

# Investigating glufosinate herbicide for annual ryegrass control; preliminary results

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## Key findings

- Seasonal conditions at Hart and Hill River were relatively dry from July through to Spring reducing emergence of annual ryegrass (ARG) populations. Trials conducted at these two sites targeted varying susceptibility; 100% susceptible to all chemistry (Hart) and moderate resistance to Group 1 – DIM herbicides + and strong resistance to Group 2 – Imidazolinone herbicides (Hill River).
- Data from field trials show that Liberty® herbicide (200 g/L glufosinate) applied as a two-spray approach, tank mixed with either clethodim or registered glyphosate products in early applications controlled annual ryegrass.
- Liberty® herbicide at low label rates of 2 L/ha (+2% Liase) applied at two timings ~14 days apart is not adequate for the control of annual ryegrass. In only one of two field trials, higher label rates of 3 L/ha were able to reduce weed number, however overall ARG head suppression was observed at both sites under low ARG populations.

## Introduction

A new project across SA in 2023 investigated best-use strategies for the control of annual ryegrass (ARG) with glufosinate herbicide. A series of agronomic field experiments were conducted, in addition to pot experiments exploring the effects of temperature and humidity on herbicide efficacy. In this article, preliminary data from field experiments at two locations across the Mid-North region of SA will be provided.

## Methodology

### *Site selection and rainfall*

Two field trials were implemented in the medium rainfall zone of the Mid-North in 2023 to evaluate the efficacy of glufosinate herbicide (Table 1).

The core trial site was located at Hill River with a known background population of ARG, susceptible to glyphosate and glufosinate herbicides. The site had moderate resistance to Group 1 – DIM herbicides (45% survival) and strong resistance to Group 2 – Imidazolinone herbicides (60% survival). Total annual rainfall received was 388 mm with 312 mm of growing season rainfall (GSR). Early rainfall from April – June promoted germination of ARG, however rainfall from late July through to spring were below average (Figure 1) suppressing conditions for further ryegrass populations to emerge.

Similar conditions were observed at the Hart field site, SA where a secondary trial was located, however both GSR and annual rainfall were lower, receiving 236 and 355 mm, respectively.

Table 1. Site details for glufosinate trials at Hart and Hill River, SA in 2023.

<b>Hart</b>	<b>Plot size</b>	2.0 m x 10.0 m	<b>Water rate</b>	100 L/ha
	<b>Seeding date</b>	April 2, 2023	<b>Nozzle type</b>	Coarse
	<b>Seed rate</b>	45 plants/m <sup>2</sup>		
	<b>Previous crop</b>	Oaten hay		
<b>Hill River</b>	<b>Plot size</b>	2.0 m x 10.0 m	<b>Water rate</b>	70 – 100 L/ha
	<b>Seeding date</b>	June 16, 2023	<b>Nozzle type</b>	Coarse
	<b>Seed rate</b>	45 plants/m <sup>2</sup>		
	<b>Harvest date</b>	November 22, 2023		
	<b>Previous crop</b>	Oaten hay		

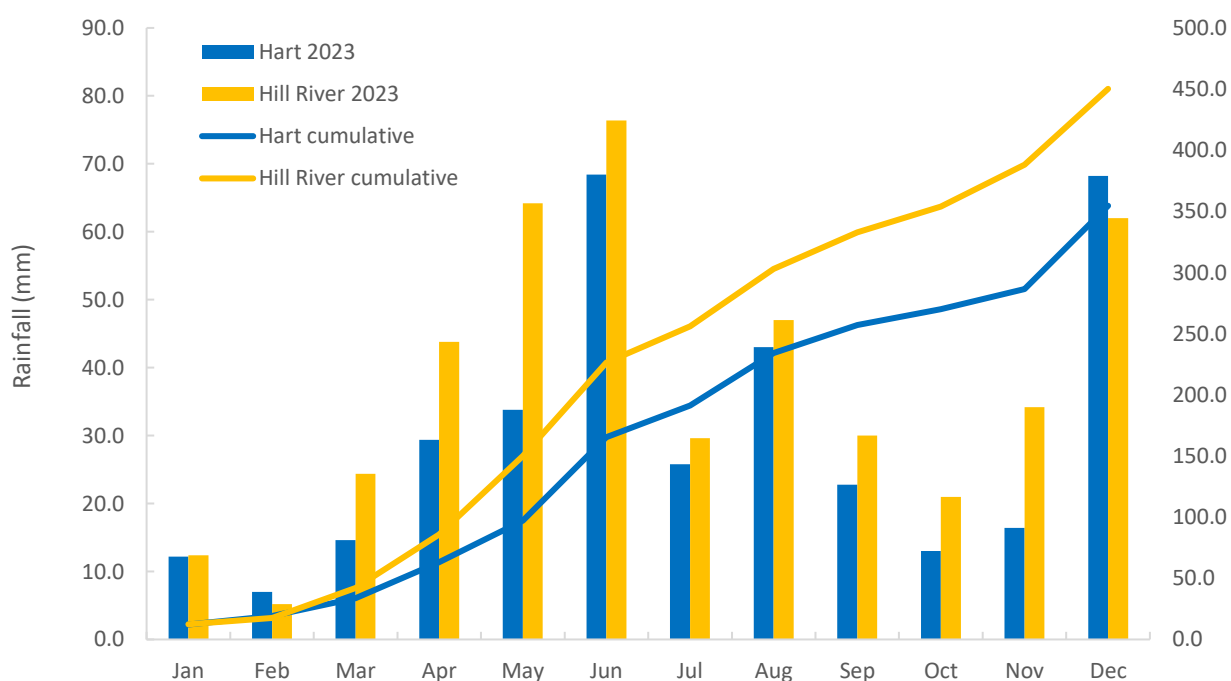


Figure 1. Monthly and cumulative rainfall for Hart and Clare (nearest Mesonet station to Hill River) in 2023 (Source: Mid-North Mesonet).

## *Trial design and treatments*

### *Hill River*

A trial was located at Hill River, SA as a randomised complete block layout with a complex treatment structure, where a full set of treatments were randomised within a replicate. There were three replicates, each containing 16 treatments. The aim of this trial was to investigate and test best-use spray strategies required to optimise ARG control with the use of glufosinate herbicide (Table 2). The trial compares the effects of:

- Liberty<sup>®</sup> herbicide at two rates (2 and 3 L/ha)
- Rate of Liase (2% and 4%)
- Liberty<sup>®</sup> herbicide +/- Liase
- Application timing (7, 14 and 21 days after initial application)
- Water rate (70 or 100 L/ha)
- Tank mixes as either glyphosate or clethodim
- Extended application window (first flower)
- Spray conditions (low temperature)

Three varieties with herbicide tolerances, including the LibertyLink<sup>®</sup> trait were included:

- InVigor LT 4530P: LibertyLink<sup>®</sup> + Triazine Tolerant (TT) + PodGuard<sup>®</sup> (TT) (early – mid maturity)
- InVigor LR 4540P: LibertyLink<sup>®</sup> + TruFlex<sup>®</sup> + PodGuard<sup>®</sup> (early – mid maturity)
- InVigor R 4520P: TruFlex<sup>®</sup> + PodGuard<sup>®</sup> (early – mid maturity)

The glufosinate herbicide product used was Liberty (200 g/L glufosinate) and Liase was selected as the ammonium sulphate (417 g/L) inclusion. Roundup Ready PL herbicide was selected as the glyphosate option, however Crucial is also registered for use on Roundup Ready<sup>®</sup>, TruFlex<sup>®</sup> or Optimum GLY<sup>®</sup> canola options. Herbicide applications were applied from August 11 to September 13, 2023 (Table 2 and Figure 2).

### *Hart field site*

A secondary trial was implemented at the Hart field site and was designed as a split-plot design with five treatments and three application timings. This trial investigated Liberty herbicide standalone at two rates, with Liase (ammonium sulphate) or in tank mixes to evaluate the control of ARG at different growth stages (Table 3). Application dates and climate data can be found in Appendix 1.

The trial was sown to Liberty tolerant InVigor LR 4540P canola by a knife point press wheel system on April 2, 2023. Prior to seeding, ARG with a known susceptibility to all herbicide groups was spread across the site ensuring adequate background populations emerged (250 plants/m<sup>2</sup>).

Four herbicide treatments were applied at three ARG growth stages from early emergence through to tillering (2 – 4 leaf, 1 – 2 tiller and 3 – 4 tiller) using a 100 L/ha water rate and coarse nozzles. No residual herbicides were applied pre-seeding.

Field assessments for both trials at Hart and Hill River included weed counts (weeds/m<sup>2</sup>) and panicle counts (heads/m<sup>2</sup>) as a measure of seed set, impacting weed management in consecutive years. Oilseed yield (t/ha) was also measured at Hill River. All data was analysed using a REML spatial model (Regular Grid) in Genstat 23<sup>rd</sup> edition.

Table 2. Treatment list and application dates for glufosinate trial located at Hill River, SA in 2023.

Trt	PSPE		2-4 Leaf		6-8 Leaf		10-Leaf		Stem elongation		First flower	
	Product	Rate	Product	Rate	Product	Rate	Product	Rate	Product	Rate	Product	Rate
1	Nil											
2	Atrazine	1 kg	Liberty + clethodim + Uptake + Liase	2 L + 330 mL + 0.5% + 2%			Liberty + Liase	2 L + 2%				
3			Liberty + Roundup PL + Liase	2 L + 1.67 L + 2%			Liberty + Liase	2 L + 2%				
4			Roundup PL + clethodim + Uptake + Liase	1.67 L + 330 mL + 0.5% + 2%			Roundup PL + Liase	1.67 L + 2%				
5			Liberty + Roundup PL	2 L + 1.67 L			Liberty	2 L				
6			Liberty + Roundup PL + Liase	2 L + 1.67 L + 4%			Liberty + Liase	2 L + 4%				
7			Clethodim + Liberty + Uptake + Liase	330 mL + 2 L + 0.5% + 2%			Liberty + Liase	2 L + 2%				
8			Liberty + Roundup PL + Liase	1.15 L + 0.5% + 2%			Liberty + Liase	2 L + 2%				
9			Liberty + Liase	2 L + 2%			Liberty + Liase	2 L + 2%				
10			Clethodim + Liberty + Uptake + Liase	330 mL + 2 L + 0.5% + 2%			Liberty + Liase	2 L + 2%				
11			Clethodim + Liberty + Uptake + Liase	330 mL + 2 L + 0.5% + 2%	Liberty + Liase	2 L + 2%						
12			Liberty	2 L			Liberty	2 L				
13			Liberty + Liase	3 L + 2%			Liberty + Liase	3 L + 2%				
14			Clethodim + Liberty + Uptake + Liase	330 mL + 2 L + 0.5% + 2%			Liberty + Liase	2 L + 2%				
15			Liberty + Liase	2 L + 2%			Liberty + Liase	2 L + 2%				1.67 L + 2%
16*			Clethodim + Liberty + Uptake + Liase	330 mL + 2 L + 0.5% + 2%			Liberty + Liase	2 L + 2%				

\*Second application applied early morning in cold temperatures of 9 degrees Celsius (°C).

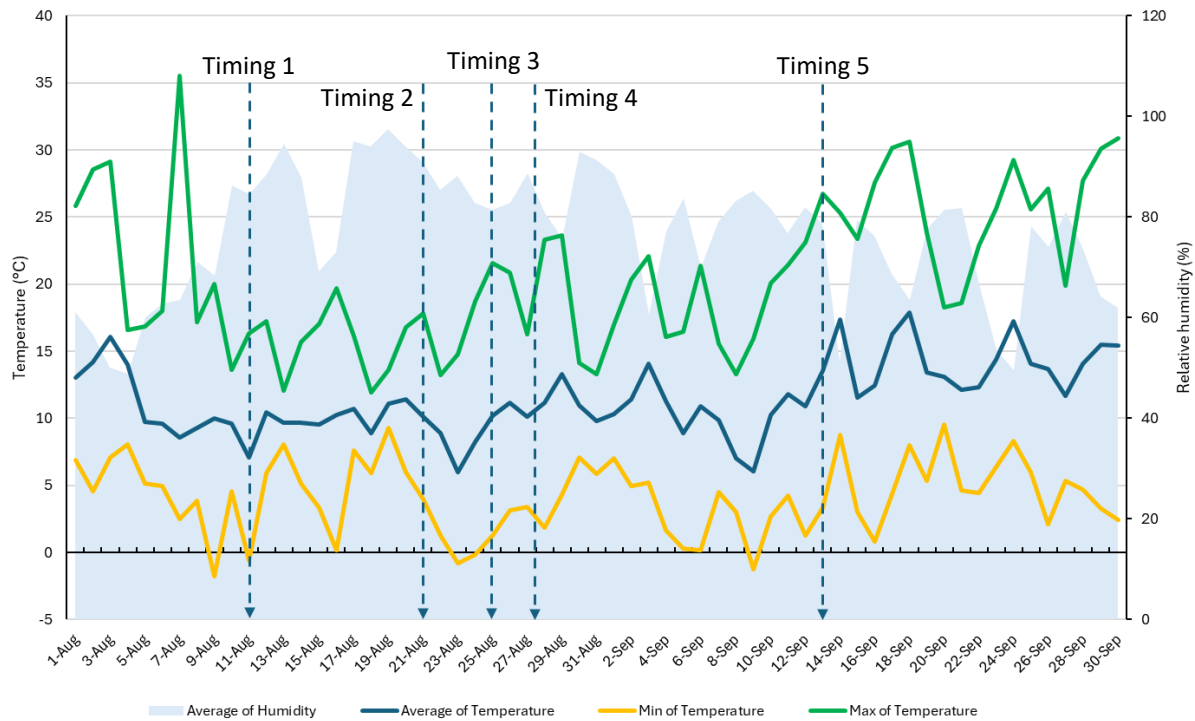


Figure 2. Minimum, maximum, average temperature (°C) and average relative humidity (RH%) for Hill River, SA. Arrows indicate each application timing.

Table 3. Treatment list for glufosinate trial located at the Hart field site, SA in 2023. Each treatment was applied to annual ryegrass at three different growth stages.

Trt	Timing 1		Timing 2 (10 – 14 days later)	
1	Nil			
2	Liberty + Liase	2 L + 2%	Liberty + Liase	2 L + 2%
3	Liberty + Liase	3 L + 2%	Liberty + Liase	3 L + 2%
4	Liberty + Roundup PL + Liase	2 L + 1.67 L + 2%	Liberty + Liase	2 L + 2%
5	Liberty + clethodim + Uptake + Liase	2 L + 330 mL + 0.5% + 2%	Liberty + Liase	2 L + 2%

## Results and discussion

### Hill River

#### Weed control

Initial ARG numbers were low across the trial site at Hill River in 2023 (61 plants/m<sup>2</sup>), despite the paddock having a known high annual ryegrass pressure. Low ARG numbers likely resulted from effective pre-emergent herbicide activity in wet conditions, combined with below average winter rainfall from July onwards.

The untreated control (Nil treatment) had the highest level of ARG present of 120 plants/m<sup>2</sup> when final weed counts were conducted on October 9, 2023. It also had the highest number of ARG heads with 195 heads/m<sup>2</sup> (Figure 3).

Reduced weed control was observed for all standalone Liberty treatments (Treatments 9 and 12) at 2 L/ha +/- Liase, applied as a two-spray approach (Figure 3). A trend showing that Liberty herbicide applied at 3 L/ha + Liase as a two-spray approach (Treatment 13) could improve weed control, however significantly lower ARG control was observed when compared to all other herbicide treatments.

Similar trends were observed for ARG head counts for standalone Liberty treatments at 2 L/ha +/- Liase, with a greater number of heads measured (43 heads/m<sup>2</sup>). When rates of Liberty were increased to 3 L/ha (+ Liase), overall weed control at maturity, as a measure of potential seed set for consecutive years, increased and was similar to all other treatments, with an average of 1 head/m<sup>2</sup>.

Liberty treatments tank mixed with clethodim, uptake and Liase, showed no negative impact resulting from reduced water rates at applications from 100 – 70 L/ha. There was also no effect observed by delaying follow-up applications of Liberty from 7 – 21 days, however it is important to note that ARG populations across the site were low.

TruFlex spray regimes including applications of Roundup Ready PL + clethodim (fb Roundup Ready PL) performed similarly to Liberty herbicide options when applied with glyphosate or clethodim at an initial spray timing (fb Liberty ~14 days later), despite moderate levels of Group 1 – DIM resistance.

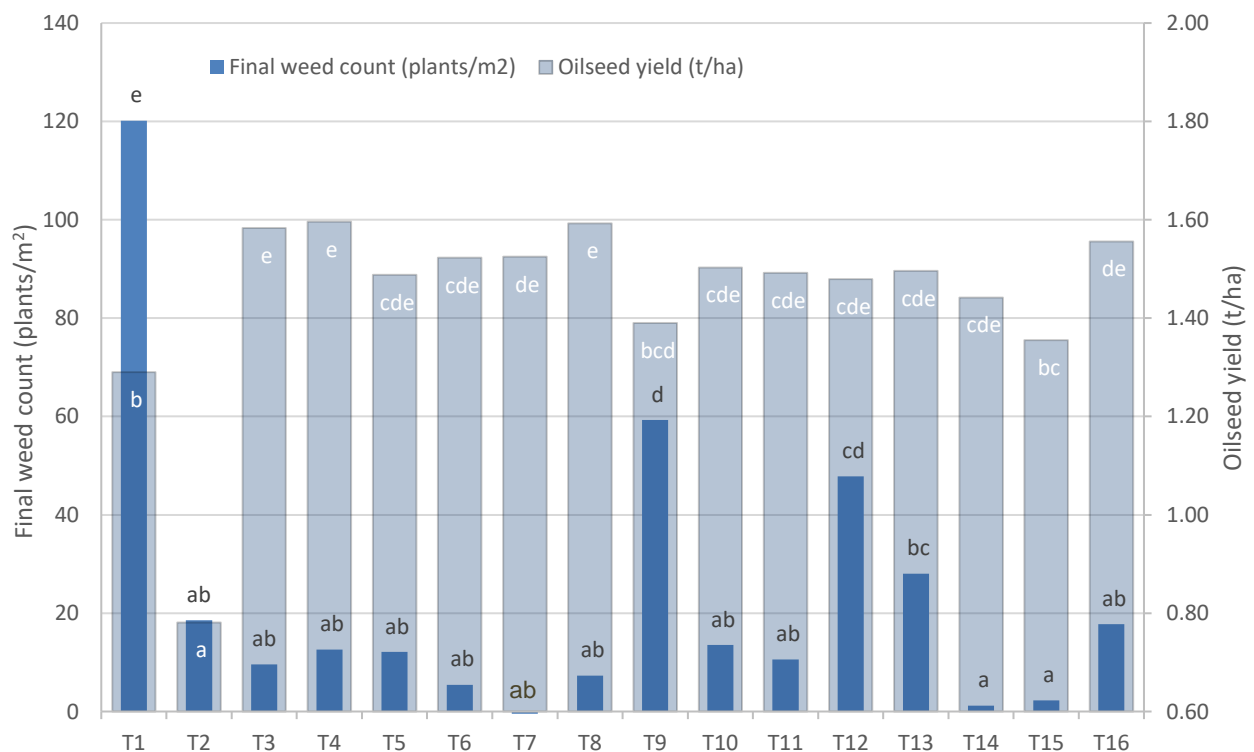


Figure 3. Final weed count (plants/m<sup>2</sup>) and oilseed yield (t/ha) for all treatments at Hill River, SA in 2023. Columns for final weed count (■) or oilseed yield (■) with the same letter are not significantly different.

#### Grain yield

The lowest grain yield observed at Hill River was stacked tolerance variety InVigor LT 4530P (LibertyLink + Triazine Tolerant + PodGuard). This result was not expected and may be associated with a yield penalty at times observed from TT herbicide tolerance traits. The untreated control also performed poorly (1.29 t/ha), in addition to Liberty herbicide at 2 L (+/-Liase) as a two-spray regime (1.36 – 1.39 t/ha). These results are attributed to higher ARG numbers, competing with canola for soil moisture and nutrition (Figure 3).



## Hart

### Weed control

Results at the Hart field site in 2023, on a susceptible ARG population show that herbicide regime was most significant in determining weed control (plants/m<sup>2</sup>). It is important to note that while applications were made to ARG at varying growth stages from 2 – 4 leaf to 2 – 4 tiller, tillering ARG plants were small and sprayed early (not at stem elongation). Similar humidity (RH%) and temperature (°C) conditions were observed at each application (see Appendix 1).

Similarly to Hill River results, applications of Liberty standalone sprayed as a sequential two-spray regime had reduced ARG control (62 plants/m<sup>2</sup>), when compared to Liberty tank mixed with clethodim or Roundup Ready PL (23 plants/m<sup>2</sup>) in initial spray timings (Liase included at all spray timings). Liberty at 3 L/ha performed similarly, reducing weed number which was a contrasting result to observations at Hill River.

The untreated control had the highest level of ARG present, with an average of 219 plants/m<sup>2</sup> (Figure 4).



Figure 4. Photos: Post final application for 2-4 leaf treatments; 2 L/ha Liberty + 330 mL clethodim + 2% Liase (left), untreated control (middle) and 2 L/ha Liberty + 2% Liase (right). All treatments were followed by 2 L/ha Liberty + 2% Liase 12 days later.

### Summary

Preliminary data from field trials across Hill River and Hart in the Mid-North of SA show that Liberty herbicide tank mixed with either clethodim or registered glyphosate options in early spray applications, can control annual ryegrass. Liberty herbicide at low label rates of 2 L/ha + ammonium sulphate are not adequate for the control of ARG. In only one of two field trials, higher label rates of 3 L/ha were able to reduce weed number, however overall ARG head suppression was observed at both sites. A detailed report outlining further results will be published in 2024.

### Acknowledgements

The authors would like to gratefully acknowledge South Australian Grains Industry Trust (SAGIT) for their financial contribution supporting this project. We'd also like to thank project partners Plant Science Consulting and local growers for kindly hosting field trials in addition to the various organisations for their supply of chemical and seed to conduct these trials.



## References

Appendix 1. Application timing details for glufosinate trial at Hart, 2023.

<b>ARG</b> <b>growth stage</b> <b>timing at</b> <b>Application 1:</b>  <b>2-4 leaf</b>	<b>Application 1</b> Canola growth stage: 2-4 leaf Date: June 29 Time: 12:30pm Cloud cover: 10% RH% 66% Temperature: 12
	<b>Application 2</b> Canola growth stage: 2-4 leaf <b>Days since application: 12</b> Date: July 11 Time: 12:30pm Cloud cover: 10% RH% 59% Temperature: 17
<b>ARG</b> <b>growth stage</b> <b>timing at</b> <b>Application 1:</b>  <b>1-2 tiller</b>	<b>Application 1</b> Canola growth stage: 6 Leaf Date: July 21 Time: 1:00pm Cloud cover: 15% RH% 69% Temperature: 13
	<b>Application 2</b> Canola growth stage: 10 leaf <b>Days since application: 17</b> Date: August 7 Time: 12:00pm Cloud cover: 90% but conditions still bright RH% 62% Temperature: 17
<b>ARG</b> <b>growth stage</b> <b>timing at</b> <b>Application 1:</b>  <b>2-4 tiller</b>	<b>Application 1</b> Canola growth stage: 10 leaf Date: August 7 Time: 12:00pm Cloud cover: 90% but conditions still bright RH% 62% Temperature: 17
	<b>Application 2</b> Canola growth stage: stem elongation - budding <b>Days since application: 14</b> Date: August 21 Time: 1:00pm Cloud cover: 10% cloud cover from 3pm + small amount of rain RH% 67% Temperature: 18