GOA Trial Site Report

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

Trial Code:	GOWE05319-1
Season/Year:	Autumn, 2019
Location:	"Tichborne", Parkes
Trial Partners:	Mark Kinsey and Cameron Corke

Keywords

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

Take home messages

- Using more robust rates or/and adding adjuvants will not always overcome lack of susceptibility to glyphosate with moisture stressed plants.
- 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].

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

[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

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 KANDOSOL
Previous Crop	Wheat
Weed Size (at application)	3-6 leaf
ARG resistance status	Detailed in appendix- Suspected resistance

Table 2. Application records

First application	**Date Applied**	16/04/2019	**Temp (°C)**	**Wind (km/h)**	**Wind Dir.**	**Humidity (%)**
	Start time	9.20am	22	3-Jul	E	49.2
	Finish Time	10.05pm	**Δt**	6.8	**% Cloud**	5%
	Water rate (L/ha)	100	**Nozzle**	DG015	**Pressure**	3
	Equipment	ATV	**Speed**	6-7 km/hr		

Table 3. Tichborne 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)						

Results

Full results are tabled 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 moderately resistant to Group A Fops (verdict) and low level resistant to Group B imidazolinones (Intervix). The resistance report is included in the annex.

In this trial all treatments had significantly fewer surviving plants than untreated control with no significant differences between the treatments with the exception of the Glyphosate 62% IPA (363) + Terwet (8%) treatment).

Discussion

A moderate population of ARG was present in this trial with ~100 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.

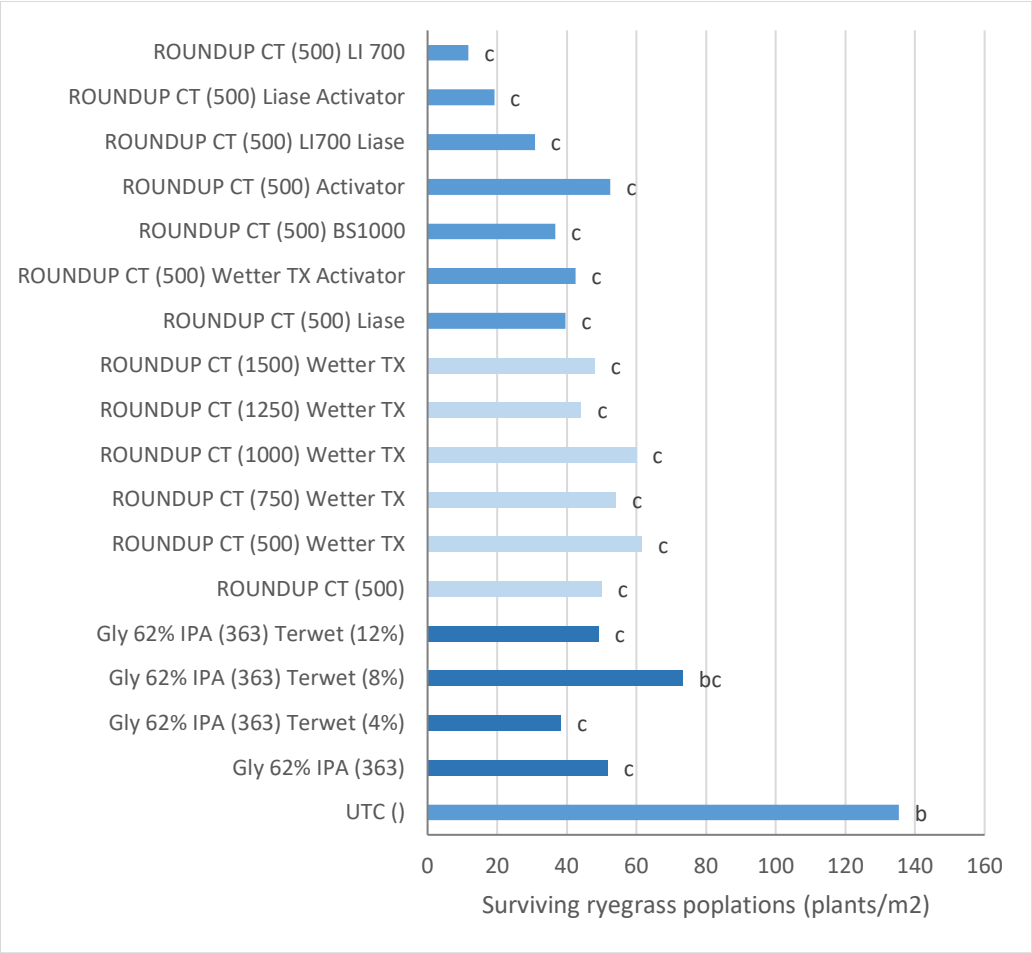

Figure 1. Surviving annual ryegrass populations following application various Glyphosate products, rates and adjuvants, assessed 21 days after initial application.

The trial site was selected on advice from the grower and advisor as there was suspected resistance to glyphosate because of past poor control. This was not supported by commercial resistance testing with no resistance to glyphosate detected at any rate of glyphosate tested. However resistance to Verdict and Intervix was detected.

All treatments with one exception had fewer surviving plants than the untreated control, however there was no statistical difference between these treatments and no treatments tested would be considered acceptable commercial control. In all cases the number of surviving ARG plants was greater than 10% of the untreated control population, i.e. less than 90% control (with the exception of the Roundup CT/Liase treatment). The relatively poor levels of control possibly reflect the stress levels of ARG plants at the time of application. While it is possible that the application technique contributed to the result, this is unlikely as previous and ongoing GOA research has successfully completed many trials using the same spray setup and water source.

It is not uncommon for growers to increase glyphosate rate to overcome deficiencies in spray setup or environmental conditions. However, in this trial increasing glyphosate rate to highest label recommendations (i.e. 1500 ml/ha Roundup CT) still did not achieve a level of control that might be considered commercially acceptable.

Furthermore, the addition of various adjuvants to Roundup CT (at 500 ml/ha) did not result in less surviving plants than where it was not used. There is a possibility that addition of other surfactants or adjuvants at the highest rates of glyphosate may have improved control, but this was not tested.

Conclusion

In this trial the most plausible explanation is that moisture stress reduced overall control and manipulating product choice, rate or adding addition surfactants or adjuvants did not result in commercially acceptable control.

Furthermore, the poor results from in this trial cannot be explained by the presence of resistance as none was detected but it had been blamed in the past. The reason for failure in this circumstance is likely moisture stress but explanations are not always clear. The trial does demonstrate that spray failures are not always predictable in such circumstances jumping immediately to a conclusion of glyphosate resistance with out confirmation by testing is not ideal.

In cases of spray failure is is advisable to always investigate the causes and if resiatnce is detected it should be confirmed with testing.

Acknowledgements

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DISCLAIMER — TECHNICAL

Appendix –

Figure 2- Excerpt from herbicide resistance tests performed on ARG population

Herbicide	Herbicide Group	Paddock Sample Tichborne	
		Survival	Rating
Paraquat 1L/ha + 0.2% BS1000	Group L	0	S
Select 350ml/ha + 1% Hasten	Group A - Dims	0	S
Select 500ml/ha + 1% Hasten	Group A - Dims	0	S
Verdict 100ml/ha + 1% Hasten	Group A - Fops	70	RR
Intervix 750ml/ha + 1% Hasten	Group B - Imidazolinones	15	RR
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

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

Product	Adjuvant	plants/m^2	LSD
UTC		135	b
Glyphosate 62% IPA (363)		22	c
Glyphosate 62% IPA (363)	Terwet (4%)	38	c
	Terwet (8%)	73	bc
	Terwet (12%)	49	c
ROUNDUP CT® (500)	Wetter TX (0.2%)	62	c
ROUNDUP CT® (750)		54	c
ROUNDUP CT® (1000		60	c
ROUNDUP CT® (1250)		44	c
ROUNDUP CT® (1500)		48	c
ROUNDUP CT® (500)		19	c
ROUNDUP CT® (500)	Activator (0.125%)	53	c
	BS1000 (0.1%)	37	c
	LI 700 (0.5%)	12	c
	LI700 (0.5%), Liase (2%)	31	c
	Liase (2%)	40	c
	Liase (2%), Activator (0.125%)	19	c
	Wetter TX (0.2%), Activator (0.125%)	43	c
	Wetter TX (0.2%), LI700 (0.5%)*		
lsd		82	

*unexpected results from this treatment, hence excluded