GOA Trial Site Report

Improving annual ryegrass (*Lolium rigidum*) knockdown- assessment of various glyphosate formulations, rates and adjuvant combinations- Forbes 2019

Trial Code:	GOWE05319-1
Season/Year:	Autumn, 2019
Location:	'Wullara', Forbes
Trial Partners:	Matt Duff and Mat Shepherd

Keywords

Annual ryegrass, *Lolium rigidum*, resistance, knockdown, glyphosate, paraquat, wetter, surfactants, GOWE053, Forbes.

Take home messages

- Use robust rates to ensure adequate ryegrass control with glyphosate
- Know the glyphosate resistance status of ryegrass populations to determine rate requirements for better control.
- Adding wetter or using glyphosate products with built-in surfactants can improve control, however, an alternative may be to increase glyphosate rate
- Herbicide failures should thoroughly investigated and avoid conclusions of resistance without confirming by testing

Background

Annual ryegrass (ARG) is expressing increasing levels of resistance to various herbicides across the Orana Region[1]. One of the most concerning is developing resistance to glyphosate, rendering it useless for fallow or pre-sowing knockdown control. Retaining glyphosate effectiveness is critical to prolong its useful life.

Growers have numerous options to maintain and maximise glyphosate effectiveness. For example, choice of glyphosate product which may contain different surfactant packages, form and concentration of glyphosate active ingredient, adding additional surfactants, and glyphosate rate.

Research has shown that glyphosate resistant ARG is often rate responsive- that is increasing glyphosate rate will increase control. Increasing glyphosate rates may also contribute to more effective control by "… counteracting poor application, improving control of older plants, stressed plants or overcoming reduced efficacy caused by using poor quality water or treating plants covered by dust. Higher label rates can also improve glyphosate activity of plants exposed to higher temperatures that can arise in early autumn or late spring"[2].

[1] See GOA report: http://www.grainorana.com.au/documents?download=29

[2] https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2015/02/optimising-the-impact-of-glyphosate

The active ingredient, glyphosate, is generally poorly absorbed by plants and many commercially available glyphosate formulations generally have surfactants or adjuvants included to bolster performance by aiding in droplet retention on the target and absorption by the plant. Despite the inclusion of these surfactants, additional surfactants and/or adjuvant use is common. However there exist significant inconsistencies, ambiguity and lack of quantifiable benefits regarding the use of additional surfactants or adjuvants on product labels

Wetter TX is most commonly recommended on various glyphosate product labels suggesting improvement in ARG control under specific circumstances (i.e. Roundup Ultra®Max recommendation to add in late winter and spring). However, there are a range of alternate surfactants also available.

Glyphosate also comes in a range of salt forms and concentrations. Some of these products are often considered premium and are often promoted as likely to result in better spray outcomes.

Aim

This trial aimed to investigate some key choices available to improve control of populations of ARG suspected of glyphosate resistance. Specific investigation focused on

- A range of alternate additional surfactants
- Rate of glyphosate applied

Methods

Trial design was a small plot randomised complete block strip design with three replicates. It was established in a growers' paddock with visible ARG population.

Herbicide treatments were applied using an ATV mounted boom. A double knock treatment of 2 l/ha paraquat was applied to half of each plot (split design).

Results were analysed by ANOVA and results 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

Trial Establishment Date	Autumn, 2019
Soil Type	Red Chromosol
Previous Crop	Wheat
Weed Size (at application)	3-6 leaf
ARG resistance status	Resistant to Group A fops and Group B Imidazolinones, details in appendix

Table 2. Forbes site treatment list.

Product	Rate		Adjuvant	Rate	Adjuvant	Rate
	mL/ha	Glyphosate (g ai/ha)				
Roundup CT®	500	225	Wetter TX	0.20%		
	750	337.5	Wetter TX	0.20%		
	1000	450	Wetter TX	0.20%		
	1250	562.5	Wetter TX	0.20%		
	1500	675	Wetter TX	0.20%		
	500	225	Activator	0.13%		
	500	225	LI 700	0.50%		
	500	225	BS1000	0.10%		
	500	225	Wetter TX	0.20%	LI700	0.50%
	500	225	LI700	0.50%	Liase	2.00%
	500	225	Liase	2.00%		
	500	225	Wetter TX	0.20%	Activator	0.13%
	500	225	Liase	2.00%	Activator	0.13%
	500	225				
Glyphosate 62% IPA	363.0	225				
	363.0	225	Terwet	4.00%		
	363.0	225	Terwet	8.00%		
	363.0	225	Terwet	12.00%		
Untreated control (UTC)						

Table 3. Application records

First application	**Date Applied**	15/04/2019	**Temp (°C)**	**Wind (km/h)**	**Wind Dir.**	**Humidity (%)**
	Start time	10.50am	25.8	8-11k	NNE	42.8
	Finish Time	12.15pm	**Δt**	8.4	**% Cloud**	5%
	Water rate (L/ha)	100	**Nozzle**	AIXR015	**Pressure**	3
	Equipment	ATV	**Speed**	6-7 km/hr		

Results

Full results are tabled is in appendix at the end of the document.

Commercial resistance testing of ARG sampled from the site prior to applications indicated no resistance to glyphosate. The population however was highly resistant to Group A Fops (verdict) and Group B imidazolinones (Intervix). The resistance report is included in the annex.

Impact of product rate: Lowest application rate of 225 g ai/ha of Roundup CT® provided the lowest level of control at 54% of ARG. Level of control increased with glyphosate rate, up to 93% at the highest rate of 1500 mL/ha Roundup CT® or 675g ai (Figure 1).

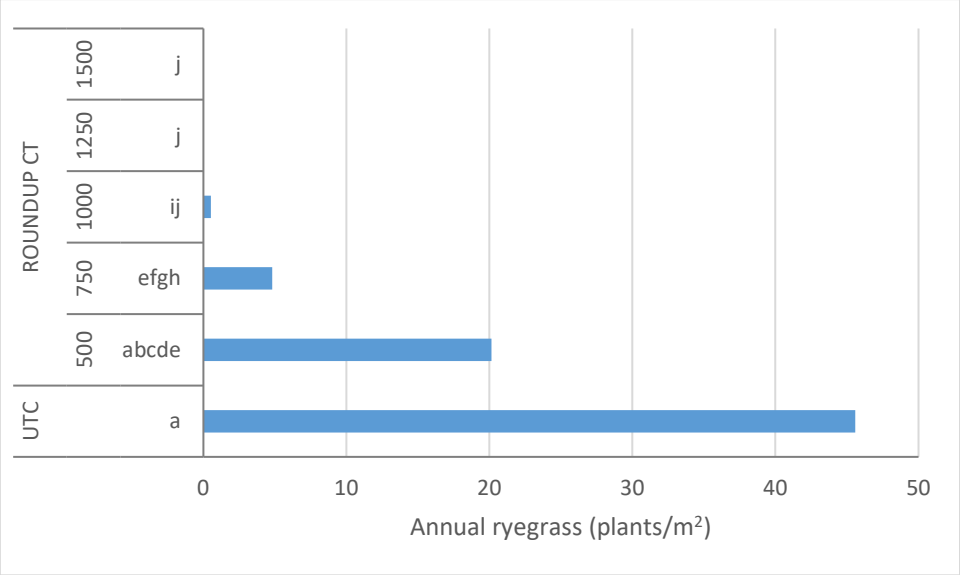

Figure 1. Surviving annual ryegrass populations following application of four rates of Roundup CT® assessed 21 days after initial application. All Roundup CT® treatments were applied with Wetter TX at 0.2%.

Impact of additional surfactants: Where Roundup CT® was applied at 500 mL/ha (225g ai/ha) without any adjuvant control was approximately 37%. A non-commercially available formulation of 620 g/L glyphosate which has no surfactants contained in the formulation was not significantly different to Roundup CT® when applied at the same rate of active ingredient. Increasing the rate of Terwett with the 620 g/L glyphosate did improve control at both the 4% and 8% rate however at 12% control was poor. The addition of various other adjuvants tested to Roundup CT® at 500 mL/ha did not significantly improve control, with the exception of Liase, Liase plus Activator and Wetter TX plus Activator (**Figure 2**).

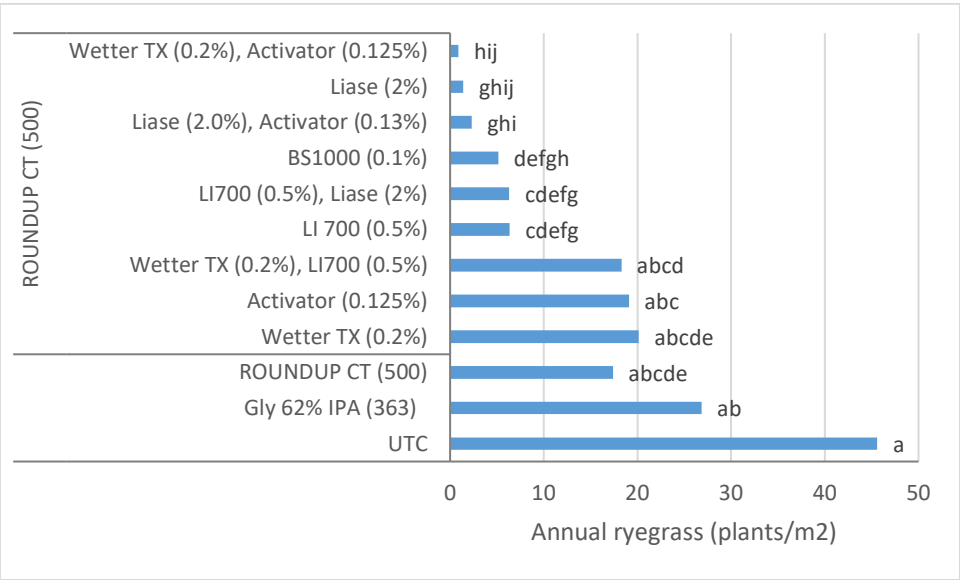

Figure 2. Surviving annual ryegrass populations following applications of Roundup CT® and glyphosate 620g/L with and without various adjuvant packages. All treatments used the equivalent rate of active ingredient (glyphosate) (i.e. equivalent to 500 mL/ha Roundup CT® or 225g ai/ha). Treatments followed by the same letter are not significantly different. Assessed 21 days after initial application.

Discussion

A modest population of ARG was present in this trial with ~45 plants/m^2 in the untreated control. Conditions at application were marginal due to ongoing drought. Plants were 3-6 leaf and visibly moisture stressed.

Trial site was selected on advice from the grower and advisor as there was suspected resistance ARG to glyphosate because of past poor control. This was not previously confirmed by resistance testing. Subsequent resistance testing within this work showed the population to be susceptible to glyphosate at all rates tested. The population did have some resistances to Group A and B herbicides.

The reduction in ARG plant population at this site by glyphosate was about 55% when using the lower rates tested. When glyphosate rate was increased (i.e. 1.25 l/ha Roundup CT)[3] the surviving ARG population was significantly reduced to ~1% of the untreated plots. At the higher label rate virtually no ARG plants survived.

Addition of Terwett to the 62% glyphosate with no surfactant in the formulation did improve control supporting the need for surfactants to improve glyphosate uptake and subsequent control. In a practical sense this may also support growers using more reputable brands where surfactant rates are maintained. Addition of various other adjuvants to Roundup CT® generally did not improve efficacy in this trial (with the exception of Liase, Liase plus Activator and Wetter TX plus Activator. However, when comparing the addition of adjuvants to using a higher rate of glyphosate the later was the more robust option.

Lack of confirmed glyphosate resistance and high levels of control of even stressed plants achieved in this trial even at moderate label rates tend to suggest that poor past control may have been a result of application and/or plant size, or other environmental issues, and would warrant further investigation.

While this trial demonstrated good reductions in ARG populations with glyphosate, it is not conclusive in demonstrating that increasing glyphosate application rate can improve control of glyphosate resistant ARG as resistance was not detected.

Results of this trial suggest that determination of ARG resistance status would allow for more effective use of glyphosate and improved ongoing management of resistance toward it.

Conclusion

Knowing the glyphosate resistance status of ARG populations to determine rate requirements for better control is clearly important.

Adding wetter or using glyphosate products with built-in surfactants can sometimes improve control, however, a more robust alternative may simply be to increase the glyphosate rate. Susceptible ARG populations can be controlled at lower rates under the right conditions.

[3] Current label recommendation for ARG control in minimum tillage situations is 1.2 – 1.6 l/ha with Wetter TX @ 200 mL/100 L https://www.sinochem.com.au/wp-content/uploads/2015/07/Roundup-CT_WebLabel_V2.0.pdf

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Appendix –

Figure 3- Excerpt from herbicide resistance tests performed on ARG population

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

Resistance-rating:	RRR- indicates plants tested have strong resistance	RR - indicates medium-level resistance	R-indicates low-level but detectable resistance	S- indicates no detection of resistance

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

Product	Adjuvant	plants/m^2	LSD
UTC		27	ab
Glyphosate 62% IPA (363)		22	Abc
Glyphosate 62% IPA (363)	Terwet (4%)	11	bcdef
	Terwet (8%)	3	fghi
	Terwet (12%)	20	abcde
ROUNDUP CT® (500)	Wetter TX (0.2%)	5	efgh
ROUNDUP CT® (750)		1	ij
ROUNDUP CT® (1000		0	j
ROUNDUP CT® (1250		0	j
ROUNDUP CT® (1500		17	abcde
ROUNDUP CT® (500)		19	abc
ROUNDUP CT® (500)	Activator (0.125%)	5	defgh
	BS1000 (0.1%)	6	cdefg
	LI 700 (0.5%)	6	cdefg
	LI700 (0.5%), Liase (2%)	1	ghij
	Liase (2%)	2	ghi
	Liase (2%), Activator (0.125%)	1	hij
	Wetter TX (0.2%), Activator (0.125%)	18	abcd
	Wetter TX (0.2%), LI700 (0.5%)	46	a
lsd		N/A	