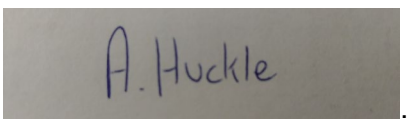
SCEPTREPLUS

Final Trial Report

Trial code:	2020. SP13b Yr 3
Title:	**AHDB Sceptreplus Pumpkin post-emergence herbicide screen**
Crop	Group: field vegetables – Cucurbita (pumpkin)
Target	General broadleaf weeds and grasses, 3WEEDT
Lead researcher:	Angela Huckle
Organisation:	RSK ADAS
Period:	1st April 2020 – 31st January 2021
Report date:	26/11/21
Report author:	Angela Huckle Diana Pooley
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

26th November 2021
Date



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Authors signature

Trial Summary

Introduction

There are currently very few herbicide options for weed control for cucurbit growers with only four 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. Cucurbit crops are very sensitive, and not many herbicides are safe to apply over the top of the crop, therefore there is a need to test new products over the crop as well as pre-emergence for crop safety.

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 post-emergence timings for their efficacy and crop safety 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 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 drilled on 28th May 2020, in Weston Sands Milcote. Eight treatments were applied on 25th May 2020 once the crop reached one true leaf (Timing A). 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 8 treatments, one of which was an untreated control. There were 32 plots in total, each measuring 2 m x 5 m.

The plots were assessed on six occasions (see 'Assessment details'), focusing on crop phytotoxicity (i.e. treatment safety), weed cover and species present for five 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 at 2, 15, 30, 37, 66, 94, and 116 days after treatments were applied.

Results

No phytotoxicity was seen throughout the study, indicating that all products evaluated were safe under these test conditions with no negative effects observed on the pumpkin crop. Weeds, and particularly thistles exhibited chlorosis of growing points at two weeks after application where Gamit 36 CS was applied as part of a tank mix, but this was a transient effect. The pumpkin plants were unaffected.

There were no significant reductions in weed cover from any of the treatments ($p>0.05$) (Table 1). Eight separate weed species were observed throughout the trial; fat hen, groundsel, many seeded goosefoot, sow thistle, black bindweed, redshank, clover and black nightshade. The products used in the trial are mainly residual in action with only Gamit 36 CS having limited contact activity. As the weeds were already present when the products were applied, this would have reduced their efficacy.

In the trial, the application was being targeted at post crop emergence, to evaluate crop safety over pumpkins, therefore in commercial practice for greatest efficacy the application would be best targeted pre-emergence of weeds. For example, within a week after planting in a transplanted crop before weeds emerge.

There were weakly significant differences in the reduction of overall percentage mean weed cover on 24th and 30th June assessment ($p< 0.05$, L.s.d = 6.854). These were carried out approximately four and five weeks after spray application. If the data is investigated further at a species level it can be observed that there is a significant reduction in fat hen on 24th June which has influenced the data at this assessment timing. Those treatments which reduced the weeds the greatest at these dates were the standard Flexidor 0.5 L/ha + Gamit 36 CS 0.25 L/ha, AHDB 9987 either alone or in a tank mix with Gamit 36 CS and AHDB 9917. However, the significant reduction was short-lived.

Table 1. Mean percentage weed cover of the transformed mean (ANG) and back transformed mean (BT) at five dates through the assessment period. DAA = Days after application

Trt no	Treatment	Overall percentage cover of weeds per plot (%)									
		10th June 15 DAA		24th June 30 DAA		30th June 37 DAA		29th July 66 DAA		26th August 94 DAA	
		ANG	BT	ANG	BT	ANG	BT	ANG	BT	ANG	BT
1	Untreated	28.9	23.8	55.4	67.5	49.3	57.5	41.0	43.8	45.1	50.0
2	Kerb Flo 1.8 L/ha + Gamit 36 CS 0.25 L/ha	22.2	14.2	43.5	47.5	35.3	33.8	36.3	36.2	38.0	38.8
3	Flexidor 0.5 L/ha + Gamit 36 CS 0.25 L/ha	21.1	13.2	31.6	28.8	30.5	26.2	35.1	33.8	35.0	33.8
4	AHDB 9987	19.9	11.8	39.1	40.0	31.3	27.5	25.8	20.0	29.1	25.0
5	AHDB 9987 + Gamit 36 CS 0.35 L/ha	24.5	17.5	39.1	40.0	36.1	35.0	30.3	27.5	37.4	37.5
6	AHDB 9987 + AHDB 9898	21.7	13.8	43.5	47.5	36.9	36.2	34.0	32.5	28.9	25.0
7	AHDB 9917	22.5	15.0	41.3	43.8	34.5	33.8	28.0	23.8	29.9	26.2
8	AHDB 9898	21.8	14.2	43.5	47.5	37.6	37.5	39.4	41.2	35.2	33.8
	p-value	0.185 (NS)		0.089		0.064		0.479 (NS)		0.401 (NS)	
	d.f.	21		21		21		21		21	
	L.S.D.	6.434		13.58		11.18		16.03		15.50	
Significantly different to the control											
Not significantly different to the control											

Conclusions

- All treatments were safe to use over the drilled crop at 1 true leaf.
- There were no significant reductions in overall weed control.
    - Due to weeds already being present at application.
    - Treatments are residual in activity and are more effective applied pre-emergence of weeds
- There was a significant reduction in fat hen at four weeks after herbicide application but the effect did not persist.

Take home message:

The products evaluated in the trial are safe to use over pumpkins, which are often sensitive to many other herbicides when they are applied over the foliage. When applied pre-emergence of weeds these products would provide effective control of selected weed species such as fat hen without significant damage to the crop.

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
PP 1/152 (4)	Design and analysis of efficacy evaluation trials	None
PP 1/135(4)	Phytotoxicity assessment	None
EPPO PP1/225 (2)	Minimum effective dose	EPPO PP1/225 (2)
PP 1/181 (4)	Conduct and reporting of efficacy evaluation trials including GEP	None

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^2)	10
Number of plants per plot:	Varied due to variable establishment
Leaf Wall Area calculations	N/A

Treatment details

AHDB Code	Active substance	Product name/ manufacturers code	Formulation batch number	Content of active substance in product	Formulation type
Untreated	-	-	-	-	-
N/a	propyzamide	Kerb Flo Gamit 36 CS	Not known 124684734	400 g/L 360 g/L	- Suspension concentrate - Capsule suspension

AHDB Code	Active substance	Product name/ manufacturers code	Formulation batch number	Content of active substance in product	Formulation type
N/A	isoxaben + clomazone	Flexidor Gamit 36 CS	Not known 124684734	500 g/L 360 g/L	- Suspension 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 9917	Confidential				
AHDB 9898	Confidential				

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

Application details

	Timing A
Application date	25/05/2020
Time of day	08:20 AM
Crop growth stage (Max, min average BBCH)	1 true leaf BBCH 11
Crop height (cm)	20
Crop coverage (%)	25
Application Method	Spray
Application Placement	Foliar
Application equipment	OPS spray equipment
Nozzle pressure	2 (bar)

	Timing A
Nozzle type	Flat fan
Nozzle size	03/F110
Application water volume/ha	200 L/ha
Temperature of air - shade (°C)	18.15
Relative humidity (%)	60.3
Wind speed range (kph)	0.1
Dew presence (Y/N)	N
Temperature of soil - 2-5 cm (°C)	N/A
Wetness of soil - 2-5 cm	Damp
Cloud cover (%)	80

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

Common name	Scientific Name	EPPO Code	Infestation level pre-application 27th May	Infestation level at start of assessment period 10th June	Infestation level at end of assessment period 26th August
Broad leaved weeds and grasses	N/A	3WEEDT	-	23.8%	50.0%

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%.

Crop Phytotoxicity scoring.

Crop tolerance score	Equivalent to crop damage (% phytotoxicity)
0	*(no damage) 0%*
1	10%
*2	20%
3	30%
4	40%
5	50%
6	60%
7	70%
8	80%
9	90%
10	(complete crop kill) 100%

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 Timing			
Evaluation date	**Days after Application A**	**Crop Growth Stage (BBCH)**	**Evaluation type (efficacy, phytotox)**	**Assessment**
27/05/2020	2	11	Phytotoxicity/Efficacy	Phytotox (scale 0-10, 10 = dead) & Percentage of weed cover (whole plot score). Weed species.
10/06/2020	15	14	Phytotoxicity/Efficacy	Phytotox (scale 0-10, 10 = dead) & Percentage of weed cover (whole plot score). Weed species.
24/06/2020	30	51	Efficacy	Percentage of weed cover (whole plot score). Weed species.
30/06/2020	37	52	Efficacy	Percentage of weed cover (whole plot score). Weed species.
29/07/2020	66	71	Efficacy	Percentage of weed cover (whole plot score). Weed species.
26/08/2020	94	81	Efficacy	Percentage of weed cover (whole plot score). Weed species.
17/09/2020	116	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

No effects of phytotoxicity were observed on the pumpkin plants in the trial in any of the treatments. Weeds, and particularly thistles exhibited chlorosis of growing points at two weeks after application where Gamit 36 CS was applied as part of a tank mix, but this was a transient effect. The pumpkin plants were unaffected.

Efficacy

There were no significant reductions in weed cover from any of the treatments ($p>0.05$). Eight separate weed species were observed throughout the trial; fat hen, groundsel, many seeded goosefoot, sow thistle, black bindweed, redshank, clover and black nightshade. Overall, weed levels were moderate to high in the untreated, and rose from 23.4% to 50% by the end of the trial (Table 1 and Figure 1). The percentage of weeds increased rapidly between the 2nd and 3rd assessments (10th and 24th June respectively) after rain showers promoted weed germination and growth.

The level of mean percentage weed cover declined through July, this was likely due to the natural senescence of the weeds.

Table 1. Mean percentage weed cover of the transformed mean (ANG) and back transformed mean (BT) at five dates through the assessment period. DAA = Days after application

Trt no	Treatment	Overall percentage cover of weeds per plot (%)									
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3	Flexidor 0.5 L/ha + Gamit 36 CS 0.25 L/ha	21.1	12.9	31.6	27.4	30.5	25.8	35.1	33.1	35.0	32.9
4	AHDB 9987	19.9	11.7	39.1	39.8	31.3	27.0	25.8	19.0	29.1	23.7
5	AHDB 9987 + Gamit 36 CS 0.35 L/ha	24.5	17.2	39.1	39.8	36.1	34.8	30.3	25.4	37.4	37.0
6	AHDB 9987 + AHDB 9898	21.7	13.7	43.5	47.4	36.9	36.0	34.0	31.2	28.9	23.4
7	AHDB 9917	22.5	14.6	41.3	43.5	34.5	32.0	28.0	22.0	29.9	24.9
8	AHDB 9898	21.8	13.7	43.5	47.4	37.6	37.3	39.4	40.4	35.2	33.3
	p-value	0.185 (NS)		0.089		0.064		0.479 (NS)		0.401 (NS)	
	d.f.	21		21		21		21		21	
	L.S.D.	6.434		13.58		11.18		16.03		15.50	
Significantly different to the control											
Not significantly different to the control											

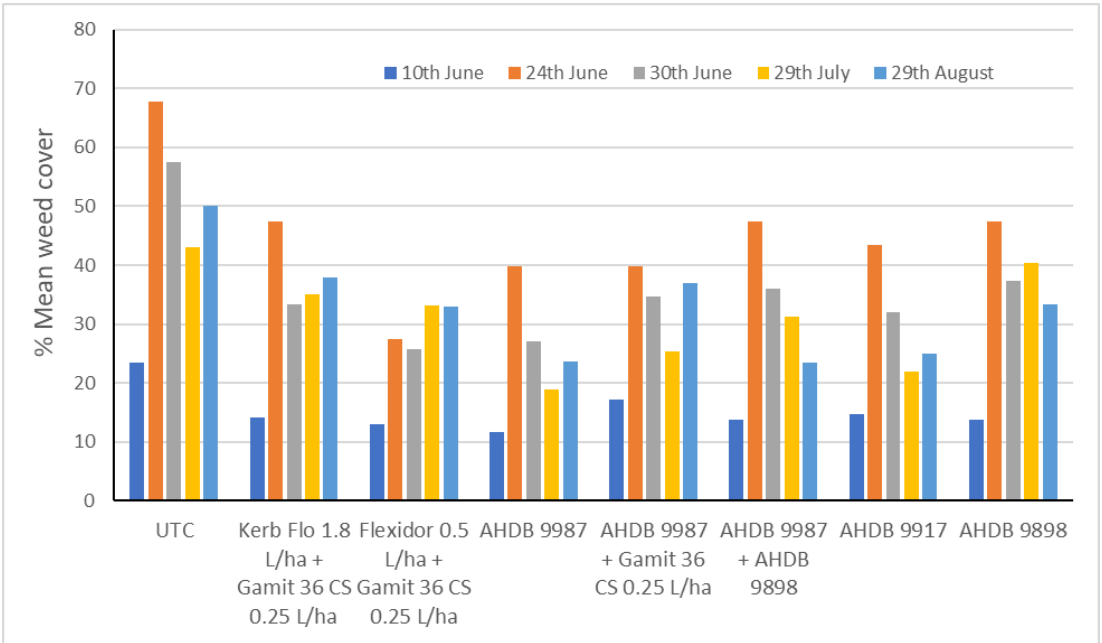


Figure 1. Mean weed cover (%) of at five assessment dates, 15, 30, 37, 66 and 94 days after application of the treatments. Back transformed data.

There were weakly significant differences in the reduction of overall percentage mean weed cover on 24th and 30th June assessment (p< 0.05, L.s.d = 6.854). These were carried out approximately four and five weeks after spray application. If the data is investigated further at a species level it can be observed that there is a significant reduction in fat hen on 24th June which has influenced the data at that assessment. These results are presented in Figure 2 and Table 2. Those treatments which reduced the weeds the greatest at these dates were the standard Flexidor 0.5 L/ha + Gamit 36 CS 0.25 L/ha, AHDB 9987 either alone or in a tank mix with Gamit 36 CS and AHDB 9917 suggesting these have activity on fat hen.

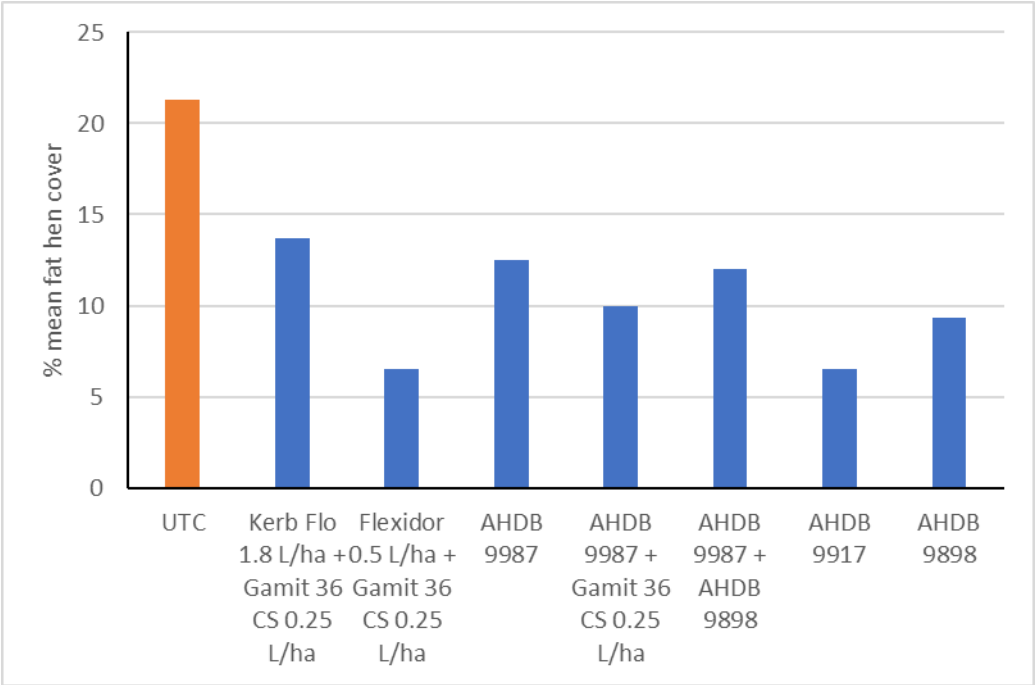


Figure 2. Mean percentage cover of Fat Hen at assessment 2 (24th June), the yellow bar is the untreated control. (p< 0.05, L.s.d = 6.854).

Table 2: Percentage reduction of fat hen on 24 June, percentage reduction calculated using Abbotts formula.

Treatment	Mean % fat hen weed cover per plot	% reduction using Abbotts formula
UTC	21.3	-
Kerb Flo 1.8 L/ha + Gamit 36 CS 0.25 L/ha	13.7	35.7
Flexidor 0.5 L/ha + Gamit 36 CS 0.25 L/ha	6.5	69.5
AHDB 9987	12.5	41.3
AHDB 9987 + Gamit 36 CS 0.25 L/ha	10.0	53.1
AHDB 9987 + AHDB 9898	12.0	43.7
AHDB 9917	6.5	69.5
AHDB 9898	9.3	56.3
F pr	**0.005**	
d.f.	**21**	
LSD	**6.854**	
Significantly different to the control		
Not significantly different to the control		

Percentage overall weed reduction using Abbotts's formula

The percentage reduction in overall weed cover is presented in Table 3, this is calculated using Abbotts's formula.

Table 3: Percentage reduction in weed cover compared to the untreated control calculated using Abbott's formula from back transformed means at five dates throughout the duration of the trial. DAA = days after application.

Treatment	10th June	24th June	30th June	29th July	29th Aug
	15 DAA	30 DAA	37 DAA	66 DAA	94 DAA
Kerb Flo 1.8 L/ha + Gamit 36 CS 0.25 L/ha	39.3	30.2	41.9	18.5	24.3
Flexidor 0.5 L/ha + Gamit 36 CS 0.25 L/ha	44.9	59.6	55.2	22.9	34.4
AHDB 9987	50.0	41.4	53.1	55.9	52.7
AHDB 9987 + Gamit 36 CS 0.25 L/ha	26.5	41.4	39.6	40.8	26.2
AHDB 9987 + AHDB 9898	41.5	30.2	37.4	27.3	53.3
AHDB 9917	37.6	35.9	44.3	48.8	50.3
AHDB 9898	41.5	30.2	35.2	6.0	33.5

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

No phytotoxicity was seen throughout the study, indicating that all products evaluated were safe under these test conditions with no negative effects observed on the pumpkin crop. Weeds, and particularly thistles exhibited chlorosis of growing points at two weeks after application where Gamit 36 CS was applied as part of a tank mix, but this was a transient effect. The pumpkin plants were unaffected.

There were no significant reductions in weed cover from any of the treatments ($p>0.05$). Eight separate weed species were observed throughout the trial; fat hen, groundsel, many seeded goosefoot, sow thistle, black bindweed, redshank, clover and black nightshade. The products used in the trial are mainly residual in action with only Gamit 36 CS having limited contact activity. As the weeds were already present when the products were applied, this would have reduced their efficacy. In the trial, the application was being targeted at post crop emergence, to evaluate crop safety over pumpkins, therefore in commercial practice for greatest efficacy the application would be best targeted pre-emergence of weeds. For example, within a week after planting in a transplanted crop before weeds emerge.

There were weakly significant differences in the reduction of overall percentage mean weed cover on 24th and 30th June assessment ($p< 0.05$, L.s.d = 6.854). These were carried out approximately four and five weeks after spray application. If the data is investigated further at a species level it can be observed that there is a significant reduction in fat hen on 24th June which has influenced the data at that assessment timing. These results are presented in Figure 2 and Table 2. Those treatments which reduced the weeds the greatest at these dates were the standard Flexidor 0.5 L/ha + Gamit 36 CS 0.25 L/ha, AHDB 9987 either alone or in a tank mix with Gamit 36 CS and AHDB 9917. However, the significant reduction was short-lived.

Conclusions

- All treatments were safe to use over the crop at 1 true leaf after drilling.
- There were no significant reductions in overall weed control.
    - Due to weeds already being present at application.
    - Treatments are residual in activity and are more effective applied pre-emergence of weeds
- There was a significant reduction in fat hen at four weeks after herbicide application but the effect did not persist.

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	28th 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

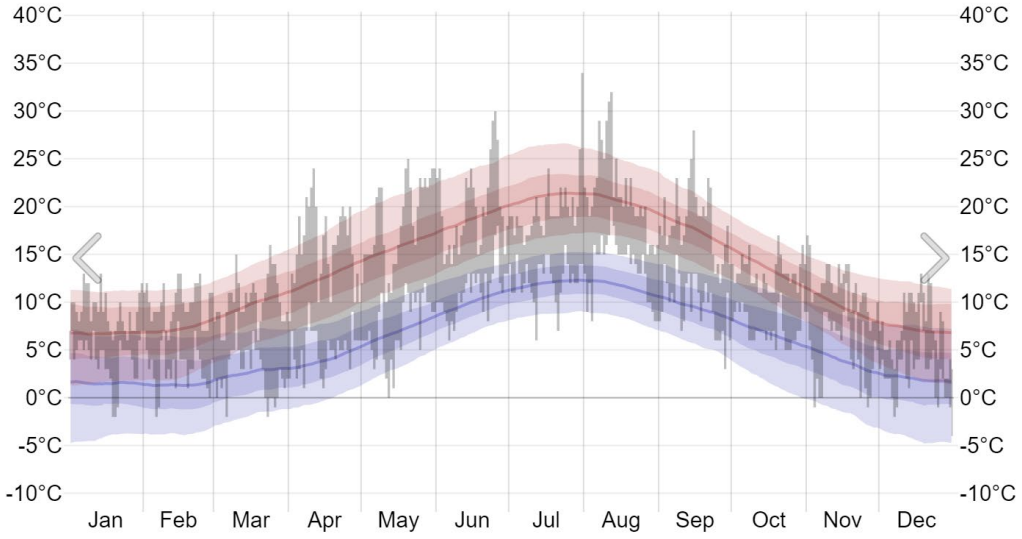
Details of irrigation regime – not irrigated

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
27/05/2020	Timing A post-emergence treatments applied.
10/06/2020	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.
29/08/2020	Assessment – phytotoxicity, weed cover.
17/09/2020	Harvest measurements – no of pumpkins – diameter, colour

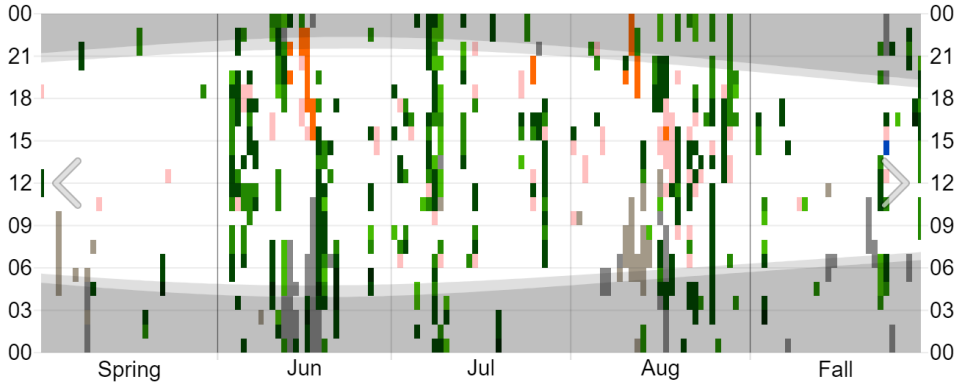
c. Climatological data during study period from © WeatherSpark.com as no logger data available



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



d. Trial design

TREATMENT	DISCARD	7	2	8	4	DISCARD	DISCARD	2	1	5	2	DISCARD
BLOCK	DISCARD	1	1	2	2	DISCARD	DISCARD	3	3	4	4	DISCARD
PLOT	DISCARD	104	108	204	208	DISCARD	DISCARD	304	308	404	408	DISCARD
TREATMENT	DISCARD	1	6	3	2	DISCARD	DISCARD	4	3	6	7	DISCARD
BLOCK	DISCARD	1	1	2	2	DISCARD	DISCARD	3	3	4	4	DISCARD
PLOT	DISCARD	103	107	203	207	DISCARD	DISCARD	303	307	403	407	DISCARD
TREATMENT	DISCARD	4	8	7	6	DISCARD	DISCARD	8	5	4	1	DISCARD
BLOCK	DISCARD	1	1	2	2	DISCARD	DISCARD	3	3	4	4	DISCARD
PLOT	DISCARD	102	106	202	206	DISCARD	DISCARD	302	306	402	406	DISCARD
TREATMENT	DISCARD	3	5	1	5	DISCARD	DISCARD	6	7	3	8	DISCARD
BLOCK	DISCARD	1	1	2	2	DISCARD	DISCARD	3	3	4	4	DISCARD
PLOT	DISCARD	101	105	201	205	DISCARD	DISCARD	301	305	401	405	DISCARD

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