20	1
23/05/2019	8	21	0
24/05/2019	10	21	0
25/05/2019	11	21	0
26/05/2019	12	20	2
27/05/2019	10	18	7
28/05/2019	8	16	6
29/05/2019	5	17	2
30/05/2019	15	23	0
31/05/2019	14	22	0
01/06/2019	14	24	0
02/06/2019	12	23	2

Date	Min. temp. (°C)	Max. temp. (°C)	Precip. (mm)
03/06/2019	11	21	0
04/06/2019	9	18	2
05/06/2019	9	17	0
06/06/2019	8	20	0
07/06/2019	6	18	4
08/06/2019	10	14	7
09/06/2019	8	19	0
10/06/2019	9	15	12
11/06/2019	10	13	30
12/06/2019	10	16	22
13/06/2019	8	14	8
14/06/2019	8	17	6
15/06/2019	9	18	1
16/06/2019	7	19	1
17/06/2019	13	21	0
18/06/2019	12	19	2
19/06/2019	12	19	2
20/06/2019	8	17	1
21/06/2019	7	19	0
22/06/2019	8	22	0
23/06/2019	11	20	3
24/06/2019	14	21	0
25/06/2019	13	17	6
26/06/2019	9	15	0
27/06/2019	8	21	0
28/06/2019	12	20	0
29/06/2019	10	29	0
30/06/2019	15	23	0
01/07/2019	11	19	0
02/07/2019	9	19	0
03/07/2019	9	21	0
04/07/2019	11	23	0
05/07/2019	15	23	0
06/07/2019	12	21	1
07/07/2019	10	20	0
08/07/2019	11	19	0
09/07/2019	12	19	0
10/07/2019	15	23	0
11/07/2019	15	24	1
12/07/2019	13	24	2
13/07/2019	13	22	3
14/07/2019	10	19	2
15/07/2019	10	23	0
16/07/2019	11	24	0
17/07/2019	15	25	1
18/07/2019	14	20	1
19/07/2019	10	19	4
20/07/2019	12	21	2
21/07/2019	12	22	0
22/07/2019	17	27	0
23/07/2019	14	30	0

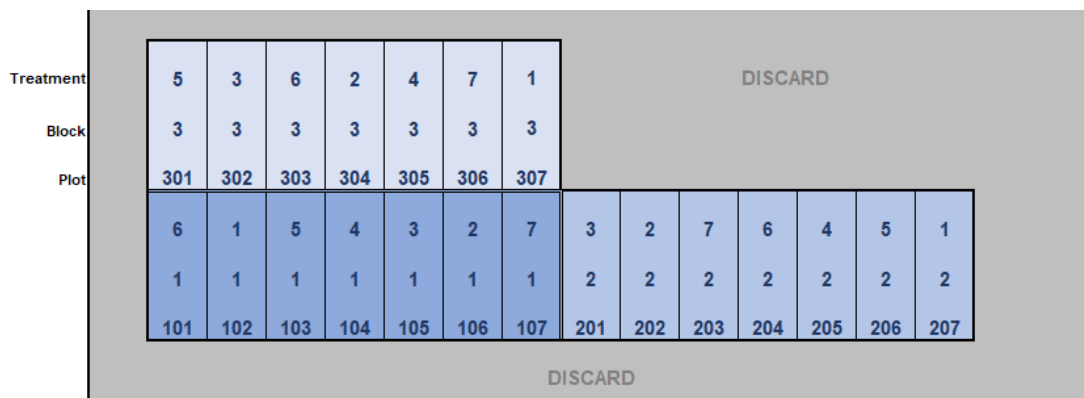
Date	Min. temp. (°C)	Max. temp. (°C)	Precip. (mm)
24/07/2019	18	28	3
25/07/2019	16	35	0
26/07/2019	19	23	0
27/07/2019	15	19	19
28/07/2019	15	19	2
29/07/2019	14	23	1
30/07/2019	15	24	3
31/07/2019	16	20	12
01/08/2019	14	23	0
02/08/2019	14	21	0
03/08/2019	10	24	0
04/08/2019	16	25	0
05/08/2019	14	22	3
06/08/2019	13	22	3
07/08/2019	13	21	0
08/08/2019	12	24	0
09/08/2019	16	25	16
10/08/2019	15	21	2
11/08/2019	11	20	0
12/08/2019	9	17	0
13/08/2019	10	18	1
14/08/2019	10	16	7
15/08/2019	11	19	0
16/08/2019	11	17	16
17/08/2019	13	21	0
18/08/2019	12	21	1
19/08/2019	11	20	0
20/08/2019	10	18	1
21/08/2019	12	21	0
22/08/2019	15	22	0
23/08/2019	15	25	0
24/08/2019	13	27	0
25/08/2019	12	30	0
26/08/2019	14	29	0
27/08/2019	15	29	0
28/08/2019	11	20	5
29/08/2019	9	21	0
30/08/2019	15	22	0
31/08/2019	9	19	1
01/09/2019	9	17	2
02/09/2019	10	19	1
03/09/2019	15	22	0
04/09/2019	12	17	2
05/09/2019	9	17	0
06/09/2019	12	18	0

e. Trial design

Site 1:



Site 2:



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

