

SCEPTREPLUS

Final Trial Report

Trial code:	2017. SP 02
Title:	AHDB SCEPTREplus herb herbicide screen – drilled herbs
Crop:	Leafy vegetables (herbs)
Target:	General broadleaf weeds and grasses, 3WEEDT EPPO1/89(3) Weeds in leafy and brassica vegetables
Lead researcher:	Angela Huckle
Organisation:	RSK ADAS
Period:	9 th August 2017 – 30 th September 2017
Report date:	1 st July 2019
Report author:	Angela Huckle Emily Lawrence Dr Laura Davies
ORETO Number: (certificate should be attached)	ORETO 374

I the undersigned, hereby declare that the work was performed according to the procedures herein described and that this report is an accurate and faithful record of the results obtained

19th July 2019
Date


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Authors signature

Trial Summary

Introduction

The wide range of herb species grown presents a challenge for growers to identify herbicides which are crop safe to each particular species. There is often little information from manufacturers as herbs are considered minor crops. While the herb sector is small, these crops are of high value. Any defects or discolouration can lead to rejection, as many herbs are sold as fresh cut products, so knowledge of the crop safety of potential new herbicides is critical for the supply chain.

Linuron has been a key component of herbicide programs for herbs along with pendimethalin, prosulfocarb and lenacil. It has formed the basis of commercial programs and was used in tank mixes—both pre- and post-emergence—to complement the weed control spectrums of the other actives. With linuron now withdrawn (3rd June 2018), growers are left with very few options for weed control for which they have knowledge of crop safety. It is a high priority for growers to find potential replacement products which are safe to apply.

The objective of this trial was to identify crop safe herbicides for weed control in a range of herb species and to expand the options available to growers. These trials concentrated on potential new herbicides which may be used to partly or fully replace linuron.

Methods

Six herb species were selected for the trial – basil (BAS), chives (CHIV), coriander (COR), dill, fenugreek (FENU) and parsley (PAR). These were chosen in consultation with the British Herb Trade Association. Seeds were hand sown into soil-filled pots placed on hard standing uncovered at ADAS Boxworth to allow free drainage. Treatments were either incorporated into the soil before potting (treatments 2, 3 and 4 – Devrinol 450 SC), applied over soil in pots prior to germination (treatments 5 to 10, AHDB9987 and AHDB9974), or applied over the herbs 34 days (COR, DILL, FENU) or 49 days (BAS, CHIV, PAR) after sowing (treatments 11 to 22 AHDB9974, AHDB9981, AHDB9953 and Centurion Max). The first treatments (Application A) were applied on 10th August 2017. Application B treatments were applied on 12th and 27th September 2017. The treatments were applied with a 0.5m lance and an Oxford Precision Sprayer knapsack at 200 L/ha water volume.

A fully randomised block design was used with four replicates of 22 treatments, including an untreated control for comparison. Each 'plot' consisted of a 3L pot, with the whole trial totaling 528 pots. Germination counts were made on 13 September in untreated pots and those which received pre-emergence treatments. Crop safety was also assessed – vigour scores were recorded, comparing the overall appearance of treated and untreated pots. Scores were recorded on 13th September for pre-emergence treated pots, and on 9th (COR, DILL, FENU) and 19th (BAS, CHIV, PAR) October for post-emergence treated pots.

Results

Table 1. Mean germination counts for each pre-emergence treatment and herb variety at five weeks after sowing (13th September), with overall percent germination and percent germination relative to untreated control.

Treatment (incl. application rate)	Basil		Chives		Coriander		Dill		Fenugreek		Parsley	
	Overall %	Relative %	Overall %	Relative %	Overall %	Relative %	Overall %	Relative %	Overall %	Relative %	Overall %	Relative %
UTC	35.00	100.00	62.50	100.00	100.00	100.00	70.00	100.00	82.50	100.00	60.00	100.00
Devrinol 450 SC 1.4 L/ha (0.5x)	20.00	57.14	50.00	80.00	87.50	87.50	57.50	82.14	95.00	115.15	45.00	75.00
Devrinol 450 SC 2.8 L/ha (1x)	25.00	71.43	17.50	28.00	70.00	70.00	45.00	64.29	97.50	118.18	60.00	100.00
Devrinol 450 SC 5.6 L/ha (2x)	47.50	135.71	10.00	16.00	55.00	55.00	45.00	64.29	92.50	112.12	57.50	95.83
AHDB 9987 (0.5x)	5.00	14.29	0.00	0.00	77.50	77.50	5.00	7.14	80.00	96.97	37.50	62.50
AHDB 9987 (1x)	2.50	7.14	0.00	0.00	45.00	45.00	7.50	10.71	45.00	54.55	32.50	54.17
AHDB 9987 (2x)	0.00	0.00	0.00	0.00	22.50	22.50	0.00	0.00	12.50	15.15	2.50	4.17
AHDB 9974 (0.5x)	12.50	35.71	15.00	24.00	100.00	100.00	22.50	32.14	35.00	42.42	80.00	133.33
AHDB 9974 (1x)	0.00	0.00	0.00	0.00	100.00	100.00	2.50	3.57	0.00	0.00	37.50	62.50
AHDB 9974 (2x)	0.00	0.00	0.00	0.00	85.00	85.00	0.00	0.00	0.00	0.00	27.50	45.83
F prob. value	<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	
d.f.	27		27		27		27		27		27	
S.E.D.	0.774		0.841		1.203		1.138		1.006		1.331	
L.S.D.	1.589		1.726		2.469		2.334		2.063		2.731	

Table 2. Mean vigour scores for each herb variety. Assessments carried out on 13th September 2017 (Application A; all varieties), 9th October 2017 (Application B; coriander, dill, fenugreek), and 19th October 2017 (Application B; basil, chives, parsley). Scored from 0 to 10; 0 = complete crop death, 10 = no quality reduction, scores <8 deemed commercially unacceptable damage.

Timing	Treatment	BAS	CHIV	COR	DILL	FENU	PAR
Application A (pre-emergence)	Devrinol 450 SC 1.4 L/ha (0.5x)	7.3	8.5	9.0	7.3	9.5	7.3
	Devrinol 450 SC 2.8 L/ha (1x)	6.7	4.5	8.5	4.7	9.5	8.7
	Devrinol 450 SC 5.6 L/ha (2x)	8.7	2.0	7.3	5.7	6.7	8.5
	AHDB 9987 (0.5x)	0.3	0.0	8.0	0.7	6.5	5.0
	AHDB 9987 (1x)	1.5	0.0	4.0	2.5	4.0	6.7
	AHDB 9987 (2x)	0.0	0.0	1.7	0.0	1.0	0.3
	AHDB 9974 (0.5x)	3.3	1.7	10.0	4.0	4.5	10.0
	AHDB 9974 (1x)	0.0	0.0	9.3	0.5	0.0	5.7
	AHDB 9974 (2x)	0.0	0.0	9.0	0.0	0.0	3.7
	F prob. value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	d.f.	27	27	27	27	27	27
	S.E.D.	1.798	1.289	1.127	1.464	1.184	1.663
	L.S.D.	3.688	2.644	2.312	3.003	2.429	3.412
Application B (post-emergence)	AHDB 9974 (0.5x)	7.0	8.0	10.0	0.4	0.6	10.0
	AHDB 9974 (1x)	0.0	0.0	9.7	0.0	0.3	0.0
	AHDB 9974 (2x)	0.0	0.0	10.0	2.5	0.0	0.0
	AHDB 9981 (0.5x)	6.0	5.7	7.7	9.3	9.5	0.7
	AHDB 9981 (1x)	0.5	1.5	9.3	9.3	9.7	0.0
	AHDB 9981 (2x)	0.0	0.5	8.3	10.0	8.0	0.0
	Centurion Max 0.5 L/ha (0.5x)	8.7	8.5	10.0	10.0	8.5	10.0
	Centurion Max 1.0 L/ha (1x)	3.5	8.5	10.0	8.7	9.0	8.0
	Centurion Max 2.0 L/ha (2x)	4.5	4.7	9.5	10.0	9.3	9.0
	AHDB 9953 (0.5x)	4.7	6.3	10.0	10.0	9.7	9.3
	AHDB 9953 (1x)	6.5	9.0	10.0	9.3	9.0	7.5
	AHDB 9953 (2x)	3.0	9.5	10.0	7.7	9.0	8.0
	F prob. value	<0.001	<0.001	0.438	<0.001	<0.001	<0.001
d.f.	36	36	36	36	36	36	
S.E.D.	2.294	1.703	1.035	1.164	0.979	1.032	
L.S.D.	4.653	3.453	2.099	2.360	1.985	2.094	

Conclusions

Note: these results are based on pot trials, and the most promising would need repeating in soil grown crops in the field to confirm crop safety.

For those herbs where germination was greater than 60% (chives, coriander, dill, fenugreek and parsley) the following conclusions can be drawn -

Pre-emergence

- Devrinol 450 SC was safe to nearly all the herb species when applied at up to 1.4 L/ha (half dose) with the exception of dill. However, it has subsequently been approved for use at a lower rate of 0.85 L/ha, but this rate was not tested in the trial. There is a possibility that it could still be safe to dill, but this warrants further testing.
- AHDB 9987 was only safe to coriander up to half dose, but it gave a reduction in the percentage of seedlings which emerged and therefore this product is less promising for use in herbs.
- AHDB 9974 was safe to use on coriander up to single dose or label rate, and half dose rate in parsley

Post-emergence

- AHDB 9974 was safe to use over coriander up to double rate, but only up to half rate/dose for parsley
- AHDB 9981 was safe to dill and fenugreek up to single dose
- Centurion Max was safe to all herbs listed above when applied up to a rate of 1.0 L/ha (single dose).
- AHDB 9953 was safe to all herbs listed above when applied up to half dose

Take Home Message

There is at least one promising post-emergence herbicide for each herb species which can be taken forward for testing in the field, as well - warranting investigation for EAMU authorisation. For pre-emergence herbicides there is a promising herbicide for each herb species except dill, which was sensitive to all tested.

Objectives

1. To test the crop safety of pre- and post-emergence herbicides on several species of herb.

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	ADAS Boxworth (hard standing, uncovered) Battle Gate Road Boxworth CB23 4NN Cambridgeshire Grid reference: TL 34330 63366
Crop	Herbs
Cultivar	Basil, chives, coriander, dill, fenugreek, parsley
Soil or substrate type	Sterilised loam mix (Rothamsted 'weed mix' - sterilised Kettering loam and lime free grit 3-6mm in a 4:1 ratio, plus 2kg/m ³ Osmacote mini 5-6 months 4:1 loam:grit)
Agronomic practice	N/A
Prior history of site	N/A

Trial design

Item	Details
Trial design:	Fully randomised block
Number of replicates:	4
Plot size:	3L pot
Number of plants per plot:	Approx. 10
<i>Leaf Wall Area calculations</i>	N/A

Treatment details

AHDB code	Active substance	Product name/ manufacturers code	Formulation batch number	Content of active substance in product (g/L)	Formulation type
N/A	napropamide	Devrinol 450 SC	429H	450	Suspension Concentrate
AHDB 9987	N/D	N/D	N/D	N/D	N/D
AHDB 9974	N/D	N/D	N/D	N/D	N/D
AHDB 9981	N/D	N/D	N/D	N/D	N/D
N/A	clethodim	Centurion Max	N/K	120	Emulsifiable Concentrate
AHDB 9953	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	Untreated	-	-	-
2	Devrinol 450 SC	630	1.4	A
3	Devrinol 450 SC	1260	2.8	A
4	Devrinol 450 SC	2520	5.6	A
5	AHDB 9987	600	1.0	A
6	AHDB 9987	1200	2.0	A
7	AHDB 9987	2400	4.0	A
8	AHDB 9974	1000	2.5	A
9	AHDB 9974	2000	5.0	A
10	AHDB 9974	4000	10.0	A
11	AHDB 9974	1000	2.5	B
12	AHDB 9974	2000	5.0	B
13	AHDB 9974	4000	10.0	B
14	AHDB 9981	450	1.0	B
15	AHDB 9981	900	2.0	B
16	AHDB 9981	1800	4.0	B
17	Centurion Max	60	0.5	B
18	Centurion Max	120	1.0	B
19	Centurion Max	240	2.0	B
20	AHDB 9953	62.5	1.25	B
21	AHDB 9953	125	2.5	B
22	AHDB 9953	250	5.0	B

Application details

	Application A	Application B (COR, DILL, FENU)	Application B (BAS, CHIV, PAR)
Application date	10/08/2017	12/09/2017	27/09/2017
Time of day	11:00 – 14:00	11:40 – 14:25	09:10 – 11:00
Crop growth stage (Max, min average BBCH)	N/A	12 - 14	12 - 14
Crop height (cm)	N/A	varies 5-10cm	varies 5-10cm
Crop coverage (%)	N/A	N/A	N/A
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	2.0 bar	2.0 bar	2.5 bar
Nozzle type	flat fan	flat fan	flat fan
Nozzle size	F11002	F10002	F10002
Application water volume/ha	200	200	200
Temperature of air (°C)	24.2 – 24.9	24.9 – 25.8	23.1 – 23.4
Relative humidity (%)	48.1 – 49.6	44.4 – 45.3	65.3 – 66.2
Wind speed range (mph)	N/A	N/A	N/A
Dew presence (Y/N)	N	N	N
Temperature of soil - 10 cm (°C)	N/A	N/A	N/A
Wetness of soil - 2-5 cm	dry	damp	damp
Cloud cover (%)	N/A	N/A	100

Assessment details

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)
13/09/2017	35	12-14	emergence, vigour	Germination counts and crop vigour (% size reduction compared to UTC; visual comparison, scored 0-9)
09/10/2017	61	16-17	vigour	Crop vigour (% size reduction compared to UTC; visual comparison, scored 0-9)
19/10/2017	71	Not recorded	vigour	Crop vigour (% size reduction compared to UTC; visual comparison, scored 0-9)

* DA – days after application A

Statistical analysis

The trial design was a fully randomised block design, with four replicates of 22 treatments, including an untreated control.

All data were analysed by ANOVA using Genstat 16.0 by Emily Lawrence at RSK ADAS.

Results

SEEDLING GERMINATION

The results for the mean percentage seedling germination per treatment for each herb variety are presented in Table 3. Assessments were carried out 35 days post-treatment.

Table 3. Mean germination counts for each pre-emergence treatment and herb variety, with overall percent germination and percent germination relative to untreated control.

Treatment (incl. application rate)	Basil		Chives		Coriander		Dill		Fenugreek		Parsley	
	Overall %	Relative %	Overall %	Relative %	Overall %	Relative %	Overall %	Relative %	Overall %	Relative %	Overall %	Relative %
UTC	35.00	100.00	62.50	100.00	100.00	100.00	70.00	100.00	82.50	100.00	60.00	100.00
Devrinol 450 SC 1.4 L/ha (0.5x)	20.00	57.14	50.00	80.00	87.50	87.50	57.50	82.14	95.00	115.15	45.00	75.00
Devrinol 450 SC 2.8 L/ha (1x)	25.00	71.43	17.50	28.00	70.00	70.00	45.00	64.29	97.50	118.18	60.00	100.00
Devrinol 450 SC 5.6 L/ha (2x)	47.50	135.71	10.00	16.00	55.00	55.00	45.00	64.29	92.50	112.12	57.50	95.83
AHDB 9987 (0.5x)	5.00	14.29	0.00	0.00	77.50	77.50	5.00	7.14	80.00	96.97	37.50	62.50
AHDB 9987 (1x)	2.50	7.14	0.00	0.00	45.00	45.00	7.50	10.71	45.00	54.55	32.50	54.17
AHDB 9987 (2x)	0.00	0.00	0.00	0.00	22.50	22.50	0.00	0.00	12.50	15.15	2.50	4.17
AHDB 9974 (0.5x)	12.50	35.71	15.00	24.00	100.00	100.00	22.50	32.14	35.00	42.42	80.00	133.33
AHDB 9974 (1x)	0.00	0.00	0.00	0.00	100.00	100.00	2.50	3.57	0.00	0.00	37.50	62.50
AHDB 9974 (2x)	0.00	0.00	0.00	0.00	85.00	85.00	0.00	0.00	0.00	0.00	27.50	45.83
F prob. value	<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	
d.f.	27		27		27		27		27		27	
S.E.D.	0.774		0.841		1.203		1.138		1.006		1.331	
L.S.D.	1.589		1.726		2.469		2.334		2.063		2.731	

Basil

Basil germination averaged 14.7% across all treatments, and therefore it was not possible to draw any firm conclusions on crop safety as there was also low emergence in the untreated pots (35%). However, equivalent or near equivalent germination numbers in the pots treated with Devrinol 450 SC mean that this product warrants further investigation. (Table 3, Figure 1).

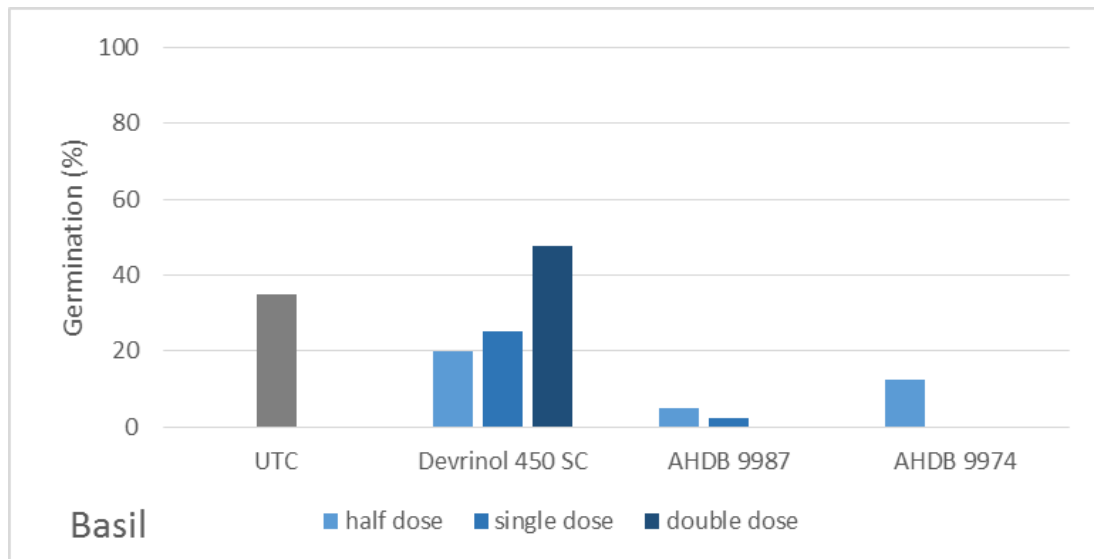


Figure 1. Mean germination counts (%) for pre-emergence treatments on basil.

Chives

Devrinol 450 SC applied at 1.4 L/ha (half dose) slightly reduced the germination rate of chives; higher rates of this product had a greater effect, markedly reducing germination (Table 3, Figure 2). AHDB 9987 and AHDB 9974 are not safe to use pre-emergence of a chive crop, with little or no emergence seen in pots sprayed with these treatments.

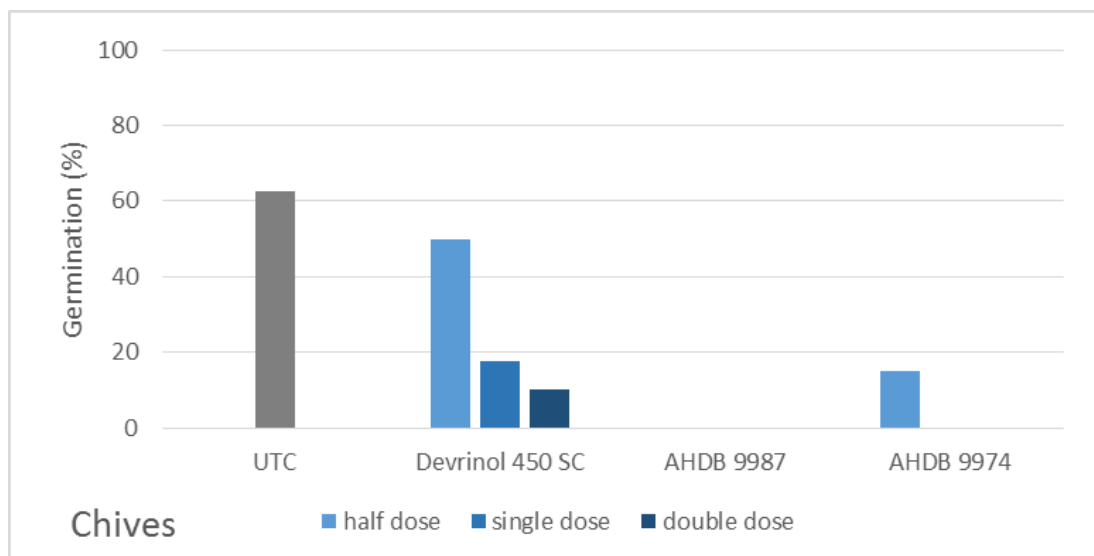


Figure 2. Mean germination counts (%) for pre-emergence treatments on chives.

Coriander

Germination rates were high in coriander, with 100% germination in untreated pots. (Table 3, Figure 3). Pre-emergence treatment with Devrinol 450 SC or AHDB 9987 showed a significant difference in levels of coriander germination with increasing application rates – a steady decline in the number of seedlings emerging was seen with the increase in treatment concentration. Even at half doses of each product a significant reduction in germination was seen to reduce numbers by 12.5 – 22.5%. However, the germination of coriander treated with AHDB 9974 was high, with all seeds germinating in pots sprayed with the lower treatment rates. Though AHDB 9974 application at double dose rate caused a 15% reduction in germination rate.

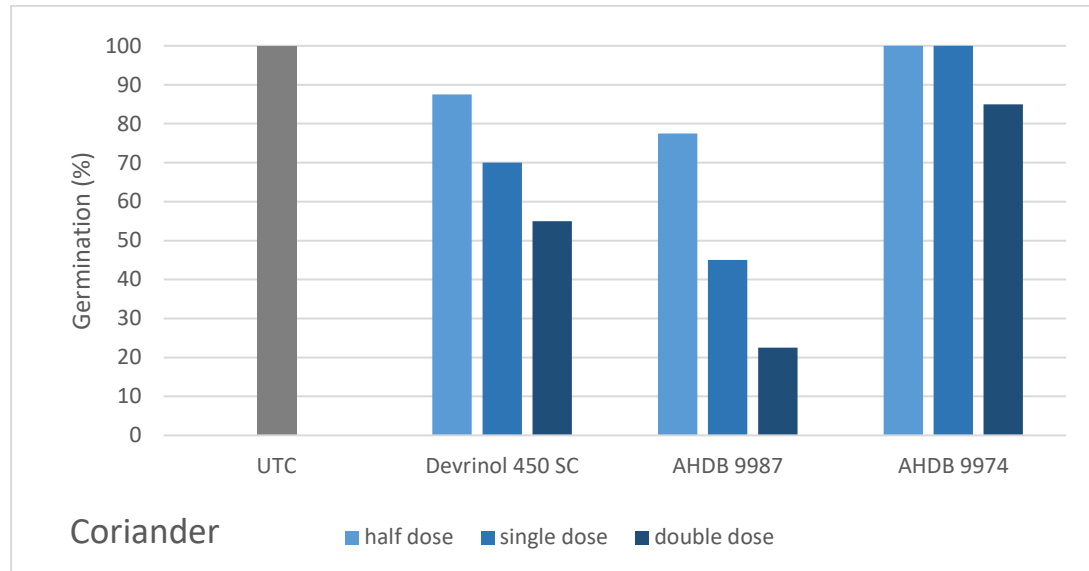


Figure 3. Mean germination counts (%) for pre-emergence treatments on coriander.

Dill

Dill germination was reasonable at 70%. All pre-emergence treatments applied to dill caused a significant reduction in the rate of germination, compared to the untreated control, with AHDB 9987 and AHDB 9974 treated pots showing very low germination, with seeds treated at the highest rate not emerging at all. (Table 3, Figure 4). No pre-emergence treatments in this trial appear safe to dill.

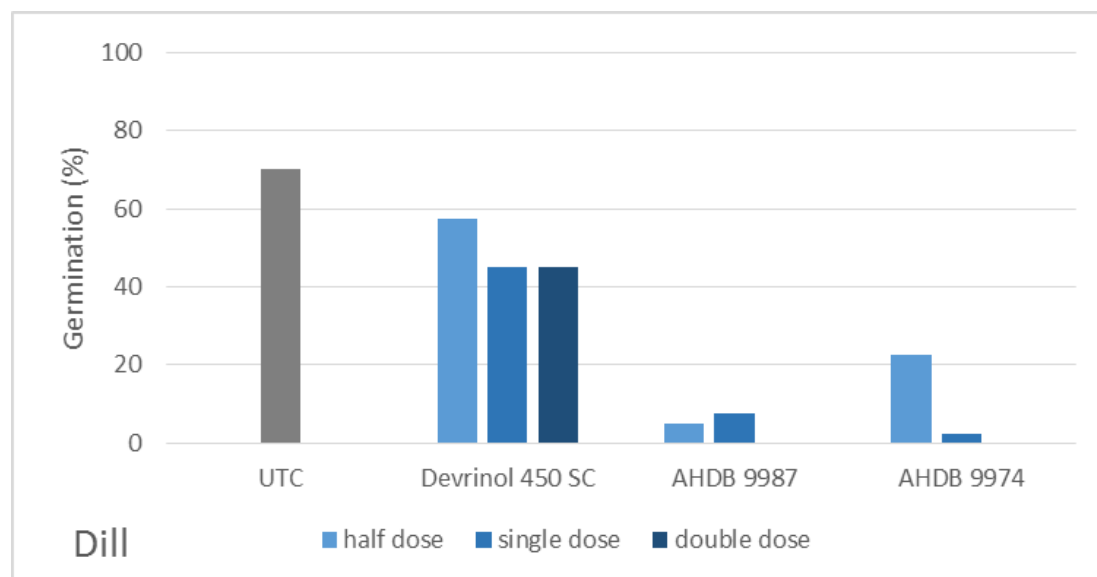


Figure 4. Mean germination counts (%) for pre-emergence treatments on dill.

Fenugreek

Fenugreek germination was good with 82.5% germination in untreated pots. Pre-emergence application of Devrinol 450 SC at any rate, or AHDB 9987 applied at half dose rate did not significantly reduce germination rate, and these products appear to be safe for use in fenugreek (Table 3, Figure 5). However, at label rate or double dose AHDB 9987 caused a notable significant reduction in fenugreek germination. AHDB 9974 at any rate markedly reduced germination, with the higher rates inhibiting fenugreek germination entirely.

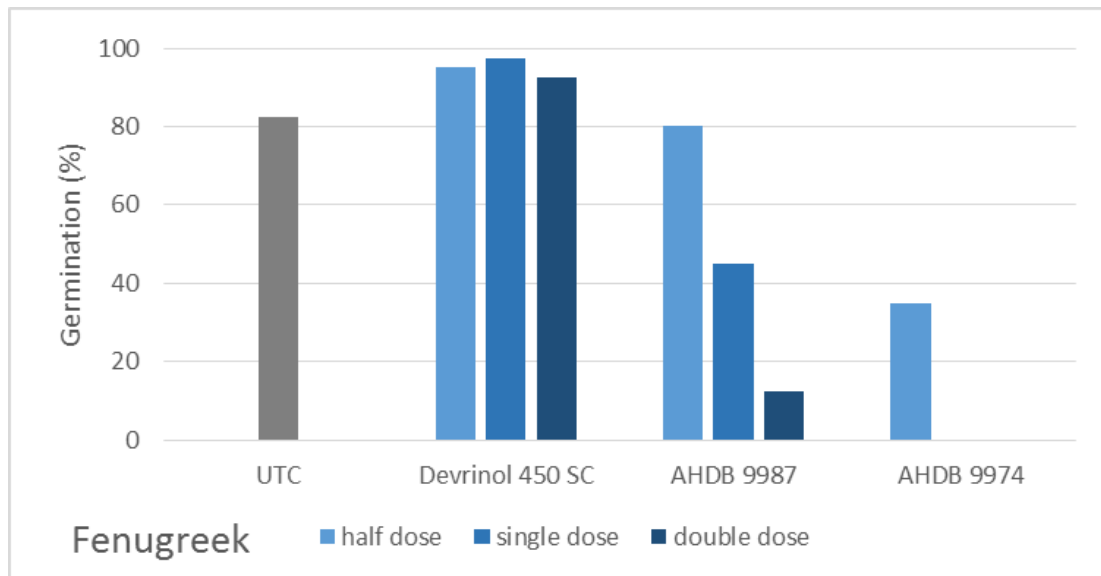


Figure 5. Mean germination counts (%) for pre-emergence treatments on fenugreek.

Parsley

Parsley germination only reached 60% in the untreated control, but germination rate in treated pots was—in many cases—greater than that of the untreated, and significant differences were seen. Devrinol 450 SC appears relatively crop safe when applied pre-emergence to parsley up to 5.6 L/ha (double dose) (Table 3, Figure 6). But, AHDB 9987 at any rate gave a significant reduction in parsley seedling emergence of 37.5% to 96% depending on rate used when, compared to the untreated control. Higher rates of AHDB 9987 giving a greater reduction in germination. AHDB 9974 applied at half normal dose rate appears crop safe – germination rate in pots that received this treatment were notably higher than the untreated control. However, treatment with full or double normal rate of AHDB 9974 caused a marked reduction in germination rate.

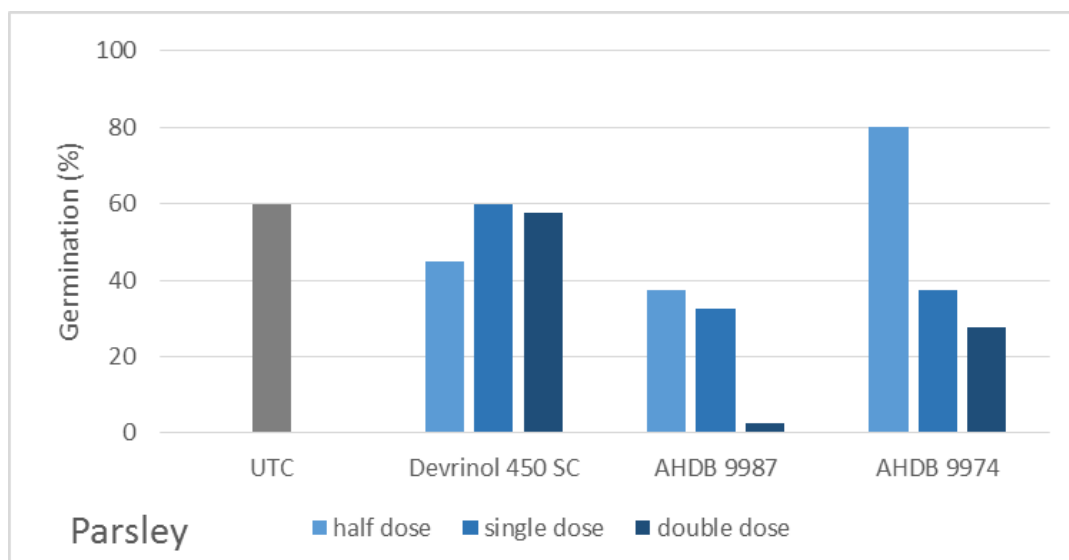


Figure 6. Mean germination counts (%) for pre-emergence treatments on parsley.

VIGOUR

The results for the mean vigour per treatment for each herb variety are presented in Table 4.

Vigour was recorded using the following scale:

Crop vigour score	Equivalent to crop damage (% quality reduction)
0	complete crop kill 100%
1	80-95% damage
2	70-80%
3	60-70%
4	50-60%
5	40-50%
6	25-40%
7	15-25%
8*	10-15%
9	5-10%
10	no damage

* 8 = minimum level of acceptable vigour reduction, i.e. damage unlikely to reduce yield, and acceptable to grower.

Table 4. Mean vigour scores for each herb variety. Assessments carried out on 13th September 2017 (Application A; all varieties), 9th October 2017 (Application B; coriander, dill, fenugreek), and 19th October 2017 (Application B; basil, chives, parsley). Scored from 0 to 10; 0 = complete crop death, 10 = no quality reduction, scores <8 deemed commercially unacceptable damage.

Timing	Treatment	BAS	CHIV	COR	DILL	FENU	PAR
Application A (pre-emergence)	Devrinol 450 SC 1.4 L/ha (0.5x)	7.3	8.5	9.0	7.3	9.5	7.3
	Devrinol 450 SC 2.8 L/ha (1x)	6.7	4.5	8.5	4.7	9.5	8.7
	Devrinol 450 SC 5.6 L/ha (2x)	8.7	2.0	7.3	5.7	6.7	8.5
	AHDB 9987 (0.5x)	0.3	0.0	8.0	0.7	6.5	5.0
	AHDB 9987 (1x)	1.5	0.0	4.0	2.5	4.0	6.7
	AHDB 9987 (2x)	0.0	0.0	1.7	0.0	1.0	0.3
	AHDB 9974 (0.5x)	3.3	1.7	10.0	4.0	4.5	10.0
	AHDB 9974 (1x)	0.0	0.0	9.3	0.5	0.0	5.7
	AHDB 9974 (2x)	0.0	0.0	9.0	0.0	0.0	3.7
	F prob. value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	d.f.	27	27	27	27	27	27
	S.E.D.	1.798	1.289	1.127	1.464	1.184	1.663
	L.S.D.	3.688	2.644	2.312	3.003	2.429	3.412
Application B (post-emergence)	AHDB 9974 (0.5x)	7.0	8.0	10.0	0.4	0.6	10.0
	AHDB 9974 (1x)	0.0	0.0	9.7	0.0	0.3	0.0
	AHDB 9974 (2x)	0.0	0.0	10.0	2.5	0.0	0.0
	AHDB 9981 (0.5x)	6.0	5.7	7.7	9.3	9.5	0.7
	AHDB 9981 (1x)	0.5	1.5	9.3	9.3	9.7	0.0
	AHDB 9981 (2x)	0.0	0.5	8.3	10.0	8.0	0.0
	Centurion Max 0.5 L/ha (0.5x)	8.7	8.5	10.0	10.0	8.5	10.0
	Centurion Max 1.0 L/ha (1x)	3.5	8.5	10.0	8.7	9.0	8.0
	Centurion Max 2.0 L/ha (2x)	4.5	4.7	9.5	10.0	9.3	9.0
	AHDB 9953 (0.5x)	4.7	6.3	10.0	10.0	9.7	9.3
	AHDB 9953 (1x)	6.5	9.0	10.0	9.3	9.0	7.5
	AHDB 9953 (2x)	3.0	9.5	10.0	7.7	9.0	8.0
	F prob. value	<0.001	<0.001	0.438	<0.001	<0.001	<0.001
d.f.	36	36	36	36	36	36	
S.E.D.	2.294	1.703	1.035	1.164	0.979	1.032	
L.S.D.	4.653	3.453	2.099	2.360	1.985	2.094	

Basil

Basil germination averaged 14.7% across all treatments, and therefore it was not possible to draw any firm conclusions on crop safety as there was also low emergence in the untreated pots (35%). Although no firm conclusions can be made from the results on basil, the following trends were noted. Basil which emerged from the pots treated with Devrinol 450 SC was only just under an acceptable vigour and may warrant further investigation. (Table 4, Figure 7). However, any seedlings which managed to emerge from pots treated with AHDB9987 or AHDB9974 at pre-emergence had markedly reduced vigour and therefore these products are not safe to use in basil. AHDB 9974 also reduced basil vigour when applied post-emergence.

The only product which was safe to use over basil at a post-emergence timing was Centurion Max at a rate of 0.5 L/ha (half dose). All other products reduced vigour, in many cases significantly.

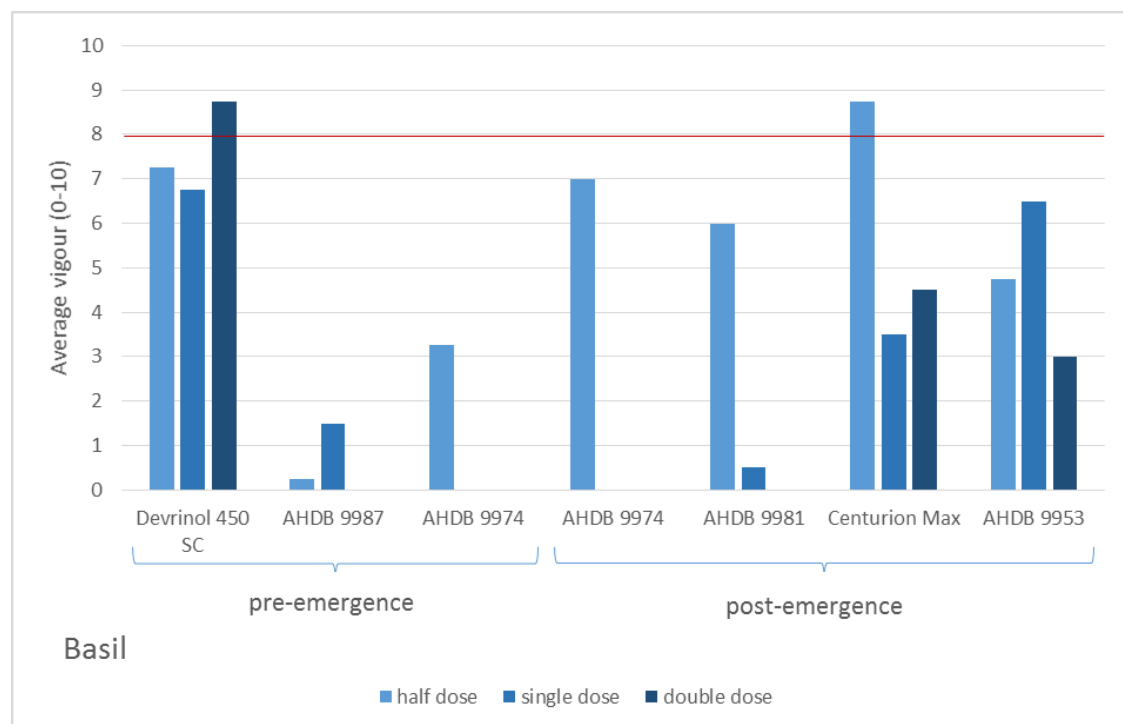


Figure 7. Mean vigour scores for basil treated with various herbicides, at half, single or double dose rate. Pre-emergence treatment assessments carried out 35 days after treatment, and post-emergence treatment assessments carried out 71 days after treatment. Scores of 8 or above deemed acceptable vigour (as indicated by red line).

Chives

Chive germination was reasonable at 62.5%, and of the pre-emergence treatments Devrinol appears the most promising when applied at 1.4 L/ha (half-dose) (Table 4, Figure 8). Applying Devrinol 450 SC above 1.4 L/ha, reduces vigour and germination rate significantly (see germination results in previous section), AHDB9987 and AHDB9974 significantly reduce vigour when applied pre-emergence, and are not crop safe to basil.

Post-emergence application of Centurion Max up to 1.0 L/ha (single dose), and up to double dose of AHDB9953 appear safe to use in chives with only a slight reduction in vigour at these rates. AHDB9974 was only safe to chives up to half dose, but gave a very significant reduction in vigour if applied at single rate or above with complete crop death. AHDB9981 was not safe to chives and gave a significant reduction in vigour at all rates causing scorch and twisting.

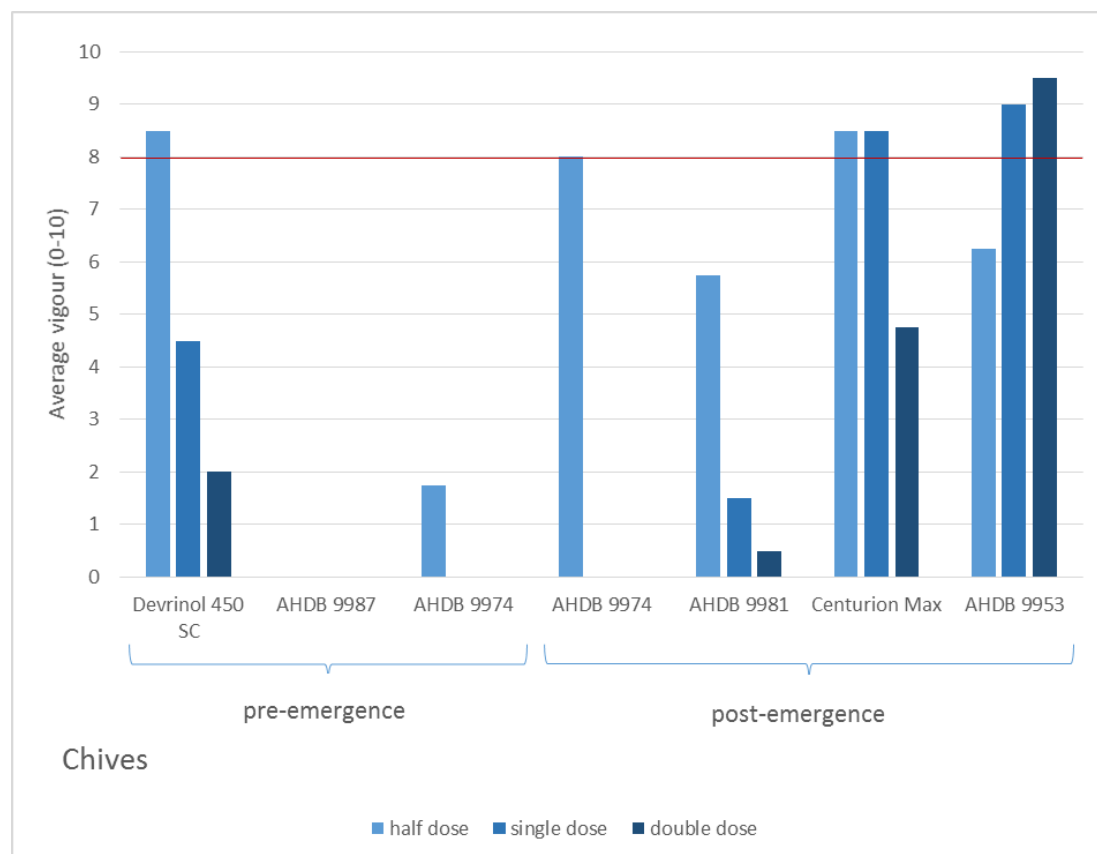


Figure 8. Mean vigour scores for chives treated with various herbicides, at half, single or double dose rate. Pre-emergence treatment assessments carried out 35 days after treatment, and post-emergence treatment assessments carried out 71 days after treatment. Scores of 8 or above deemed acceptable vigour (as indicated by red line).

Coriander

All post-emergence treatments tested were safe to apply to coriander up to at least single dose or label rate for the coded products and Centurion Max was safe up to 2.0 L/ha (Table 4, Figure 9). AHDB9981 may cause some cloudy yellow spotting soon after application, but the plants recovered by maturity.

At pre-emergence AHDB9974 showed no significant reduction in vigour in the seedlings which had germinated, at any rate used, but in the germination counts, there was a slight reduction in numbers when the product was applied at double dose (see germination results in previous section). Therefore AHDB9974 is only safe up to single dose. For Devrinol 450 SC and AHDB9987 there was reduced vigour with increasing rate, and taking into account the germination data as well, then these products may only be safe up to half dose for AHDB9987, or 1.4 L/ha for Devrinol 450 SC. And, even then there was a slight reduction in number of seedlings germinated.

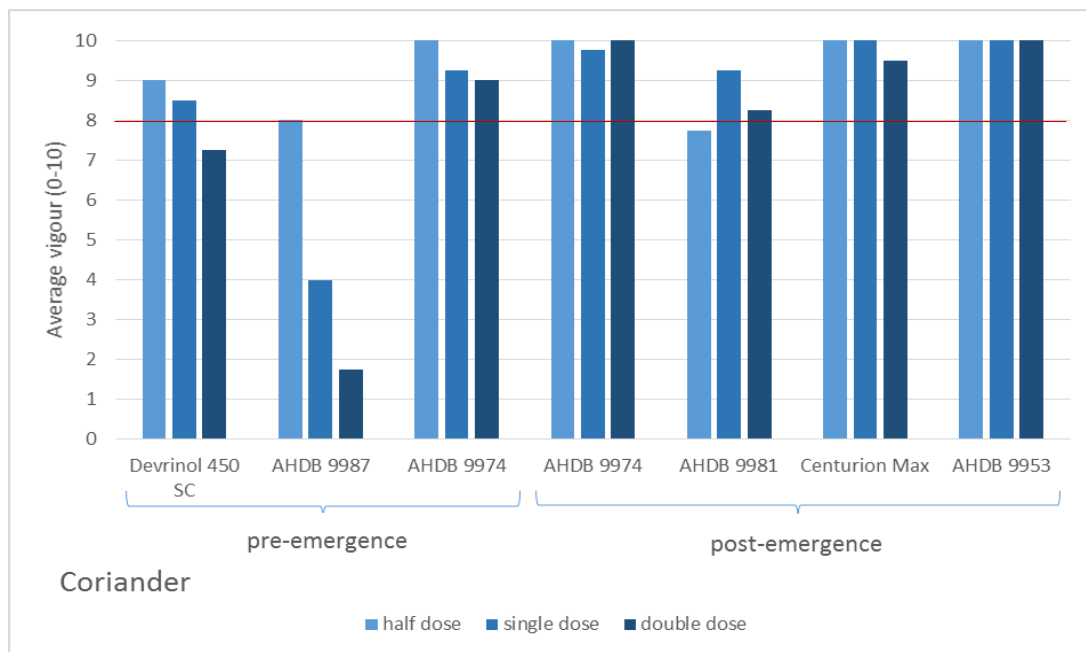


Figure 9. Mean vigour scores for coriander treated with various herbicides, at half, single or double dose rate. Pre-emergence treatment assessments carried out 35 days after treatment, and post-emergence treatment assessments carried out 61 days after treatment. Scores of 8 or above deemed acceptable vigour (as indicated by red line).

Dill

Three of the post-emergence treatments were safe to use over dill up to at least single dose (AHDB9981, AHDB9953 and Centurion Max) (Table 4, Figure 10). AHDB9974 was not safe to use over dill with a significant reduction in vigour at any rate used with severe scorching, stunting and crop death.

Pre-emergence applications of Devrinol 450 SC, AHDB9987 and AHDB9974 were not safe to use for dill, and at any rate tested gave a significant reduction in the vigour of any seedlings which had germinated.

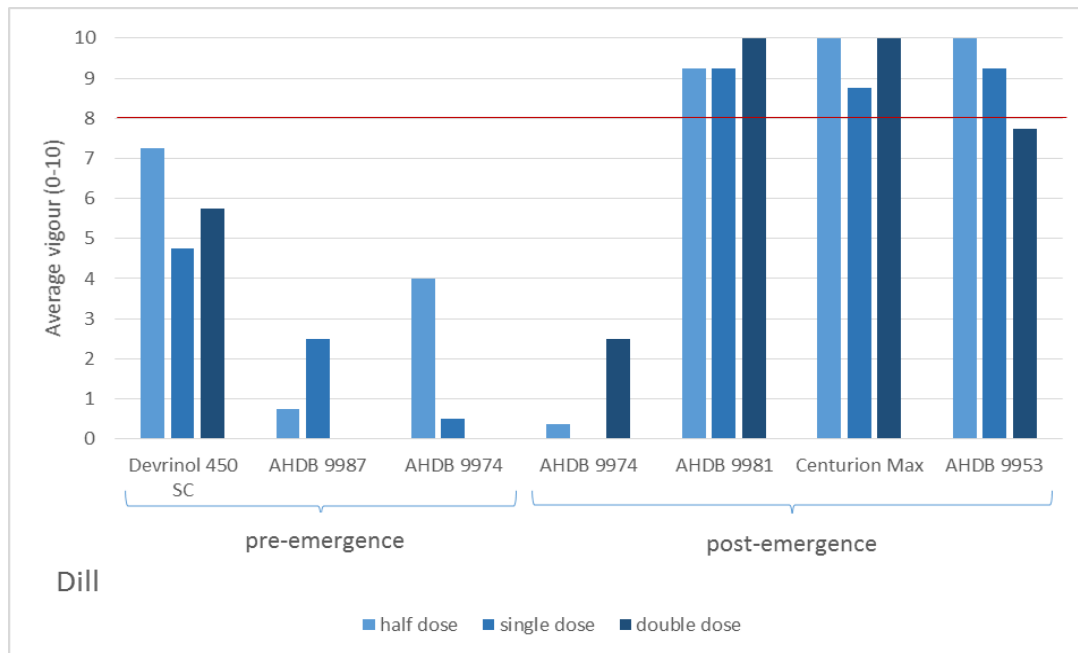


Figure 10. Mean vigour scores for dill treated with various herbicides, at half, single or double dose rate. Pre-emergence treatment assessments carried out 35 days after treatment, and post-emergence treatment assessments carried out 61 days after treatment. Scores of 8 or above deemed acceptable vigour (as indicated by red line).

Fenugreek

Three of the post-emergence treatments were safe to use over fenugreek up to at least single dose (AHDB9981, AHDB9953 and Centurion Max) (Table, 4, Figure 11). As with dill, AHDB9974 was not safe to use over fenugreek with a significant reduction in vigour at any rate used with severe scorching, stunting and crop death.

Devrinol 450 SC was safe to dill applied pre-emergence up to 2.8 L/ha (single dose), but when applied at 5.6 L/ha (double dose), a significant reduction in vigour was seen. AHDB9987 and AHDB 9974 were not safe to fenugreek when applied pre-emergence and caused stunting and reduced emergence.

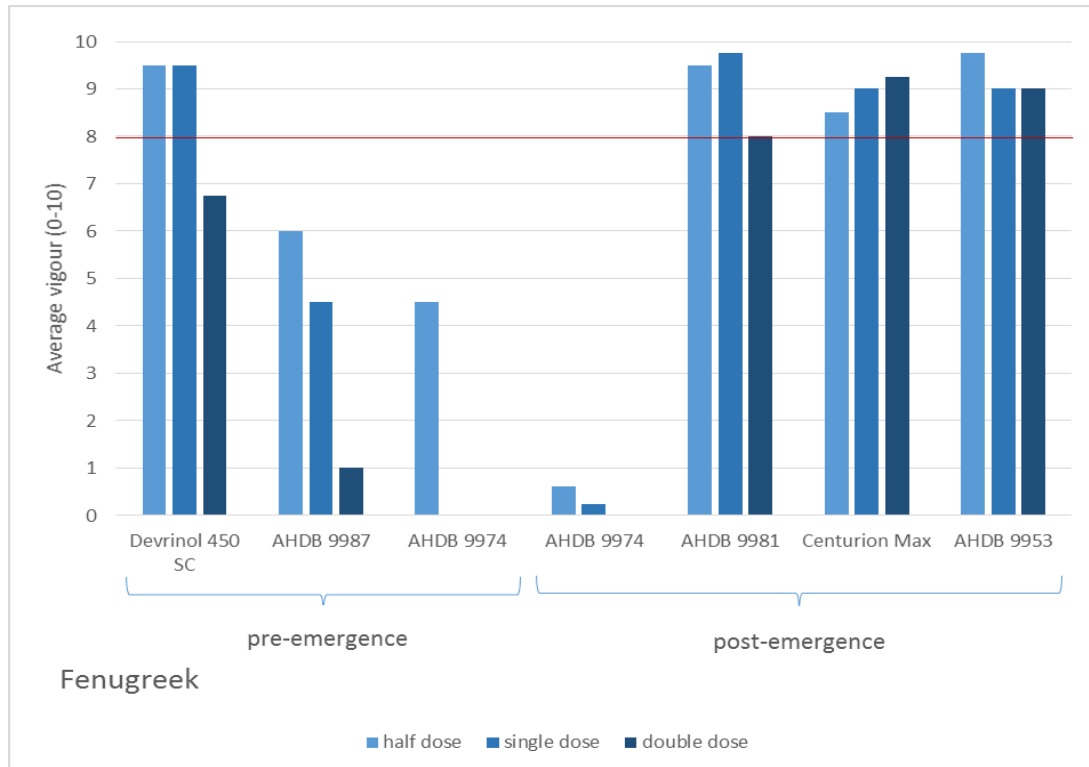


Figure 11. Mean vigour scores for fenugreek treated with various herbicides, at half, single or double dose rate. Pre-emergence treatment assessments carried out 35 days after treatment, and post-emergence treatment assessments carried out 61 days after treatment. Scores of 8 or above deemed acceptable vigour (as indicated by red line).

Parsley

Two of the pre-emergence treatments could be safe to use in parsley; the vigour of plants treated with Devrinol 450 SC was close to acceptable at all applied rates, while AHDB 9974 was safe to parsley up to half dose, but if applied above this rate no seedlings emerged. (Table 4, Figure 12). AHDB 9987 was not safe applied pre-emergence and significantly reduced the vigour of the parsley.

Three of the post-emergence treatments were safe to use over parsley up to half dose (AHDB974, AHDB9953 and Centurion Max). AHDB9981 was not safe to use over parsley, causing crop death and severe stunting.

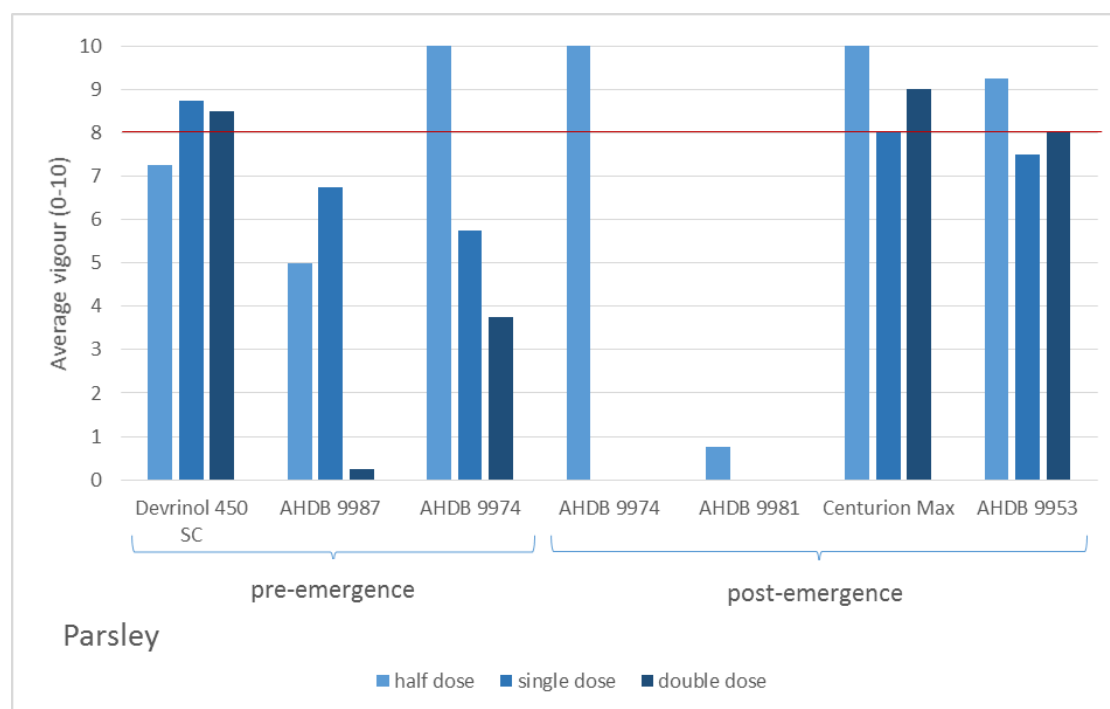


Figure 12. Mean vigour scores for parsley treated with various herbicides, at half, single or double dose rate. Pre-emergence treatment assessments carried out 35 days after treatment, and post-emergence treatment assessments carried out 71 days after treatment. Scores of 8 or above deemed acceptable vigour (as indicated by red line).

Conclusions

Note: these results are based on pot trials, and the most promising would need repeating in soil grown crops to confirm crop safety.

For those herbs where germination was greater than 60% (chives, coriander, dill, fenugreek and parsley) the following conclusions can be drawn

Pre-emergence

- Devrinol 450 SC was safe to nearly all the herb species when applied at up to 1.4 L/ha (half dose) with the exception of dill. However, it has subsequently been approved for use at a lower rate of 0.85 L/ha, and this rate wasn't tested in the trial. There is a possibility that it could still be safe to dill, and this warrants further testing.
- AHDB 9987 was only safe to coriander up to half dose, but still gave a reduction in the percentage of seedlings which emerged and therefore this product is less promising for use in herbs.
- AHDB 9974 was safe to use on coriander up to single dose or label rate, and half dose rate in parsley

Post-emergence

- AHDB 9974 was safe to use over coriander up to double rate, but only up to half rate/dose for parsley
- AHDB 9981 was safe to dill and fenugreek up to single dose
- Centurion Max was safe to all herbs listed above when applied up to a rate of 1.0 L/ha (single dose).
- AHDB 9953 was safe to all herbs listed above when applied up to half dose

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 the BHTA, particularly Claire Donkin and Rob Gibb for their technical input.

Appendix

- a. Crop diary – events related to growing crop

Crop	Cultivar	Planting date
Herbs	Basil Chives Coriander Dill Fenugreek Parsley	09/08/2017

Details of irrigation regime

Date	Type, rate and duration	Amount applied (mm)
N/A	Automatic sprinkler, and hand watering as necessary	-

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

Date	Event
10/08/2017	Applied pre-emergences treatments (Timing A, treatments 2 to 10).
12/09/2017	Applied post-emergence sprays to fenugreek only (Timing B, treatments 11 to 28). COR, DILL, FENU
27/09/2017	Applied post-emergence sprays to fenugreek only (Timing B, treatments 11 to 28). BAS, CHIV, PARS
13/09/2017	35 Days after application A Emergence and Vigour assessment
09/10/2017	Carried out vigour assessment
19/10/2017	Carried out vigour assessment.

c. Trial design (extract, block 1 of 4)

Block 1											
Plot	Herb	Trt	Plot	Herb	Trt	Plot	Herb	Trt	Plot	Herb	Trt
40	CHI	4	80	COR	12	120	PAR	2			
39	CHI	10	79	COR	18	119	CHI	22			
38	PAR	10	78	PAR	18	118	CHI	2			
37	FENU	22	77	PAR	5	117	PAR	20			
36	FENU	7	76	DILL	4	116	FENU	6			
35	DILL	12	75	FENU	9	115	FENU	1			
34	FENU	20	74	COR	6	114	FENU	12			
33	BAS	15	73	CHI	21	113	BAS	3			
32	PAR	6	72	CHI	11	112	COR	21			
31	COR	10	71	BAS	13	111	FENU	16			
30	CHI	8	70	CHI	15	110	COR	1			
29	BAS	1	69	CHI	14	109	BAS	4			
28	CHI	12	68	PAR	7	108	FENU	21			
27	DILL	5	67	PAR	11	107	FENU	15			
26	COR	7	66	FENU	8	106	COR	14			
25	CHI	5	65	BAS	8	105	FENU	11			
24	BAS	6	64	PAR	12	104	DILL	21			
23	DILL	9	63	BAS	10	103	COR	13			
22	CHI	16	62	COR	15	102	DILL	19			
21	CHI	13	61	CHI	20	101	FENU	3			
20	COR	16	60	BAS	12	100	DILL	18			
19	BAS	16	59	BAS	11	99	DILL	2			
18	DILL	7	58	PAR	22	98	PAR	19			
17	DILL	17	57	COR	9	97	BAS	7			
16	CHI	9	56	COR	5	96	CHI	6			
15	DILL	3	55	DILL	14	95	FENU	5			
14	DILL	16	54	COR	17	94	CHI	7			
13	FENU	10	53	COR	20	93	PAR	17			
12	BAS	19	52	PAR	21	92	BAS	21	132	DILL	1
11	FENU	2	51	DILL	10	91	PAR	16	131	FENU	13
10	DILL	15	50	FENU	14	90	CHI	18	130	COR	19
9	PAR	8	49	FENU	4	89	BAS	20	129	COR	2
8	BAS	18	48	DILL	6	88	BAS	5	128	BAS	9
7	BAS	22	47	DILL	11	87	CHI	17	127	DILL	13
6	BAS	2	46	PAR	9	86	DILL	8	126	BAS	14
5	FENU	19	45	PAR	15	85	PAR	3	125	CHI	3
4	FENU	18	44	COR	4	84	DILL	22	124	BAS	17
3	COR	3	43	PAR	14	83	CHI	19	123	COR	11
2	PAR	4	42	COR	22	82	CHI	1	122	PAR	13
1	COR	8	41	FENU	17	81	PAR	1	121	DILL	20

d. 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
Biologicals and Semiochemicals
Stored Crops**

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

Signature

Authorised signatory

Certification Number

ORETO 374

