



## Improving the reliability of Group 1 herbicides in winter broadleaf crops

Location: Rowena, NSW

### Objectives of the trial

- Evaluate the impact of temperature / frost on performance
- Evaluate the impact of hard water and water conditioners on performance
- Evaluate the impact of weed size on performance
- Evaluate the impact of Group 1 mixtures on performance

With the emergence of Group 1 herbicide resistance in winter weeds, the importance of correct application, weed size, water quality and environmental conditions has been shown to have a significant bearing on results achieved with clethodim against annual ryegrass. Where annual ryegrass populations are still susceptible to Group 1 herbicides, these application factors typically have minimal impact of product efficacy – with robust application rates often able to mitigate effects in susceptible populations. However, as resistance emerges, these application factors become increasingly important, especially for DIM herbicides such as clethodim or butoxydim.

In the northern farming systems, many growers are reporting difficulty in obtaining acceptable results with post emergent Group 1 herbicides when targeting weeds such as phalaris and wild oats. Generally, there is a low frequency of formal resistance testing of these populations, with often the assumption being that poor results from Group 1 herbicides indicates the presence of herbicide resistance.

Treatments used in this trial allows for comparison of multiple factors known to impact Group 1 herbicide performance (at least against ryegrass):

- Temperature at application. Application in sunny afternoon conditions versus early morning after frost
- Rainwater versus bore water
- Different water conditioning treatments
- Fops versus dims – applied alone and in mixtures
- New versus old clethodim stock.

This trial sought to evaluate some of these factors against suspected Group 1 resistant phalaris.

Target weed: Phalaris with some wild oats present

Crop: Chickpea

Application timing: Post-emergent. Chickpea 8 node growth stage

100L/ha      Rainwater      110015 AIXR @ 2 Bar 6km/hr      4 Reps

	Date	Weed size	Time	Temp	RH%	Delta T
Timing 1	16/7/2025	2 leaf – 4	3pm	15°C	65%	4.2
Timing 2	17/7/2025	tiller	7am	1°C	60%	1.0

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## Treatment list

	Herbicide	Timing	Water	Adjuvant
1	Untreated			
2	Clethodim 360 - 333mL/ha	Afternoon	Rain	1% Hasten
3	Clethodim 360 - 333mL/ha	Afternoon	Rain	1% Hasten + 2% AMS
4	Clethodim 360 - 333mL/ha + Butroxydim 250 - 180g/ha	Afternoon	Rain	1% Hasten
5	Verdict® 520 - 100mL/ha	Afternoon	Rain	1% Hasten
6	Verdict 520 - 100mL/ha + Clethodim 360 - 333mL/ha	Afternoon	Rain	1% Hasten
7	Clethodim 360 - 333mL/ha	Afternoon	Bore	1% Hasten
8	Clethodim 360 - 333mL/ha	Afternoon	Bore	1% Hasten + 2% AMS
9	Clethodim 360 - 333mL/ha	Morning	Rain	1% Hasten
10	Clethodim 360 - 333mL/ha	Morning	Rain	1% Hasten + 2% AMS
11	Clethodim 360 - 333mL/ha	Morning	Bore	1% Hasten
12	Clethodim 360 - 333mL/ha	Morning	Bore	1% Hasten + 2% AMS
13	Clethodim 360 - 333mL/ha	Morning	Bore	1% Hasten + 0.3%Supalink
14	Clethodim 360 - 333mL/ha + Butroxydim 250 - 180g/ha	Morning	Rain	1% Hasten
15	Verdict 520 - 100mL/ha	Morning	Rain	1% Hasten
16	Verdict 520 - 100mL/ha + Clethodim 360 - 333mL/ha	Morning	Rain	1% Hasten
17	Clethodim 240 - 500mL/ha (old stock)	Morning	Rain	1% Hasten
18	Clethodim 360 - 333mL/ha + Leopard® 125mL/ha	Afternoon	Bore	1% Hasten + 2% AMS
19	Clethodim 360 - 333mL/ha + Zinc 1L/ha	Afternoon	Bore	1% Hasten + 2% AMS
20	Clethodim 360 - 333mL/ha + mancozeb 1kg/ha	Afternoon	Bore	1% Hasten + 2% AMS
21	Clethodim 360 - 333mL/ha	Afternoon	Bore	0.05% Steadfast
22	Clethodim 360 - 333mL/ha	Afternoon	Rain	0.05% Steadfast
23	Clethodim 360 - 333mL/ha	Afternoon	Bore	0.1% Wilt 700
24	Clethodim 360 - 333mL/ha	Afternoon	Bore	0.1% Fulltec
25	Clethodim 360 - 333mL/ha	Afternoon	Bore	0.5% Hasten + 2% AMS
26	Clethodim 360 - 333mL/ha + Veritas® Opti - 500mL/ha	Afternoon	Bore	1% Hasten + 2% AMS

### Product

Clethodim  
Butroxydim 250  
Verdict 520  
Leopard  
Amps PlantPro Zinc  
Mancozeb  
Veritas Opti

### Ingredient

360 g/L or 240 g/L clethodim  
250 g/kg butroxydim  
520 g/L haloxyfop-R-methyl  
200 g/L quizalofop-P-ethyl  
Zinc  
750 g/kg mancozeb  
370 g/L tebuconazole + 222 g/L azoxystrobin

## Bore water quality

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**PROJECT NO: EW250200**

**Location: Bore Water Analysis**

CLIENT SAMPLE ID					Sample 1	
SOURCE					Bore	
Test Parameter	Method Description	Method Reference	Units	LOR	250200-1	
Total Dissolved Salts	Calc	PMW-03	mg/L	na	758	
Electrical Conductivity	Electrode	PMW-03	dS/m	0.01	1.57	
pH	Electrode	PMW-04	units	na	7.40	
Carbonate	Titration	PMW-07	mg/L	1	<1.00	
Bicarbonate	Titration	PMW-07	mg/L	1	372	
Hydroxide	Titration	PMW-07	mg/L	1	<1.00	
Total Alkalinity	Titration	PMW-07	mg/L	10	372	
Chlorides	DA	DAP-07	mg/L	10	363	
Nitrate-N Soluble	DA	DAP-04	mg/L	0.5	3.45	
Phosphorus Soluble	ICP-OES	ICP-09	mg/L	0.5	<0.50	
Copper Soluble	ICP-OES	ICP-09	mg/L	0.05	<0.05	
Zinc Soluble	ICP-OES	ICP-09	mg/L	0.05	<0.05	
Manganese Soluble	ICP-OES	ICP-09	mg/L	0.05	<0.05	
Iron Soluble	ICP-OES	ICP-09	mg/L	0.05	<0.05	
Boron Soluble	ICP-OES	ICP-09	mg/L	0.05	0.05	
Potassium Soluble	ICP-OES	ICP-09	mg/L	0.5	4.13	
Calcium Soluble	ICP-OES	ICP-09	mg/L	0.5	171	
Magnesium Soluble	ICP-OES	ICP-09	mg/L	0.5	85.7	
Sodium Soluble	ICP-OES	ICP-09	mg/L	0.5	80.1	
Sodium Adsorption Ratio	Calc	SAR	na	na	1.2	
Total Hardness	Calculation	APHA2340B	mg/L	na	779	
Sulphate Soluble	ICP-OES	ICP-09	mg/L	0.5	70.1	

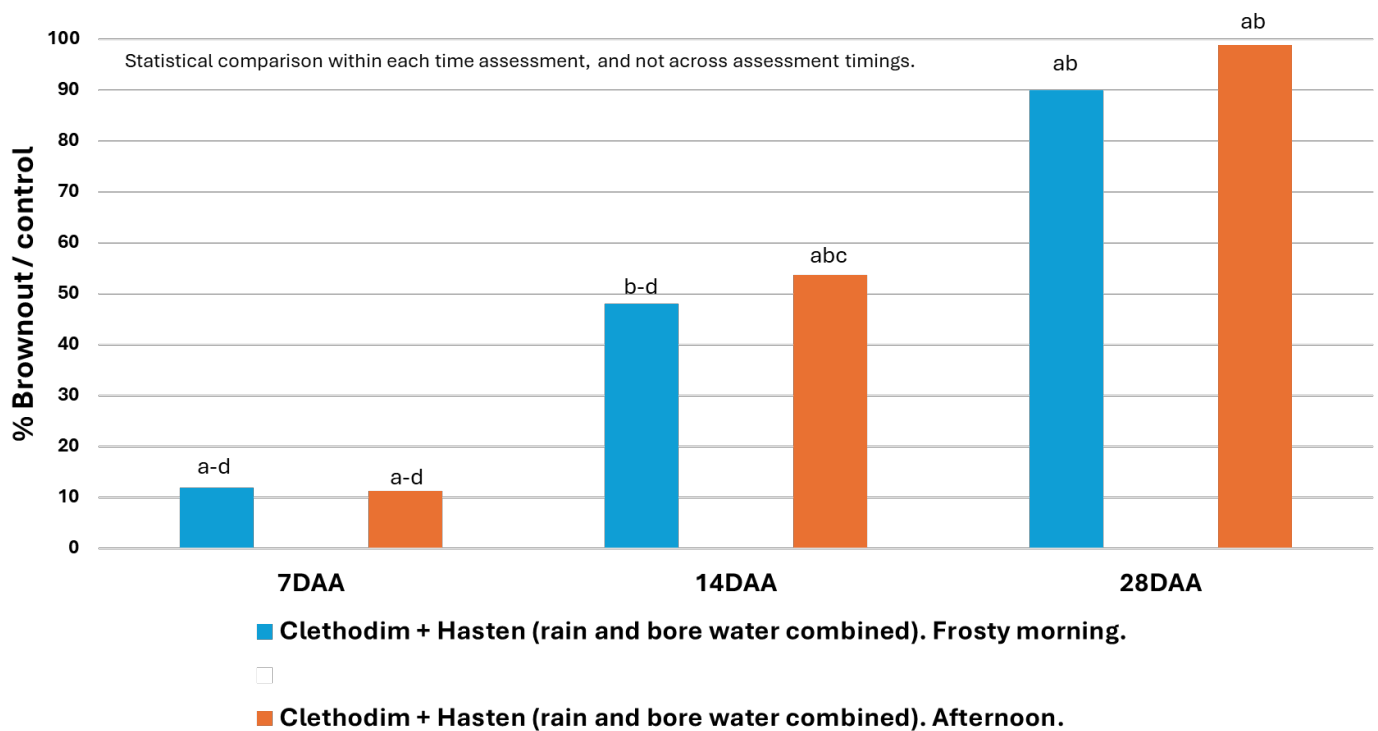
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## Results

Cool, frosty conditions prior to application reduce control of grass weeds by Group 1 herbicides. This effect is far more evident with resistant populations. With this knowledge, we wanted to evaluate performance of clethodim under different temperature regimes against the population of phalaris present. Treatments were applied either after lunch when conditions were warmer (15°C), or the following morning under frosty conditions (1°C). Not all treatments were duplicated under both conditions.

The graph below shows performance of Clethodim + Hasten under the two different environmental conditions (rain and hard water treatments combined). While there was numerically a 9% performance advantage to applying clethodim under the warmer conditions the day prior to a frost (compared to the morning after a frost), this was not statistically significant.

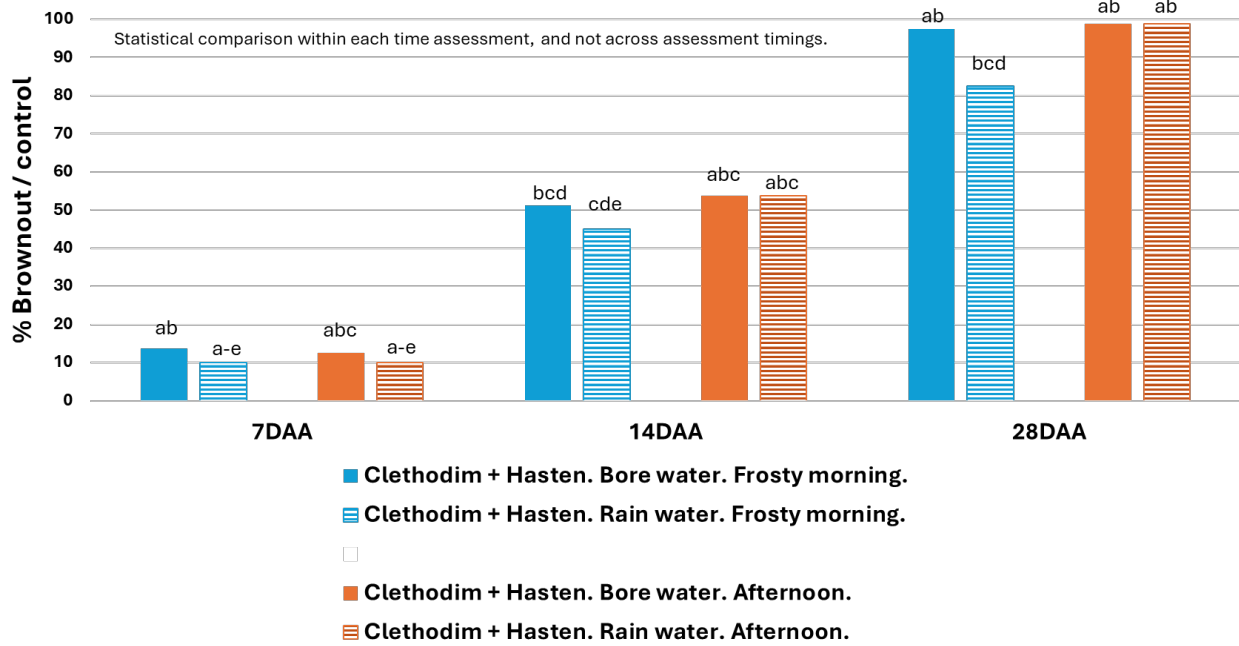


**Figure 1.** Percentage brownout/control comparing application in warm conditions the afternoon prior to a frost, with application on a frosty morning. Treatments at the same assessment time with the same letter are not significantly different (P 0.05)

The addition of ammonium sulphate to weak acid herbicides can often improve performance. This is achieved either by sulphates neutralising cations commonly found in hard (bore) water, and/or the ammonium assisting cell membrane transfer within the leaf even when soft (rain) water is used.

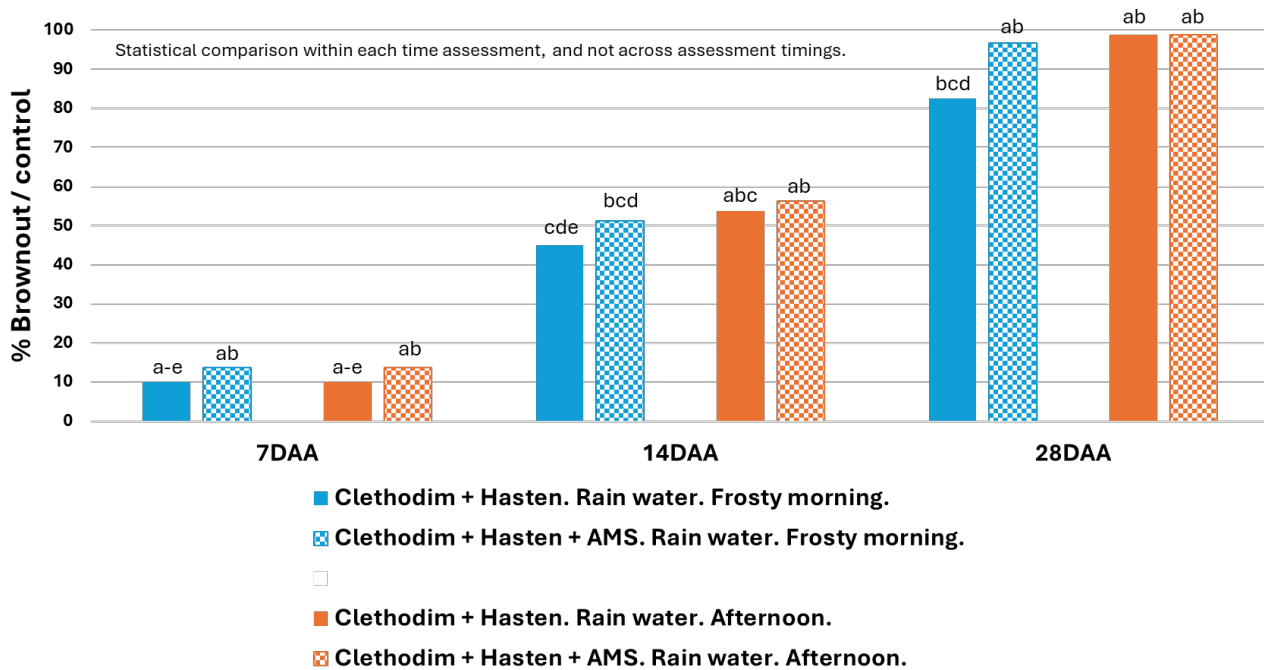
In this trial, bore water was compared to rainwater. The bore water did not adversely affect the performance of clethodim, and the addition of AMS had no significant influence where bore water was used.

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**Figure 2.** Percentage brownout/control comparing rain and bore water treatments. Treatments at the same assessment time with the same letter are not significantly different (P 0.05)

When used with rainwater, there was a trend to a numerical advantage with the addition of AMS, although this was not statistically significant.

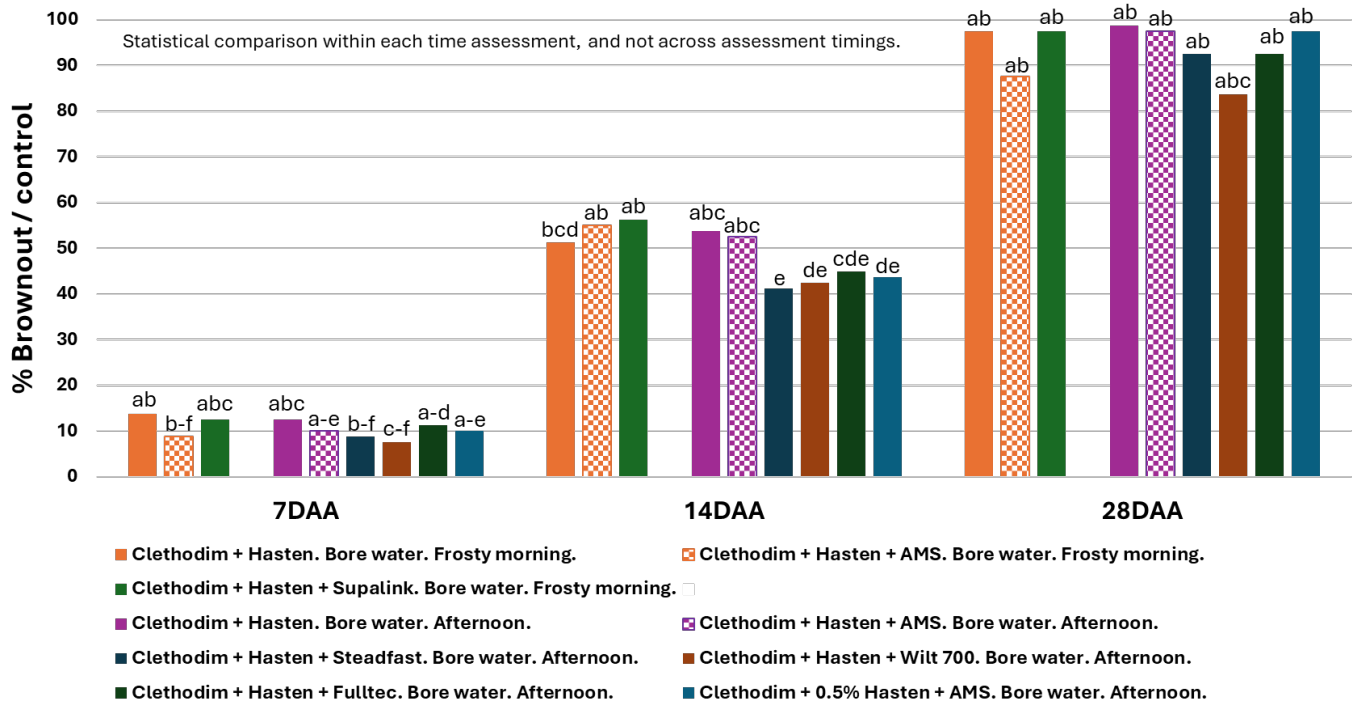


**Figure 3.** Percentage brownout/control comparing the addition of AMS. Treatments at the same assessment time with the same letter are not significantly different (P 0.05)

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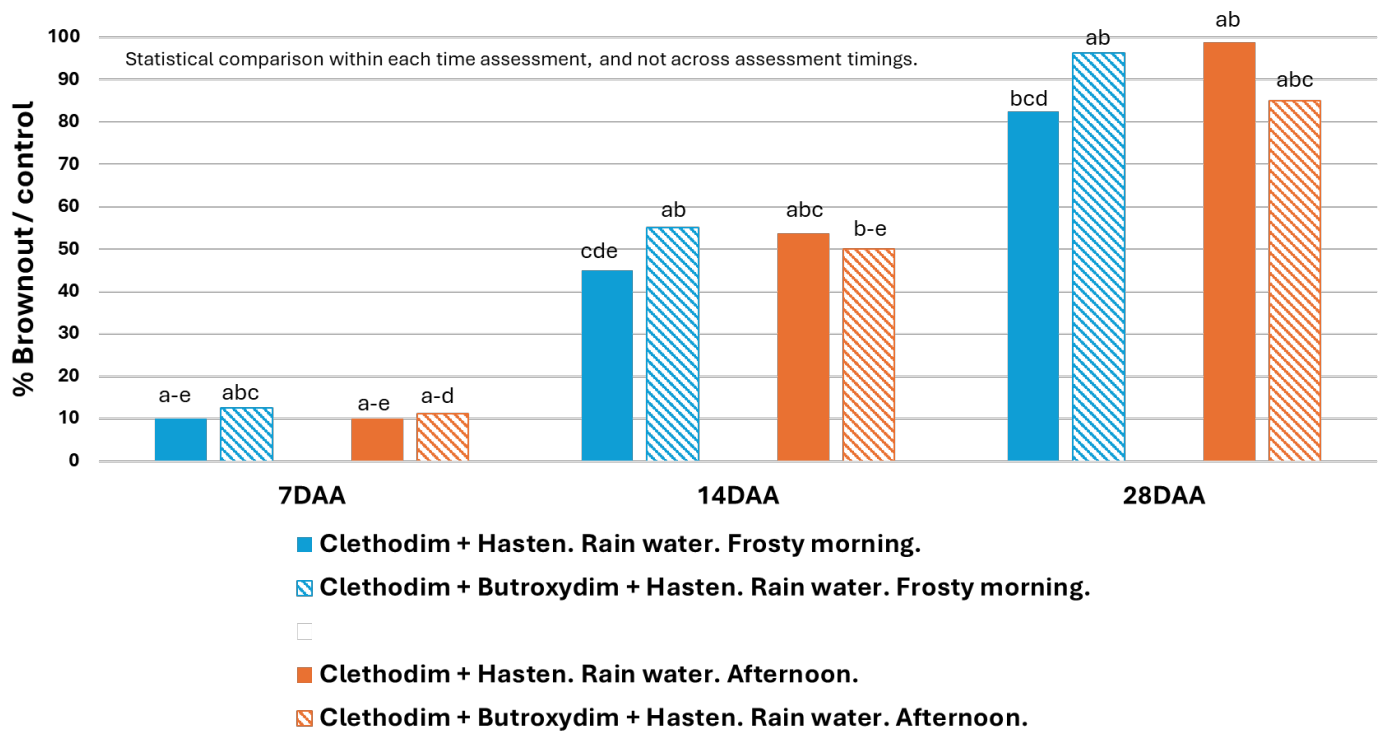
A range of other acidifying tank mix surfactants were evaluated in comparison to the standard Hasten or Hasten + AMS adjuvant system commonly recommended for clethodim applications. At final ratings there was no significant difference between the different surfactant combinations tested. However, at the 14DAA assessment, several of the alternative surfactants were behind the current standard of Hasten or Hasten + AMS.



**Figure 4.** Percentage brownout/control comparing acidifying tank mix surfactants in comparison to the standard Hasten or Hasten + AMS adjuvant system commonly recommended for clethodim applications. Treatments at the same assessment time with the same letter are not significantly different (P 0.05)

When targeting clethodim resistant ryegrass in pulse crops, there is sometimes advantage from adding butoxydim to the full label rate of clethodim. Clethodim + butoxydim was compared to clethodim alone in this trial, applied both in the sunny afternoon conditions and frosty morning conditions. As the clethodim alone generally performed adequately against this weed population, there was no strong benefit from the addition of butoxydim, although numerically the combination performed better when applied under frosty conditions.

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**Figure 5.** Percentage brownout/control comparing clethodim + butoxydim to clethodim alone. Treatments at the same assessment time with the same letter are not significantly different (P 0.05)

Haloxypfop was also compared to clethodim in this trial, either applied alone or in combination with clethodim. Verdict alone performed poorer compared to clethodim treatments applied under similar conditions when both herbicides were applied at their registered label rates for phalaris. There appears to be some evidence of additive control from the tank mix of Verdict + Clethodim under frosty application conditions, however this was not significant over clethodim alone, and was also not evident under the milder application conditions where clethodim alone performed marginally better.

It may be tempting to assume that there is a level of FOP resistance present in this population which may explain the poorer results from Verdict. However, the label rate of clethodim (120 gai/ha) used in this trial needs to be compared to the label rate of Verdict (52 gai/ha of haloxypfop). It is possible that the difference in results achieved in this situation is simply a factor of a higher registered application rate (in gai/ha) for clethodim. Although some impact from herbicide resistance cannot be completely ruled out in the absence of a formal resistance test.

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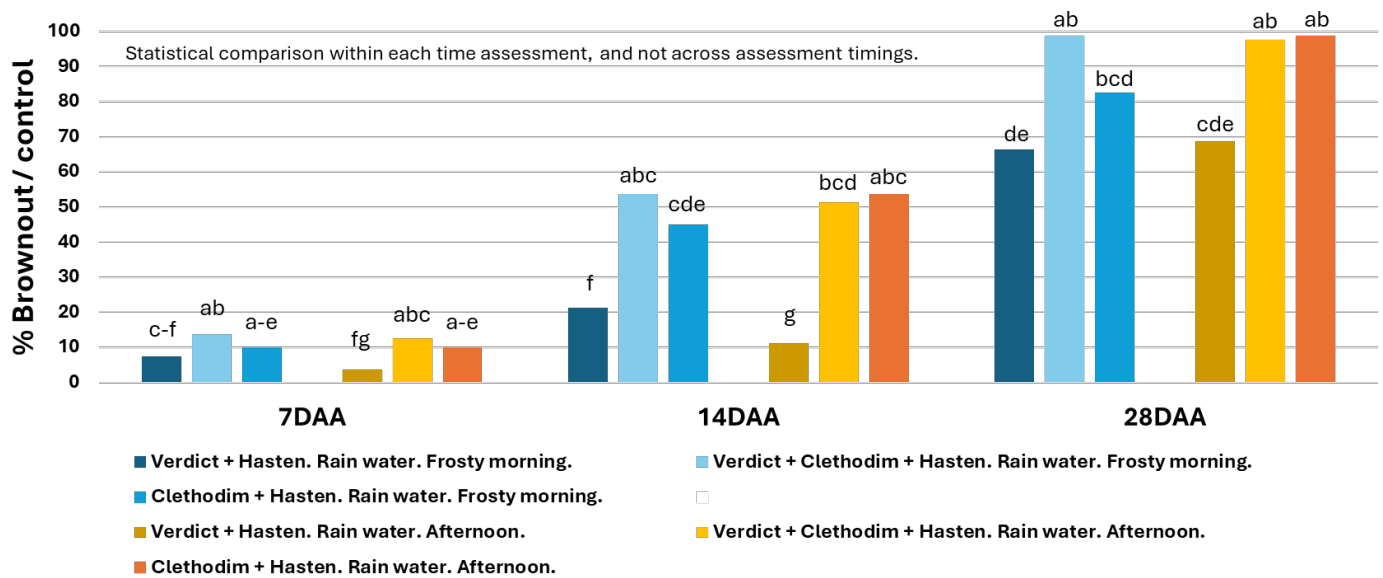
Verdict 520 @ 100mL/ha + Hasten Rainwater. Frosty morning timing.



Verdict + Clethodim + Hasten Rainwater. Frosty morning timing.



Clethodim 360 @ 333mL/ha + Hasten Rainwater. Frosty morning timing.



**Figure 6.** Percentage brownout/control comparing clethodim and Verdict treatments. Treatments at the same assessment time with the same letter are not significantly different (P 0.05)

Across the trial, the addition of the mancozeb or Veritas Opti (azoxystrobin + tebuconazole) fungicides had no effect on performance of clethodim (data not shown).

Clethodim formulations are known to undergo slow degradation of active ingredient when in storage. In this trial we had the opportunity to compare an old (2019) clethodim 240 g/L formulation with new stock of a 360g/L formulation. The graph below shows performance from 'old' stock (red) compared to 'new' stock (green) when applied at the same gai/ha rate and under the same application conditions, water quality and adjuvant package. These results reinforce that clethodim formulations should be used as soon as possible after manufacture.

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Results from this trial suggest that the phalaris population is likely to still be susceptible to Group 1 herbicides. As a result, the impact of water quality, temperature at application and response to AMS was less evident than may have been expected if the population had a higher level of Group 1 resistance.

While generally not statistically significant, there was a common trend that flowed through the majority of comparisons whereby clethodim results were slightly reduced when applied the morning after frost, rather than under warmer conditions the afternoon prior to frost. The addition of ammonium sulphate or butoxydim or Verdict generally appeared to improve performance of clethodim when applied under frosty conditions to a level similar to application under warmer conditions. However, as general performance of clethodim was good under all conditions and with all mixes, it is difficult to make definitive recommendations from this single trial.

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