

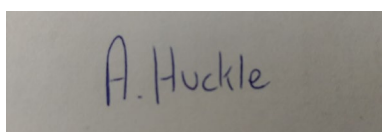
# SCEPTREPLUS

## Final Trial Report

<b>Trial code:</b>	2020. SP13
<b>Title:</b>	<b>AHDB Sceptreplus Pumpkin pre-emergence herbicide screen</b>
<b>Crop</b>	Group: field vegetables – Cucurbita (pumpkin)
<b>Target</b>	General broadleaf weeds and grasses, 3WEEDT
<b>Lead researcher:</b>	Angela Huckle
<b>Organisation:</b>	RSK ADAS
<b>Period:</b>	1 <sup>st</sup> April 2020 – 31 <sup>st</sup> January 2021
<b>Report date:</b>	1/11/2021
<b>Report author:</b>	Angela Huckle Callum Burgess
<b>ORETO Number: (certificate should be attached)</b>	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

1<sup>st</sup> November 2021...  
Date



Authors signature

# Trial Summary

## Introduction

There are currently very few herbicide options for weed control for cucurbit growers with only three residual herbicides approved under EAMU for use on the crop. These include isoxaben, propyzamide and, most recently, clomazone which gained approval in 2015 to improve control of groundsel. Wing-P (dimethenamid-P and pendimethalin) is also approved for inter-row application, but it only offers temporary suppression and can be damaging if not applied with care, such as use of a shielded applicator.

This limited range of herbicides leaves gaps in the weed control spectrum, and growers experience problems with a wide range of weeds. In particular, polygonum weeds, black nightshade, black bindweed, sowthistle, and several grass weeds including annual meadow grass, volunteer cereals (especially barley), wild oat, black-grass and brome are problematic for growers. As well as competing with the crop for nutrients and water, these weeds also hinder pickers, reducing harvest efficiency.

This study was set up to compare several herbicides both new and commercially available at pre-emergence timings for their efficacy against weed species in a crop of drilled pumpkins. Weeds are the most common problem in field crops and can lead to crop loss, yield reduction and reduced plant health. Specific target herbicides that deal with broad leaved and grass species are very few and the diversity of weed species makes it particularly difficult to find broad effective treatments for weeds that don't also damage the crop. Transport and distribution of weeds can commonly occur through soil dormancy, soil transfer, animal vectors and through the air, and can be frequently found on borders and field margins.

The objective of this trial was to identify crop safe and effective herbicides for weed control in pumpkins, aiming to expand the options available to growers.

## Methods

The trial was sited in a pumpkin crop cv. Mars, in Weston Sands Milcote. Ten treatments were applied on 1<sup>st</sup> May 2020 pre- crop emergence , and three days after drilling (Timing A). Finalsan + Li-700 and AHDB 9897 were applied seven days after drilling and before crop-emergence on 8<sup>th</sup> May (Timing B) to catch any emerging weeds prior to crop emergence. All treatments were applied with a 2 m boom, using a knapsack sprayed at 200 L/ha water volume. A randomized block design was used for the trial layout, with four replicates of 14 treatments, two of which were untreated controls. There were 56 plots in total, each measuring 2 m x 5 m.

The plots were assessed on eight occasions (see 'Assessment details'), focusing on crop phytotoxicity (i.e. treatment safety), weed cover and species present for six of the assessments, with the final assessment considering crop quality. At this final harvest assessment, parameters such as numbers of pumpkins per plot, and diameter and colour or ripeness were measured. Assessments were carried out 20, 26, 40, 54, 60, 89, 118 and 139 days after treatments were applied.

## Results

Seven treatments significantly reduced percentage weed cover at 118 days (nearly 17 weeks) after application. These were the standard Kerb Flo 1.8 L/ha + Gamit 0.25 L/ha, AHDB 9898 alone or in a tank mix with AHDB 9987 1.0 L/ha, AHDB 9917 and AHDB 9994 1.0 L/ha when applied early pre-emergence, and AHDB 9897 or Finalsan 17 L/ha + Li-700 applied a week after drilling, but still pre-emergence (Table 1). The standard, Kerb Flo 1.8 L/ha + Gamit 0.25 L/ha, AHDB 9897, and Finalsan 17 L/ha + Li-700 reduced the weed cover by the greatest amount of 76.4%, 77.4% and 72.9% respectively at 118 days after application (Table 2).

Differences did not become clearly apparent until 54 days after application due to low weed germination for the first two months as the weather was very dry. These dry conditions at drilling and application also affected the efficacy of selected residual herbicides such as Flexidor and AHDB9987 which require moisture at application to work well.

At the assessment 89 days after the Timing A Application weed levels were seen to drop in the figures, this is likely due to the size of the pumpkin canopy confounding the visual assessment. The weed levels across the treatments still follow a similar pattern to the previous and following assessment, so are still valid.

**Table 1.** Mean percentage weed cover values at 26, 40, 54, 60, 89, and 118 days after preharvest treatment application. Timing A = just after drilling, Timing B = 7 days

Treatment	Timing	Mean percentage weed cover (%) At days after Timing A application						
		26 DAA	40 DAA	54 DAA	60 DAA	89 DAA	118 DAA	
		27 <sup>th</sup> May	10 <sup>th</sup> June	24 <sup>th</sup> June	30 <sup>th</sup> June	29 <sup>th</sup> July	27 <sup>th</sup> Aug	
Untreated		7.7	11.2	40.6	40.0	35.0	52.5	
Kerb Flo 1.8 L/ha Gamit 36 CS 0.25 L/ha	A	3.5	6.7	25.0	15.0	15.0	12.5	
Flexidor 0.5 L/ha Gamit 36 CS 0.25 L/ha	A	6.8	13.7	33.7	43.0	18.8	38.7	
AHDB 9987 2.0 L/ha	A	6.0	13.7	40.0	53.7	36.2	48.7	
AHDB 9987 1.0 L/ha Gamit 36 CS 0.25 L/ha	A	4.0	6.0	23.7	28.0	17.5	30.0	
AHDB 9987 1.0 L/ha AHDB 9898	A	4.0	10.0	25.0	23.7	15.0	17.5	
AHDB 9987 1.0 L/ha AHDB 9917	A	7.7	10.0	31.3	43.0	38.8	30.0	
AHDB 9898	A	5.3	7.3	26.3	18.0	18.8	26.3	
AHDB 9917	A	5.5	9.5	32.5	28.7	29.2	26.3	
AHDB 9918	A	5.5	13.3	31.3	36.3	20.0	30.0	
AHDB 9994 1.0 L/ha	A	4.3	8.3	22.5	31.3	27.0	27.5	
AHDB 9897	B	1.4	4.0	11.3	8.3	13.7	12.5	
Finalsan 17.0 L/ha Li-700 1.0 L/ha	B	2.5	6.0	10.5	17.5	11.7	15.0	
<b>p-value</b>		0.115 (NS)	0.013	0.049	0.004	0.315 (NS)	0.006	
<b>d.f.</b>		40	40	40	40	40	40	
<b>L.S.D.</b>		4.612	5.685	20.11	21.90	28.31	24.30	
		Significantly different from the untreated control						
		Not significantly different from the untreated control						

**Table 2.** Percentage reduction in weed cover compared to the untreated control calculated using Abbott's formula from back transformed means at 26, 40, 54, and 60, 89, and 118 days after preharvest treatment application. Minus figures indicate an increase in weed.

Treatment	Timing	Percentage reduction in weed cover At days after Timing A application					
		26 DAA	40 DAA	54 DAA	60 DAA	89 DAA	118 DAA
		27 <sup>th</sup> May	10 <sup>th</sup> June	24 <sup>th</sup> June	30 <sup>th</sup> June	29 <sup>th</sup> July	27 <sup>th</sup> Aug
Kerb Flo 1.8 L/ha Gamit 36 CS 0.25 L/ha	A	50.6	38.5	41.5	61.8	59.2	76.4
Flexidor 0.5 L/ha Gamit 36 CS 0.25 L/ha	A	16.1	-24.9	19.1	-8.2	46.3	29.8
AHDB 9987 2.0 L/ha	A	19.8	-27.9	1.4	-40.4	-5.2	7.9
AHDB 9987 1.0 L/ha Gamit 36 CS 0.25 L/ha	A	48.7	42.2	44.6	31.5	50.6	45.3
AHDB 9987 1.0 L/ha AHDB 9898	A	48.7	5.6	39.9	40.9	57.1	67.4

Treatment	Timing	Percentage reduction in weed cover At days after Timing A application					
		26 DAA	40 DAA	54 DAA	60 DAA	89 DAA	118 DAA
		27 <sup>th</sup> May	10 <sup>th</sup> June	24 <sup>th</sup> June	30 <sup>th</sup> June	29 <sup>th</sup> July	27 <sup>th</sup> Aug
AHDB 9987 1.0 L/ha AHDB 9917	A	-5.6	8.1	23.4	-9.3	-29.5	44.9
AHDB 9898	A	25.7	32.4	36.1	54.4	45.7	50.3
AHDB 9917	A	25.7	12.9	22.6	28.9	25.2	53.4
AHDB 9918	A	25.4	-19.8	23.7	9.9	42.3	45.8
AHDB 9994 1.0 L/ha	A	47.7	25.6	48.5	24.1	85.5	51.8
AHDB 9897	B	92.2	64.7	74.8	80.6	60.9	77.4
Finalsan 17.0 L/ha Li-700 1.0 L/ha	B	73.9	50.7	76.6	56.4	71.3	72.9

The best performing treatments were foliar contact acting herbicides **AHDB 9897** and **Finalsan 17.0 L/ha + Li-700 1.0 L/ha** applied a week after drilling. It is likely that some weeds had germinated and although not all were visible at the soil surface, the spray application would have made contact with the hypocotyl at peri-emergence and killed them. A degree of brinkmanship and risk is associated with this approach as the weeds need to be caught before the pumpkins reach peri-emergence.

**Kerb Flo** in a tank mix with **Gamit 36 CS** was the second most effective treatment used in this trial. Propyzamide which is the active ingredient of **Kerb Flo** has a long half-life of  $DT_{50}$  50-233 days which would cover the entire trial period in ideal conditions of cool weather, and although it was dry at application, the persistent nature of the herbicide would have meant that it would have still have had some activity when the rain eventually occurred at the end of June. In contrast **Flexidor** and **AHDB 9987** are less persistent ( $DT_{50}$  of 105 to 123, and 80 days respectively) and both need moisture at application to be effective, therefore the environmental conditions when the sprays were applied were not conducive to the effectiveness of these herbicides and they showed poor performance. Conditions at application need to be taken into account when these products are used, and when selecting which product to use.

The inclusion of **Gamit 36 CS** in a tank mix with **Flexidor** and **AHDB 9987** improved efficacy of weed control compared to when the products were used alone, and was bringing most of the control in the tank mix with AHDB 9987. Gamit 36 CS is also useful for control of fat hen and black nightshade, and has a little contact activity.

**AHDB 9898** also shows promise reducing percentage weed levels by 50% by the final assessment when used alone, and could be a promising product to tank mix with Gamit 36 CS as an alternative to Flexidor and Kerb. The product improved weed control efficacy when tank mixed with AHDB 9987 increasing weed control by 60% from 7.9% weed reduction to a 67.4% weed reduction. AHDB 9898 has activity on weeds such as annual grasses, amaranth, fat hen, black nightshade and groundsel.

**AHDB 9917** significantly reduced weed levels by 53.4% when used alone, even though it is a residual herbicide targeted at grass weeds. It was safe to use pre-emergence, and an authorization for the crop could be useful. **AHDB 9994 1.0 L/ha** also significantly reduced percentage weed cover by a similar level, and was safe to use alone pre-emergence, but care would need to be taken with tank mixes as seen in its commercial use in carrots.

## Conclusions

- Seven treatments significantly reduced percentage weed cover –
  - These were the standard Kerb Flo 1.8 L/ha + Gamit 0.25 L/ha, AHDB 9898 alone or in a tank mix with AHDB 9987 1.0 L/ha, AHDB 9917 and AHDB 9994 1.0 L/ha when applied early pre-emergence.

- And AHDB 9897 or Finalsan 17 L/ha + Li-700 applied a week after drilling, but still pre-emergence.
- All treatments were crop safe with only transient and slight effects observed on the crop, which persisted for no more than two weeks after application.

**Take home message:**

Using **Finalsan 17 L/ha plus an appropriate adjuvant** as a stale seed bed, or pre-emergence spray in pumpkins could improve weed control in current grower programs. The authorization of **AHDB 9897, AHDB 9898, AHDB 9918, AHDB 9987 or AHDB 9994 1.0 L/ha** as pre-emergence applications would also improve weed control, and provide growers with alternatives to aid in preventing the development of resistance to currently available actives.

## Objectives

To compare a number of new and novel herbicides at a pre-emergence application timing for selectivity (crop safety) and efficacy in pumpkins.

## 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	EPPO PP1/135(4)
EPPO PP1/152(4)	Guideline on design and analysis of efficacy evaluation trials	EPPO PP1/152(4)
EPPO PP1/225 (2)	Minimum effective dose	EPPO PP1/225 (2)
EPPO PP1/181 (4)	Conduct and reporting of efficacy evaluation trials including good experimental practice	EPPO PP1/181 (4)

There were no deviations from EPPO guidance:

## Test site

Item	Details
Location address	Weston Sands Milcote Weston on Avon CV37 8JW
Crop	Pumpkin
Cultivar	Mars
Soil or substrate type	Sandy loam
Agronomic practice	N/A
Prior history of site	N/A

## Trial design

Item	Details
Trial design:	Randomized block
Number of replicates:	4
Row spacing:	N/A
Plot size: (w x l)	2 m x 5 m
Plot size: (m <sup>2</sup> )	10
Number of plants per plot:	Varied due to variable establishment
<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	Formulation type
Untreated	-	-	-	-	-
Untreated	-	-	-	-	-
N/A	Propyzamide + Clomazone	Kerb Flo Gamit 36 CS	Not known 124684734	400 g/L 360 g/L	- Suspension concentrate - Capsule suspension
N/A	isoxaben +	Flexidor	Not known	500 g/L	- Suspension

AHDB Code	Active substance	Product name/ manufacturers code	Formulation batch number	Content of active substance in product	Formulation type
	clomazone	Gamit 36 CS	124684734	360 g/L	concentrate - Capsule suspension
AHDB 9987	Confidential				
AHDB 9987 + N/A	Confidential				
	clomazone	Gamit 36 CS	124684734	360 g/L	- Capsule suspension
AHDB 9987 + AHDB 9898	Confidential				
AHDB 9987 + AHDB 9917	Confidential				
AHDB 9898	Confidential				
AHDB 9917	Confidential				
AHDB 9918	Confidential				
AHDB 9994	Confidential				
AHDB 9897	Confidential				
N/A	pelargonic acid	Finalsan	11900432	186.7 g/L	- Emulsifiable concentrate
	lecithin, propionic acid and alcohol ethoxylate	Li-700	Not known	35% 35% 9.39%	- Emulsifiable concentrate

### 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	Untreated	-	-	-
3	Kerb Flo + Gamit 36 CS	720 90	1.80 0.25	A
4	Flexidor + Gamit 36 CS	250 90	0.50 0.25	A
5	AHDB 9987	1200	2.00	A
6	AHDB 9987 + Gamit 36 CS	600 90	1.00 0.25	A
7	AHDB 9987 + AHDB 9898	600 252	1.00 0.35	A
8	AHDB 9987 + AHDB 9917	600 525	1.00 0.70	A
9	AHDB 9898	504	0.70	A
10	AHDB 9917	525	0.70	A

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
11	AHDB 9918	240	0.48	A
12	AHDB 9994	600	1.00	A
13	AHDB 9897	21.2	0.80	B
14	Finalsan	3173.9	17.00	B
	Li-700	350	1.00	
		93.9		

### Application details

	Application A	Application B
Application date	01/05/2020	08/05/2020
Time of day	11.15 - 13.15	09:55 – 11:10
Crop growth stage (Max, min average BBCH)	Pre-emergence	Pre-emergence
Crop height (cm)	0	0
Crop coverage (%)	N/A	N/A
Application Method	Spray	Spray
Application Placement	Soil	Soil
Application equipment	OPS sprayer with a 2 m boom	OPS sprayer with a 2 m boom
Nozzle pressure	2 Bar	2 Bar
Nozzle type	02/F110	02/F110
Nozzle size	Medium	Medium
Application water volume/ha	200 L/ha	200 L/ha
Temperature of air - shade (°C)	13.95	22.0
Relative humidity (%)	72.55	73.65
Wind speed range (m/s)	3.5	0.05
Dew presence (Y/N)	N	N
Temperature of soil - 2-5 cm (°C)	N/A	N/A
Wetness of soil - 2-5 cm	Damp	Dry
Cloud cover (%)	25	30

### 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	0%	7.7%	52.5%



## Assessment details

All results from the phytotoxicity assessments were digitally recorded and were based on visual symptoms seen on the plants. Symptoms could include stunting of growth, discoloration, chlorosis, spotting, necrosis, twisting, crinkling, leaf thickening or scorch, amongst other effects. Where any phytotoxicity was suspected details of the condition were described and scored. Scores ranged from 0 to 10 with each score relating to a percentage from 0 – 100%.

The overall weed levels were recorded at every assessment as a % total weed cover score for each plot. A record of the weed species present in each plot was also made at each assessment. Comments on any effects of the treatments on the weeds once the herbicides have been applied were noted.

Evaluation date	Evaluation Timing		Evaluation type (efficacy, phytotox)	Assessment
	Days after Application A	Crop Growth Stage (BBCH)		
21/05/2020	20	10	Phytotoxicity/Crop emergence	Phytotox (scale 0-10, 10 = dead) & Percentage of crop cover (whole plot score). Weed species.
27/05/2020	26	11	Phytotoxicity/Efficacy	Phytotox (scale 0-10, 10 = dead) & Percentage of weed cover (whole plot score). Weed species.
10/06/2020	40	14	Phytotoxicity/Efficacy	Phytotox (scale 0-10, 10 = dead) & Percentage of weed cover (whole plot score). Weed species.
24/06/2020	54	51	Efficacy	Percentage of weed cover (whole plot score). Weed species.
30/06/2020	60	52	Efficacy	Percentage of weed cover (whole plot score). Weed species.
29/07/2020	89	71	Efficacy	Percentage of weed cover (whole plot score). Weed species.
27/08/2020	118	81	Efficacy	Percentage of weed cover (whole plot score). Weed species.
17/09/2020	139	89	Crop quality and pumpkin circumference	Harvest

## Statistical analysis

Data was analysed by analysis of variance by Chris Dyer using Genstat. A significance level of  $p < 0.05$  was used to compare all treatments. All significant results were analyzed with a Duncans test and % reduction is calculated using Abbots formula from results which have undergone angular transformation. Angular and back transformation of the data was used where appropriate as the distribution of the weeds across the trial area was uneven.

## Results

### Phytotoxicity

There were no persistent crop effects, but there was some slight stunting in plots treated with AHDB 9994 1.0 L/ha, AHDB9897 and Finalsan 17 L/ha + Li-700. This stunting had passed a month after application. Therefore, the results of the phytotoxicity test indicated no statistical significance for all assessment dates due to there being little to no damage to the pumpkin plants.

There were no statistically significant differences in percentage crop emergence after 20, 26, and 40 days. The crop was patchy but this was due to the seed batch and field effects rather than treatments (Table 1).

**Table 1.** Mean percentage crop emergence at 20, 26, and 40 days after preharvest treatment Timing A application.

Treatment	Timing	Mean percentage crop emergence (%) At days after Timing A application		
		20 DAA	26 DAA	40 DAA
		21 <sup>st</sup> May	27 <sup>th</sup> May	10 <sup>th</sup> June
Untreated		38.8	45.6	45.6
Kerb Flo 1.8 L/ha Gamit 36 CS 0.25 L/ha	A	45.0	45.0	45.0
Flexidor 0.5 L/ha Gamit 36 CS 0.25 L/ha	A	40.0	45.0	45.0
AHDB 9987 2.0 L/ha	A	42.5	32.5	32.5
AHDB 9987 1.0 L/ha Gamit 36 CS 0.25 L/ha	A	47.5	52.5	52.5
AHDB 9987 1.0 L/ha AHDB 9898	A	52.5	57.5	57.5
AHDB 9987 1.0 L/ha AHDB 9917	A	42.5	42.5	42.5
AHDB 9898	A	35.0	38.8	38.8
AHDB 9917	A	40.0	45.0	45.0
AHDB 9918	A	47.5	42.5	42.5
AHDB 9994 1.0 L/ha	A	48.9	47.5	47.5
AHDB 9897	B	51.2	55.0	55.0
Finalsan 17.0 L/ha Li-700 1.0 L/ha	B	40.0	55.0	55.0
<b>p-value</b>		0.845	0.412	0.412
<b>d.f.</b>		39	39	39
<b>L.S.D.</b>		20.62	19.54	19.54
		Significantly different from the untreated control		
		Not significantly different from the untreated control		

### Efficacy

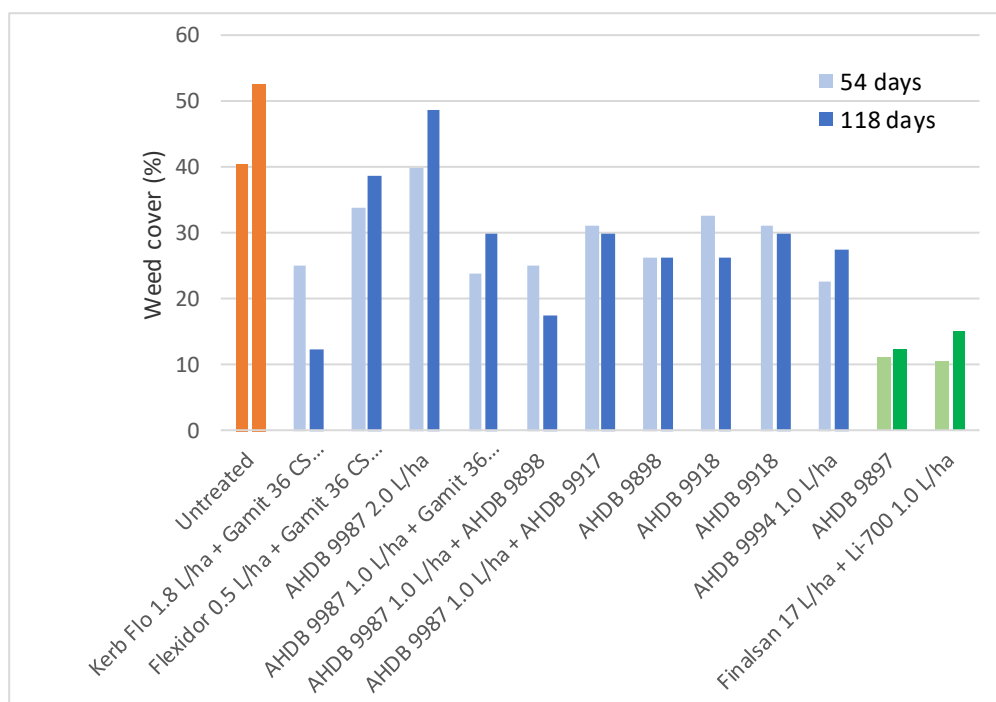
Seven treatments significantly reduced percentage weed cover at 118 days (nearly 17 weeks) after application (Table 2 and 3, Figure 1). These were the standard Kerb Flo 1.8 L/ha + Gamit 0.25 L/ha, AHDB 9898 alone or in a tank mix with AHDB 9987 1.0 L/ha, AHDB 9917 and AHDB 9994 1.0 L/ha when applied early pre-emergence. And AHDB 9897 or Finalsan 17 L/ha + Li-700 applied a week after drilling, but still pre-emergence. The standard, Kerb Flo 1.8 L/ha + Gamit 0.25 L/ha, AHDB 9897 and Finalsan 17 L/ha + Li-700 reduced the weed cover by the greatest amount of 76.4%, 77.4% and 72.9% respectively at 118 days after application (Table 4).

Differences did not become clearly apparent until 54 days after application due to low weed levels for the first two months as the weather was very dry.

At the assessment 89 days after the Timing A application weed levels were seen to drop in the figures, this is likely due to the size of the pumpkin canopy confounding the visual assessment. The weed levels across the treatments still follow a similar pattern to the previous and following assessment, so are still valid.

**Table 2.** Mean percentage weed cover values at 26, 40, 54, and 60, 89, and 118 days after preharvest treatment application.

Treatment	Timing	Mean percentage weed cover (%)						
		At days after Timing A application						
		26 DAA	40 DAA	54 DAA	60 DAA	89 DAA	118 DAA	
		27 <sup>th</sup> May	10 <sup>th</sup> June	24 <sup>th</sup> June	30 <sup>th</sup> June	29 <sup>th</sup> July	27 <sup>th</sup> Aug	
Untreated	-	7.7	11.2	40.6	40.0	35.0	52.5	
Kerb Flo 1.8 L/ha Gamit 36 CS 0.25 L/ha	A	3.5	6.7	25.0	15.0	15.0	12.5	
Flexidor 0.5 L/ha Gamit 36 CS 0.25 L/ha	A	6.8	13.7	33.7	43.0	18.8	38.7	
AHDB 9987 2.0 L/ha	A	6.0	13.7	40.0	53.7	36.2	48.7	
AHDB 9987 1.0 L/ha Gamit 36 CS 0.25 L/ha	A	4.0	6.0	23.7	28.0	17.5	30.0	
AHDB 9987 1.0 L/ha AHDB 9898	A	4.0	10.0	25.0	23.7	15.0	17.5	
AHDB 9987 1.0 L/ha AHDB 9917	A	7.7	10.0	31.3	43.0	38.8	30.0	
AHDB 9898	A	5.3	7.3	26.3	18.0	18.8	26.3	
AHDB 9917	A	5.5	9.5	32.5	28.7	29.2	26.3	
AHDB 9918	A	5.5	13.3	31.3	36.3	20.0	30.0	
AHDB 9994 1.0 L/ha	A	4.3	8.3	22.5	31.3	27.0	27.5	
AHDB 9897	B	1.4	4.0	11.3	8.3	13.7	12.5	
Finalsan 17.0 L/ha Li-700 1.0 L/ha	B	2.5	6.0	10.5	17.5	11.7	15.0	
<b>p-value</b>		0.115	0.013	0.049	0.004	0.315	0.006	
<b>d.f.</b>		40	40	40	40	40	40	
<b>L.S.D.</b>		4.612	5.685	20.11	21.90	28.31	24.30	
		Significantly different from the untreated control						
		Not significantly different from the untreated control						



**Figure 1.** Percentage weed cover at 54 and 118 days after Timing A treatment application with the untreated control shown in orange and the two Timing B applications shown in green. The paler colour bars indicate results from 54 days, and the bolder colours show results from the last assessment at 118 days.

In Figure 1, the weed levels show expected trends of either increasing or remaining the same between the two assessments at 54 and 118 days, with the exception of Kerb Flo 1.8 L/ha + Gamit 36 CS 0.25 L/ha where the weed level reduced from 25% cover to 12.5% cover. This could be due to the long half life of the active propryzamide, which means it is persistent and still present to be reactivated by moisture after showers at the end of June, which would have initiated further weed germination and growth.

**Table 2.** Mean percentage weed cover values after angular (ANG) and back (BAC) transformation at 26, 40, 54, and 60, 89, and 118 days after preharvest treatment application.

Treatment	Timing	Mean percentage weed cover (%)											
		At days after Timing A application											
		26 DAA		40 DAA		54 DAA		60 DAA		89 DAA		118 DAA	
		27 <sup>th</sup> May	10 <sup>th</sup> June	24 <sup>th</sup> June	30 <sup>th</sup> June	29 <sup>th</sup> July	27 <sup>th</sup> Aug						
		ANG	BAC	ANG	BAC	ANG	BAC	ANG	BAC	ANG	BAC	ANG	BAC
Untreated		15.4	7.0	18.9	10.5	39.4	40.3	38.8	39.3	35.6	33.8	46.4	52.5
Kerb Flo 1.8 L/ha Gamit 36 CS 0.25 L/ha	A	10.7	3.5	14.7	6.5	29.1	23.6	22.8	15.0	21.8	13.8	20.6	12.4
Flexidor 0.5 L/ha Gamit 36 CS 0.25 L/ha	A	14.1	5.8	21.3	13.2	34.8	32.6	40.7	42.5	25.2	18.2	37.4	36.8
AHDB 9987 2.0 L/ha	A	13.7	5.6	21.6	13.5	39.1	39.8	48.0	55.2	36.6	35.6	44.1	48.4
AHDB 9987 1.0 L/ha Gamit 36 CS 0.25 L/ha	A	10.9	3.6	14.3	6.1	28.2	22.3	31.3	26.9	24.2	16.7	32.4	28.7
AHDB 9987 1.0 L/ha AHDB 9898	A	11.5	3.9	18.4	9.9	29.5	24.2	28.8	23.2	22.4	14.5	24.4	17.2
AHDB 9987 1.0 L/ha AHDB 9917	A	15.8	7.4	18.2	9.7	33.8	30.8	40.9	42.9	41.5	43.8	32.5	28.9
AHDB 9898	A	13.2	5.2	15.5	7.2	30.5	25.7	25.0	17.9	25.4	18.4	30.7	26.2
AHDB 9917	A	13.2	5.3	17.6	9.2	34.0	31.2	31.9	27.9	30.2	25.4	29.6	24.5
AHDB 9918	A	13.2	5.2	20.8	12.6	33.7	30.8	36.5	35.4	26.3	19.6	32.2	28.5
AHDB 9994 1.0 L/ha	A	11.1	3.6	16.3	7.8	27.1	20.7	33.1	29.8	12.8	4.9	30.2	25.3

Treatment	Timing	Mean percentage weed cover (%)											
		At days after Timing A application											
		26 DAA		40 DAA		54 DAA		60 DAA		89 DAA		118 DAA	
		27 <sup>th</sup> May		10 <sup>th</sup> June		24 <sup>th</sup> June		30 <sup>th</sup> June		29 <sup>th</sup> July		27 <sup>th</sup> Aug	
AHDB 9897	B	4.3	0.5	11.2	3.7	18.6	10.2	16.0	7.6	21.3	13.3	20.2	11.9
Finalsan 17.0 L/ha Li-700 1.0 L/ha	B	7.7	1.8	13.2	5.2	17.9	9.4	24.4	17.2	18.2	9.7	22.1	14.2
<b>p-value</b>		0.026		0.001		0.018		0.002		0.218 (NS)		0.005	
<b>d.f.</b>		40		40		40		40		40		40	
<b>L.S.D.</b>		6.233		5.009		12.99		13.91		20.33		15.41	
		Significantly different from the untreated control											
		Not significantly different from the untreated control											

NS = not significant

**Table 3.** Percentage reduction in weed cover compared to the untreated control calculated using Abbott's formula from back transformed means at 26, 40, 54, and 60, 89, and 118 days after preharvest treatment application. Minus figures indicate an increase in weed.

Treatment	Timing	Percentage reduction in weed cover					
		At days after Timing A application					
		26 DAA	40 DAA	54 DAA	60 DAA	89 DAA	118 DAA
		27 <sup>th</sup> May	10 <sup>th</sup> June	24 <sup>th</sup> June	30 <sup>th</sup> June	29 <sup>th</sup> July	27 <sup>th</sup> Aug
Kerb Flo 1.8 L/ha Gamit 36 CS 0.25 L/ha	A	50.6	38.5	41.5	61.8	59.2	76.4
Flexidor 0.5 L/ha Gamit 36 CS 0.25 L/ha	A	16.1	-24.9	19.1	-8.2	46.3	29.8
AHDB 9987 2.0 L/ha	A	19.8	-27.9	1.4	-40.4	-5.2	7.9
AHDB 9987 1.0 L/ha Gamit 36 CS 0.25 L/ha	A	48.7	42.2	44.6	31.5	50.6	45.3
AHDB 9987 1.0 L/ha AHDB 9898	A	48.7	5.6	39.9	40.9	57.1	67.4
AHDB 9987 1.0 L/ha AHDB 9917	A	-5.6	8.1	23.4	-9.3	-29.5	44.9
AHDB 9898	A	25.7	32.4	36.1	54.4	45.7	50.3
AHDB 9917	A	25.7	12.9	22.6	28.9	25.2	53.4
AHDB 9918	A	25.4	-19.8	23.7	9.9	42.3	45.8
AHDB 9994 1.0 L/ha	A	47.7	25.6	48.5	24.1	85.5	51.8
AHDB 9897	B	92.2	64.7	74.8	80.6	60.9	77.4
Finalsan 17.0 L/ha Li-700 1.0 L/ha	B	73.9	50.7	76.6	56.4	71.3	72.9

**Table 4.** Percentage cover of the main weed species at the final assessment on 27<sup>th</sup> August, 118 days after preharvest treatment application A.

Treatment	Timing	Mean percentage cover of selected weed species (%)				
		Fat hen	Black Nightshade	Clover	Redshank	Sow Thistle
Untreated		17.5	16.2	10.0	3.7	5.0
Kerb Flo 1.8 L/ha Gamit 36 CS 0.25 L/ha	A	3.8	0.0	5.0	0.5	3.3
Flexidor 0.5 L/ha Gamit 36 CS 0.25 L/ha	A	15.0	12.5	7.5	1.3	2.5
AHDB 9987 2.0 L/ha	A	23.8	13.8	6.3	2.5	2.5
AHDB 9987 1.0 L/ha Gamit 36 CS 0.25 L/ha	A	10.0	7.5	8.7	0.7	3.0
AHDB 9987 1.0 L/ha AHDB 9898	A	8.2	6.2	3.0	0.0	0.0
AHDB 9987 1.0 L/ha AHDB 9917	A	17.5	2.5	7.5	2.5	0.0
AHDB 9898	A	8.8	12.2	5.3	0.0	0.0
AHDB 9917	A	5.0	12.5	8.7	0.0	0.0
AHDB 9918	A	21.2	5.0	3.7	0.0	0.0
AHDB 9994 1.0 L/ha	A	7.5	11.2	7.5	0.0	1.3
AHDB 9897	B	1.2	1.2	6.3	0.0	3.7
Finalsan 17.0 L/ha Li-700 1.0 L/ha	B	1.7	0.0	11.3	0.7	1.3
<b>p-value</b>		0.072	0.059	0.911 (NS)	0.198 (NS)	0.352 (NS)
<b>d.f.</b>		40	40	40	40	40
<b>L.S.D.</b>		16.08	12.61	10.398	3.522	5.181
		Significantly different from the untreated control				
		Not significantly different from the untreated control				

NS = not significant

The results of the assessment of harvest parameters showed no statistically significant difference between the total number or average diameter of the pumpkins, and percentage of orange, or ripe pumpkins. Therefore the treatments had no detrimental effects on the fruit.

## Discussion

Seven treatments significantly reduced percentage weed cover at 118 days (nearly 17 weeks) after application. These were the standard Kerb Flo 1.8 L/ha + Gamit 0.25 L/ha, AHDB 9898 alone or in a tank mix with AHDB 9987 1.0 L/ha, AHDB 9917 and AHDB 9994 1.0 L/ha when applied early pre-emergence. And AHDB 9897 or Finalsan 17 L/ha + Li-700 applied a week after drilling, but still pre-emergence. The standard, Kerb Flo 1.8 L/ha + Gamit 0.25 L/ha, AHDB 9897 and Finalsan 17 L/ha + Li-700 reduced the weed cover by the greatest amount of 76.4%, 77.4% and 72.9% respectively at 118 days after application

Differences did not become clearly apparent until 54 days after application due to low weed germination for the first two months as the weather was very dry. These dry conditions at drilling and application also affected the efficacy of selected residual herbicides such as Flexidor and AHDB9987 which require moisture at application to work well.

At the assessment 89 days after the Timing A Application weed levels were seen to drop in the figures, this is likely due to the size of the pumpkin canopy confounding the visual assessment. The weed levels across the treatments still follow a similar pattern to the previous and following assessment, so are still valid.

The best performing treatments were foliar contact acting herbicides **AHDB 9897** and **Finalsan 17.0 L/ha + Li-700 1.0 L/ha** applied a week after drilling. It is likely that some weeds had germinated and although not all were visible at the soil surface, the spray application would have made contact with the hypocotyl at peri-emergence and killed the weeds. A degree of brinkmanship and risk is associated with this approach as the weeds need to be caught before the pumpkins reach peri-emergence. **AHDB 9897** and **Finalsan 17.0 L/ha + Li-700 1.0 L/ha** also reduced levels of all weed species with the exception of clover, being the only treatment to show significant reductions in weed coverage or count throughout all but one of the assessments.

**Kerb Flo** in a tank mix with **Gamit 36 CS** was the second most effective treatment used in this trial. Propyzamide which is the active ingredient of **Kerb Flo** has a long half-life of  $DT_{50}$  50-233 days which would cover the entire trial period in ideal conditions of cool weather, and although it was dry at application, the persistent nature of the herbicide would have meant that it would have still have had some activity when the rain eventually occurred at the end of June. In contrast **Flexidor** and **AHDB 9987** are less persistent ( $DT_{50}$  of 105 to 123, and 80 days respectively) and both need moisture at application to be effective, therefore the environmental conditions when the sprays were applied were not conducive to the effectiveness of these herbicides and they showed poor performance. Conditions at application need to be taken into account when these products are used, and when selecting which product to use.

The inclusion of **Gamit 36 CS** in a tank mix with **Flexidor** and **AHDB 9987** improved efficacy of weed control compared to when the products were used alone, and was bringing most of the control in the tank mix with AHDB 9987. Gamit 36 CS is also useful for control of fat hen and black nightshade, and has a little contact activity.

**AHDB 9898** also shows promise reducing percentage weed levels by 50% by the final assessment when used alone, and could be a promising product to tank mix with Gamit 36 CS as an alternative to Flexidor and Kerb. The product improved weed control efficacy when tank mixed with AHDB 9987 increasing weed control by 60% from 7.9% weed reduction to a 67.4% weed reduction. AHDB 9898 has activity on weeds such as annual grasses, amaranth, fat hen, black nightshade and groundsel.

**AHDB 9917** significantly reduced weed levels by 53.4% when used alone, even though it is a residual herbicide targeted at grass weeds. It was safe to use pre-emergence, and an authorization for the crop could be useful. **AHDB 9994 1.0 L/ha** also significantly reduced percentage weed cover by a similar level, and was safe to use alone pre-emergence, but care would need to be taken with tank mixes as seen in its commercial use in carrots.

## Conclusions

- Seven treatments significantly reduced percentage weed cover –
  - These were the standard Kerb Flo 1.8 L/ha + Gamit 0.25 L/ha, AHDB 9898 alone or in a tank mix with AHDB 9987 1.0 L/ha, AHDB 9917 and AHDB 9994 1.0 L/ha when applied early pre-emergence.
  - And AHDB 9897 or Finalsan 17 L/ha + Li-700 applied a week after drilling, but still pre-emergence.
- All treatments were crop safe with only transient and slight effects observed on the crop, which persisted for no more than two weeks after application.

## 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 grower who provided the site and crop for the trials as well as technical input, particularly W.R Haines, and Katie Dew of Agrovista.

## Appendix

a. Crop details – N/A = not available

Crop	Cultivar	Planting date	Row width
Pumpkin	Mars	28 <sup>th</sup> April 2020	0.75 m

### Previous cropping

Year	Crop
2019	Grass
2018	Grass
2017	Grass

### Cultivations

Date	Description	Depth (cm)
N/A	N/A	N/A
N/A	N/A	N/A

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

Date	Product	Rate
N/A	N/A	N/A
N/A	N/A	N/A

### Details of irrigation regime – not irrigated

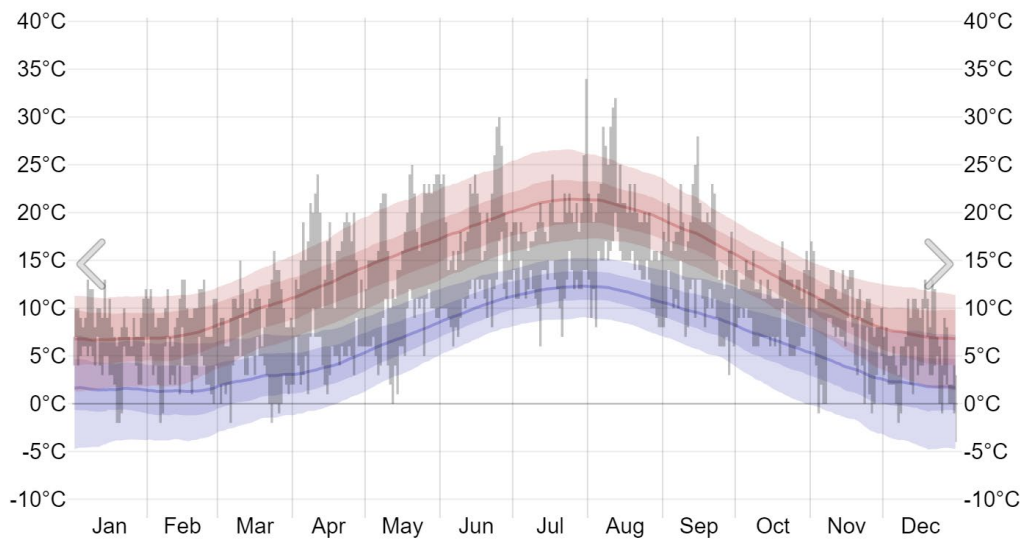
Date	Type, rate and duration	Amount applied (mm)
N/A	N/A	N/A
N/A	N/A	N/A

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

Date	Event
28/04/2020	Trial marked out at drilling
01/05/2020	Timing A treatments applied.
08/05/2020	Timing B treatments applied.
21/05/2020	Assessment – phytotoxicity, weed cover.
27/05/2020	Assessment – phytotoxicity, weed cover.
24/06/2020	Assessment – phytotoxicity, weed cover.
30/06/2020	Assessment – phytotoxicity, weed cover.
29/07/2020	Assessment – phytotoxicity, weed cover.
27/08/2020	Assessment – phytotoxicity, weed cover.
17/09/2020	Harvest measurements – no of pumpkins – diameter, colour



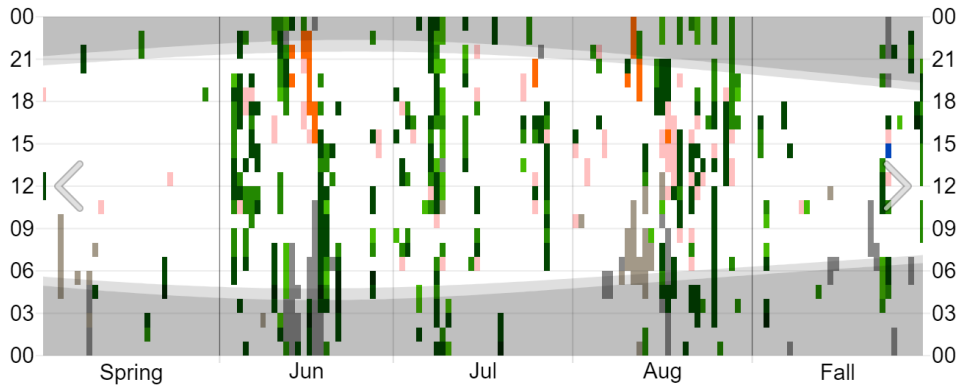
c. Climatological data during study period from © WeatherSpark.com as no logger data available



Rainfall events in green - © WeatherSpark.com as no logger data available

Note – very dry until early June

Light green = light rain  
 Dark green = moderate rain  
 Orange = thunderstorm





e. ORETO certificate



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**Effective date: 18 March 2018**  
**Expiry date: 17 March 2023**

**Signature**   
Authorised signatory

<b>Certification Number</b> ORETO 409
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Chemicals Regulation Division

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Agriculture and  
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