Project title:	AHDB Field Vegetable Centres – Brassicas, Lincolnshire - Kale post-planting herbicides demonstration
Project number:	FV 462
Project leader:	Angela Huckle, ADAS Horticulture
Report:	Annual report, December 2020
Previous report:	Annual report, March 2020
Key staff:	Angela Huckle, ADAS Horticulture (report editor) Gabrielle Roxby, ADAS Horticulture (report author) Georgia Hassell, ADAS Chris Dyer, ADAS Statistician Carl Sharp, Allium and Brassica Centre
Location of project:	Old Leake, Lincolnshire
Industry Representative:	Andy Richardson, Allium and Brassica Centre, Wash Road, Boston, Lincs PE20 1QQ.
Date project commenced:	1 April 2019

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The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

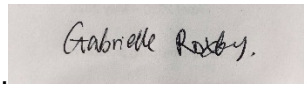
AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

Gabrielle Roxby

Senior Research Technician

ADAS Horticulture

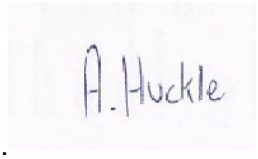
Signature .....  ..... Date .....21/12/2020.....

Report authorised by:

Angela Huckle

Associate Director – Crop Health

ADAS Horticulture

Signature .....  ..... Date .....21/12/2020.....

CONTENTS

GROWER SUMMARY

Headline

- The residual herbicide AHDB 9987 used alone or in a tank-mix with Gamit 36 CS (clomazone) gives effective weed control for up to nine weeks when applied soon after planting, and was safe to apply over the kale.
- The residual/contact herbicide AHDB 9875 was also safe to use over the kale when applied at a month after planting, and significantly reduced weed levels up to five weeks after application.

Background

The limited range of herbicides currently available for use in brassica crops such as kale leaves gaps in the weed control spectrum, and growers experience problems with a wide range of weeds. Broad leaved weeds remain a key concern for brassica growers, particularly fat-hen, red-shank, charlock and fumitory (AHDB Gap Analysis, 2016). In addition to having a short list of approved actives, only a small subset of these offer the longevity of control required to protect longer season brassicas, such as kale. A further challenge for authorisation of products in these minor crops is the availability of crop safety and efficacy data to guide growers with their use, as products are usually only trialled over the major brassica types such as cauliflower and headed cabbage.

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

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

The objectives of this trial are to compare and demonstrate a number of new herbicides from the SceptrePlus project which are close to authorisation at two post-planting application timings for selectivity (crop safety) and efficacy in kale.

Summary

Materials and methods

The trial was located at the HL Hutchinsons trial ground at F. Daubney and Sons, Lincs within a crop of the commercially grown variety of kale, Oldenbor, planted on 7 August 2020. The trial was sited in a field with a history of weed problems, and a moderate level of weeds was established in the untreated control plots by the end of the trial which included the species chickweed (*Stellaria media*), fat hen (*Chenopodium album*), mayweed (*Matricaria spp.*), pale persicaria (*Persicaria lapathifolia*), groundsel (*Senecio vulgaris*) and Shepherds purse (*Capsella-bursa pastoris*). The trial comprised a randomised block design with 12 treatments (Table 1), including one untreated control, two commercial industry standards (Dow Shield and Lentagran) and was replicated three times – although only the first two replicates were assessed for the initial trial measurements until weed levels increased. An area of bed 15 metres wide gave a total trial area for each crop of 12 m x 36 m. Plots were 6 m of a 2 m-wide bed comprising three rows of kale with discard beds planted either side of the trial.

Table 1. Treatment products, rates and timings for the kale herbicide screen at Old Leake, Lincs, 2020

	Timing 1 – Applied within 7 days of planting 10th August 2020		**Timing 2 – Applied at BBCH16 3rd September 2020**	
Trt. No.	**Product**	**Rate (L/ha** or **kg/ha)**	**Product**	**Rate (L/ha** or **kg/ha)**
1	UTC	-		
2*	-	-	Lentagran	2.0 kg/ha
3*	-	-	Dow Shield 400	0.5 L/ha
4	AHDB 9987	2.0 L/ha	-	-
5	AHDB 9987 + Gamit 36 CS	1.0 L/ha 0.25 L/ha	-	-
6	AHDB 9917	0.7 L/ha	-	-
7	-	-	AHDB 9875	3.0 L/ha
8	-	-	AHDB 9840	0.5 L/ha
9	-	-	AHDB 9840	0.75 L/ha
10	-	-	AHDB 9887	0.5 L/ha
11	-	-	AHDB 9887	0.75 L/ha
12	-	-	AHDB 9887	1.0 L/ha

Treatments were applied using a precision knapsack sprayer with a 2-metre boom and 02F110 nozzles at medium quality and 200 litres per hectare water volume. All treatments were applied post-planting. Timing 1 applications - Treatments 4, 5 and 6 - were applied on August 10th, within seven days after planting. The Timing 2 applications - treatments 2, 3 and 7-12 - were applied on September 3rd, four weeks after planting when the kale reached nine true leaves. Data was collected on weed levels and species, and any effects on the crop were recorded for phytotoxicity (crop damage) assessments. The crop growth stage and any variation within the plots was recorded at each visit.

Weed assessments were carried out at the second application, then, six, eight and nine weeks after the ‘Timing 1’ treatment application. Overall weed levels were recorded at every assessment as percentage cover per plot. Due to the moderate number of weeds in the initial weed assessment at four weeks after the first application, the weed cover of the five most common weed species was estimated as a percentage of the plot area that each weed species covered within the plot. There were lower weed levels in the second and third weed assessments, therefore a 0.25 x 0.25 m quadrat was used to estimate species present at three points per plot, recording weed species present in each plot.

To assess crop damage, any observed effects attributable to phytotoxicity such as chlorosis or scorch were recorded, and photographs were taken. Crop damage was assessed at the same time as the weed assessments. The results of these assessments were analysed using analysis of variance, with Duncan’s multiple range test to determine where significant differences between treatments lay.

Results and discussion

Although soil conditions were moist when the first applications were made, later weather in August was drier and this meant that weeds did not germinate or grow rapidly until two months into the trial. But, the initial moisture at application led to good conditions for the residual herbicides such as AHDB 9987, and then subsequently with weeds emerging and growing slowly in the dry, they remained small, and at cotyledon to two true leaves when the contact herbicides were applied a month later. Which was the ideal weed size and timing for the contact herbicides to work effectively.

There were two products which combined good crop safety with effective weed control, these were AHDB 9987 applied with or without Gamit 36 CS soon after planting, and AHDB 9875 applied at nine true leaves, and a month after planting (Table 2). Both products significantly reduced percentage weed cover compared to the untreated control at the final assessment nine weeks after the first application. They also reduced percentage overall weed cover greater than the current commercial standard, Lentagran, though it wasn’t a significantly greater reduction. AHDB 9840 reduced overall weed levels by approximately 60% at the final assessment and performed similarly to Lentagran, but due to the products weed spectrum being more targeted, this wasn’t a significant level of weed reduction. However, AHDB 9840 would give useful control of fumitory which is not covered by other experimental products and existing authorisations.

Table 2. Mean percentage weed cover as back-transformed results at the baseline assessment, and four, six, eight and nine weeks after the first spray application. WAA = weeks after timing 1 application. Sprays applied on 10 August, and 3 Sept. Lincs, 2020. * = treatment not applied by that assessment

Trt no	Treatment	Timing	Mean weed cover (%)			
			4 WAA 3 Sept	6 WAA 17 Sept	8 WAA 2 Oct	9 WAA 9 Oct
1	Untreated control	-	9.0	11.0	28.5	35.3
2	Lentagran 2.0 kg/ha	2	2.5*	3.5	4.0	13.3
3	Dow Shield 400 0.5 L/ha	2	11.5*	12.5	24.0	46.0
4	AHDB 9987 2.0 L/ha	1	0.0	0.0	2.5	2.8
5	AHDB 9987 1.0 L/ha + Gamit 36 CS 0.25 L/ha	1	0.0	0.0	0.5	1.3
6	AHDB 9917 0.7 L/ha	1	7.0	8.5	18.0	36.7
7	AHDB 9875 3.0 L/ha	2	0.5*	0.5	9.0	9.3
8	AHDB 9840 0.5 L/ha	2	7.5*	11.0	9.5	20.7
9	AHDB 9840 0.75 L/ha	2	10.0*	12.5	11.0	14.0
10	AHDB 9887 0.5 L/ha	2	16.0*	17.5	25.0	36.7
11	AHDB 9887 0.75 L/ha	2	15.0*	17.5	27.5	28.3
12	AHDB 9887 1.0 L/ha	2	20.0*	22.0	25.0	24.0
		F pr.	0.190	0.200	0.222	0.020
		d.f.	11	11	11	22
		L.S.D	15.81	17.78	25.62	25.58
		significantly different from the untreated				
		not significantly different from the untreated				

AHDB 9987 performed well in this trial as it was applied soon after planting and before weeds had emerged. If applied after the weeds have emerged, it is ineffective.

There were no significant effects on the kale from any of the treatments with the exception of AHDB 9840 which caused a thickening of leaf veins in the newest expanded leaves (Figure 1). However, the crop grew through this, and as kale is sold as a shredded product, this may not affect the quality of the final product as it wouldn't be noticeable when shredded. Lentagran treated plots showed signs of leaf scorch soon after application, which is expected from the product, but the kale recovered and grew through the scorch.

Figure 1. left, Typical thickened veins in kale caused by product AHDB 9840; **right**, untreated control

Financial Benefits

This is difficult to quantify as weed levels vary within crops, but where weed infestation is severe, yields can be reduced by 30% due to competition, which is a substantial loss to the grower. These products would bring effective weed control, and therefore increase crop yields and profitability.

Conclusions

Overall, AHDB 9987 applied alone or in a tank-mix with Gamit 36 CS or AHDB 9875 were the most effective, with evidence that these treatments significantly minimise or eradicate weeds in those plots, reducing weed levels to below 10% mean plot cover by the final assessment in this trial. AHDB 9887 and AHDB 9840, although not as effective at reducing overall weed cover, did significantly reduce fat hen cover in the final weed cover assessment, and could be useful for control of selected weed species.

If authorised, AHDB 9987 would be a useful alternative to use in place of metazochlor at an application timing soon after planting, while AHDB 9875 would improve weed control at a later post-planting application timing once weeds have emerged.

SCIENCE SECTION

Introduction

The limited range of herbicides currently available for use in brassica crops such as kale leaves gaps in the weed control spectrum, and growers experience problems with a wide range of weeds. Broad leaved weeds remain a key concern for brassica growers, particularly fat-hen, red-shank, charlock and fumitory (AHDB Gap Analysis, 2016). In addition to having a short list of approved actives, only a small subset of these offer the longevity of control required to protect longer season brassicas, such as kale. A further challenge for authorisation of products in these minor crops is the availability of crop safety and efficacy data to guide growers with their use, as products are usually only trialled over the major brassica types such as cauliflower and headed cabbage.

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metres wide gave a total trial area for each crop of 12 m x 36 m. Plots were 6 m of a 2 m-wide bed comprising three rows of kale with discard beds planted either side of the trial.

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3*	-	-	Dow Shield 400	0.5 L/ha
4	AHDB 9987	2.0 L/ha	-	-
5	AHDB 9987 + Gamit 36 CS	1.0 L/ha 0.25 L/ha	-	-
6	AHDB 9917	0.7 L/ha	-	-
7	-	-	AHDB 9875	3.0 L/ha
8	-	-	AHDB 9840	0.5 L/ha
9	-	-	AHDB 9840	0.75 L/ha
10	-	-	AHDB 9887	0.5 L/ha
11	-	-	AHDB 9887	0.75 L/ha
12	-	-	AHDB 9887	1.0 L/ha

Table 4. Pesticide status of products used in the herbicide screen at Old Leake, Lincs, 2020

Herbicide	**Active ingredient(s)**	**MAPP No.**	**EAMU number (if applicable)**	**Experimental approval needed**
Lentagran WP	45% w/w pyridate	14162	0786/09	No
Dow Shield	clopyralid 400 g/L	14984	N/A	No
Gamit 36 CS	clomazone 360 g/L	18718	0799/19	No
AHDB 9987	-	not yet UK approved	N/A	✓
AHDB 9875	-	not yet UK approved	N/A	✓
AHDB 9917	-	not yet UK approved	N/A	✓
AHDB 9887	-	not yet UK approved	N/A	✓
AHDB 9840	-	-	N/A	✓

Table 5. Application details

	Application 1	**Application 2**
Application date	10/08/2020	03/09/2020
Time of day	08:20	12:30
Crop growth stage (Max, min average BBCH)	16	19
Application Method	Spray	Spray
Application Placement	Foliar	Foliar
Application equipment	Oxford precision sprayer	Oxford precision sprayer
Nozzle pressure	2.5	2.5
Nozzle type	Flat fan	Flat fan

	Application 1	Application 2
Nozzle size	02F110	02F110
Application water volume/ha	200 L	200
Temperature of air - shade (°C)	20	19
Relative humidity (%)	94	73
Wind speed range (kph)	8	22
Wind direction	NNE	WSW
Dew presence (Y/N)	N	N
Temperature of soil - 2-5 cm (°C)	17	17
Wetness of soil - 2-5 cm	Normal	Moist
Cloud cover (%)	15	10

Treatments were applied using a precision knapsack sprayer with a 2-metre boom and 02F110 nozzles at medium quality and 200 litres per hectare water volume (Table 5). All treatments were applied post-planting. Timing 1 applications - Treatments 4, 5 and 6 - were applied on August 10th, within seven days after planting. The Timing 2 applications - Treatments 2, 3 and 7-12 - were applied on September 3rd, four weeks after planting when the kale reached nine true leaves. Data was collected on weed levels and species, and any effects on the crop were recorded for phytotoxicity (crop damage) assessments. The crop growth stage and any variation within the plots was recorded at each visit. Weed assessments were carried out at the second application, then, six, eight and nine weeks after the 'Timing 1' treatment application. Overall weed levels were recorded at every assessment as percentage cover per plot. Due to the moderate number of weeds in the initial weed assessment at four weeks after the first application, the weed cover of the five most common weed species was estimated as a percentage of the plot area that each weed species covered within the plot. There were lower weed levels in the second and third weed assessments, therefore a 0.25 x 0.25 m quadrat was used to estimate species present at three points per plot, recording weed species present in each plot.

To assess crop damage, any observed effects attributable to phytotoxicity such as chlorosis or scorch were recorded, and photographs were taken. Any crop damage seen was assessed at the same time as the weed assessments. The results of these assessments were analysed using analysis of variance, with Duncan's multiple range test to determine where significant differences between treatments lay. Statistical analysis was carried out by the ADAS statistician, Chris Dyer.

Phytotoxicity was assessed at each assessment using Table 6 as a scale.

Table 6. Crop tolerance scores from 0-10, where 0 = no damage, to 10 = complete crop loss with an associated percentage score for each tolerance score conveying the phytotoxic damage. * ≤ 2 = acceptable damage, i.e. damage unlikely to reduce yield and acceptable to the farmer.

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%

Results

Efficacy

Treatments containing AHDB 9987 or AHDB 9875 (numbers 4, 5 and 7) significantly reduced the percentage mean overall weed cover at the final assessment. There were no significant differences in percentage reduction in weed cover until the final assessment, likely due to low levels and wide variation in weed levels between the first two replicates which were the only ones assessed at the start of the trial. For the final assessment the third replicate was also included and then consistent results were observed between treatments, and significant differences were reached (Table 7 and Figure 2). Despite no significant differences in overall mean weed cover at earlier assessments, there were differences observed between individual weed species at the assessment eight weeks after the first treatment application which are described later.

Table 7. Mean percentage weed cover as back-transformed results at the baseline assessment, and four, six, eight and nine weeks after the first spray application. WAA = weeks after timing 1 application. Sprays applied on 10 August, and 3 Sept. Lincs, 2020. * = treatment not applied by that assessment

Trt no	Treatment	Timing	Mean weed cover (%)			
			4 WAA 3 Sept	6 WAA 17 Sept	8 WAA 2 Oct	9 WAA 9 Oct
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8	AHDB 9840 0.5 L/ha	2	7.5*	11.0	9.5	20.7
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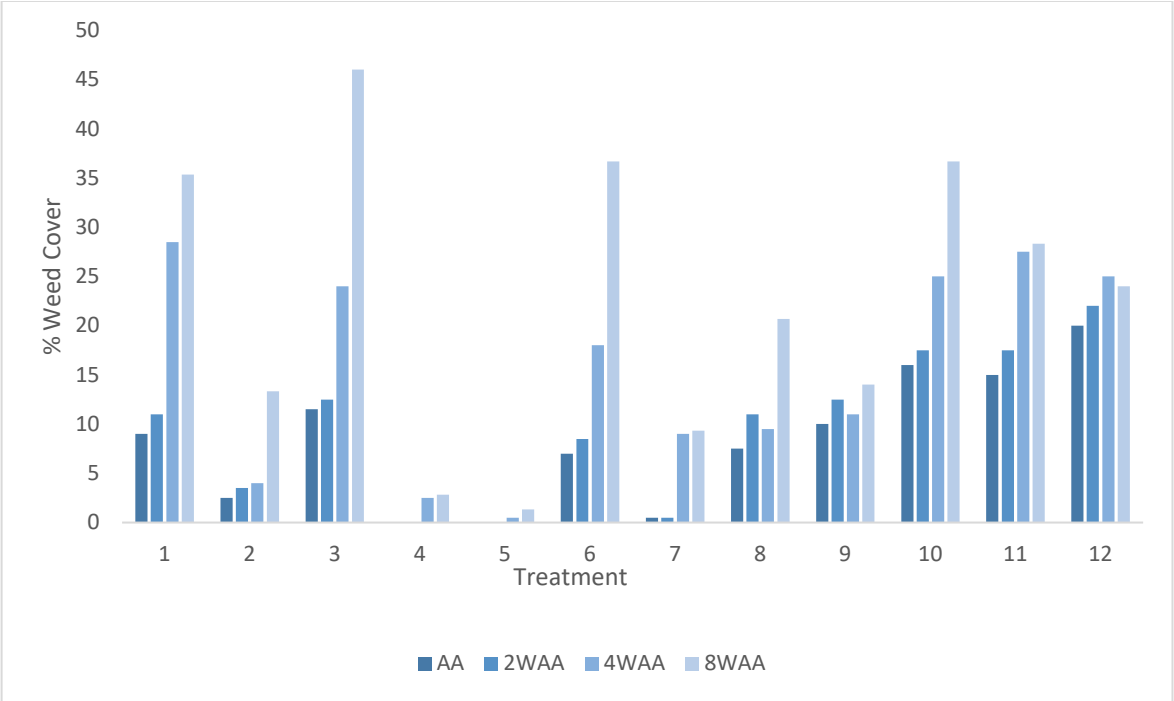
		d.f.	11	11	11	22
		L.S.D	15.81	17.78	25.62	25.58
		significantly different from the untreated				
		not significantly different from the untreated				

Figure 2. Mean total percent weed cover at four assessment timings – 3 Sept, 17 Sept, 2 Oct and 9 Oct. AA= Baseline assessment at four weeks after the first application, WAA = weeks after initial assessment and first application. Herbicide applications made on 10 August and 3 September 2020.



Weed assessments four and six weeks after the first application - 3 and 17 Sept

No significant differences were observed in percentage weed cover at the first and second assessments on 3 and 17 September respectively, at four and six weeks after the initial treatment application (Appendix, Table B and C). Weed levels were low early in the trial compared to later weed assessments due to dry soil conditions through August and early September reducing weed germination and growth (Table 7). However, notable trends were appearing with no weeds found in plots treated with AHDB 9987 and minimal weeds in plots where AHDB 9875 was applied. At this stage, only *Stellaria media* ('Chickweed'), *Matricaria spp.* ('Mayweed'), *Persicaria lapathifolia* ('Pale persicaria') and *Chenopodium album* ('Fat hen') were assessed.

Weed assessment – eight weeks after the first application (four weeks after the second application) – 2nd October

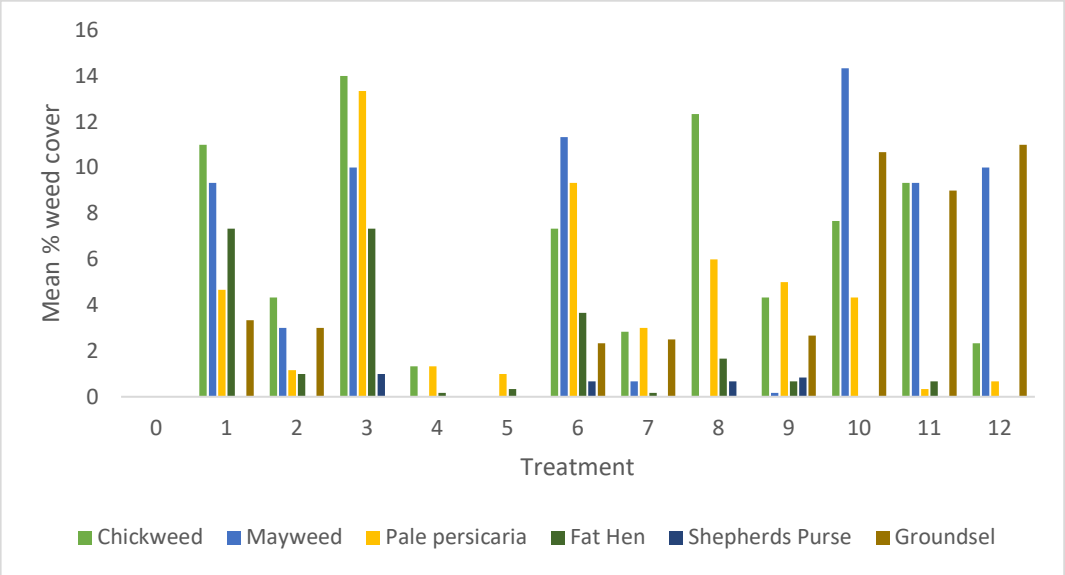
At the assessment on 2 October all treatments with the exception of Dow Shield 500 significantly reduced the levels of fat hen (P= 0.03, L.S.D. = 4) (Table D, Appendix). Overall weed cover still remained low in Treatments 4 and 5 where AHDB 9987 had been applied alone or with Gamit 36 CS, with an overall 98% weed reduction in plots treated with AHDB 9987 + Gamit 36 CS, and a 91% reduction in plots treated with AHDB 9987 (Appendix, Table E).

Final Weed assessment - nine weeks after the first application (five weeks after the second application - 9th October.

Significant reductions in weed cover were observed in the final assessment, with treatments where AHDB 9987 was applied soon after planting giving the greatest reduction in weed cover (P = 0.020, L.S.D. 25.58) (Table 7). Using Abbotts formula, the weed cover was reduced by 96% in plots treated with AHDB 9987 in a tank mix with Gamit 36 CS, and still by 92% where AHDB 9987 was used alone (Appendix,Table G). Due to the limited weed spectrum which Dow Shield 400 controls, plots treated with the product had significantly greater weed cover compared to the remaining treatments. This is because Dow Shield mainly controls mayweed, and is less effective on the main weed species present in this trial. At the individual weed species level, pale persicaria, and fat hen showed treatment effects, which were significant in the case of fat hen (Figure 3 and Appendix, Table F). Plots where Lentagran, AHDB 9987 applied alone or in a tank-mix with Gamit 36 CS, or AHDB 9887 at the two higher rates gave a trend to be the most effective in reducing pale persicaria, but it was not significant due to low weed levels. A significant reduction in percentage cover of fat hen was observed in all treatments with the exception of Dow Shield 400. The greatest reduction in fat hen was

observed in those plots where Lentagran, AHDB 9987, AHDB 9875, AHDB 9887 or AHDB 9840 were applied.

Figure 3. Mean total per cent weed cover by weed type on the final assessment on 9 October. Sprays applied on 10 August, and 3 Sept. Lincs, 2020. Analysis of variance on overall % weed cover in the final assessment show a statistically significant difference between treatments (F p.r.= 0.02, LSD= 25.58).



Crop damage/safety

There were no significant effects on the kale from any of the treatments with the exception of AHDB 9840 which caused a thickening of leaf veins in the newest expanded leaves (Figure 4 and 5). However, the crop grew through this, and as kale is sold as a shredded product, this may not affect the quality of final product as it wouldn't be noticeable when shredded.

Figure 4. Mean phytotoxicity by treatment number, with crop safety (phytotoxicity) scores, 0= 0% phytotoxicity, no observed damage, 10= 100% phytotoxicity and complete crop kill. Red line indicates the threshold of 'acceptable damage' for scores 2 and below.

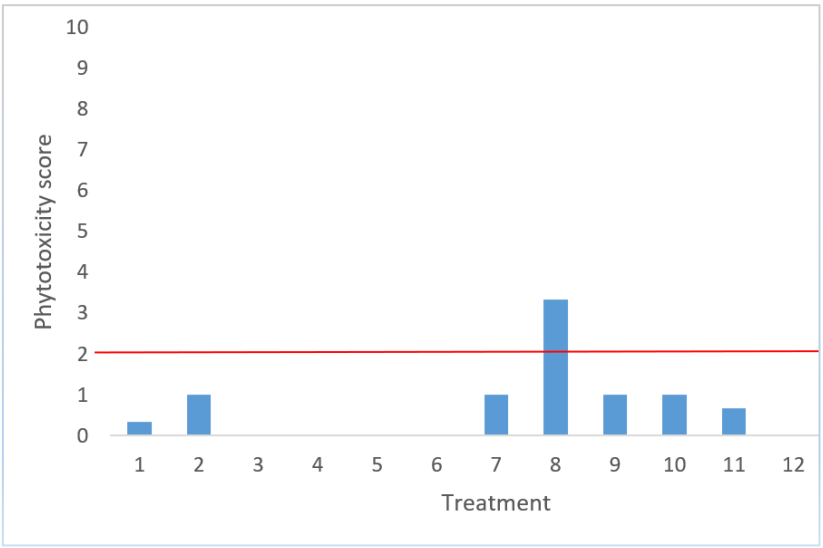


Figure 5. left, Typical thickened veins in kale caused by product AHDB 9840 0.75 L/ha; **right**, untreated control

Discussion

Although soil conditions were moist when the first applications were made, later weather in August was drier and this meant that weeds did not germinate or grow rapidly until two months into the trial. But, the initial moisture at application led to good conditions for the residual herbicides such as AHDB 9987 to work, and then subsequently with weeds emerging and growing slowly in the dry, they remained small, and at cotyledon to two true leaves when the contact herbicides were applied a month later. Which was the ideal weed size and timing for the contact herbicides to work effectively.

There were two products which combined good crop safety with effective weed control, these were AHDB 9987 applied with or without Gamit 36 CS soon after planting, and AHDB 9875 applied at nine true leaves, and a month after planting. Both products significantly reduced percentage weed cover compared to the untreated control at the final assessment nine weeks after the first application. They also reduced percentage overall weed cover greater than the current commercial standard, Lentagran, though it wasn't a significantly greater reduction. AHDB 9840 reduced overall weed levels by approximately 60% at the final assessment and performed similarly to Lentagran, but due to the products weed spectrum being more targeted, this wasn't a significant level of weed reduction. However, AHDB 9840 would give useful control of fumitory which is not covered by other experimental products and existing authorisations.

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There were no significant effects on the kale from any of the treatments with the exception of AHDB 9840 which caused a thickening of leaf veins in the newest expanded leaves. However, the crop grew through this, and as kale is sold as a shredded product, this may not affect the quality of the final product as it wouldn't be noticeable when shredded. Lentagran showed signs of leaf scorch soon after application, which is expected from the product, but the kale recovered and grew through the scorch.

Conclusion

Overall, AHDB 9987 applied alone or in a tank-mix with Gamit 36 CS or AHDB 9875 were the most effective, with evidence that these treatments significantly minimise or eradicate weeds in those plots, reducing weed levels to below 10% mean plot cover by the final assessment in this trial. AHDB 9887 and AHDB 9840, although not as effective at reducing overall weed cover, did significantly reduce fat hen cover in the final weed cover assessment, and could be useful for control of selected weed species.

If authorised, AHDB 9987 would be a useful alternative to use in place of metazochlor at an application timing soon after planting, while AHDB 9875 would improve weed control at a later post-planting application timing once weeds have emerged.

Knowledge and Technology Transfer

Presentation to the Brassica Grower Association – 14 October 2020

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Appendices

Table A. Mean % total weed cover by assessment timing. WAA = weeks after first assessment application. * = spray not applied at this assessment

Trt no	Treatment name	Total % weed cover (4AA)	Total % weed cover (6WAA)	Total % weed cover (8WAA)	Total % weed cover (9WAA)
1	Untreated control	9.0	11.0	28.5	35.3
2	Lentagran 2.0 kg/ha	2.5*	3.5	4.0	13.3
3	Dow Shield 400 0.5 L/ha	11.5*	12.5	24.0	46.0
4	AHDB 9987 2.0 L/ha	0.0	0.0	2.5	2.8
5	AHDB 9987 1.0 L/ha + Gamit 36 CS 0.25 L/ha	0.0	0.0	0.5	1.3
6	AHDB 9917 0.7 L/ha	7.0	8.5	18.0	36.7
7	AHDB 9875 3.0 L/ha	0.5*	0.5	9.0	9.3
8	AHDB 9840 0.5 L/ha	7.5*	11.0	9.5	20.7
9	AHDB 9840 0.75 L/ha	10.0*	12.5	11.0	14.0
10	AHDB 9887 0.5 L/ha	16.0*	17.5	25.0	36.7
11	AHDB 9887 0.75 L/ha	15.0*	17.5	27.5	28.3
12	AHDB 9887 1.0 L/ha	20.0*	22.0	25.0	24.0
	F pr.	0.190	0.200	0.222	0.020
	d.f	15.81	17.78	25.62	25.58
	L.S.D	9.0	11.0	28.5	35.3

Table B. Assessment 1 on 03.09.2020. Analysis of variance table of means showing no significant reduction in percentage weed cover on the baseline assessment.

		Weed species (% cover)			
Treatment no	Treatment name	Chickweed	Mayweed	Pale persicaria	Fat hen
1	Untreated control	3.5	3.5	1.0	1.0
2	Lentagran 2.0 kg/ha	1.0	1.5	0.0	0.0
3	Dow Shield 400 0.5 L/ha	2.5	3.5	2.0	2.5
4	AHDB 9987 2.0 L/ha	0.0	0.0	0.0	0.0
5	AHDB 9987 1.0 L/ha + Gamit 36 CS 0.25 L/ha	0.0	0.0	0.0	0.0
6	AHDB 9917 0.7 L/ha	3.0	3.0	1.0	0.0
7	AHDB 9875 3.0 L/ha	0.5	0.0	0.0	0
8	AHDB 9840 0.5 L/ha	3.0	1.0	3.0	0.0
9	AHDB 9840 0.75 L/ha	3.0	3.0	1.0	2.5
10	AHDB 9887 0.5 L/ha	5.0	5.0	6.0	0.0
11	AHDB 9887 0.75 L/ha	5.5	5.5	1.5	0.0
12	AHDB 9887 1.0 L/ha	7.5	7.5	5.0	0.0
	F pr.	0.29	0.22	0.49	0.65
	d.f	11	11	11	11
	L.S.D	6.01	5.92	6.17	3.44

Table C. Assessment 2 17.09.2020. Analysis of variance table of means showing no significant reduction in weed cover assessment 2 weeks after Application 1.

		Weed species (% cover)			
Treatment no	**Treatment name**	**Chickweed**	**Mayweed**	**Pale persicaria**	**Fat hen**
1	Untreated control	5.5	3.5	1.0	1.0
2	Lentagran 2.0 kg/ha	2.0	1.5	0.0	0.0
3	Dow Shield 400 0.5 L/ha	3.5	3.5	2.0	2.5
4	AHDB 9987 2.0 L/ha	0.0	0.0	0.0	0.0
5	AHDB 9987 1.0 L/ha + Gamit 36 CS 0.25 L/ha	0.0	0.0	0.0	0.0
6	AHDB 9917 0.7 L/ha	4.5	3.0	1.0	0.0
7	AHDB 9875 3.0 L/ha	0.5	0.0	0.0	0.0
8	AHDB 9840 0.5 L/ha	5.5	1.0	3.0	0.0
9	AHDB 9840 0.75 L/ha	5.5	3.0	1.0	2.5
10	AHDB 9887 0.5 L/ha	6.5	5.0	6.0	0.0
11	AHDB 9887 0.75 L/ha	8.0	5.5	1.5	0.0
12	AHDB 9887 1.0 L/ha	9.5	7.5	5.0	0.0
F pr.		0.39	0.22	0.49	0.65
d.f		11	11	11	11
L.S.D		8.9	5.92	6.17	3.44

Table D. Assessment 3 02.10.2020. Analysis of variance table of means showing a significant reduction in Fat hen cover 4 weeks after Application 1. Significant result highlighted in bold.

		Weed species (% cover)					
Trt no	**Treatment name**	**Chick weed**	**Mayw eed**	**Pale persicaria**	**Fat hen**	**Shepherds purse**	**Ground sel**
1	Untreated control	6.0	6.0	6.0	6.0	0.0	3.0
2	Lentagran 2.0 kg/ha	1.5	1.5	1.5	**0.0**	0.0	0.3
3	Dow Shield 400 0.5 L/ha	7.5	2.5	5.7	6.0	1.5	0.0
4	AHDB 9987 2.0 L/ha	1.5	0.0	1.0	**0.5**	0.0	0.0
5	AHDB 9987 1.0 L/ha + Gamit 36 CS 0.25 L/ha	0.0	0.0	0.5	**0.0**	0.0	0.0
6	AHDB 9917 0.7 L/ha	6.5	2.0	6.5	**1.0**	0.0	2.5
7	AHDB 9875 3.0 L/ha	3.0	1.0	3.0	**0.0**	0.0	3.5
8	AHDB 9840 0.5 L/ha	3.5	1.0	6.5	**1.0**	0.0	0.0
9	AHDB 9840 0.75 L/ha	2.5	0.0	4.0	**0.0**	0.5	4.0
10	AHDB 9887 0.5 L/ha	7.5	5.0	5.0	**0.0**	0.0	7.5
11	AHDB 9887 0.75 L/ha	10.0	2.5	0.0	**0.0**	0.0	12.5
12	AHDB 9887 1.0 L/ha	8.5	2.5	1.0	**0.0**	0.0	12.0
F pr.		0.72	0.81	0.53	**0.03**	0.57	0.2
d.f		11	11	11	11	11	11
L.S.D		12	3.83	8.01	4	1.46	10.95

Table E. Abbotts formula per cent reduction in overall weed cover on 2 October 2020 - 8 weeks after Application 1.

		Abbotts formula
	Mean	%reduction
Trt		
1	28.5	
2	4	85.96
3	24	15.79
4	2.5	91.23
5	0.5	98.25
6	18	36.84
7	9	68.42
8	9.5	66.67
9	11	61.4
10	25	12.28
11	27.5	3.51
12	25	12.28

Table F. Assessment 4 09.10.2020. Analysis of variance table of means showing significant reductions in Pale persicaria, Fat hen and Groundsel 5 weeks after Application 1. Significant result highlighted in bold.

		Weed species (% cover)					
Trt no	**Treatment name**	**Chickweed**	**Mayweed**	**Pale persicaria**	**Fat hen**	**Shepherds purse**	**Groundsel**
1	Untreated control	11.0	9.3	4.7	7.3	0.0	3.3
2	Lentagran 2.0 kg/ha	4.3	3.0	1.2	**1.0**	0.0	3.0
3	Dow Shield 400 0.5 L/ha	14.0	10.0	13.3	7.3	1.0	0.0
4	AHDB 9987 2.0 L/ha	1.3	0.0	1.3	**0.2**	0.0	0.0
5	AHDB 9987 1.0 L/ha + Gamit 36 CS 0.25 L/ha	0.0	0.0	1.0	**0.3**	0.0	0.0
6	AHDB 9917 0.7 L/ha	7.3	11.3	9.3	**3.7**	0.7	2.3
7	AHDB 9875 3.0 L/ha	2.8	0.7	3.0	**0.2**	0.0	2.5
8	AHDB 9840 0.5 L/ha	12.3	0.0	6.0	**1.7**	0.7	0.0
9	AHDB 9840 0.75 L/ha	4.3	0.2	5.0	**0.7**	0.8	2.7
10	AHDB 9887 0.5 L/ha	7.7	14.3	4.3	**0.0**	0.0	10.7
11	AHDB 9887 0.75 L/ha	9.3	9.3	0.3	**0.7**	0.0	9.0
12	AHDB 9887 1.0 L/ha	2.3	10.0	0.7	**0.0**	0.0	11.0
F pr.		0.25	0.06	**0.02**	**<.001**	0.81	**0.04**
d.f		11	11	11	11	11	11
L.S.D		11.37	10.9	6.95	3.18	1.31	7.88

Table G. Abbotts formula per cent reduction and Duncan's test in bold for overall weed cover on 9 October 2020 - 9 weeks after Application 1.

		Abbotts formula
	Mean	%reduction
Trt		
1	35.33	bc
2	13.33	62.27 **ab**
3	46	-30.2 **c**
4	2.83	91.99 **a**
5	1.33	96.24 **a**
6	36.67	-3.79 **bc**
7	9.33	73.59 **ab**
8	20.67	41.49 **abc**
9	14	60.37 **ab**
10	36.67	-3.79 **bc**
11	28.33	19.81 **abc**
12	24	32.07 **abc**

Table H. Table showing overall mean per cent weed cover by weed species on 9 October 2020.

Treatment	Chickweed	Mayweed	Pale persicaria	Groundsel	Fat Hen	Shepherds Purse
1	21.0	18.0	10.0	5.3	12.7	0.0
2	7.3	6.0	2.2	3.2	1.0	0.0
3	23.0	16.3	19.8	0.0	14.7	2.0
4	2.3	0.0	2.0	0.0	0.5	0.0
5	0.0	0.0	1.3	0.0	0.3	0.0
6	16.7	16.7	15.0	4.0	4.3	0.7
7	5.5	1.3	5.0	4.8	0.2	0.0
8	20.3	2.0	14.3	0.0	2.3	0.7
9	11.7	4.2	9.0	5.3	4.0	1.2
10	20.3	24.3	15.7	15.7	0.0	0.0
11	25.0	18.3	2.3	17.3	0.7	0.0
12	19.3	21.7	8.0	19.0	0.0	0.0