

## Investigating alternative herbicide options for the control of resistant populations of annual ryegrass (*Lolium rigidum*)

**Trial Code:** GOWE04919-1  
**Season/Year:** Autumn, 2019  
**Location:** 'Wullara', Forbes  
**Trial Partners:** Matt Duff and Mat Shepherd

### Keywords

GOWE049, Annual ryegrass, resistance, knockdown, adjuvants, glyphosate, paraquat, wetters, Forbes

### Take home messages

- Confirming resistance status through testing rather than assumptions of resistance of ARG populations is important to determine useful herbicide options and rates for effective control.
- Paraquat or products with a paraquat component can provide good control of annual ryegrass – although it is important to ensure adequate spray coverage to achieve good control

Annual ryegrass (ARG) is expressing increasing levels of resistance to various herbicides across the Orana Region. Developing resistance to glyphosate is highly concerning, as it is a key tool for ARG knockdown control in fallows and pre-winter crop sowing. Effectiveness of glyphosate needs to be protected as much as possible to prolong its useful life.

This trial focuses on testing various alternate knockdown options (including glyphosate tank mixes) for control of glyphosate resistant ARG.

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### Aim

Test the efficacy of a range of knockdown herbicide products on the control of ARG with suspected resistance to glyphosate.

### Methods

This trial used a small plot randomised complete block split design with three replicates, established in growers' paddock with visible ARG population with suspected glyphosate resistance.

Herbicide treatments (Table 2), were applied using an ATV mounted boom.

Results were analysed by ANOVA and compared by using an LSD method with a 95% confidence interval. Any references to differences between treatments should be assumed to be statistically different unless otherwise stated.

Table 1. Trial site details

<b>Trial Establishment Date</b>	Winter, 2019
<b>Soil Type</b>	Red Chromosol
<b>Previous Crop</b>	Wheat
<b>Weed Size (at application)</b>	3-6 leaf
<b>Situation</b>	Prior to establishing a crop or pasture with an implement that gives MINIMAL OR NO SOIL DISTURBANCE
<b>ARG resistance status</b>	Resistant to Group A fops and Group B Imidazolinones, details in appendix

Table 2. Treatment list (products, chemical groups and active ingredients are listed in the annex).

Product 1	Rate (mL or g)	Product 2	Rate (mL or g)	Adjuvant	rate %
Alliance®	2800	-	-	-	-
Alliance®	1500	-	-	-	-
Boxer Gold®	2500	-	-	-	-
Clethodim	250	-	-	Uptake™	0.50%
	500	-	-	Uptake™	0.50%
Paraquat	1000	Balance®	100	-	-
	1000	Boxer Gold®	2500	-	-
	1000	diuron	280	-	-
	1000	-	-	-	-
	1500	-	-	-	-
	2000	-	-	-	-
Roundup CT®	500	Boxer Gold®	2500	Wetter TX	0.20%
	500	clethodim	250	Uptake™	0.50%
	500	Sledge®	150	Wetter TX	0.20%
	500	Sharpen®	34	Hasten™	1.00%
	500	Verdict™	150	Uptake™	0.50%
	500	-	-	Wetter TX	0.20%
Verdict™ 520	150	-	-	Uptake™	0.50%
	300	-	-	Uptake™	0.50%
Untreated control (UTC)	-	-	-	-	-

Table 3. Application records

Date Applied	15/4/2019	Temp (°C)	Wind (km/h)	Wind Dir.	Humidity (%)
Start time	12:30 pm	25	5-10	NE	35.6%
Finish Time	13:00 pm	$\Delta t$	10.2	% Cloud	5%
Water rate (L/ha)	100	Nozzle	DG015	Pressure	3 bar
Equipment	ATV	Speed	7-8 km/hr		

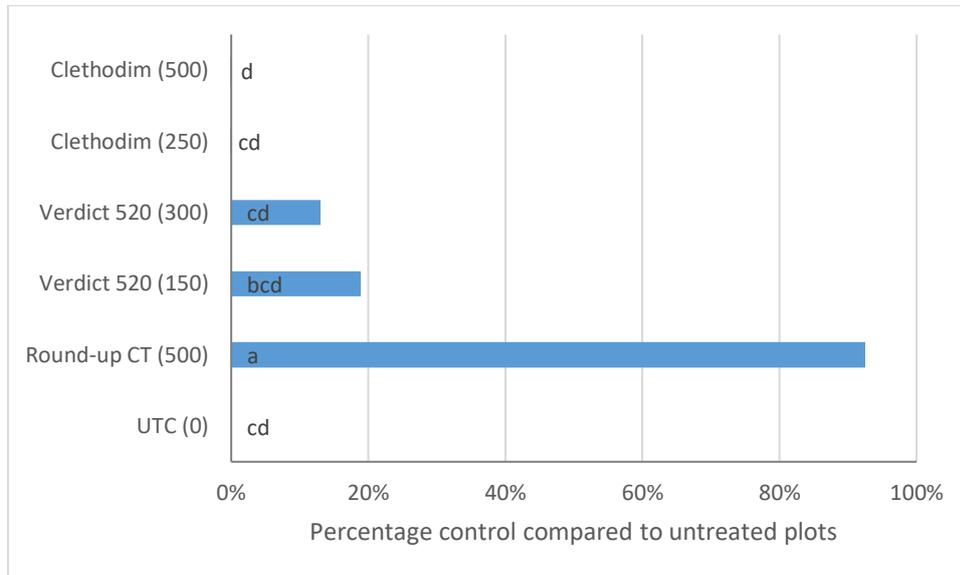
## Results

Full result tables are documented in the annex.

ARG population was moderate, with over 80 plants/m<sup>2</sup> (assessed in the UTC).

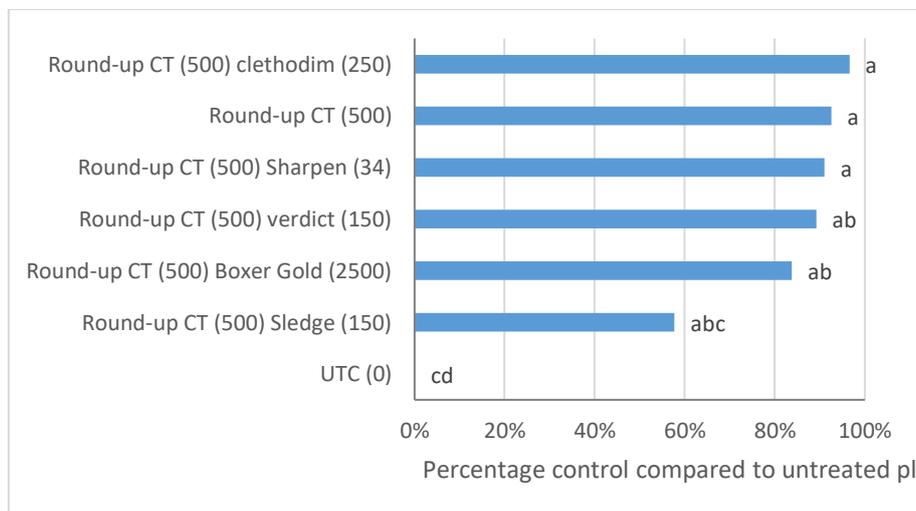
While the site was selected because grower and agronomist suspected ARG resistant to glyphosate, commercial testing did not detect resistance. However, the ARG population was strongly resistant to Verdict™ with 100% survival and had 75% resistance to Intervix. Resistance to clethodim was not detected.

Group A herbicides: Application of Group A did not result offer any control of ARG when compared to the untreated plots (**Figure 1**).



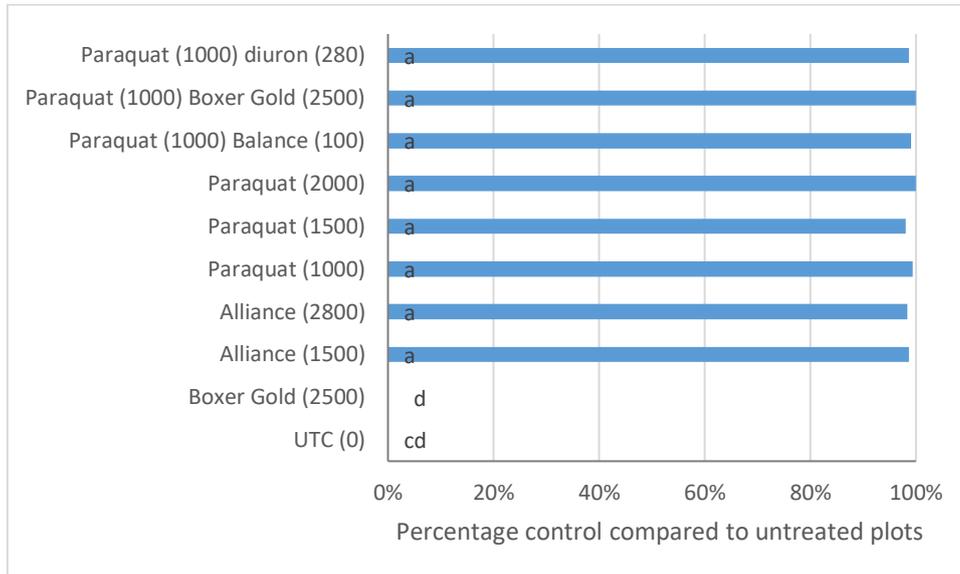
**Figure 1.** Percentage ARG control (compared UTC) for a single application of selected Group A herbicides and Roundup CT (plus Wetter TX), 21 days after application (DAA1).

Glyphosate tank mixes: Roundup CT (500 mL/ha) achieved close to 93% control when compared to UTC. But the addition of Verdict™, Sledge®, Sharpen® Clethodim or Boxer Gold® did not improve control (**Figure 2**) over glyphosate alone.



**Figure 2.** Percentage ARG control for selected herbicides tank mixed with Roundup CT®, assessed 21 DAA1.

Paraquat, Alliance (amitrole 250g/L+ paraquat 125g/L) and paraquat or paraquat tank mixes resulted in high levels of control, well over 90%. Boxer Gold provided no detectible levels of improved control compared to the untreated control (**Figure 3**).



**Figure 3.** Percentage ARG control (compared to UTC) for paraquat, selected herbicides tank mixed with paraquat, Alliance® and Boxer Gold. Assessed 21 DAA1.

## Discussion

Trial site was selected because both the grower and agronomist suspected ARG resistance to glyphosate, due to of previous poor levels of control. However commercial testing did not detect any glyphosate resistance at any level in the ARG population.

ARG population was found to be resistant to Verdict™ with 100% survival. Although resistance to clethodim was not detected, neither product provided commercially acceptable levels of ARG control.

Roundup CT® @ 500 mL/ha (rate lower than label recommendations for this situation) was designed to demonstrate any potential for additional spikes to improve ARG control. However this lower rate still provided over 90% control. Adding tank mixes did not significantly improve or impede results suggesting they would be of little benefit in controlling ARG in this situation.

Paraquat and Alliance® provided high levels of control, though were not significantly better than Roundup CT® at 500 mL/ha. Again adding various tank mix partners to paraquat did not improve ARG control.

ARG plants appeared to be suffering from drought at time of application; conditions were very dry and visible stress signs were evident. Levels of control provided by Roundup CT at 500 ml/ha (below label recommendation) suggest that even when plants are stressed, good levels of control can be achieved with correct application setup and favourable spaying conditions. However other GOA trials conducted via similar technology have noted Roundup failures when ARG plants have been in stress conditions. “Stress” is not a simply defined condition with many factors at play and exact ‘stress’ tipping points for ARG susceptibility to herbicides is possibly not well understood.

## Conclusion

Results from this trial reinforce the importance of adequately assessing resistance status of an ARG population. In this example ‘suspecting’ glyphosate resistance without testing could lead to

unnecessarily excluding it as an option for control. This trial also demonstrated that paraquat can be a viable alternative to glyphosate, and regardless of ARG resistance status, can be considered a useful tool for herbicide rotations within an integrated weed management strategy.

Paraquat and products containing paraquat provided high levels of control and could be considered as options for ARG control or as an effective alternative where glyphosate resistant populations occur. But trial results suggest that Group A products and some other potential tank mix partners are unlikely to be a good alternative to glyphosate in ARG resistant populations.

## Acknowledgements

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## Appendix –

Figure 4- Excerpt from herbicide resistance tests performed on ARG population

**Table 1:** Results as determined by resistance testing 3 weeks after treatment. Data recorded as % survival (% of plants surviving) as compared to untreated plants. 100% refers to all plants surviving and 0% refers to death. Data is the mean of 2 replicate pots per herbicide rate. Included in the test was a susceptible (S) biotype and resistant biotypes. Data for the S and R biotypes is not shown.

Herbicide	Herbicide Group	Paddock Sample Sth Forbes	
		Survival	Rating
Select 350ml/ha + 1% Hasten	Group A - Dims	0	S
Select 500ml/ha + 1% Hasten	Group A - Dims	0	S
Intervix 750ml/ha + 1% Hasten	Group B - Imidazolinones	75	RR
Verdict 100ml/ha + 1% Hasten	Group A - Fops	100	RRR
Paraquat 1L/ha + 0.2% BS1000	Group L	0	S
Roundup CT 0.5L/ha + 0.2% Wetter TX	Group M	0	S
Roundup CT 0.75L/ha + 0.2% Wetter TX	Group M	0	S
Roundup CT 1.0L/ha + 0.2% Wetter TX	Group M	0	S
Roundup CT 1.25L/ha + 0.2% Wetter TX	Group M	0	S
Roundup CT 1.5L/ha + 0.2% Wetter TX	Group M	0	S

Table 4 Ryegrass control 21 days after the application of various glyphosate treatments.

Product 1	Rate 1	Product 2	Rate 2	Adjuvant	Rate	ARG/m <sup>2</sup>		Control (%) <sup>1</sup>	
Alliance®	1500					1	g	99%	a
	2800					1	efg	98%	a
Boxer Gold®	2500					68	ab	0%	d
Clethodim	250			Uptake™	0.50%	43	ab	0%	cd
	500			Uptake™	0.50%	112	a	0%	d
Paraquat	1000	Balance®	100			1	efg	99%	a
	1000	Boxer Gold®	2500			0	g	100%	a
	1000	diuron	280			1	g	99%	a
Paraquat	1000					1	fg	99%	a
	1500					2	efg	98%	a
	2000					0	g	100%	a
Roundup CT®	500	Boxer Gold®	2500	Wetter TX	0.20%	7	def	84%	ab
		clethodim	250	Uptake™	0.50%	2	efg	97%	a
		Sharpen®	34	Hasten™	1.00%	3	defg	91%	a
		Sledge®	150	Wetter TX	0.20%	16	bcd	58%	abc
		Verdict™	150	Uptake™	0.50%	8	cde	89%	ab
				Wetter TX	0.20%	4	defg	93%	a
Verdict™ 520	150			Uptake™	0.50%	36	abc	19%	bcd
	300			Uptake™	0.50%	56	ab	13%	cd
UTC						80	a	0%	cd
Isd <sup>2</sup>								71%	

Table 5 List of products and active ingredients

Registered Name	Group	Active
Alliance	L Q	250 g/l amitrole, 125 g/l paraquat
Boxer Gold®	J K	800 g/l Prosulfocarb, 120 g/l S-Metolachlor
Roundup CT	M	455 g/l glyphosate
Sharpen® WG	G	700 g/kg saflufenacil
Sledge®	G	25 g/L Pyraflufen-ethyl
Platinum	A	240 g/L Clethodim
Diurex	C	900g/kg diuron
Verdict 520	A	520 g/l Haloxypop

<sup>1</sup> Where ARG populations in treated plots exceed populations in untreated plots 0% control is assumed

<sup>2</sup> Arg population data was analysed using a LOG transformation, predicted values were back calculated however there is not yet a sound method to calculate Isd on transformed data.