GOA Trial Site Report

Improving annual ryegrass (*Lolium rigidum*) knockdown- assessment of various glyphosate formulations, rates and adjuvant combinations - Parkes 2017

Trial Code:	GOWE05317-3
Season/Year:	Autumn, 2017
Location:	Parkes
Trial Partners:	Allan McGill and Peter Yelland

Keywords

Annual ryegrass, *Lolium rigidum*, resistance, knockdown, glyphosate, paraquat, adjuvants, wetter, surfactants, GOWE05317-3, Parkes

Take home messages

- Use robust rates of glyphosate to ensure adequate ryegrass control.
- Adding wetter or using glyphosate products with built-in surfactants can improve control at lower rates, however, a more reliable alternative maybe to increase the glyphosate rate.
- In this trial where control by the first glyphosate pass was poor (where low glyphosate rates were applied), a paraquat double knock did not improve control to acceptable commercial standards.
- Knowing the resistance status of ryegrass populations allows for the use of the appropriate management options

Background

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

Growers have numerous options available to them to try to maintain and maximise the effectiveness of glyphosate. For example, the choice of glyphosate products which may contain different surfactant packages, the form and the concentration of the active ingredient, the choice to add additional surfactants and rates applied.

Control of glyphosate resistant ARG is commonly rate responsive- that is increasing the application rate will increase the level of 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

Active glyphosate generally is poorly absorbed by plants and many commercially available glyphosate formulations have surfactants or adjuvants included to bolster performance by aiding in droplet retention on target weeds and absorption by them. Despite inclusion of these surfactants, additional surfactant use is common. 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 is also a range of alternate available surfactants.

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

Aim

This trial aimed to investigate the main glyphosate choices growers have available and the resultant control on populations of ARG suspected of glyphosate resistance-

- The formulation/brand of glyphosate
- A range of alternate additional surfactants
- The rate of product (glyphosate) applied
- The use of a double knock using paraquat

Methods

An extremely high population of ARG with over 700 plants/m^2 was observed in the untreated control (UTC) of this trial indicating the deliberate choosing of a high ARG population. The trial site was selected as both grower and advisor suspected ARG populations had significant glyphosate resistance because of past poor control. However, commercial testing did not detect any resistance (detailed in the appendix).

This trial used a small plot randomised complete block strip design with three replicates. The trial was established in 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 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, 2017
Soil Type	Red sandy clay loam
Previous Crop	Wheat
ARG resistance status	Detailed in appendix- suspected resistance to glyphosate

Table 2. Parkes site treatment list. All treatments received a double knock on half the plot consisting of 2 L/ha paraquat.

Treatment	Product	Rate		Adjuvant	rate %
		mL/ha	g ai/ha		
13	Generic 450 g/L glyphosate	750	337	Nil	NA
14	Generic 450 g/L glyphosate	1500	675		
15	Generic 450 g/L glyphosate	3000	1350		
1	Roundup CT®	750	337		
2	Roundup CT®	1500	675		
3	Roundup CT®	3000	1350		
4	Roundup CT®	750	337	Wetter TX	0.25%
5	Roundup CT®	1500	675		
6	Roundup CT®	3000	1350		
7	Roundup CT®	750	337	Activator	0.13%
8	Roundup CT®	1500	675		
9	Roundup CT®	3000	1350		
17	Roundup CT®	3000	1350	Consume#	0.20%
19	Roundup CT®	750	337		
18	Roundup CT®	6000	2700	nil	nil
10	Roundup Ultra®Max	592	337		
11	Roundup Ultra®Max	1184	675		
12	Roundup Ultra®Max	2368	1350		
16	UTC				

Consume- 1020g/L Polyether Modified Polysiloxane

Table 3. Application records

First application	**Date Applied**	12/04/2017	**Temp (°C)**	**Wind (km/hr)**	**Wind Dir.**	**Humidity (%)**
	Start time	9.00 am	18.6	7-6k	E	63.3%
	Finish Time	9.45 am	**Δt**	4.5	**% Cloud**	0%
	Water rate (L/ha)	100	**Nozzle**	DG015	**Pressure**	3
	Equipment	ATV	**Speed**	8 km/hr		
Double knock	**Date Applied**	19/04/2017	**Temp (°C)**	**Wind (km/hr)**	**Wind Dir.**	**Humidity (%)**
	Start time	9:40 am	21.8	4-10	E	52.2%
	Finish Time	9:45 am	**Δt**	6.1	**% Cloud**	5%
	Water rate (L/ha)	100	**Nozzle**	AIXR	**Pressure**	2.5
	Equipment	ATV	**Speed**	6-7 km/hr		

Results

Full results are detailed in a table in the appendix at the end of the document.

Impact of product rate: Rates of 337 g ai/ha glyphosate (Roundup CT® product) provided the lowest level of control at 81% (when compared to untreated control). Increasing application rates (675, 1350 g ai/ha glyphosate) resulted in increased levels of control with all achieving better than 90% (**Figure 1**).

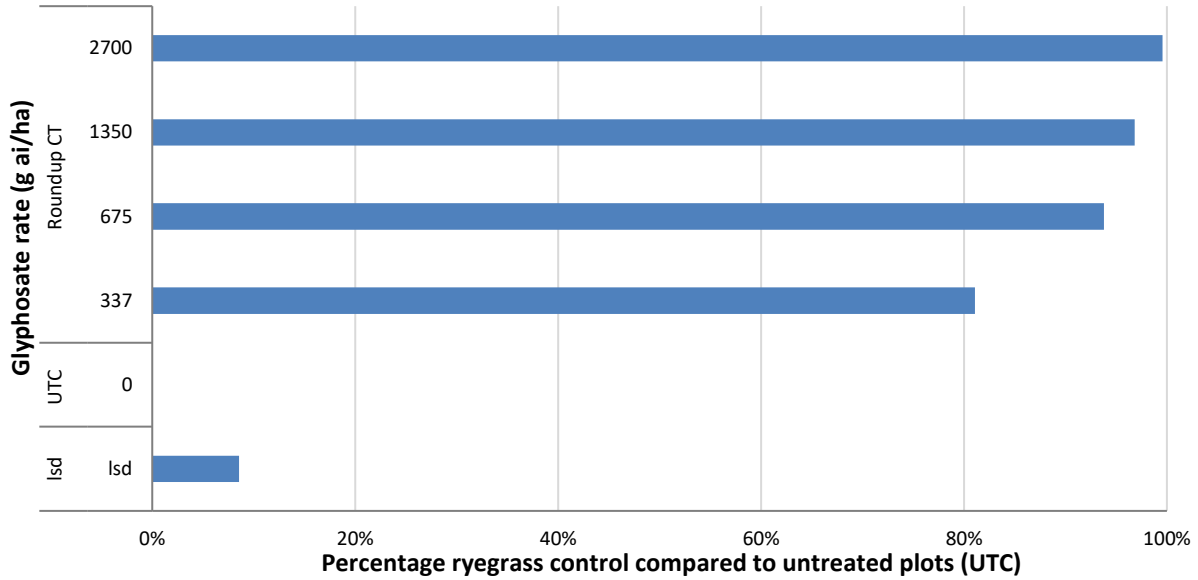

Figure 1. Percentage control (compared to the UTC) for four rates of glyphosate (Roundup CT® product). Assessed 30 days after initial application (DAA1).

Impact of additional surfactants: At glyphosate rates of 675 g ai/ha and higher, the addition of surfactants did not improve ARG control. However, at the lowest rates of a Roundup CT® (337 g glyphosate ai/ha) only the addition of Activator significantly improved control (from 85% to 91%)

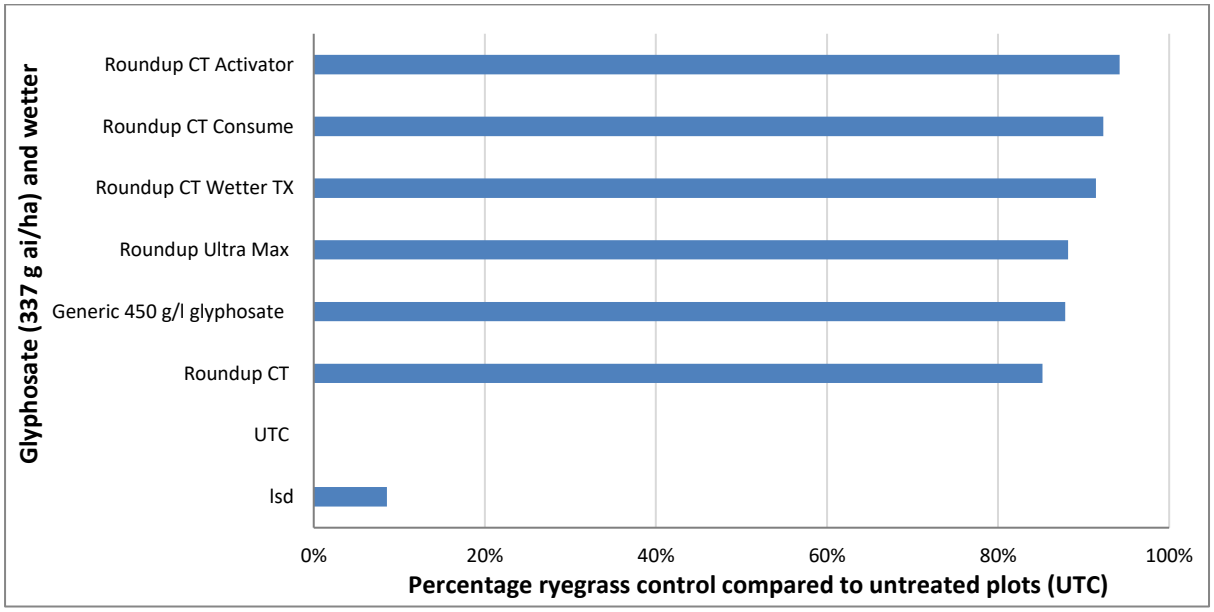

Figure 2. Although, other adjuvant options did not provide any significant levels of improved control compared to stand alone Roundup CT®.

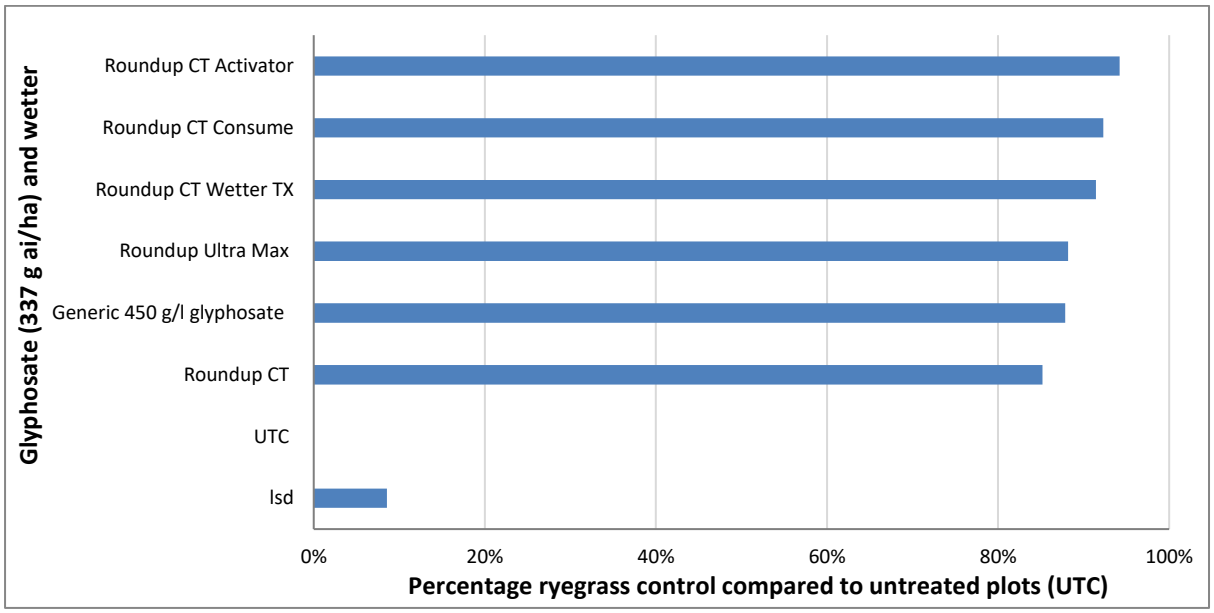

Figure 2. Percentage control (compared to the UTC) for Roundup CT (337 g ai/ha) with selected adjuvant packages at. Assessed 30DAA1.

Impact of different formulation/product choice: At any given rate of active ingredient applied as either the generic product, Roundup CT® or Roundup Ultra Max® there was no difference in the resultant control.

Impact of a double knock: Seven days after the initial application of the glyphosate treatments, 2 L/ha of paraquat (DK) was applied to one half of each plot. Paraquat applied as a stand alone (at the double knock timing) achieved 74% control.

When applied following application of the lowest rate of Roundup CT® (337 g ai/ha), the DK improved level of control from 81% to 89%. DK following higher rates of glyphosate often also resulted in improved control. However, given the high level of control from the higher rates of glyphosate the improvement from DK was only ~2-5% (**Figure 3**). Data for the impact following glyphosate/surfactant combinations is not shown.

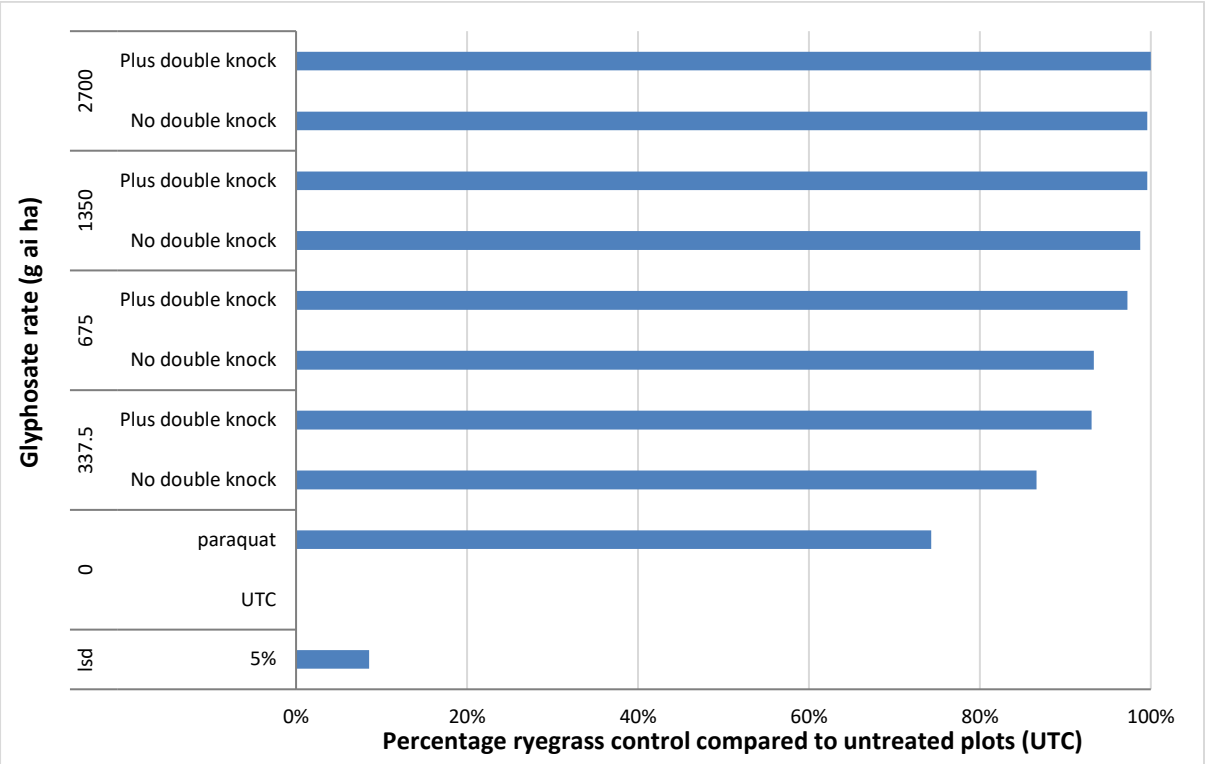

Figure 3. Percentage control (compared to the untreated) of the single pass application of Roundup CT with and without a DK application of 2 L/ha paraquat applied 7 days after the initial application. Assessed 30DDA1.

Discussion

Selection of this trial site postulates why has there been such poor commercial experiences with glyphosate with the ARG population? Could it be related to application set up, water quality for spraying or timing to name a few?

Prior to the establishment of the trial local BOM sites indicated significant rainfall events in March (approximately 170mm) ensured an ample germination. A further ~35mm fell in April and a further 45mm in May. At the time of initial glyphosate application, plants were from 3-6 leaf and not visibly stressed. However, the conditions at the time were hot and dry.

Control of ARG increased with increasing glyphosate application rates- the population was rate responsive. However, because resistance tests did not detect glyphosate resistance in the population the trial is not conclusive in demonstrating that increasing application rate can improve control of glyphosate resistant ARG. However, the trial provides additional information that even in non resistant ARG populations, higher rates of glyphosate are commonly the best strategy.

The addition of only one of the alternate surfactants (Activator) was effective at the lowest rate of glyphosate. There was no impact when added to higher rates of glyphosate suggesting they may only be of advantage when marginal rates of product are applied. The alternative approach though, may be to simply increase the application rate of glyphosate.

The most noticeable benefit of applying DK of paraquat was at the lower glyphosate rate increasing control from 87% to 93%. However, at higher rates of glyphosate benefit of DK in the trial was small. There could be longer term advantages of applying a DK in controlling any resistant individuals preventing seed set and proliferation of a resistant population.

Of note is the relatively poor control (74%) of ARG by single pass paraquat where no prior glyphosate application. This indicates that control by paraquat alone on high populations may be not be as reliable (as glyphosate).

Conclusion

This trial showed that increasing glyphosate rate (regardless of formulation) improves the level of control. Adding a surfactant or using glyphosate products with a surfactant loading can also improve control but most likely only where marginal rates of glyphosate are used.

The use of DK in this situation has not shown any benefits in the immediate term but the longer terms benefits in controlling resistant individuals cannot be underestimated. When DK (with paraquat) ensuring glyphosate rates used are robust enough to maximise control of ARG population and adequate spray coverage for the contact herbicide is important.

There are implications to confirming suspected ARG resistance. Where resistance is not found the reasons for past poor results should be investigated. Additionally, confirmation of suspected resistance will avoid the exclusion of potentially effective control options that may otherwise be overlooked.

Acknowledgements

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DISCLAIMER — TECHNICAL

Appendix –

Ryegrass control 30DAA1 of various glyphosate treatments.

Single or double knock	Glyphosate active rate g/ha	Product rate mL/ha	Treatment	Control %	Groups
Single pass	0	0	UTC	0%	J
	337	750	Generic 450 g/l glyphosate	85%	FGH
			Roundup CT	81%	HI
			Roundup CT Activator	91%	ABCDEFG
			Roundup CT Consume	90%	CDEFG
			Roundup CT Wetter TX	88%	EFGH
		592	Roundup Ultra Max	84%	GH
	675	1500	Generic 450 g/l glyphosate	90%	DEFGH
			Roundup CT	94%	ABCDE
			Roundup CT Activator	94%	ABCDEF
			Roundup CT Wetter TX	96%	ABCDE
		1184	Roundup Ultra Max	94%	ABCDE
	1350	3000	Generic 450 g/l glyphosate	99%	AB
			Roundup CT	97%	ABCD
			Roundup CT Activator	99%	A
			Roundup CT Consume	99%	ABC
			Roundup CT Wetter TX	100%	A
		2368	Roundup Ultra Max	99%	A
	2700	6000	Roundup CT	100%	A
Double knock	0		Double knock only	74%	I
	337	750	Generic 450 g/l glyphosate	90%	BCDEFG
			Roundup CT	89%	DEFGH
			Roundup CT Activator	97%	ABCD
			Roundup CT Consume	95%	ABCDE
			Roundup CT Wetter TX	95%	ABCDE
		592	Roundup Ultra Max	92%	ABCDEFG
	675	1500	Generic 450 g/l glyphosate	94%	ABCDE
			Roundup CT	98%	ABCD
			Roundup CT Activator	99%	A
			Roundup CT Wetter TX	99%	A
		1184	Roundup Ultra Max	96%	ABCDE
	1350	3000	Generic 450 g/l glyphosate	100%	A
			Roundup CT	99%	AB
			Roundup CT Activator	100%	A
			Roundup CT Consume	100%	A
			Roundup CT Wetter TX	100%	A
		2368	Roundup Ultra Max	100%	A
	2700	6000	Roundup CT	100%	A
LSD				9%	

Figure 4- Excerpt from herbicide resistance tests performed on ARG population- Parkes 2017

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** Goa Trial Site	
		Survival	Rating
Select 350ml/ha + 1% Hasten	Group A - Dims	95	RR
Select 500ml/ha + 1% Hasten	Group A - Dims	10	R
Verdict 100ml/ha + 1% Hasten	Group A - Fops	100	RRR
Paraquat 1L/ha + 0.2% BS1000	Group L	0	S
Glyphosate 540@ 1.0L/ha	Group M	0	S
Glyphosate 540@ 1.5L/ha	Group M	0	S
Glyphosate 540@ 3L/ha	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