21. Managing Group A-resistance ryegrass in a canola, wheat, faba beat rotation

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KEY MESSAGES

- Cropping frequency and ryegrass resistant to Group A herbicides have mutually increased in HRZ
- Long-term management of Group A-resistant ryegrass can be achieved where appropriate crop phases and herbicide strategies are utilised; the first year is crucial when weed density is highest
- Seasonal influences can impact management, ryegrass is a prolific seed producer and failure to provide effective control in wetter years (i.e. 2016) can lead to large rebound in weed infestation; consider tactics like crop-topping and windrow burning that offer an opportunity to reduce seed set

Background

There is increasing prevalence of annual ryegrass with resistance to Group A herbicides (i.e. Targa®, Select®, Factor®) across southern Australia. The loss of these important grass selective herbicides is making management of ryegrass far more difficult in break crops, where traditionally growers expect greatest control. In an effort to achieve acceptable control, higher rates of these herbicides have become widespread industry practice; however the sustainability of this approach is being questioned with reports of crop damage (e.g. canola damage with ≥500 mL Select®). Furthermore, resistance to these important post-emergent herbicides means growers are now placing greater reliance on pre-emergent herbicides, particularly in the cereal phases of the rotation.

To address the challenge of Group A-resistant ryegrass management in a cropping rotation, a 3-yr trial has been undertaken on the Victorian side of Frances. In this trial, we have investigated the impact of different management strategies in RT-canola, wheat and faba bean on the long-term control of Group A-resistant ryegrass.

Management Strategies & Trial Management

In yr-1 of the 3-yr study, RT-canola (RT-Hyola 525®) was established and low, medium and high intensity management strategies were investigated (Table 1). RT-canola was followed by Mace wheat in yr-2 (2015), which was followed last season (2016) by PBA Samira faba beans. Specific details on herbicide treatments used in each cropping phase (RT-canola/wheat/faba bean) are presented in Table 1.

In 2016, The replicated trial was sown to PBA Samira faba beans at 140 kg/ha on the 16th May using a standard knife-point press wheel system on 22.5 cm (9") row spacing. Fertiliser rates were applied as per district practice. Pre-sowing herbicides were incorporated within a few hours of application, while post-emergent Select® + Factor® was applied with Uptake surfactant (0.5% v/v) when ryegrass had reached the 3-leaf to early tillering growth stage. Herbicide screening confirmed low level resistance in the ryegrass population to both Select (clethodim) and Factor (butroxydim). Assessments included ryegrass control (reduction in plant, seed set and seedbank), crop yield and grain quality.

Table 1. Management and herbicide strategies used in long-term ryegrass trial at Frances in 2014 (RT-canola phase), 2015 (wheat), and 2016 (faba bean).

Management & herbicide strategy	Cropping phase		
	RT-canola (2014)	Wheat (2015)	Faba bean (2016)
Low intensity (MS1 – H1)	Simazine (1.1 kg/ha) pre Atrazine (1.1 kg/ha) + Select (500 mL/ha) post	Sakura (0.118 kg/ha) pre	Simazine (1.1 kg/ha) + Boxer Gold (2.5 L/ha) pre + Select (500 mL/ha) + Factor (180 g/ha) POST
Medium intensity (MS2 – H2)	Simazine (1.1 kg/ha) pre RoundupReady (0.9 kg/ha) cotyledon RoundupReady (0.9 kg/ha) + Atrazine (1.1 kg/ha) 6-leaf	Sakura (0.118 kg/ha) + Avadex Xtra (2 L/ha) pre	Simazine (1.1 kg/ha) + Boxer Gold (2.5 L/ha) pre + Select (500 mL/ha) + Factor (180 g/ha) POST + Glyphosate (500 mL/ha) crop-top
High intensity (MS3 – H3)	Rustler (1 kg/ha) + Avadex Xtra (2 L/ha) pre RoundupReady (0.9 kg/ha) cotyledon RoundupReady (0.9 kg/ha) + Atrazine (1.1 kg/ha) 6-leaf Weedmaster DST (2.4 L/ha) crop-top	Sakura (0.118 kg/ha) pre Boxer Gold (2.5 L/ha) post	Simazine (1.1 kg/ha) + Edge (1.1 kg/ha) pre + Select (500 mL/ha) + Factor (180 g/ha) POST + Glyphosate (500 mL/ha) crop-top

Results & Discussion

In yr-1 of the study (2014), the level of ryegrass control in RT-canola varied considerably between the different management strategies (MS1-3) in response to the resistance status of the ryegrass. Because the population was resistant to Select herbicide, poor control was obtained under the low intensity management strategy (MS1) where considerable reliance was placed on grass selective herbicides. The subsequent seedbank in MS1 increased from 3137 seeds/m2 to 6509 seeds/m2 after RT-canola (Figure 1a). By contrast the seedbank declined by 49 to 54% in the medium (MS2) and high intensity management strategies (MS3) where ryegrass was more effectively controlled (Figure 1b & 1c). The combination of in-crop glyphosate and soil residual atrazine proved to be extremely effective at reducing ryegrass seed set in MS2 & MS3.

To deplete the seedbank further in yr-2 (2015), effective pre-emergent herbicides were deployed in wheat. Plots were spilt into treatments of either Sakura (H1), Sakura plus Avadex (H2), or Sakura plus post-emergent Boxer Gold (H3). Despite high weed infestation under MS1 (161 to 522 plants/m2) due to the legacy effect of poor control in the previous canola phase, the seedbank declined from 6509 seeds/m2 to < 1200 seeds/m2 following herbicide treatment in wheat (Figure 1a). Where effective control was obtained at lower weed-infestation rates under MS2 (36 to 172 plants/m2) and MS3 (19 to 52 plants/m2), the seedbank declined over the two consecutive years for both management strategies (< 850 seeds/m2 for MS2; < 350 seeds/m2 for MS3). Whilst in part the decline in seedbank can be attributed to the herbicide treatments (H1-3), the drought conditions experienced in 2015 probably had a greater influence, resulting in little or no ryegrass seed set.

Although the seedbank declined under each management strategy (MS1-3) following the wheat phase, relative differences in weed infestation remained with higher pre- and post-plant ryegrass under MS1 relative to MS2 and MS3 (Figure 2). A carry-over effect of poor management and seedbank build-up under MS1 following canola in yr-1.

In yr-3 of the study (2016), faba beans were sown and three herbicide treatments were deployed over the previous year's treatments in wheat (MS1 to 3; Table 1). For a second consecutive season there were clear and significant ($P<0.001$) differences in ryegrass density between the 3 management strategies (Table 2). The legacy effect of the RT-canola phase (MS1 to MS3) was again evident and had carried-over from the wheat to the faba bean phase with average ryegrass density of 70 plants/m2 in MS1, 33 plants/m2 in MS2, and 31 plants/m2 in MS3. However, despite the clear differences in ryegrass between MS in the faba bean phase, there was no significant herbicide effect or interaction with MS (Table 2).

Even though grass selective herbicides Select and Factor were applied to faba beans, significant amounts of ryegrass survived (28 to 85 plants/m2) because of resistance. This is not entirely surprising given the population was confirmed resistant to both these herbicides following testing back in 2014.
From the wheat to faba bean phase, ryegrass spike density increased by 2.3-fold in MS1, 4-fold in MS2, and 10.9-fold in MS3 (Table 3). The combination of poor weed control with Select and Factor coupled with the above average rainfall received in spring of 2016 caused ryegrass to flourish. Ryegrass is well known for its ability to exploit favourable conditions during reproductive development, producing large amounts of seed and allowing it to rapidly build-up infestations from low levels. Crop-topping faba beans with glyphosate under MS2 and MS3 may help reduce the level of seed set, however the benefits of the practice won't be known until seedbank sampling is again undertaken in April of this year.

As differences in ryegrass density within management strategies were relatively small, herbicide effect on grain yield of faba bean was non-significant, and data were pooled across herbicide treatments within each MS. However, larger differences in ryegrass density between MS were reflected in faba bean yield (Figure 3). As a consequence of reduced competition from ryegrass, MS3 produced 5 to 12% more grain than MS2 (medium) and MS1 (low) respectively.

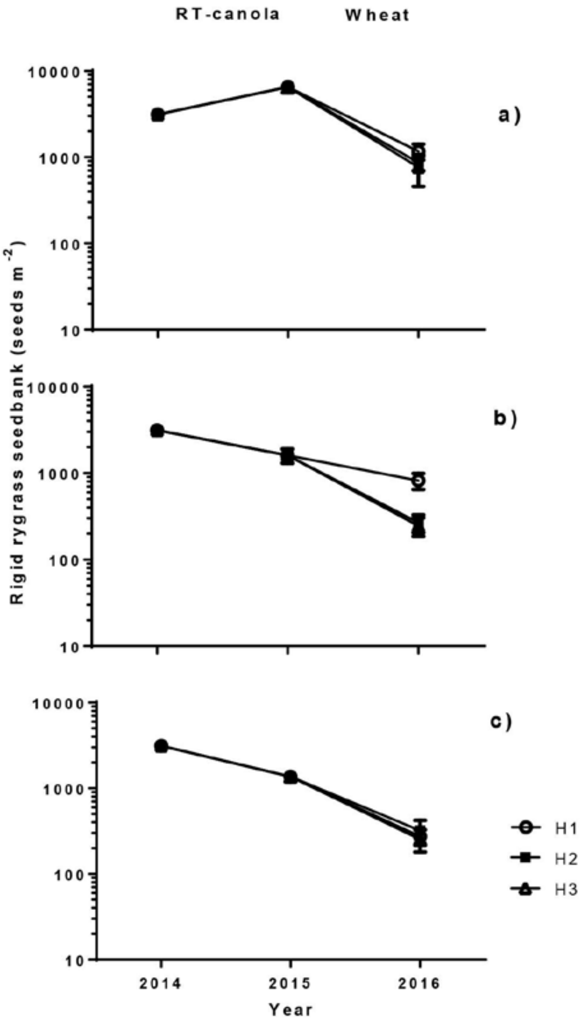

Figure 1. Change in ryegrass seedbank in response to low (a; MS1), medium (b; MS2), and high (c; MS3) intensity management strategies at Frances in 2014 (RT-canola), and 2015 (wheat). etailed description of herbicide treatments (H1-3) are presented in Table 1. Vertical bars represent SE.

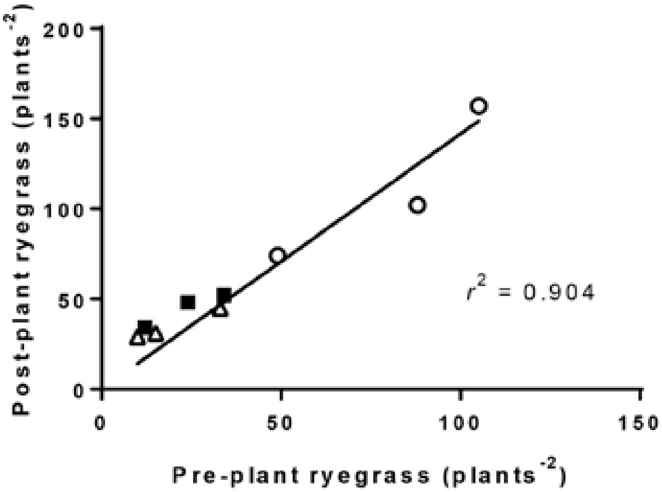

Figure 2. Relationship between pre- and post-plant annual ryegrass density for low (MS1; O), medium (MS2; ■) and high (MS3; △) intensity management strategies at Frances in 2016. Pre-plant ryegrass was assessed prior to the knockdown herbicide application.

Table 2: Influence of management strategy (MS) and herbicide treatment on annual ryegrass density in PBA Samira faba bean at Frances in 2016.

Management strategy (MS)	MS1	MS2	MS3	Mean
	Ryegrass density (plants m^{-2})			
Herbicide (2016)				
H1	85	38	33	52
H2	58	32	31	40
H3	67	28	30	42
Mean	70	33	31	
Interaction	0.73			
Management_S	<0.001			
Herbicide	0.29			

Table 3: Changes to ryegrass spike density in response to management strategy (MS1-3) and herbicide treatment (H1-3) at Frances from 2014 to 2016.

Management strategy (MS)	Herbicide (H)	RT_canola (2014)	Wheat (2015)	Faba bean (2016)
		Ryegrass spikes (spikes m^{-2})		
MS1	H1	303	91	130
	H2		53	134
	H3		22	115
	Mean		55	127
MS2	H1	86	35	88
	H2		11	81
	H3		11	56
	Mean		19	75
MS3	H1	23	4	85
	H2		14	118
	H3		6	57
	Mean		8	87
Interaction			0.10	0.74
Management_S		<0.001	<0.01	<0.05
Herbicide			<0.05	0.08

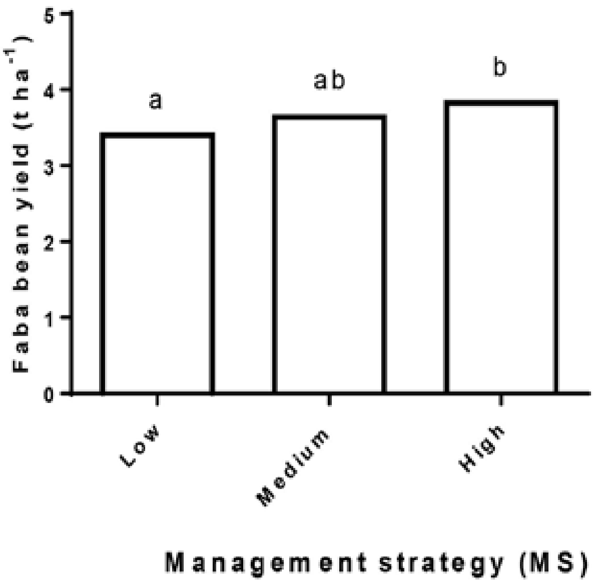

Figure 3: Faba bean yield for low (MS1), medium (MS2) and high intensity management strategies (MS3) at Frances in 2016. Because herbicide effect on faba bean yield was non-significant data were combined over herbicide treatment and presented as the mean of management strategy. Different letters indicate significant differences between means.

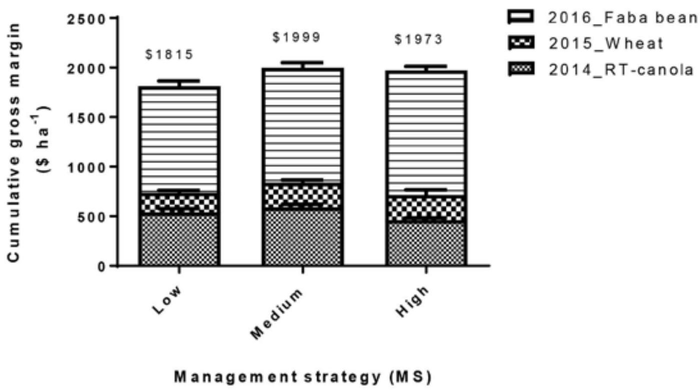

Figure 4: Effect of management strategy (MS1-3) on cumulative gross margin for the three year rotation (RT-canola/wheat/faba bean) at Frances. Gross margin estimates are based on crop yield, farm expenses and historical commodity prices averaged from 2011 to 2016 (source: Rural Solutions 2014, 2015 & 2016 Farm Gross Margin & Enterprising Planning Guide). Vertical bars represent SE.

Over the 3-yr cropping sequence in this study (2014-2016), more effective management of ryegrass in MS3 and MS2 provided only a modest economic return of $155 and $184, as compared with MS1 ($1815; Figure 4). Previous research (Roy 1999; Kleemann et al. 2016) showed that effective management of ryegrass in the first year of the cropping cycle, when weed density was the highest, greatly improved profitability. In our study, additional investment in yr-1 and yr-2 in canola and wheat, combined with relatively poor yields because of below average rainfall in these years, reduced potential returns from improved management of ryegrass in MS2 and MS3. Only in the last season (2016) reasonable gross margins were achieved (>$1000/ha) because of the higher yielding faba bean crop (>3 t/ha). However, low weed densities in 2016 reduced grain yield response to management strategies even though the differences were statistically significant.

Conclusion

The study has shown that effective management of Group A-resistant ryegrass can be achieved in canola, wheat and faba bean provided suitable herbicide package is deployed. Ability to reduce ryegrass seed set and seedbank replenishment in the first year of the cropping cycle appears to be crucial to longer-term management. However, seasonal influences can have a significant impact on management with failure to provide effective control in wetter years likely to lead to large rebound in weed infestation. Therefore, crop-topping in high rainfall seasons could be an extremely important tactic for long-term weed population management. Whilst the economic benefits were reduced due to low rainfall and below-average yields in dry growing seasons, maintaining ryegrass seedbanks at low levels is critical to prevent rapid build-up in weed infestations.

References

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ACKNOWLEDGEMENTS

We are grateful to GRDC (Grains Research and Development Corporation) for project funding (project UCS00020), Louie and Charlie Koch for allowing us to undertake the trial on their property, the SARDI team from Struan for planting and maintaining the trial, and Jerome Martin and Alicia Merriam for providing technical assistance.

FURTHER INFORMATION

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