Managing clethodim resistant ryegrass without oaten hay

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Key findings

- The decline in ryegrass has been greater after field peas.
- The high intensity herbicide strategy was the most effective option in both rotations.

Background

An increasing number of paddocks in the Mid North of South Australia contain clethodim (ie Select®) resistant annual ryegrass. Managing herbicide resistant ryegrass can come at a great expense and requires an approach which uses chemical and non-chemical strategies.

Crop rotation is important to the overall success of long-term ryegrass management. Oaten hay is a popular and profitable option for growers to reduce ryegrass numbers. However, there are a number of crop rotation options available to best suit individual growers in terms of success and profitability. In addition to crop selection different herbicide strategies can be used to provide successful ryegrass control.

Aim: To conduct a multi-year trial to determine the effects of crop sequence and low, medium and high intensity management strategies to reduce clethodim-resistant ryegrass.

Materials & methods

In year 1 of the study (2013) ryegrass seed with low-medium level resistance to clethodim (ie Select®) and Factor® (ai butroxydim) was hand broadcast and lightly incorporated across the site for the purpose of establishing a seedbank. Resistance screening of the Hart population against a known susceptible population (SLR4) confirmed resistance to both clethodim (10-fold more resistant) and Factor (2-fold more resistant).

Soil core samples (10 cm diameter) were taken across the trial site in April of 2014 and 2015 to determine the ryegrass seedbank. Soil samples were transferred to shallow trays and germinating ryegrass assessed at regular intervals. Seedbank was determined based on the total number of ryegrass seedlings to germinate, and the total area sampled (i.e. core area (πr^2) x number of cores sampled (n=120, 2014; n=162, 2015) and converted to a unit area (ie seeds/m^2). The starting seedbank in April 2014 was determined to be ~1138 ryegrass seeds/m^2.

The first cropping phase of two 3-yr rotations (peas/wheat/barley and canola/wheat/barley) of field peas and canola was established in 2014. Wheat was planted in 2015 (Mace at 80 kg/ha), and will be followed by barley this season (2016). A standard knife-point press wheel system was used to sow the trials on 22.5 cm (9") row spacings. Fertiliser rates were undertaken as per district practice. Ryegrass management strategies of low (MS1), medium (MS2) and high intensity (MS3) were imposed in each cropping sequence phase and are presented in detail in Table 1.

The trial design is a split-plot; with crop sequence assigned to main-plots and management strategies to sub-plots with 3 replicates. Pre-sowing herbicides were incorporated by sowing within a few hours of application, while post-emergent Boxer Gold® was applied to ryegrass at the 1-2 leaf growth stage. Assessments included ryegrass control (reduction in plant density, seed set and seedbank), crop yield and grain quality (protein, test weight and screenings).

Table 1. Management strategies used in long-term ryegrass trial at Hart in 2014 (canola & field peas) and 2015 (wheat).

Management strategy (MS)	Canola_2014	Crop sequence Field peas_2014	Wheat_2015
Low intensity (MS1)	Trifluralin (1.6 L/ha) pre Clethodim (0.5 L/ha) post	Trifluralin (1.6 L/ha) pre Clethodim (0.7 L/ha) post	Sakura (0.118 kg/ha) pre
Medium intensity (MS2)	Triallate (2 L/ha) + propyzamide (1 L/ha) pre	Triallate (2 L/ha) + propyzamide (1 L/ha) + trifluralin (1.6 L/ha) pre Clethodim (0.7 L/ha) post Paraquat crop-top	Sakura (0.118 kg/ha) + triallate (2 L/ha) pre
High intensity (MS3)	Propyzamide (1 L/ha) pre Clethodim (0.5 L/ha) post Weedmaster DST crop-top	Triallate (2 L/ha) + propyzamide (1 L/ha) + trifluralin (1.6 L/ha) pre Clethodim (0.7 L/ha) + Factor (0.18 kg/ha) post Paraquat crop-top	Sakura (0.118 kg/ha) pre Boxer Gold (2.5 L/ha) post

Results and discussion

In response to the three different management strategies (MS) imposed in year 1 (2014), ryegrass seedbank declined following both field peas (54-83%) and canola (27-55%; Table 1). Where excellent ryegrass control was obtained in field peas with pre-sowing propyzamide + triallate and followed by grass selective herbicides (ie clethodim & Factor) and crop-top, the decline was greatest for MS2 (78%) and MS3 (83%). In contrast, the reduction was much smaller following canola, particularly in MS1 (27%). Control in this treatment was initially poor with trifluralin, which placed greater reliance on clethodim, to which the population has some resistance.

Even though there was no ryegrass seed set under MS2 and MS3 in field peas ryegrass was still present prior to sowing wheat in 2015, from the persistent fraction of the seedbank (~15%). Fortunately, this level of persistence is relatively low in comparison to other weed species, however ryegrass is a prolific seed producer and only a few escapes are required to replenish the seedbank.

In this study, crop-topping with paraquat in field peas (MS2 & MS3) and glyphosate in canola (MS3) appeared to provide some additional seed set control and reduction in the seedbank. Performance of crop-topping can however be quite variable both in terms of ryegrass seed control and crop safety. To avoid excessive yield loss in this study, crop-topping was delayed until grain moisture content of field peas was less than 30% and when 20% of canola seeds had changed colour. Such unavoidable delays can often compromise seed set control.

Table 2. Impact of crop sequence and management strategy (MS1-3) on reduction of Group A resistant ryegrass at Hart in 2015. Detailed description of management strategies and herbicides are presented in Table 1. Canola and field peas were sown in 2014 and wheat in 2015. The initial ryegrass seedbank was ~1138 ryegrass seeds/m^2.

Crop sequence	Management strategy (MS)	% reduction in ryegrass seedbank from 2014 to 2015	Ryegrass	
			(plants/m^2)	(heads/m^2)
Field peas/wheat	1	54	3b	8ab
	2	78	3b	3a
	3	83	1a	2a
Canola/wheat	1	27	22d	42c
	2	38	3b	19b
	3	55	8c	10ab
LSD (P=0.05)†			1.8*	13.6*
Crop sequence (CS)			*	*
MS			*	**

†Represents the significance of the interaction between crop sequence x MS.
*, *P<0.05*; **, *P<0.01*.

Differences in density and seed production of ryegrass were evident in wheat, the result of both cropping sequence and MS (Table 2). Even though pre-sowing herbicides were effective in wheat (MS1-3), ryegrass was generally more prevalent in canola/wheat cropping sequence. A carryon effect of poor initial control in canola with trifluralin and clethodim, and absence of preventative seed set measures (i.e. crop-top). Wheat following canola had greater seed production (10-42 heads/m^2) relative to wheat after field peas (<8 heads/m^2). The ineffectiveness of canola/wheat crop sequence to contain ryegrass and prevent seed set could lead to a rapid build-up in weed infestation in the following barley phase. However, the full impact of MS and cropping sequence on ryegrass seedbank won't be fully known until sampling is undertaken in April of this year (2016).

Although there were significant differences in ryegrass control between MS treatments (Table 2), this had little effect on the grain yield of wheat (P=0.05). This is not entirely surprising given ryegrass in its own right is a relatively weak competitor, with higher numbers (>100 plants/m^2) required to produce measurable yield losses. Given the effectiveness of MS to maintain this population at low levels, the competitive influence of ryegrass would have been negligible.

When the results were combined for all MS and presented as the mean of cropping sequence (Table 3), differences in wheat yield and quality (% protein) between the two crop sequences were significant (P<0.05). Wheat grain yield and protein was on average higher following field peas (3.32 t/ha; 11.9 % protein) than canola (2.69 t/ha; 10.3% protein), presumably because of increased availability of nitrogen and water.

Table 3. Impact of crop sequence on grain yield and quality of wheat at Hart in 2015. Because management strategy effect on wheat yield and quality was non-significant data were combined over low, medium and high intensity treatments (MS1-3) and presented as the mean of crop sequence.

Crop sequence	Wheat yield (t/ha)	Grain protein (%)	Test_wt (kg/hL)	% screenings (≤2 mm)
Field peas/wheat	3.32	11.9	77.9	5.7
Canola/wheat	2.69	10.3	78.8	3.7
LSD (P=0.05)	0.144**	0.49**	ns	ns

**, *P<0.01*; ns, not significant.

Conclusion

A three year field trial was initiated at Hart to identify alternate MS and crop sequences to hay, for management of Group A resistant ryegrass. Results from the trial thus far have shown that following crop phases of field peas and canola, where effective MS were imposed on ryegrass, the seedbank was reduced (27-88%). The decline was greater after field peas (78-88%) where more effective pre- and post-sowing herbicide mixtures were used (i.e. pre-sowing propyzamide + triallate followed by clethodim + Factor) and importantly followed by late crop-top for seed set control. In contrast, the standard grower practice of trifluralin and clethodim in canola was the least effective option, resulting in the smallest seedbank decline (27%). Even though pre-sowing herbicides were effective in the following wheat crop, ryegrass appeared more prevalent in MS1 treatment after canola, producing more seed to replenish the seedbank. Ineffectiveness to contain ryegrass may lead to a large rebound in weed infestation in the following barley phase. Consequently, maintaining ryegrass seedbanks at low levels is critical, given its prolific seed production, competitiveness, and propensity at high densities to rapidly evolve resistance to different mode-of-action herbicides.

Acknowledgements

The financial assistance of GRDC and the collaboration of Hart Field-Site Group staff are gratefully acknowledged. We also thank staff from SARDI and Malinee Thongmee (UA) for providing technical assistance.

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