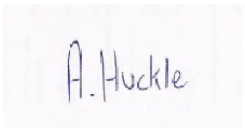
Final Trial Report

Trial code:	SP 28. 2018
Title:	AHDB SCEPTREplus allium contact herbicide screen
Crop	Group: field vegetables – Alliums (bulb onion and salad onion)
Target	General broadleaf weeds and grasses, 3WEEDT EPPO1/75(3) Weeds in Allium crops
Lead researcher:	Angela Huckle
Organisation:	RSK ADAS
Period:	16th May 2018 – 31st March 2019
Report date:	27st March 2022
Report author:	Angela Huckle Emily Lawrence
ORETO Number: (certificate 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

28th March 2018
Date



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Trial Summary

Introduction

Lack of comprehensive weed control for alliums is due to a combination of crop sensitivity to available herbicides and insufficient available actives to cover the full weed spectrum. Particularly problematic broad leaf weed types for allium producers are fat hen, field pansy, small nettle, composite and polygonums as well as a range of grasses (AHDB Gap Analysis 2016). A number of growers are currently trialing the use of band sprayed glyphosate for weed control using directed hooded sprays (approved under EAMU). This method is however, slow and can only be used at early crop growth stages and doesn't control weeds in the crop rows. A combination of approaches for effective weed control is therefore needed; and crop safe approvals for broadacre applied herbicides are still required.

The objective of this trial was to identify crop safe and effective post-emergence applied contact herbicides for weed control in alliums, aiming to expand the options available to growers. The products were tested alone, and in tank-mixes.

Method

Bulb onions

The bulb onion trial was sited at a commercial onion grower in Essex. The trial field was drilled on 24th March 2018, with bulb onion variety 'Hybound'.

Treatments were applied twice, first at 2-3 true leaves (24th May), and then a repeat application of the same treatments three weeks later, at 3-4 true leaves (4th June). All treatments were applied with a 1.5 m boom, using a knapsack sprayer at 200 L/ha water volume.

A randomised block design was used, with three replicates of twenty treatments, including two untreated controls. There were sixty plots in total, each measuring 1.8 m x 6 m.

The trial was assessed on four occasions, focussing on weed species and crop phytotoxicity (i.e. treatment safety). In addition to the baseline weed assessment prior to the first treatment application, assessments were carried out approximately two, four, six and seven weeks after the first treatment was applied.

Salad onions

The salad onion trial was sited at a commercial onion grower in Warwickshire. The trial field was drilled on 20th May 2018, with salad onion variety 'Parade'.

Treatments were applied twice, first at 2-3 true leaves (22nd June), and then a repeat application of the same treatments three weeks later, at 3-4 true leaves (12th July). All treatments were applied with a 1.5 m boom, using a knapsack sprayer at 200 L/ha water volume. A randomised block design was used, with three replicates of twenty-two treatments, including two untreated controls. There were sixty-six plots in total, each measuring 1.8m x 6m.

The trial was assessed on six occasions, focussing on weed species and crop phytotoxicity (i.e. treatment safety). In addition to the baseline weed assessment prior to the first treatment application, assessments were carried out approximately two, three, five, seven and eight weeks after the first treatment was applied.

Results and discussion

Emerger and tank mixes containing Emerger were safe to use in the salad onion trial, causing only a yellow halo on a small number of plants. In the bulb onion trial, Emerger applied alone at either 0.5 or 1.0 L/ha and AHDB 9890 at half rate were safe to use on bulb onions causing no effects which were commercially unacceptable throughout the trial assessment period (**Table 1**), the main effect being a slight yellow band from Emerger which grew out. Unlike salad onions, some foliar damage can be tolerated on a bulb onion crop.

Emerger 0.5 L/ha was also crop safe throughout the trial when applied in a tank mix with Buctril 0.2 L/ha. When Emerger 0.5 L/ha was included in the three-way tank mix with Basagran 0.3 kg/ha and Starane 0.2 L/ha, there were slight effects of scorch and leaf twisting on the crop at two and four weeks after application but these had reduced to an acceptable level by the end of the trial assessment period (T2 + 6 weeks).

Crop effects increased after the second application in both the bulb and salad onion trials as the weather was dull at this application timing in both situations. This means the crop foliage would likely be less fully waxed, and the leaves may still have been a little de-waxed after the first herbicide application and more sensitive to damage. This allowed the crop effects from the herbicides to be tested in less ideal application conditions and highlighted that AHDB 9889 in particular caused the greatest crop effects. This was exhibited as scorching of the leaves which persisted at an unacceptable level on the salad onion crop until the end of the trial assessment period when AHDB 9889 was either applied at the higher rate or in a three-way tank mix.

Weed levels were not great enough in the bulb onion trial to draw robust conclusions but weed cover (87.8% in the untreated control) in the salad onion trial was sufficient to provide indications on product performance against groundsel, redshank, black bindweed and fat hen which can commonly be found in onion crops.

At four weeks after the second and final application, the three-way tank mix of Emerger 0.5 L/ha + Basagran 0.3 kg/ha + Starane 0.2 L/ha reduced weed cover by the greatest percentage (97.7%). When AHDB 9889 and AHDB 9890 were included in the three-way tank mixes, the reduction in weed cover was still greater than 80%, but neither product added as much control to the tank mix on the weed spectrum present as Emerger alone.

A similar pattern was observed when the experimental products were tank mixed with either Basagran 0.3 kg/ha or Starane 0.2 L/ha. Emerger 0.5 L/ha contributed the greatest reduction in weed control to the mix, with AHDB 9889 performing nearly as well, and AHDB 9890 performing the least well of the products tested. AHDB 9890 does not have as wide a weed spectrum of control as Emerger or AHDB 9889.

When comparing products applied alone, Emerger 1.0 L/ha reduced percentage weed cover by the greatest amount and reducing the rate to 0.5 L/ha substantially reduces efficacy, therefore at the lower rate Emerger requires a tank-mix partner. But, as can be seen above, it still adds value to a tank mix at 0.5 L/ha. Again, AHDB 9889 at 2/3 rate, then 1/3 rate perform next well in comparison, with AHDB 9890 reducing percentage weed cover the least when applied alone. None of the products perform as well as the commercial standard, Buctril 0.4 L/ha, but Emerger 1.0 L/ha alone, or at 0.5 L/ha in a tank mix offers a suitable alternative.

AHDB 9889 and AHDB 9890 caused greater phytotoxic effects and AHDB 9890 did not reduce percentage weed levels as much as Emerger or AHDB 9889 in the trial on salad onions. Therefore Emerger provides the most favourable alternative to Buctril for post-emergence weed control from this trial.

Table 1. Summary of crop damage (4 weeks post- final treatment) and percentage weed cover in the salad onion trial at two and four weeks after the Timing 2 application (backtransformed). Scores ≥8 deemed commercially acceptable damage, those <8 (unacceptable damage) are highlighted in red.

Trt. No.	Crop damage (0-10)		Weed cover (%)	
	T2 + 4 weeks		T2 + 2 weeks	T2 + 4 weeks
	Bulb onion	Salad onion	Salad onion	
Untreated	10.0	10.0	89.9	99.8
Buctril* 0.4 L/ha	-	9.7	13.9	16.9
Buctril* 0.2 L/ha Starane 0.2 L/ha	-	9.5	8.2	7.8
Emerger 0.5 L/ha	9.0	8.6	39.4	64.9

Trt. No.	Crop damage (0-10)		Weed cover (%)	
	T2 + 4 weeks		T2 + 2 weeks	T2 + 4 weeks
	Bulb onion	Salad onion	Salad onion	
Emerger 1.0 L/ha	9.0	8.7	18.4	28.4
AHDB 9889 ⅓ N rate	8.0	9.0	29.1	53.4
AHDB 9889 ⅔ N rate	7.3	7.0	31.5	39.6
AHDB 9890 ⅓ N rate	8.7	8.3	55.2	66.4
AHDB 9890 N rate	7.7	8.0	56.8	80.2
Buctril* 0.2 L/ha + Emerger 0.5 L/ha	8.7	9.5	3.8	6.7
Buctril* 0.2 L/ha + AHDB 9889 ⅓ N rate	8.3	9.0	9.3	9.6
Buctril* 0.2 L/ha + AHDB 9890 ⅓ N rate	6.7	8.7	21.1	37.2
Basagran 0.3 kg/ha + Emerger 0.5 L/ha	7.3	9.0	17.8	34.1
Basagran 0.3 kg/ha + AHDB 9889 ⅓ N rate	6.7	8.3	25.3	34.8
Basagran 0.3 kg/ha + AHDB 9890 ⅓ N rate	7.3	8.7	50.0	60.2
Starane 0.2 L/ha + Emerger 0.5 L/ha	7.3	9.0	8.2	13.3
Starane 0.2 L/ha + AHDB 9889 ⅓ N rate	7.7	8.7	18.9	20.9
Starane 0.2 L/ha + AHDB 9890 ⅓ N rate	7.3	8.3	36.6	53.4
Basagran 0.3 kg/ha + Starane 0.2 L/ha + Emerger 0.5 L/ha	7.0	9.3	2.0	2.3
Basagran 0.3 kg/ha + Starane 0.2 L/ha + AHDB 9889 ⅓ N rate	6.7	7.7	12.6	18.2
Basagran 0.3 kg/ha + Starane 0.2 L/ha + AHDB 9890 ⅓ N rate	7.0	8.0	10.0	15.0
p value	<0.001	0.115	<0.001	<0.001
d.f.	39	43	43	43
L.S.D.	1.167	1.502	15.74	13.56
	Not significantly different from untreated control (p>0.05)			
	Significantly different from untreated control (p<0.05)			

Conclusion

- Emerger provides the most favourable combination of crop safety and efficacy from the three products in the trial.
- At four weeks after the second and final application in the salad onion trial, the three-way tank mix of Emerger 0.5 L/ha + Basagran 0.3 kg/ha + Starane 0.2 L/ha reduced weed cover by the greatest percentage (97.7%).
    - This combination caused crop effects of slight twisting and a small percentage of the crop to be affected by yellow ‘bands’, but the effect was transient.
- AHDB 9889 performed to a near equivalent level of efficacy to Emerger, but was more phytotoxic causing greater levels of scorch, particularly if applied in dull conditions.
- AHDB 9890 significantly reduced percentage weed cover, but was not the best performer in the trial as it has a narrower weed spectrum of control.

** Buctril was withdrawn as an approved use September 2021*

Take home message

Emerger provides the most favourable combination of crop safety and efficacy from the three products in the trial and would aid onion growers in improving post-emergence weed control, whether used alone or in a tank mix.

Objectives

1. To compare a number of novel contact herbicides applied alone and in combination for selectivity (crop safety) and efficacy in bulb and salad onions. There is no commercial standard, but commercially available products are used in combination with the experimental products.

Trial conduct

UK regulatory guidelines were followed but EPPO guideline took precedence. The following EPPO guidelines were followed:

Relevant EPPO guideline(s)		**Variation from EPPO**
EPPO PP1/135(4)	Phytotoxicity assessment	None
EPPO PP1/152(4)	Guideline on design and analysis of efficacy evaluation trials	None
EPPO PP1/225 (2)	Minimum effective dose	None
EPPO PP1/181 (4)	Conduct and reporting of efficacy evaluation trials including good experimental practice	None
EPPO PP 1/214(3)	Principles of acceptable efficacy	None
EPPO PP 1/224(2)	Principles of efficacy evaluation for minor uses	None

Deviations from EPPO guidance:

PP 175 (3) Weeds in allium crops. Section 1.4, Design and lay-out of trial.
“Replicates: at least 4”
Current study to have only 3 replicates – number of treatments provides acceptable number of residual degrees of freedom, and client has requested only three replicates.

Test site – Site 1 Bulb onions

Item	**Details**
Location address	Field: Higham Hall Field Rix Farms Higham Essex C07 6JY
Crop	Bulb onion
Cultivar	Hybound
Soil or substrate type	Sandy clay loam
Agronomic practice	See Appendix A
Prior history of site	See Appendix A

Test site – Site 2 Salad onions

Item	**Details**
Location address	Field: Field Pond Close Sandfield Farms Ripple WR8 0PX Grid ref: SO 87516 38771
Crop	Salad onion
Cultivar	Parade
Soil or substrate type	Sandy clay loam
Agronomic practice	See Appendix A
Prior history of site	See Appendix A

Trial design – both sites

Item	Details
Trial design:	Randomised block
Number of replicates:	3
Row spacing:	4 rows per 1.8m bed
Plot size: (w x l)	1.8m x 6m
Plot size:	10.8m^2
Number of plants per plot:	N/K
Leaf Wall Area calculations	N/A

Treatment details – both sites

AHDB Code	Product name	Active substance	Formulation batch number	Content of active substance in product (g/L)	Formulation type
N/A	Emerger	aclonifen	N/A	600	Suspension Concentrate
N/A	Basagran SG	bentazone	N/A	(g/kg) 870	Water soluble granule
N/A	Buctril**	bromoxynil*	N/A	225	Emulsifiable Concentrate
AHDB 9890	ND	ND	N/A	ND	ND
AHDB 9889	ND	ND	N/A	ND	ND
N/A	Starane Hi-Load HL	fluroxypyr	N/A	333	Emulsifiable Concentrate

*** Buctril was withdrawn as an approved use in September 2021*

Application schedule

Trt. No.	Treatment: product name or AHDB code	Rate of active substance(s) (ml/ha)	Rate of product (L/ha)	Timing
1	Untreated	-	-	
2	Untreated	-	-	
3*	Buctril**	90.0	0.40	A,B
4*	Buctril** + Starane HiLoad	45.0 66.6	0.20 0.20	A,B
5	Emerger	300.0	0.50	A,B
6	Emerger	600.0	1.00	A,B
7	AHDB 9889	120.0	0.25	A,B
8	AHDB 9889	240.0	0.50	A,B
9	AHDB 9890	240.0	0.50	A,B
10	AHDB 9890	720.0	1.50	A,B
11	Buctril** + Emerger	45.0 300.0	0.20 0.50	A,B
12	Buctril** + AHDB 9889	45.0 120.0	0.20 0.25	A,B
13	Buctril** + AHDB 9890	45.0 240.0	0.20 0.50	A,B
14	Basagran SG + Emerger	261.0 300.0	0.30 0.50	A,B
15	Basagran SG +	261.0	(kg/ha) 0.30	A,B

Trt. No.	Treatment: product name or AHDB code	Rate of active substance(s) (ml/ha)	Rate of product (L/ha)	Timing
	AHDB 9889	120.0	0.25	
16	Basagran SG + AHDB 9890	261.0 240.0	(kg/ha) 0.30 0.50	A,B
17	Starane Hi-Load HL + Emerger	66.6 300.0	0.20 0.50	A,B
18	Starane Hi-Load HL + AHDB 9889	66.6 120.0	0.20 0.25	A,B
19	Starane Hi-Load HL + AHDB 9890	66.6 240.0	0.20 0.50	A,B
20	Basagran SG + Starane Hi-Load HL + Emerger	261.0 66.6 300.0	(kg/ha) 0.30 0.20 0.50	A,B
21	Basagran SG + Starane Hi-Load HL + AHDB 9889	261.0 66.6 120.0	(kg/ha) 0.30 0.20 0.25	A,B
22	Basagran SG + Starane Hi-Load HL + AHDB 9890	261.0 66.6 240.0	(kg/ha) 0.30 0.20 0.50	A,B

* not applied at bulb onion site

** *Buctril was withdrawn as an approved use in September 2021*

Application details – Site 1 Bulb onions

	Timing A	Timing B
Application date	24/05/2018	04/06/2018
Time of day	08:45	11:45
Crop growth stage (Max, min average BBCH)	BBCH 12	BBCH 13
Crop height (cm)	15	17
Crop coverage (%)	50	50
Application Method	spray	spray
Application Placement	foliar	foliar
Application equipment	AZO plot sprayer (knapsack)	AZO plot sprayer (knapsack)
Nozzle pressure	2.5	2.5
Nozzle type	Flat fan	Flat fan
Nozzle size	02-F110	02-F110
Application water volume/ha	300	300
Temperature of air - shade (°C)	21	17
Relative humidity (%)	63	81
Wind speed range (mph)	11	10
Dew presence (Y/N)	N	N
Temperature of soil - 10cm (°C)	19	19.4
Wetness of soil - 2-5 cm	Surface dry	Surface dry
Cloud cover (%)	10	100

Application details – Site 2 Salad onions

	Timing A	Timing B
Application date	22/06/2018	12/07/2018
Time of day	11:15 – 14:15	07:12 – 11:15
Crop growth stage (Max, min average BBCH)	BBCH11-12	BBCH13-14
Crop height (cm)	15	25
Crop coverage (%)	60	60
Application Method	Spray	spray
Application Placement	Foliar	foliar
Application equipment	Oxford Precision Sprayer (knapsack)	Oxford Precision Sprayer (knapsack)
Nozzle pressure	2.0	2.0
Nozzle type	Flat fan	Flat fan
Nozzle size	03F110	03F110
Application water volume/ha	200	200
Temperature of air - shade (°C)	19.2 – 20.3	16.2 – 22.1
Relative humidity (%)	31.2 – 33.2	39.2 – 47.1
Wind speed range (mph)	0.2 – 0.4	1.1 – 1.2
Dew presence (Y/N)	N/K	N/K
Temperature of soil - 10cm (°C)	N/K	N/K
Wetness of soil - 2-5 cm	Damp	damp
Cloud cover (%)	30	60

Untreated levels of pests/pathogens at application and through the assessment period – Site 1 Bulb onions

Common name	**Scientific Name**	**EPPO Code**	**Weed level mid-assessment period** (4 weeks)	**Weed level mid-assessment period** (6 weeks)	**Weed level at end of assessment period** (8 weeks)
Broad leaved weeds and grasses	*N/A*	3WEEDT	4.67% *(untreated average)*	1.33% *(untreated average)*	2.00% *(untreated average)*

Untreated levels of pests/pathogens at application and through the assessment period – Site 2 Salad onions

Common name	**Scientific Name**	**EPPO Code**	**Weed level start-assessment period** Pre-spray	**Weed level mid-assessment period** (T1+ 2 weeks)	**Weed level at end of assessment period** (T2 + 4 weeks)
Broad leaved weeds and grasses	*N/A*	3WEEDT	5% *(untreated average)*	71.5% *(untreated average)*	87.8% *(untreated average)*

Assessment details – Site 1 Bulb onions

Evaluation date	Evaluation Timing (DA)*	Crop Growth Stage (BBCH)	Evaluation type (efficacy, phytotox)	What was assessed and how (e.g. dead or live pest; disease incidence and severity; yield, marketable quality)
04/06/2018	12	13	efficacy, phytotox	Phytotox (scale 0-10, 0 = Dead) Weed species presence and count (No. in plot)
20/06/2018	28	15	efficacy, phytotox	Phytotox (scale 0-10, 0 = Dead) Percentage of weed cover – whole plot score
02/07/2018	40	41	efficacy, phytotox	Phytotox (scale 0-10, 0 = Dead) Percentage of weed cover – whole plot score
18/07/2018	56	46	efficacy, phytotox	Phytotox (scale 0-10, 0 = Dead) Percentage of weed cover – whole plot score

* DA – days after first application

Assessment details – Site 2 Salad onions

Evaluation date	Evaluation Timing (DA)*	Crop Growth Stage (BBCH)	Evaluation type (efficacy, phytotox)	What was assessed and how (e.g. dead or live pest; disease incidence and severity; yield, marketable quality)
22/06/2018	0	12	efficacy, phytotox	Phytotox (scale 0-10, 0 = Dead) Weed species presence and count (No. in plot)
05/07/2018	13	13	phytotox	Phytotox (scale 0-10, 0 = Dead)
12/07/2018	20	14	efficacy, phytotox	Phytotox (scale 0-10, 0 = Dead) Percentage of weed cover – whole plot score
25/07/2018	33	15	efficacy, phytotox	Phytotox (scale 0-10, 0 = Dead) Percentage of weed cover – whole plot score
09/08/2018	48	16	efficacy, phytotox	Phytotox (scale 0-10, 0 = Dead) Percentage of weed cover – whole plot score
17/08/2018	56	41	phytotox	Phytotox (scale 0-10, 0 = Dead)

* DA – days after first application

Statistical analysis

The trials had a randomised block design, with treatments replicated three times.

As the distribution of weeds was uneven across the trial areas – which is not unexpected in field situations – there was a need to transform this data prior to analysis. To determine treatment efficacy, an angular transformation was performed then the back transformed means presented, from which the % reduction in weeds was calculated using Abbotts formula.

All data were analysed by ANOVA using Genstat 18.4 by Emily Lawrence or Chris Dyer at RSK ADAS.

Results – bulb onions

Phytotoxicity
The results of phytotoxicity assessments from four dates are presented in **Table 2** and **Figure 1.** These were scored on a scale from 0 to 10, with 0 being 'dead', and 10 being 'no effect'. Plots deemed to have a commercially acceptable level of damage were scored 8 or above.

Phytotoxicity was recorded using the following scale:

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

* 8 = acceptable damage, i.e. damage unlikely to reduce yield, and acceptable to the farmer.

Emerger applied alone at either 0.5 or 1.0 L/ha and AHDB 9890 at half rate were safe to use on bulb onions causing no effects which were commercially unacceptable throughout the trial assessment period, the main effect being a slight yellow band from Emerger which grew out. Emerger 0.5 L/ha was also crop safe throughout the trial when applied in a tank mix with Buctril 0.2 L/ha. When Emerger 0.5 L/ha was included in the three-way tank mix with Basagran 0.3 kg/ha and Starane 0.2 L/ha, there were slight effects of scorch and leaf twisting on the crop at two and four weeks after application but these had reduced to an acceptable level by the end of the trial assessment period (T2 + 6 weeks).

AHDB 9889 caused slight to moderate scorching which remained until the end of the assessment period when applied at 2/3 of the label (N) rate. Where the rate was reduced to a third of the label rate, then the effect was transient and the crop grew through the scorch. When included in the two-way and three-way tank mixes, AHDB 9889 caused a scorch which remained just under an acceptable level until the end of the trial period with the exception of the tank mix with Buctril 0.2 L/ha.

When AHDB 9890 was tank mixed with Starane 0.2 L/ha, the crop was still exhibiting moderate phytotoxicity symptoms by the end of the trial, these were scorch and leaf twisting. However, when applied alone at One third label rate the product was safe to bulb onions with only very slight foliar scorch. When AHDB 9890 was applied in a tank mix with Basagran 0.3 L/ha or in the three-way tank mix with Basagran and Starane, there was initially symptoms of scorch, or leaf twisting where Starane was included in the mix. But, these phytotoxicity symptoms had reduced to an acceptable level by the final assessment.

Effects on the onion crop increased after the Timing 2 application, as phytotoxicity scores reduced where the two way (with Buctril or Basagran) mixes were used. Symptoms were scorching and yellowing, and slight twisting where Starane was included in the mix. The effects would have increased partly due to the additional herbicide application, but also because the weather was dull at the time of the second application and the leaves may not have been 'waxed-up'.

Table 2. Mean phytotoxicity scores at four dates throughout the trial period (0 to 10; 0 = complete crop death, 10 = no damage). Scores ≥8 deemed commercially acceptable damage, those <8 (unacceptable damage) are highlighted in red.

	Mean crop damage scores			
	4th June At Timing 2	20th June T2 + 2 weeks	2nd July T2 + 4 weeks	18th July T2 + 6 weeks
Untreated	10.0	10.0	10.0	10.0
Emerger 0.5 L/ha	8.3	9.0	9.0	8.7
Emerger 1.0 L/ha	8.7	9.0	9.0	8.3
AHDB 9889 ⅓ N rate	7.7	7.3	8.0	8.7
AHDB 9889 ⅔ N rate	6.0	6.7	7.3	7.7
AHDB 9890 ⅓ N rate	8.3	8.7	8.7	9.7
AHDB 9890 N rate	7.3	7.3	7.7	7.7
Buctril* 0.2 L/ha + Emerger 0.5 L/ha	9.3	8.7	8.7	8.7
Buctril* 0.2 L/ha + AHDB 9889 ⅓ N rate	7.7	7.7	8.3	9.0
Buctril* 0.2 L/ha + AHDB 9890 ⅓ N rate	8.0	7.0	6.7	7.7
Basagran 0.3 kg/ha + Emerger 0.5 L/ha	7.0	7.3	7.3	8.0
Basagran 0.3 kg/ha + AHDB 9889 ⅓ N rate	7.3	6.7	6.7	7.7
Basagran 0.3 kg/ha + AHDB 9890 ⅓ N rate	7.3	7.0	7.3	9.0
Starane 0.2 L/ha + Emerger 0.5 L/ha	8.3	7.3	7.3	7.7
Starane 0.2 L/ha + AHDB 9889 ⅓ N rate	7.0	7.0	7.7	7.7
Starane 0.2 L/ha + AHDB 9890 ⅓ N rate	6.7	6.7	7.3	6.7
Basagran 0.3 kg/ha + Starane 0.2 L/ha + Emerger 0.5 L/ha	8.7	7.0	7.0	8.3
Basagran 0.3 kg/ha + Starane 0.2 L/ha + AHDB 9889 ⅓ N rate	7.0	6.3	6.7	7.3
Basagran 0.3 kg/ha + Starane 0.2 L/ha + AHDB 9890 ⅓ N rate	7.0	7.3	7.0	8.0
p value	<0.001	<0.001	<0.001	0.013
d.f.	39	39	39	39
L.S.D.	1.167	1.057	1.169	1.490

Buctril was withdrawn as an approved use in September 2021

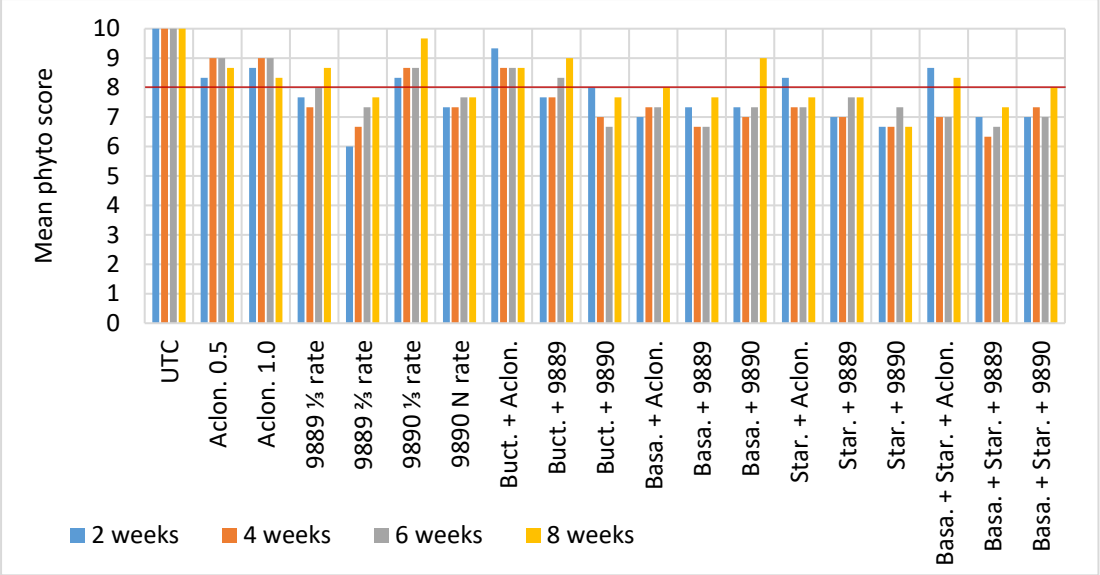

Figure 1. Mean phytotoxicity (0-10) at two, four, six and eight weeks after Timing A treatment application. Scores of 8 or above deemed acceptable damage (as indicated by red line). *Note the aclonifen product used was Emerger.*

Weed control – mean percentage weed cover

The results for the mean percentage weed cover per treatment are presented in **Table 4** and **Figure 3**. The percent reduction in weed cover compared to the untreated control was calculated from these figures (using Abbotts formula), and results for each treatment are listed in **Table 5.**

Weed levels in the bulb onion trial were low and therefore it is difficult to determine the differences between the efficacy of the treatments with certainty.

Table 3. Mean percentage weed cover values (transformed).

Trt. No.	Mean weed cover					
	20th June		2nd July		18th July	
	Ang	Back-trans	Ang	Back-trans	Ang	Back-trans
Untreated	12.30	4.54	5.98	1.09	7.25	1.59
Emerger 0.5 L/ha	7.95	1.91	9.73	2.86	6.54	1.30
Emerger 1.0 L/ha	9.73	2.86	1.91	0.11	3.32	0.34
AHDB 9889 ⅓ N rate	7.67	1.78	0.00	*	0.00	*
AHDB 9889 ⅔ N rate	7.95	1.91	7.33	1.63	9.73	2.86
AHDB 9890 ⅓ N rate	11.33	3.86	6.54	1.30	7.15	1.55
AHDB 9890 N rate	6.54	1.30	4.62	0.65	5.24	0.83
Buctril** 0.2 L/ha + Emerger 0.5 L/ha	1.91	0.11	1.91	0.11	1.91	0.11
Buctril** 0.2 L/ha + AHDB 9889 ⅓ N rate	8.47	2.17	8.47	2.17	7.95	1.91
Buctril** 0.2 L/ha + AHDB 9890 ⅓ N rate	6.54	1.30	0.00	*	1.91	0.11
Basagran 0.3 kg/ha + Emerger 0.5 L/ha	8.47	2.17	2.71	0.22	5.24	0.83
Basagran 0.3 kg/ha + AHDB 9889 ⅓ N rate	6.54	1.30	4.62	0.65	4.62	0.65
Basagran 0.3 kg/ha + AHDB 9890 ⅓ N rate	10.50	3.32	6.54	1.30	7.95	1.91
Starane 0.2 L/ha + Emerger 0.5 L/ha	8.74	2.31	7.33	1.63	7.33	1.63

Trt. No.	Mean weed cover					
	20th June		2nd July		18th July	
	Ang	Back-trans	Ang	Back-trans	Ang	Back-trans
Starane 0.2 L/ha + AHDB 9889 ⅓ N rate	6.03	1.11	1.91	0.11	1.91	0.11
Starane 0.2 L/ha + AHDB 9890 ⅓ N rate	8.74	2.31	4.62	0.65	4.62	0.65
Basagran 0.3 kg/ha + Starane 0.2 L/ha + Emerger 0.5 L/ha	8.93	2.41	7.95	1.91	7.15	1.55
Basagran 0.3 kg/ha + Starane 0.2 L/ha + AHDB 9889 ⅓ N rate	0.00	0.00	0.00	*	1.91	0.11
Basagran 0.3 kg/ha + Starane 0.2 L/ha + AHDB 9890 ⅓ N rate	6.54	1.30	2.71	0.22	5.42	0.89
p value		<0.001		0.002		0.075
d.f.		39		39		39
L.S.D.		3.913		4.367		5.103

***Buctril was withdrawn as an approved use in September 2021*

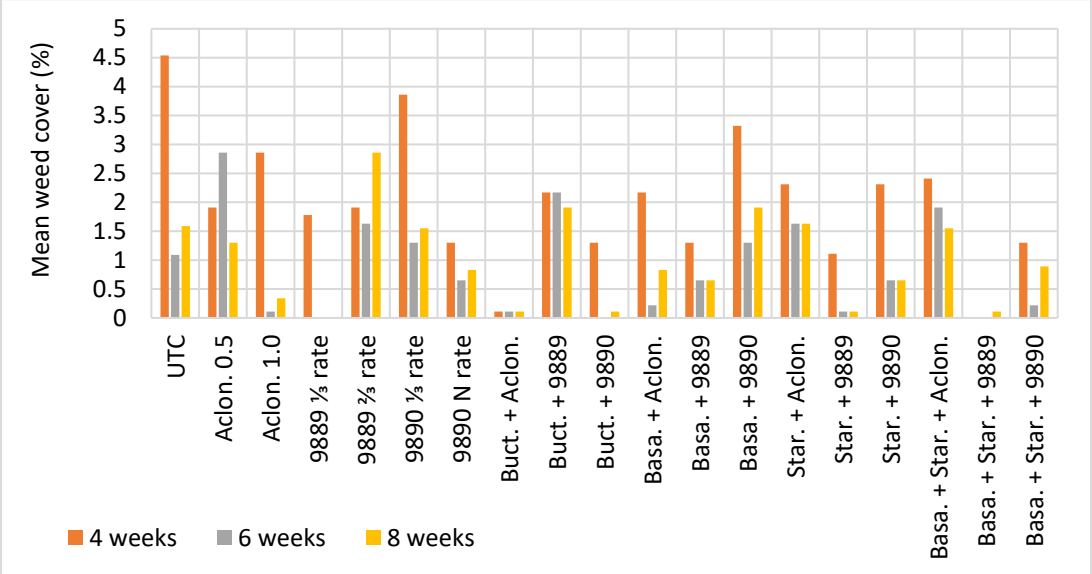

Figure 2. Mean weed cover (%) at four, six and eight weeks after treatment application. *Note: y-axis max. value of 5% Note the aclonifen product used was Emerger.*

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Table 4. Percentage reduction in weed cover four, six and eight weeks after Timing A treatment application (calculated using Abbotts formula) – highlighted values show an increase in weed cover.

	Weed cover reduction (%)		
	20th June	2nd July	18th July
Emerger 0.5 L/ha	57.84	-163.21	18.64
Emerger 1.0 L/ha	37.05	89.77	78.91
AHDB 9889 ⅓ N rate	60.71	-	-
AHDB 9889 ⅔ N rate	57.84	-50.18	-79.22
AHDB 9890 ⅓ N rate	14.84	-19.48	2.70
AHDB 9890 N rate	71.42	40.08	47.71
Buctril** 0.2 L/ha + Emerger 0.5 L/ha	97.55	89.77	93.03
Buctril** 0.2 L/ha + AHDB 9889 ⅓ N rate	52.17	-99.96	-20.03
Buctril** 0.2 L/ha + AHDB 9890 ⅓ N rate	71.42	-	93.03
Basagran 0.3 kg/ha + Emerger 0.5 L/ha	52.17	79.35	47.71
Basagran 0.3 kg/ha + AHDB 9889 ⅓ N rate	71.42	40.08	59.20
Basagran 0.3 kg/ha + AHDB 9890 ⅓ N rate	26.84	-19.48	-20.03
Starane 0.2 L/ha + Emerger 0.5 L/ha	49.04	-50.18	-2.26
Starane 0.2 L/ha + AHDB 9889 ⅓ N rate	75.63	89.77	93.03
Starane 0.2 L/ha + AHDB 9890 ⅓ N rate	49.04	40.08	59.20
Basagran 0.3 kg/ha + Starane 0.2 L/ha + Emerger 0.5 L/ha	46.86	-76.27	2.70
Basagran 0.3 kg/ha + Starane 0.2 L/ha + AHDB 9889 ⅓ N rate	100.00	-	93.03
Basagran 0.3 kg/ha + Starane 0.2 L/ha + AHDB 9890 ⅓ N rate	71.42	79.35	44.01

** *Buctril was withdrawn as an approved use in September 2021*

Results – salad onions

Phytotoxicity
The results of phytotoxicity assessments from four dates are presented in **Table 6.** These were scored on a scale from 0 to 10, with 0 being 'dead', and 10 being 'no effect'. Plots deemed to have a commercially acceptable level of damage were scored 8 or above.

Phytotoxicity was recorded using the following scale:

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

* 8 = acceptable damage, i.e. damage unlikely to reduce yield, and acceptable to the farmer.

Treatments containing Emerger exhibited only very slight crop effects throughout the whole trial period, and the crop remained commercially acceptable. The only crop effect was spotting or a yellow halo around a small number of the salad onion leaves, but this was deemed acceptable by the grower.

The first application caused very little crop damage, and was applied on a warm (19.7 ^{0}C), mainly sunny day (30% cloud cover) at midday to early afternoon. However, the second application caused greater phytotoxic effects. It was applied early morning, and although the day was warm and sunny (19.2 ^{0}C), there was greater cloud cover (60%) and therefore the leaves may not have been fully waxed up at application. In addition the first herbicide application may have de-waxed the crop allowing for crop damage to occur at the second application. But despite these early crop effects, the majority of the plots had recovered by the end of the trial, with only two treatmemts where plots still scored under the commercially acceptable level (<8).

Both these treatments included AHDB 9889, when either applied at the higher rate (2/3rd label (N) rate), alone, or in a three-way tank mix with Basagran 0.3 kg/ha and Starane 0.2 L/ha. The plots exhibited persistent phytotoxic effects for the duration of the trial assessment period, and these were scorch and yellowing. AHDB 9889 was also a common factor in tank mixes where crop effects scoring below an acceptable level were observed at two weeks after the second application. AHDB 9890 at label (N) rate, and in the three way tank mix also exhibited scores below an acceptable level after the second application, but the salad onion crop where this treatment was applied had recovered by the end of the trial indicating that effects were transient.

Treatments where Starane was included in the tank mix often exhibited slight twisting of leaves, but this was transient and is often expected where the product is applied as it is a growth hormone acting herbicide.

Table 6. Mean phytotoxicity scores at four dates throughout the trial period (0 to 10; 0 = complete crop death, 10 = no damage). Scores ≥8 deemed commercially acceptable damage, those <8 (unacceptable damage) are highlighted in red.

	Mean crop damage scores			
	5th July Post T1	25th July T2 + 2 weeks	9th August T2 + 4 weeks	17th August T2 + 5 weeks
Untreated	10.0	10.0	10.0	10.0
Buctril** 0.4 L/ha	10.0	9.7	9.7	8.7
Buctril** 0.2 L/ha Starane 0.2 L/ha	10.0	9.7	9.5	9.3
Emerger 0.5 L/ha	10.0	9.7	8.6	9.0
Emerger 1.0 L/ha	10.0	9.0	8.7	9.0
AHDB 9889 ⅓ N rate	9.0	9.0	9.0	9.7
AHDB 9889 ⅔ N rate	9.0	6.0	7.0	7.7
AHDB 9890 ⅓ N rate	10.0	8.3	8.3	8.7
AHDB 9890 N rate	10.0	7.7	8.0	8.3
Buctril** 0.2 L/ha + Emerger 0.5 L/ha	10.0	9.3	9.5	9.0
Buctril** 0.2 L/ha + AHDB 9889 ⅓ N rate	9.0	7.7	9.0	9.8
Buctril** 0.2 L/ha + AHDB 9890 ⅓ N rate	10.0	8.0	8.7	9.3
Basagran 0.3 kg/ha + Emerger 0.5 L/ha	9.7	9.7	9.0	9.7
Basagran 0.3 kg/ha + AHDB 9889 ⅓ N rate	9.0	7.3	8.3	8.3
Basagran 0.3 kg/ha + AHDB 9890 ⅓ N rate	9.0	8.3	8.7	9.2
Starane 0.2 L/ha + Emerger 0.5 L/ha	10.0	9.3	9.0	9.3
Starane 0.2 L/ha + AHDB 9889 ⅓ N rate	9.3	7.0	8.7	8.7
Starane 0.2 L/ha + AHDB 9890 ⅓ N rate	9.0	9.0	8.3	8.7
Basagran 0.3 kg/ha + Starane 0.2 L/ha + Emerger 0.5 L/ha	9.0	9.0	9.3	9.2
Basagran 0.3 kg/ha + Starane 0.2 L/ha + AHDB 9889 ⅓ N rate	9.0	8.0	7.7	7.7
Basagran 0.3 kg/ha + Starane 0.2 L/ha + AHDB 9890 ⅓ N rate	9.0	7.7	8.0	9.2
p value	<0.001	<0.001	0.115 (NS)	0.069
d.f.	43	43	43	43
L.S.D.	0.2511	0.4560	1.502	1.444

***Buctril was withdrawn as an approved use in September 2021*

Weed control – mean percentage weed cover

The results for the mean percentage weed cover per treatment are presented in **Table 7** and **Figure 4.** The percent reduction in weed cover compared to the untreated control was calculated from these figures (using Abbotts formula), and results for each treatment are listed in **Table 8.**

Weed spectrum was mainly groundsel, redshank, fat hen and black bindweed
All treatments significantly reduced percentage weed cover. The best performing treatments contained Emerger in the tank mixes. Emerger 1.0 L/ha also reduced the percentage weed cover nearly as much as the industry standard, Buctril 0.4 L/ha.

Table 7. Mean percentage weed cover values (transformed).

Trt. No.	Mean weed cover (%)			
	25th July T2 + 2 weeks		9th August T2 + 4 weeks	
	Ang	Back-trans	Ang	Back-trans
Untreated	71.5	89.9	87.8	99.8
Buctril** 0.4 L/ha	21.9	13.9	24.3	16.9
Buctril** 0.2 L/ha Starane 0.2 L/ha	16.6	8.2	16.2	7.8
Emerger 0.5 L/ha	38.8	39.4	53.7	64.9
Emerger 1.0 L/ha	25.4	18.4	32.2	28.4
AHDB 9889 ⅓ N rate	32.6	29.1	46.9	53.4
AHDB 9889 ⅔ N rate	34.2	31.5	39.0	39.6
AHDB 9890 ⅓ N rate	47.9	55.2	54.5	66.4
AHDB 9890 N rate	48.9	56.8	63.6	80.2
Buctril** 0.2 L/ha + Emerger 0.5 L/ha	11.3	3.8	15.0	6.7
Buctril** 0.2 L/ha + AHDB 9889 ⅓ N rate	17.7	9.3	18.0	9.6
Buctril** 0.2 L/ha + AHDB 9890 ⅓ N rate	27.3	21.1	37.6	37.2
Basagran 0.3 kg/ha + Emerger 0.5 L/ha	25.0	17.8	35.7	34.1
Basagran 0.3 kg/ha + AHDB 9889 ⅓ N rate	30.2	25.3	36.1	34.8
Basagran 0.3 kg/ha + AHDB 9890 ⅓ N rate	45.0	50.0	50.9	60.2
Starane 0.2 L/ha + Emerger 0.5 L/ha	16.6	8.2	21.3	13.3
Starane 0.2 L/ha + AHDB 9889 ⅓ N rate	25.8	18.9	27.2	20.9
Starane 0.2 L/ha + AHDB 9890 ⅓ N rate	37.2	36.6	46.9	53.4
Basagran 0.3 kg/ha + Starane 0.2 L/ha + Emerger 0.5 L/ha	8.2	2.0	8.6	2.3
Basagran 0.3 kg/ha + Starane 0.2 L/ha + AHDB 9889 ⅓ N rate	20.7	12.6	25.2	18.2
Basagran 0.3 kg/ha + Starane 0.2 L/ha + AHDB 9890 ⅓ N rate	18.4	10.0	22.8	15.0
p value		<0.001		<0.001
d.f.		43		43
L.S.D.		15.74		13.56
	Not significantly different from untreated control (p>0.05)			
	Significantly different from untreated control (p<0.05)			

*** Buctril was withdrawn as an approved use in September 2021*

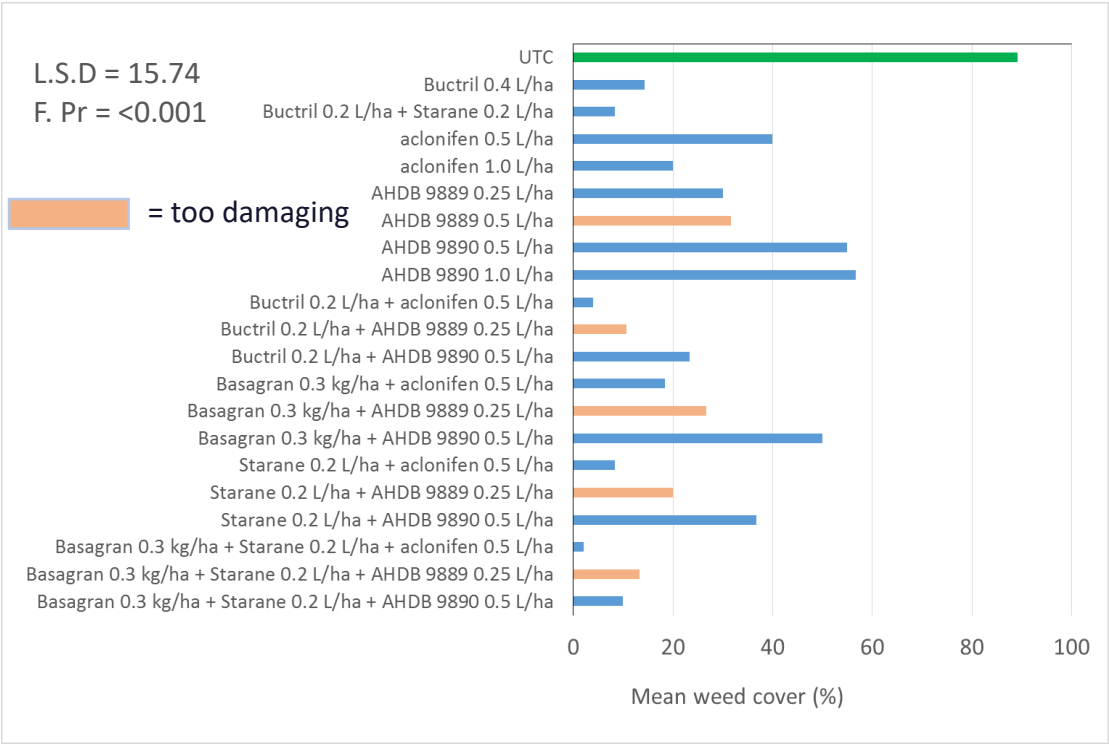


Figure 4. Percentage mean weed cover at the assessment two weeks after the second treatment application. 25th July 2018. *Note the aclonifen product used was Emerger.*

At four weeks after the second and final application, the three-way tank mix of Emerger 0.5 L/ha + Basagran 0.3 kg/ha + Starane 0.2 L/ha reduced weed cover by the greatest percentage (97.7%) (**Table 8**). When AHDB 9889 and AHDB 9890 were included in the three-way tank mixes, the reduction in weed cover was still greater than 80%, but neither product added as much control to the tank mix on the weed spectrum present as Emerger.

A similar pattern was observed when the experimental products were tank mixed with either Basagran 0.3 kg/ha or Starane 0.2 L/ha. Emerger 0.5 L/ha added the greatest reduction in weed control to the mix, with AHDB 9889 performing nearly as well, and AHDB 9890 performing the least well of the products tested. AHDB 9890 does not have as wide a weed spectrum of control as Emerger or AHDB 9889.

When comparing products applied alone, Emerger 1.0 L/ha reduced percentage weed cover by the greatest amount but reducing the rate to 0.5 L/ha substantially reduces efficacy, therefore at the lower rate Emerger requires a tank-mix partner. But, as can be seen above, it still adds value to a tank mix at 0.5 L/ha. Again, AHDB 9889 at 2/3 rate, then 1/3 rate perform next well in comparison, with AHDB 9890 reducing percentage weed cover the least when applied alone. None of the products perform as well as the commercial standard, Buctril 0.4 L/ha, but Emerger 1.0 L/ha alone, or at 0.5 L/ha in a tank mix offers a suitable alternative.

Table 8. Percentage reduction in weed cover two and four weeks after Timing B treatment application (calculated using Abbotts formula)

	Weed cover reduction (%)	
	25th July (T2 + 2 weeks)	**9th August (T2 + 4 weeks)**
Buctril** 0.4 L/ha	84.5	83.1
Buctril** 0.2 L/ha Starane 0.2 L/ha	90.9	92.2
Emerger 0.5 L/ha	56.2	34.9
Emerger 1.0 L/ha	79.6	71.5
AHDB 9889 ⅓ N rate	64.9	46.6
AHDB 9889 ⅔ N rate	67.7	60.3
AHDB 9890 ⅓ N rate	38.6	33.5
AHDB 9890 N rate	36.8	19.7
Buctril** 0.2 L/ha + Emerger 0.5 L/ha	95.7	93.3
Buctril** 0.2 L/ha + AHDB 9889 ⅓ N rate	89.7	90.4
Buctril** 0.2 L/ha + AHDB 9890 ⅓ N rate	76.6	62.7
Basagran 0.3 kg/ha + Emerger 0.5 L/ha	80.2	65.9
Basagran 0.3 kg/ha + AHDB 9889 ⅓ N rate	71.8	65.2
Basagran 0.3 kg/ha + AHDB 9890 ⅓ N rate	44.4	39.8
Starane 0.2 L/ha + Emerger 0.5 L/ha	90.9	86.7
Starane 0.2 L/ha + AHDB 9889 ⅓ N rate	78.9	79.1
Starane 0.2 L/ha + AHDB 9890 ⅓ N rate	59.3	46.6
Basagran 0.3 kg/ha + Starane 0.2 L/ha + Emerger 0.5 L/ha	97.8	97.7
Basagran 0.3 kg/ha + Starane 0.2 L/ha + AHDB 9889 ⅓ N rate	86.1	81.8
Basagran 0.3 kg/ha + Starane 0.2 L/ha + AHDB 9890 ⅓ N rate	88.8	84.9

** *Buctril was withdrawn as an approved use in September 2021*

Discussion

Emerger and tank mixes containing Emerger were safe to use in the salad onion trial, causing only a yellow halo on a small number of plants. In the bulb onion trial, Emerger applied alone at either 0.5 or 1.0 L/ha and AHDB 9890 at half rate were safe to use on bulb onions causing no effects which were commercially unacceptable throughout the trial assessment period (**Table 1**), the main effect being a slight yellow band from Emerger which grew out. Unlike salad onions, some foliar damage can be tolerated on a bulb onion crop.

Emerger 0.5 L/ha was also crop safe throughout the trial when applied in a tank mix with Buctril 0.2 L/ha. When Emerger 0.5 L/ha was included in the three-way tank mix with Basagran 0.3 kg/ha and Starane 0.2 L/ha, there were slight effects of scorch and leaf twisting on the crop at two and four weeks after application but these had reduced to an acceptable level by the end of the trial assessment period (T2 + 6 weeks).

Crop effects increased after the second application in both the bulb and salad onion trials as the weather was dull at this application timing in both situations. This means the crop foliage would likely be less fully waxed, and the leaves may still have been a little de-waxed after the first herbicide application and more sensitive to damage. This allowed the crop effects from the herbicides to be tested in less ideal application conditions and highlighted that AHDB 9889 in particular caused the greatest crop effects. This was exhibited as scorching of the leaves which persisted at an unacceptable level on the salad onion crop until the end of the trial assessment period when AHDB 9889 was either applied at the higher rate or in a three-way tank mix.

Weed levels were not great enough in the bulb onion trial to draw robust conclusions, but weed cover (87.8% in the untreated control) in the salad onion trial was sufficient to provide indications on product performance against groundsel, redshank, black bindweed and fat hen which can commonly be found in onion crops.

At four weeks after the second and final application, the three-way tank mix of Emerger 0.5 L/ha + Basagran 0.3 kg/ha + Starane 0.2 L/ha reduced weed cover by the greatest percentage (97.7%). When AHDB 9889 and AHDB 9890 were included in the three-way tank mixes, the reduction in weed cover was still greater than 80%, but neither product added as much control to the tank mix on the weed spectrum present as Emerger alone.

A similar pattern was observed when the experimental products were tank mixed with either Basagran 0.3 kg/ha or Starane 0.2 L/ha. Emerger 0.5 L/ha contributed the greatest reduction in weed control to the mix, with AHDB 9889 performing nearly as well, and AHDB 9890 performing the least well of the products tested. AHDB 9890 does not have as wide a weed spectrum of control as Emerger or AHDB 9889.

When comparing products applied alone, Emerger 1.0 L/ha reduced percentage weed cover by the greatest amount but reducing the rate to 0.5 L/ha substantially reduces efficacy, therefore at the lower rate Emerger requires a tank-mix partner. But, as can be seen above, it still adds value to a tank mix at 0.5 L/ha. Again, AHDB 9889 at 2/3 rate, then 1/3 rate perform next well in comparison, with AHDB 9890 reducing percentage weed cover the least when applied alone. None of the products perform as well as the commercial standard, Buctril 0.4 L/ha, but Emerger 1.0 L/ha alone, or at 0.5 L/ha in a tank mix offers a suitable alternative.

AHDB 9889 and AHDB 9890 caused greater phytotoxic effects and AHDB 9890 did not reduce percentage weed levels as much as Emerger or AHDB 9889 in the trial on salad onions. Therefore Emerger provides the most favourable alternative to Buctril for post-emergence weed control from this trial.

Conclusions

- Emerger provides the most favourable combination of crop safety and efficacy from the three products in the trial.
- At four weeks after the second and final application in the salad onion trial, the three-way tank mix of Emerger 0.5 L/ha + Basagran 0.3 kg/ha + Starane 0.2 L/ha reduced weed cover by the greatest percentage (97.7%).
    - This combination caused crop effects of slight twisting and a small percentage of the crop to be affected by yellow ‘bands’, but the effect was transient.
- AHDB 9889 performed to a near equivalent level of efficacy to Emerger, but was more phytotoxic causing greater levels of scorch, particularly if applied in dull conditions.
- AHDB 9890 significantly reduced percentage weed cover but was not the best performer in the trial as it has a narrower weed spectrum of control.

Acknowledgements

AHDB for funding the work, and the crop protection companies for their financial contributions as well as providing samples for the trials. Carl Sharp of the Allium and Brassica Centre for spray applications on the bulb onion trial. Thanks should also be given to the growers who provided sites and crops for the trials as well as technical input, particularly Sam Rix of P. G. Rix Farms Ltd, and Phil Langley of Sandfields farms (G's).

Appendix

a. Crop diary – events related to growing crop

Site 1: Bulb onion trial

Crop	**Cultivar**	**Drilling date**	**Row width** (m)
Bulb onion	Hybound (primed seed)	24/03/2018	0.1625

Previous cropping

Year	**Crop**
2017	Wheat
2016	Sugar beet
2015	Wheat

Cultivations

Date	**Description**	**Depth** (cm)
20/10/2017	Plough	30
24/03/2018	Seedbed harrow/germinator	7

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

Date	**Product**	**Rate** (kg/ha)
26/04/2018	Di-Ammonium Phosphate	220
17/05/2018	N:S (33:30)	152
05/06/2018	N:K:S (18:22:24.5)	220

Pesticides applied to trial area

Date	**Product**	**Rate** (L/ha)
07/04/2018	Stomp Aqua	1.0
	Wing-P	1.25
08/05/2018	Stomp Aqua	0.6
	Pyramin DF	0.25
	Maya	0.1
14/06-15/08/2018	Weekly fungicide regime	

Details of irrigation regime

Date	**Type, rate and duration**	**Amount applied** (mm)
25/06-01/08/2018	Overhead gun irrigation	20mm/ha x 7 applications

Site 2: Salad onion trial

Crop	**Cultivar**	**Drilling date**	**Row width** (m)
Salad onion	Parade	20th May 2018	N/K

Previous cropping

Year	Crop
2017	N/K
2016	N/K
2015	N/K

Cultivations

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

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

Date	Product	Rate (kg/ha)
N/K	N/K	N/K

Pesticides applied to trial area

Date	Product	Rate (L/ha)
22/05/2018	Stomp Aqua	1.0
	Wing-P	1.25
01/07-15/08/2018	Weekly fungicide regime	

Details of irrigation regime

Date	Type, rate and duration	Amount applied (mm)
26/06-16/08/2018	Overhead boom irrigation	As required

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

Site 1: Bulb onion trial

Date	Event
24/05/2018	Timing 1 treatments applied.
04/06/2018	Timing 2 treatments applied. Assessment – crop phytotoxicity, weed species presence
20/06/2018	Assessment – crop phytotoxicity, weed area
02/07/2018	Assessment – crop phytotoxicity, weed area
18/07/2018	Assessment – crop phytotoxicity, weed area

Site 1: Salad onion trial

Date	Event
22/06/2018	Timing 1 treatments applied. Assessment – weed species presence and count
05/07/2018	Assessment – crop phytotoxicity, weed area
12/07/2018	Timing 2 treatments applied. Assessment – crop phytotoxicity, weed area
25/07/2018	Assessment – crop phytotoxicity, weed area

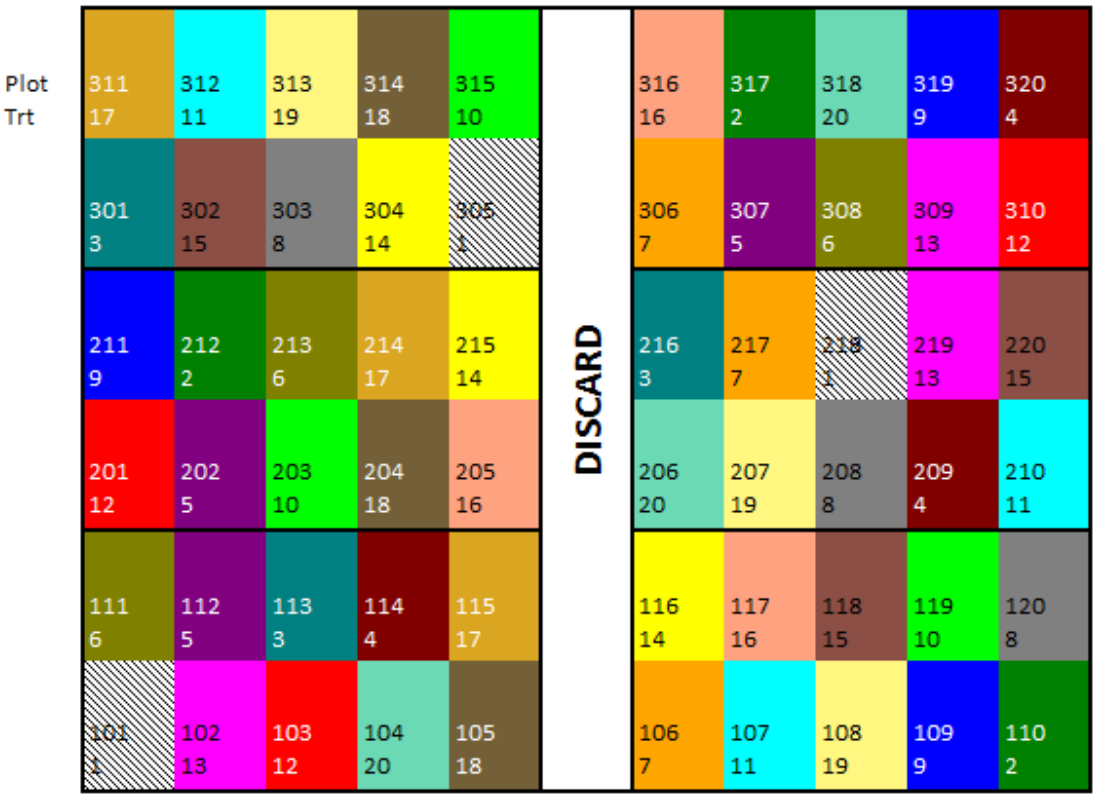
09/08/2018	Assessment – crop phytotoxicity, weed area
17/08/2018	Assessment – crop phytotoxicity

c. Climatological data during study period from bulb onion site.

Date	Temperature °C (minimum)	Temperature °C (maximum)
24/05/2018	**11**	**22**
25/05/2018	**12**	**19**
26/05/2018	**13**	**22**
27/05/2018	**14**	**23**
28/05/2018	**11**	**26**
29/05/2018	**12**	**22**
30/05/2018	**12**	**20**
31/05/2018	**12**	**20**
01/06/2018	**15**	**22**
02/06/2018	**15**	**22**
03/06/2018	**13**	**22**
04/06/2018	**12**	**17**
05/06/2018	**8**	**16**
06/06/2018	**7**	**21**
07/06/2018	**9**	**19**
08/06/2018	**9**	**19**
09/06/2018	**9**	**19**
10/06/2018	**10**	**19**
11/06/2018	**8**	**22**
12/06/2018	**9**	**16**
13/06/2018	**8**	**20**
14/06/2018	**13**	**22**
15/06/2018	**10**	**22**
16/06/2018	**11**	**19**
17/06/2018	**9**	**19**
18/06/2018	**14**	**24**
19/06/2018	**17**	**24**
20/06/2018	**15**	**25**
21/06/2018	**9**	**17**
22/06/2018	**8**	**20**
23/06/2018	**9**	**23**
24/06/2018	**9**	**22**
25/06/2018	**11**	**27**
26/06/2018	**12**	**24**
27/06/2018	**12**	**23**
28/06/2018	**11**	**24**
29/06/2018	**11**	**25**
30/06/2018	**13**	**25**
01/07/2018	**14**	**25**
02/07/2018	**14**	**25**
03/07/2018	**12**	**23**
04/07/2018	**11**	**23**
05/07/2018	**14**	**26**
06/07/2018	**15**	**27**
07/07/2018	**15**	**26**
08/07/2018	**12**	**27**
09/07/2018	**14**	**26**
10/07/2018	**14**	**19**
11/07/2018	**12**	**21**
12/07/2018	**12**	**22**
13/07/2018	**11**	**23**
14/07/2018	**13**	**25**
15/07/2018	**15**	**28**
16/07/2018	**15**	**29**
17/07/2018	**13**	**23**
18/07/2018	**13**	**24**

d. Trial design

Site 1: Bulb onion trial



Site 2: Salad onion trial

6 m Buffer zone

TREATMENT	DISCARD	12	10	5	3	11	22	9	2	18	15	14	DISCARD
BLOCK		3	3	3	3	3	3	3	3	3	3	3	
PLOT		56	57	58	59	60	61	62	63	64	65	66	
TREATMENT	DISCARD	13	19	7	6	17	16	20	4	8	21	1	DISCARD
BLOCK		3	3	3	3	3	3	3	3	3	3	3	
PLOT		45	46	47	48	49	50	51	52	53	54	55	
TREATMENT	DISCARD	16	12	14	8	3	5	11	20	10	7	2	DISCARD
BLOCK		2	2	2	2	2	2	2	2	2	2	2	
PLOT		34	35	36	37	38	39	40	41	42	43	44	
TREATMENT	DISCARD	15	17	13	21	6	19	4	18	9	1	22	DISCARD
BLOCK		2	2	2	2	2	2	2	2	2	2	2	
PLOT		23	24	25	26	27	28	29	30	31	32	33	
TREATMENT	DISCARD	10	20	8	12	15	11	14	19	16	3	18	DISCARD
BLOCK		1	1	1	1	1	1	1	1	1	1	1	
PLOT		12	13	14	15	16	17	18	19	20	21	22	
TREATMENT	DISCARD	22	6	4	9	5	13	17	1	2	21	7	DISCARD
BLOCK		1	1	1	1	1	1	1	1	1	1	1	
PLOT		1	2	3	4	5	6	7	8	9	10	11	

6 m Buffer zone

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