GOA Trial Site Report

Annual ryegrass: investigating glyphosate rate responsiveness in populations with suspected resistance.

Trial code:	GAWE06820
Season/year:	2020
Location:	'Narromine Station'
Trial partners:	Billy Browning and Campbell Muldoon

Keywords

GAWE068, annual ryegrass, resistance, glyphosate, summer fallow, knockdown herbicide

Take home messages

- A spray failure is not always an indicator of herbicide resistance. Other factors, such as application, can play a role.
- Resistance testing is useful to find out what herbicides still work.
- ARG populations with low resistance to glyphosate may be more susceptible at higher label rates.

Background

In 2103 and 2014 Grain Orana Alliance (GOA) undertook a resistance survey to better understand the prevalence of resistance in the Orana region to annual ryegrass, *Lolium rigidum* (ARG) and wild oats (*Avena fatua*). The survey was not random and [1].

Glyphosate resistance will potentially mean the loss of one of the most effective herbicides used in our reduced tillage farming systems. Prolonging its use by employing integrated weed management (IWM) is essential. Where growers are faced with resistance, investigation to form a better understanding of using high glyphosate rates (upper label limits) and the responsiveness of ARG to this chemical[2].

https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2020/02/is-our-ryegrass-really-getting-harder-to-kill-through-our-over-reliance-on-glyphosate

During recent GOA research [1] into the control of glyphosate ARG, GOA questioned if the ARG population was glyphosate resistance. Some of the confirmed glyphosate resistance populations were

[1] Paper-Street-Maurie-Is-Ryegrass-really-becoming-harder-to-kill-Dubbo-Update-2020.pdf (grdc.com.au)
[2] Optimising the impact of glyphosate - GRDC

controlled with only moderate label rates and remind us that the cause of commercial spray failures is not always resistance.

Contributing factors to weed control failure include:

• Inappropriate water rates (too high or too low)

• Poor water quality

• Incorrect droplet size for the target weed (weeds too small or large a target)

• Poor spray timing

• Antagonism with other herbicides

• Poor weather conditions.

This is not to suggest that herbicide resistance is not real or not the sole reason for failure in some circumstances.

Grain Orana Alliance, with support of the Grains Research and Development Corporation (GRDC), has undertaken several trials to understand how these factors influence spray efficacy in the Central West of NSW.

Aim

To:

- determine the 'rate' resistance status of a suspected glyphosate resistant population
- validate glyphosate rate response of a suspected resistant population.

Methods

Trial details		
Trial establishment date	Winter 2020	
Trial design	Type: small plot (~12m x 2m) Design: split randomized block Replication: 4	Analysis ASREML – randomized complete block. Tested to a 95% confidence interval
Treatment related observations and measurements	• Resistance testing • Panicle counts	
Application	Treatments applied with a hand boom (details in the appendix)	

For analysis and discussion unless otherwise stated, treatments and their effects will be compared to the UTC. Outcomes are statistically analysed by ANOVA at a 95% confidence interval with means compared by the LSD method.

This site was selected after contact from the grower and his advisor re ARG growing on his farm in September of 2022. A surviving population was observed that had been sprayed multiple times over the preceding summer fallow and in crop. At the time of observation, the ARG was approaching maturity, setting seed heads and resistance was suspected.

Treatments

- Glyphosate applied at 4 rates and an untreated control (UTC).
- There is only one label rate (1250mL/ha Roundup Ultra® MAX) for the control of ARG. Additional off-label rates were used to test possible rate responsiveness of glyphosate-resistant populations.
- Rates are set out in Table 1

Results

The application of Roundup, regardless of rate, caused a very high reduction in the number of tillers (**Table 1**). Seeds were collected from untreated plots for resistance testing. At the label rate of 1250 mL/ha the population had low levels of resistance with 15% survival (**Table 2**). Seeds from 'surviving tillers' in the treated plots were also sent for resistance testing and were reported to have 0% viability.

Table 1 Control measured by the number of remaining tillers of annual ryegrass tillers assessed 35 days after application (21/10/2020).

	Control (%)	
Treatment	**p.v.**	**lsd**
Roundup Ultra®MAX -extremely high	99.7	a
Roundup Ultra®MAX -very high	99.9	a
Roundup Ultra®MAX - high	98.1	a
Roundup Ultra®MAX 1250mL/ha	98.9	a
UTC	0.00	b
lsd	1.06	

Table 2 Herbicide resistance testing results, determined 3 weeks after treatment. 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/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 Pivot Utc	
		Survival	Rating
Roundup Ultramax @ 626ml/ha	Group M	70	RR
Roundup Ultramax @ 1250ml/ha	Group M	30	R
Roundup Ultramax @ 2.5L/ha	Group M	15	R
Roundup Ultramax @ 10L/ha	Group M	5	R

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

Discussion

It is suspected that the ARG established germinated in the fallow prior to sowing. Three fallow sprays (see appendix) were applied primarily targeting summer broadleaf weeds such as sow thistle and fleabane. It is possible that the application timings for these sprays were well suited to broadleaf weeds, and less than ideal for ARG (which may have been too small and/or stressed in the warmer fallow conditions). Some of the sprays were tank mixes of glyphosate and 2,4-D, which are known to have some antagonistic effect when it comes to ARG control, particularly where resistance is present[3].

Glyphosate (as Roundup Ultra®MAX) at the highest label rate (1250 mL/ha) reduced the number of tillers by 98.9%. Higher rates did not provide better control. A lower rate (which was not used in the field trials) was required to confirm rate responsiveness suggested by the resistance testing (where there were 70% survivors at a rate of 6726 mL/ha).

Seeds were collected from the surviving plants in both the treated and untreated plots for resistance testing. Seeds from the treated plots were reported as having 0% viability. Plants that were grown out from the untreated plots tested with 30% survival with low level resistance to the 1250 mL/ha Roundup Ultra®MAX rate.

Testing glyphosate under paddock conditions showed very high levels of control at the highest label rate of glyphosate (~675 g/ha AI) with Wetter TX. The application of treatments in this trial was done under 'plot' conditions, with course spray quality and a high water rate to ensure coverage.

Conclusion

A spray failure is not always an indicator of herbicide resistance. Other factors, such as application, can play a role.

Resistance testing is useful to find out what herbicides still work.

ARG populations with low resistance to glyphosate may be more susceptible at higher label rates (according to the resistance testing).

[3] 2,4-D antagonizes glyphosate in glyphosate-resistant barnyard grass Echinochloa colona - PMC (nih.gov)

The lack of seed survival from a population with low level resistance may indicate that there may be another pathway to controlling resistant populations (application at seed fill) with glyphosate and requires further investigation.

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DISCLAIMER — TECHNICAL

Appendix

- Application data

Date applied	16/09/2020	**Temp**	**Wind velocity**	**Wind direction**	**Humidity**	**Comments**
Start time	9.00am	23.4	4-12k	N	55.4%	Partly windy, but wind was blowing down plots.
Finish time	9.15am	**Δt**	6.2	**% Cloud**	0%	
Water rate	100	**Nozzle**	AIXR015	**Pressure**	3	
Equipment	HB	**Speed**	4.7			

Fallow herbicide applications

Date	*Rate mL/ha*	*Product*	*Water (L/ha)*	*Nozzle*
15/02/2020	2000	Glyphosate (450)	50	XC
	400	Amicide 700		
	80	Garlon		
11/03/2020	1200	Glyphosate (450)	50	C
	500	Clethodim		
	0.50%	Hasten		
20/04/2020	1500	Glyphosate (450)	50	?
	118	Sakura		
	25	Hammer		
		Wetter 1000		