SCEPTREPLUS

Final Trial Report

Trial code:	2019.SP27
Title:	AHDB SCEPTREplus brassica herbicide screens – cauliflower (pre-plant)
Crop	Group: field vegetables – Brassicas (cauliflower)
Target	General broadleaf weeds and grasses, 3WEEDT EPPO1/089(3) Weeds in leafy and brassica vegetables
Lead researcher:	Angela Huckle
Organisation:	RSK ADAS
Period:	1st April 2019 – 31st March 2020
Report date:	29th 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

31st March 2020
Date

……
Authors signature

ADAS

AHDB HORTICULTURE

Trial Summary

Introduction

The limited range of herbicides currently available for use in brassica crops leaves gaps in the weed control spectrum, and growers experience problems with a wide range of weeds. In addition to having a short list of approved actives, only a small subset of these offer the longevity of control required to protect longer season brassicas, such as cabbage.

In predominantly hand harvested crops such as brassicas, weeds are a physical impediment to those working in the crop, and species such as nettles can deter pickers. Weeds which obscure the crop further reduce harvesting efficiency; where excessive weeds mean heads are missed, harvested yields can be reduced by up to 30%. The increased humidity in the crop canopy can also increase the risk of disease and weed seeds can contaminate the fresh product.

While mechanical hoeing can be successfully used as an alternative weed control method, it is limited by crop growth stage and ground conditions—if soil conditions are not suitable, this approach cannot always be used. Therefore, further options for weed control are required.

The objective of these trials was to identify crop-safe and effective herbicides for pre-planting weed control in brassica crops, aiming to expand the options available to growers.

Method

The trial was sited at Elsoms Trial Ground in Lincolnshire,] and was planted on 1st August 2019 with cauliflower (variety 'Liria').

Treatments were applied on 1st August 2019, prior to planting. All treatments were applied with a 2 m boom, using a knapsack sprayed at 300 L/ha water volume. A randomised block design was used for the trial layout, with three replicates of six treatments, including an untreated control. There were eighteen plots in total, each measuring 2 m x 6 m.

The plots were assessed on four occasions (see 'Assessment details'), focussing on weed cover and species presence, and crop phytotoxicity (i.e. treatment safety). Assessments were carried out approximately two, four, eight, and twelve weeks after treatments were applied.

Results and discussion

Of the treatments assessed in this trial, all appeared crop safe and effective. By the conclusion of the trial—twelve weeks after the treatment application—all treatments offered a statistically significant reduction in weed cover compared to the untreated control (**Table 1**), with none exhibiting any concerning phytotoxic symptoms (**Table 2**). Conditions were good for residual activity at the time of application with plenty of moisture.

The use of **AHDB9999**, **AHDB9987**, **AHDB9875**, **AHDB9917**, or **AHDB9994** on cauliflower are not currently approved, though these products showed promise in this trial. By the conclusion of the trial, all showed lasting efficacy as pre-planting treatments without any persistent phytotoxic effects and would be valuable additions to brassica growers' weed control options—pursual of EAMUs for these products would be useful.

AHDB9987 and **AHDB9875** should add control of cranesbill and wild radish and increase control of groundsel and sow thistle. An authorisation for **AHDB9999** should give control of charlock. **AHDB9917** is a graminicide with some broad-leaved weed activity.

Table 1. Mean percentage weed cover values (transformed) at two, four, eight, and twelve weeks after post-planting treatment application.

Treatment	Mean weed cover							
	+ 2 weeks		+ 4 weeks		+ 8 weeks		+ 12 weeks	
	Ang	Back-trans	Ang	Back-trans	Ang	Back-trans	Ang	Back-trans
Untreated	7.2	1.6	9.9	2.9	39.8	41.0	35.5	33.7
AHDB9999	5.7	1.0	5.7	1.0	10.3	***3.2**	14.4	***6.2**
AHDB9987	5.7	1.0	6.5	1.3	10.0	***3.0**	13.4	***5.3**
AHDB9875	5.7	1.0	3.8	0.4	5.7	***1.0**	6.5	***1.3**
AHDB9917	5.7	1.0	5.7	1.0	8.7	***2.3**	13.6	***5.5**
AHDB9994	5.7	1.0	3.8	0.4	13.5	***5.4**	9.5	***2.8**
p-value		0.465		0.060		0.006		0.021
d.f.		10		10		10		10
L.S.D.		1.816		3.987		15.450		15.220

* significantly different to untreated control.

Table 2. Mean crop phytotoxicity scores at two, four, eight, and twelve weeks after pre-planting treatment application in cauliflower. Scored on 0 to 10 scale, with 0 being 'no effect', and 10 being 'dead'; scores ≤2 deemed commercially acceptable level of damage.

Treatment	Mean crop damage scores			
	+ 2 weeks	+ 4 weeks	+ 8 weeks	+ 12 weeks
Untreated	0.0	0.0	0.0	1.3
AHDB9999	0.0	0.7	0.3	2.0
AHDB9987	0.0	0.0	0.0	1.7
AHDB9875	0.0	0.3	0.0	1.0
AHDB9917	0.0	0.0	0.0	1.0
AHDB9994	1.3	0.7	0.3	2.0
p-value	0.030	0.090	0.465	0.810
d.f.	10	10	10	10
L.S.D.	0.858	0.6360	0.5424	2.178

Conclusion

- **AHDB9999**, **AHDB9987**, **AHDB9875**, **AHDB9917**, and **AHDB9994** are promising products for weed control in cauliflower and were shown in this trial to be safe and effective as pre-planting herbicide treatments. EAMU authorisations for pre-planting use of any of these five products in cauliflower would help growers improve weed control.

Take home message

EAMU authorisations for pre-planting use of **AHDB9999**, **AHDB9987**, **AHDB9875**, **AHDB9917**, and **AHDB9994** should be applied for, to expand the range of actives available to cauliflower growers. This would improve weed control and reduce the risk of resistance development.

Objectives

To compare a number of new and novel herbicides at the post-planting application timing for selectivity (crop safety) and efficacy in cauliflowers.

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 PP1/181(4)	Conduct and reporting of efficacy evaluation trials including good experimental practice	None
EPPO PP1/214(3)	Principles of acceptable efficacy	None
EPPO PP1/224(2)	Principles of efficacy evaluation for minor uses	None
EPPO PP1/225(2)	Minimum effective dose	None

There were no deviations from EPPO guidance.

Test site

Item	Details
Location address	Field: Elsoms Trial Ground off A16 PE11 3JG Lincolnshire Grid reference: TF 25745 25975
Crop ('cultivar')	Cauliflower ('Liria')
Soil or substrate type	Loamy and clayey soil of coastal flats with naturally high groundwater
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:	0.61 m (3 rows per 2 m wide plot)
Plot size: (w x l)	2.4 m x 5 m
Plot size:	12 m^2
Number of plants per plot:	approx. 33

Treatment details

AHDB Code	Product name	Active substance	Formulation batch number	Content of active substance (g/L)	Formulation type
AHDB9999	N/D	N/D	N/D	N/D	N/D
AHDB9987	N/D	N/D	N/D	N/D	N/D
AHDB9875	N/D	N/D	N/D	N/D	N/D
AHDB9917	N/D	N/D	N/D	N/D	N/D
AHDB9994	N/D	N/D	N/D	N/D	N/D

Application schedule

Trt. No.	Treatment: product name or AHDB code	Application timing code	Rate of active substance(s) (g/ha)	Rate of product (L/ha)
1	Untreated	-	-	-
2	AHDB9999	A	4000	5.00
3	AHDB9987	A	1200	2.00
4	AHDB9875	A	1200 240	3.00
5	AHDB9917	A	N/K	0.70
6	AHDB9994	A	1050	1.75

Application details

	Timing A
Application date	01/08/2019
Time of day	06:20 – 07:10
Crop growth stage (Max, min average BBCH)	N/A
Crop height (cm)	N/A
Crop coverage (%)	N/A
Application Method	spray
Application Placement	soil
Application equipment	AZO Plot
Nozzle pressure (bar)	2.5
Nozzle type	Flat fan
Nozzle size	02-F110
Application water volume (L/ha)	300
Temperature of air (°C)	18.6
Relative humidity (%)	91
Wind speed range (kph)	(NW) 12.0
Dew presence (Y/N)	N
Temperature of soil (°C)	15.0
Wetness of soil	wet
Cloud cover (%)	100

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	Infection level* mid-assessment period	Infection level* at end of assessment period

			(Timing A + 2 weeks)	(Timing A + 8 weeks)	(Timing A + 12 weeks)
Broad leaved weeds and grasses	*N/A*	3WEEDT	1.6%	41.0%	33.7%

* average weed cover (back-transformed).

Assessment details

Evaluation date	**Evaluation Timing** (DA)*	**Evaluation type**	**What was assessed and how** (e.g. dead or live pest; disease incidence and severity; yield, marketable quality)
15/08/2019	14	Efficacy, Phyto	Percentage of weed cover (whole plot score), weed species presence. Phyto (scale 0-10, 10 = Dead).
29/08/2019	28	Efficacy Phyto	Percentage of weed cover (whole plot score), weed species presence. Phyto (scale 0-10, 10 = Dead).
26/09/2019	56	Efficacy Phyto	Percentage of weed cover (whole plot score), weed species presence. Phyto (scale 0-10, 10 = Dead).
24/10/2019	84	Efficacy Phyto	Percentage of weed cover (whole plot score), weed species presence. Phyto (scale 0-10, 10 = Dead).

* DA – days after Timing A application.

Statistical analysis

This trial had a randomised block design and comprised twelve treatments, including an untreated control and grower standard treatment. Treatments were replicated three times.

As the distribution of weeds was uneven across the 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 and the back transformed means presented, from which the % reduction in weeds was calculated using Abbott's formula.

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

Results

Phytotoxicity

The results of phytotoxicity assessments from four 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.

There were very few phytotoxic effects recorded in this trial and no significant differences between the treatments and the untreated crop.

Table 1. Mean crop phytotoxicity scores at two, four, eight, and twelve weeks after pre-planting treatment application in cauliflower.

Treatment	Mean crop damage scores			
	+ 2 weeks	+ 4 weeks	+ 8 weeks	+ 12 weeks
Untreated	0.0	0.0	0.0	1.3
AHDB9999	0.0	0.7	0.3	2.0
AHDB9987	0.0	0.0	0.0	1.7
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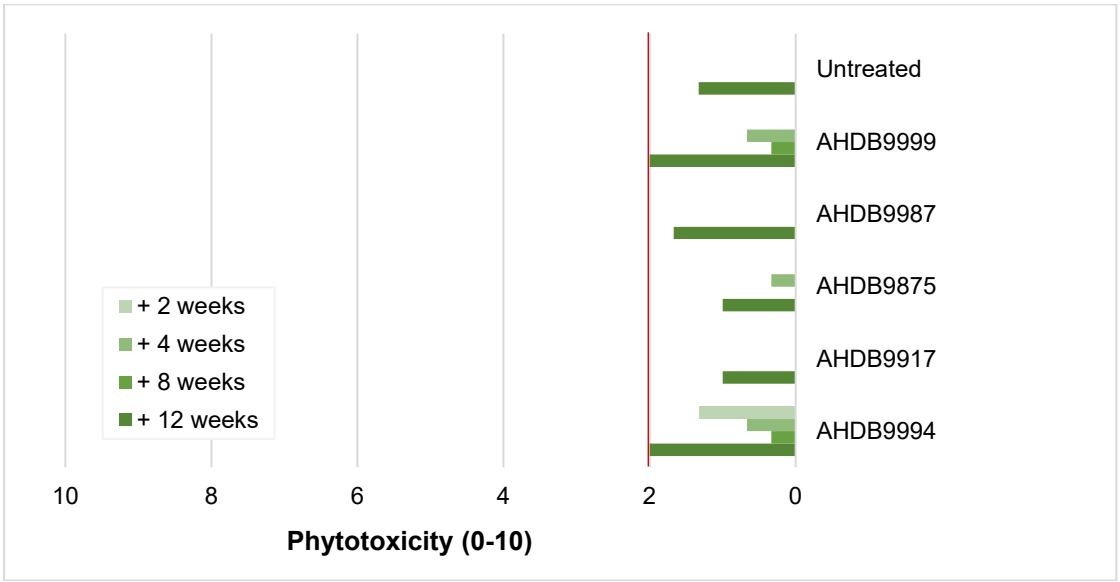

Figure 1. Mean phytotoxicity (0-10) at two, four, eight, and twelve weeks after pre-planting treatment application. Scores ≤2 (marked by red line) deemed acceptable damage.

Weed control – mean percentage weed cover

The results for the mean percentage weed cover per treatment are presented in **Table 2** and

Figure 2. The percent reduction in weed cover compared to the untreated control was calculated from these figures (using Abbott's formula), and results for each treatment are listed in **Table 3**.

In the trial area, the most common weed species were shepherd's purse, groundsel, speedwell, chickweed, mayweed, annual meadow grass and annual nettle.

At the earlier assessments—two and four weeks after the treatment application—there were very few weeds in the trial area, with an average of only 2.9% weed cover in the untreated plots at the four-week assessment. Weed levels built up as the trial progressed, with an average weed cover of 33.7% in untreated plots at the final assessment, twelve weeks after treatment application. By the conclusion of the trial, all treatments showed significantly lower weed cover than the untreated control.

Table 2. Mean percentage weed cover values (transformed) at two, four, eight, and twelve weeks after post-planting treatment application.

Treatment	Mean weed cover							
	+ 2 weeks		+ 4 weeks		+ 8 weeks		+ 12 weeks	
	Ang	Back-trans	Ang	Back-trans	Ang	Back-trans	Ang	Back-trans
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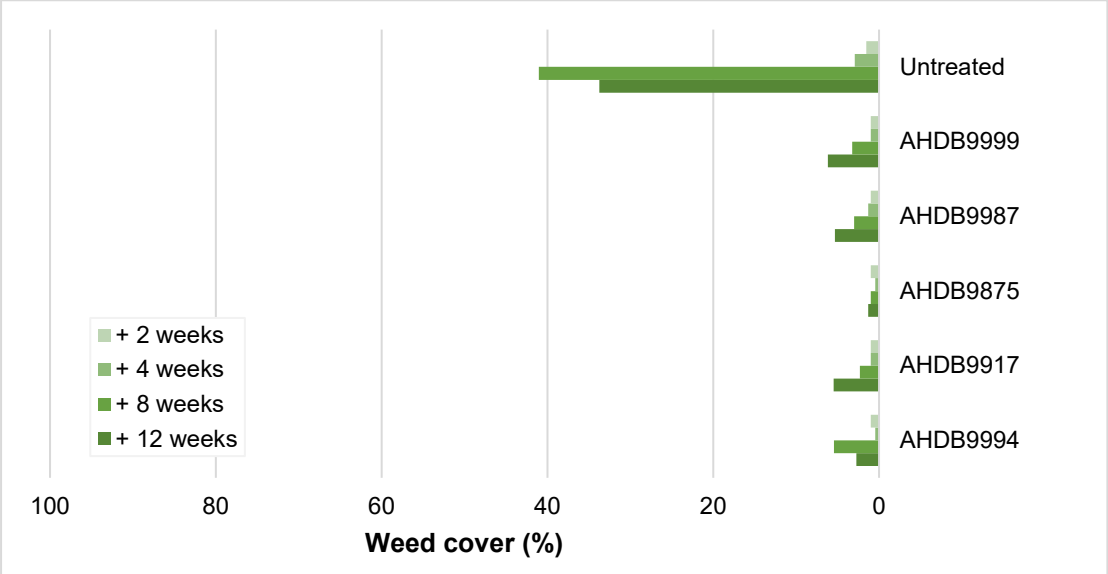

Figure 2. Mean weed cover (back transformed, %) at two, four, eight, and twelve weeks after pre-planting treatment application.

Table 3. Percentage reduction in weed cover compared to the untreated control at two, four, eight and twelve weeks after pre-planting treatment application.

Treatment	Weed cover reduction (%)			
	+ 2 weeks	+ 4 weeks	+ 8 weeks	+ 12 weeks

AHDB9999	35.5	66.0	92.1	81.7
AHDB9987	35.5	56.0	92.7	84.2
AHDB9875	35.5	84.9	97.6	96.2
AHDB9917	35.5	66.0	94.4	83.7
AHDB9994	35.5	84.9	86.8	91.8

Discussion

Of the treatments assessed in this trial, all appeared crop safe and effective. By the conclusion of the trial—twelve weeks after the treatment application—all treatments offered a statistically significant reduction in weed cover compared to the untreated control, with none exhibiting any concerning phytotoxic symptoms. Conditions were good for residual activity at the time of application with plenty of moisture.

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Conclusion

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Acknowledgements

AHDB for funding the work, and the crop protection companies for their financial contributions and provision of samples for the trials. Thanks too to Elsoms Seeds, who provided sites and crop for the trials, and to Carl Sharp of the Allium and Brassica Centre, for site management and treatment application.

Appendix

a. Crop diary – events related to growing crop

Crop	**Cultivar**	**Planting date**	**Row width** (m)
Cauliflower	Liria	01/08/2019	0.61 m

Previous cropping

Year	**Crop**
2018	PSB/cauliflower (half of the trial area)
2017	Rye (cover crop)
2016	Bare ground

Cultivations

Date	Description
Mar 2019	Power harrowed and rolled prior to planting.
Dec 2018	Subsoiled and winter ploughed.

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

Date	Product	Rate (kg/ha)
Mar 2019	Base fertiliser	250 kg/ha 10-15-21 + 20SO_3
Mar 2019	Top dressing	80 kg/ha N 26N + 35SO_3

Pesticides applied to trial area

Date	Product	Rate (L/ha)
15/10/19	Biscaya	0.4
	Tracer	0.2

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

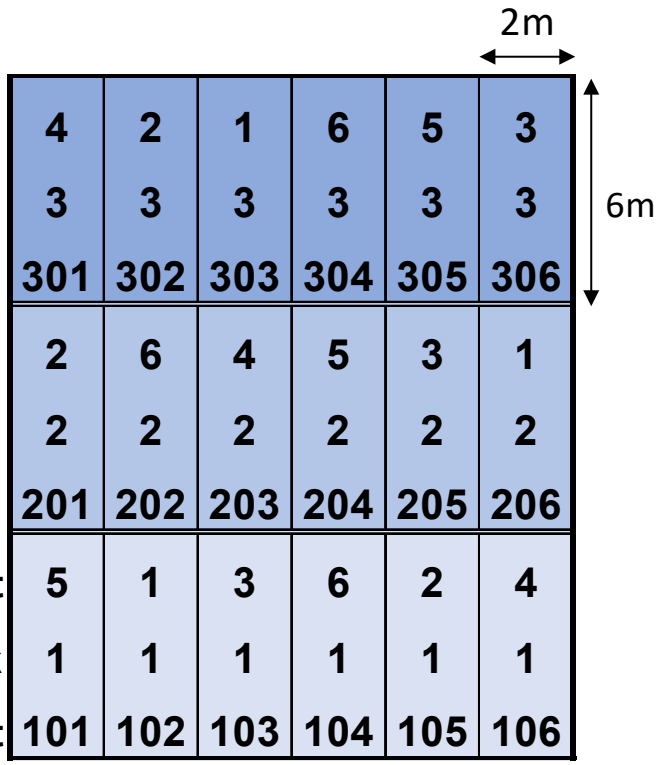
Date	Event
01/08/2019	Application A spray. Crop planted.
15/09/2019	Assessment, two weeks after treatment (phyto/weeds).
29/08/2019	Assessment, four weeks after treatment (phyto/weeds).
26/19/2019	Assessment, eight weeks after treatment (phyto/weeds).
24/10/2019	Assessment, twelve weeks after treatment (phyto/weeds).

c. Climatological data during study period from each site.

Date	Min. temp. (°C)	Max. temp. (°C)	Precip. (mm)
01/08/19	15	22	3.8
02/08/19	15	22	1.0
03/08/19	12	23	0.0
04/08/19	15	26	0.3
05/08/19	14	24	2.0
06/08/19	13	23	3.6
07/08/19	13	24	0.0
08/08/19	13	25	0.0
09/08/19	16	26	16.0
10/08/19	16	23	0.8
11/08/19	11	20	1.0
12/08/19	9	19	0.0
13/08/19	10	19	1.5
14/08/19	9	17	21.6
15/08/19	10	20	2.0
16/08/19	9	18	12.2
17/08/19	12	22	5.1
18/08/19	12	22	2.0
19/08/19	10	22	0.0
20/08/19	9	20	0.0
21/08/19	12	22	0.0
22/08/19	13	24	0.0
23/08/19	13	26	0.0
24/08/19	12	27	0.0
25/08/19	14	30	0.0
26/08/19	15	30	0.0
27/08/19	16	30	0.3
28/08/19	13	23	1.5
29/08/19	11	22	1.0
30/08/19	14	24	0.0
31/08/19	9	22	0.0
01/09/19	9	17	0.5
02/09/19	8	19	0.0
03/09/19	12	24	0.0
04/09/19	13	19	2.5
05/09/19	8	19	0.0
06/09/19	8	19	0.5
07/09/19	8	17	0.0
08/09/19	8	18	0.0
09/09/19	8	14	2.0
10/09/19	8	18	0.0
11/09/19	8	22	1.3
12/09/19	8	24	0.0

Date	Min. temp. (°C)	Max. temp. (°C)	Precip. (mm)
13/09/19	8	20	0.0
14/09/19	8	22	0.0
15/09/19	8	20	3.0
16/09/19	8	17	7.1
17/09/19	8	17	0.0
18/09/19	8	18	0.0
19/09/19	8	22	0.0
20/09/19	8	20	0.0
21/09/19	8	24	0.0
22/09/19	8	23	3.3
23/09/19	8	20	1.3
24/09/19	8	18	16.3
25/09/19	8	18	35.1
26/09/19	8	20	5.1
27/09/19	8	16	8.9
28/09/19	8	18	16.0
29/09/19	8	19	25.9
30/09/19	8	16	14.0
01/10/19	8	14	48.0
02/10/19	8	13	0.0
03/10/19	8	12	7.1
04/10/19	8	15	8.4
05/10/19	8	16	0.5
06/10/19	8	14	15.0
07/10/19	8	13	1.3
08/10/19	8	16	0.5
09/10/19	8	16	0.0
10/10/19	8	16	0.3
11/10/19	8	16	5.6
12/10/19	8	15	0.0
13/10/19	8	14	21.8
14/10/19	8	13	19.8
15/10/19	8	13	11.4
16/10/19	8	15	1.0
17/10/19	8	13	1.3
18/10/19	8	14	0.8
19/10/19	8	14	1.0
20/10/19	8	12	1.0
21/10/19	8	13	1.0
22/10/19	3	14	0.0
23/10/19	4	14	0.8
24/10/19	7	12	9.7

d. Trial design



e. 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