

Long-term Control and Seedbank Depletion of Annual Ryegrass: Management Strategies



Introduction

Annual ryegrass is a major winter annual weed of the southern Australian wheat-belt, which naturalised after its introduction as a pasture species. If not managed effectively, ryegrass can significantly reduce the yield of winter crops. Many populations of ryegrass have developed resistance to selective grass herbicides used in crops, making post-emergent control difficult. Growers must now plan carefully how to best manage ryegrass populations, and considerations start with crop choices and the associated weed control options available. A succession of years with multiple and diverse control options used in varying cropping phases is central to successful ryegrass management.

Key Points

- Large ryegrass populations can be managed without reducing crop productivity or profitability provided multiyear weed-management programs are implemented effectively.
- Depletion of ryegrass seedbanks is greatest when successive years of effective weed management are implemented, which combine both herbicide and mechanical means of control.
- Early-cut oaten hay was extremely effective for reducing annual ryegrass seedbanks.
- Successful crop-topping is vital in pulse crops to prevent large increases in annual ryegrass, especially as resistant ryegrass becomes more widespread.

Investigating the Influence of Different Weed Management Strategies

To evaluate the impact of different weed management strategies on long-term control and seedbank dynamics of annual ryegrass, a long-term field study was undertaken at Roseworthy in South Australia. Three different weed management strategies (MS1–3) were used to control ryegrass in each phase of a 4-year cropping rotation, which consisted of oaten hay - field pea - wheat - barley (Table 1).

MS	Year 1: Oaten Hay	Year 2: Field Pea	Year 3: Wheat	Year 4: Barley
1	Early-cut hay followed by Glyphosate	Trifluralin (PPI) ^a	Prosulfocarb + S-metolachlor (PPI) (<i>Boxer Gold</i> ®)	Trifluralin (PPI)
2	Early-cut hay followed by Glyphosate	Trifluralin (PPI), Clethodim (post-emergence)	Pyroxasulfone (PPI) (<i>Sakura</i> ®), Prosulfocarb + S-metolachlor (early post-emergence)	Trifluralin (PPI)
3	Early-cut hay followed by Glyphosate	Trifluralin, Clethodim (post-emergence), Glyphosate (crop-topping)	Prosulfocarb + S-metolachlor (PPI), Glyphosate (crop-topping)	Trifluralin (PPI)

Table 1. Management strategies (MS) investigated for ryegrass control in each phase of a 4-yr crop rotation. Herbicides were applied at recommended label rates & timings. ^a*pre-plant incorporated*.

Field Trial Outcomes. Integration of effective weed-management strategies over a 4-year cropping sequence depleted ryegrass seedbanks (Figure 1), reduced in-crop weed infestation (Figure 2), and returned higher grain yields and profitability (Figure 3). This study showed that large ryegrass populations can be managed successfully without reducing crop productivity and profitability, provided multiyear weed-management programs are implemented effectively.

Year 1: Early-cut Oaten Hay

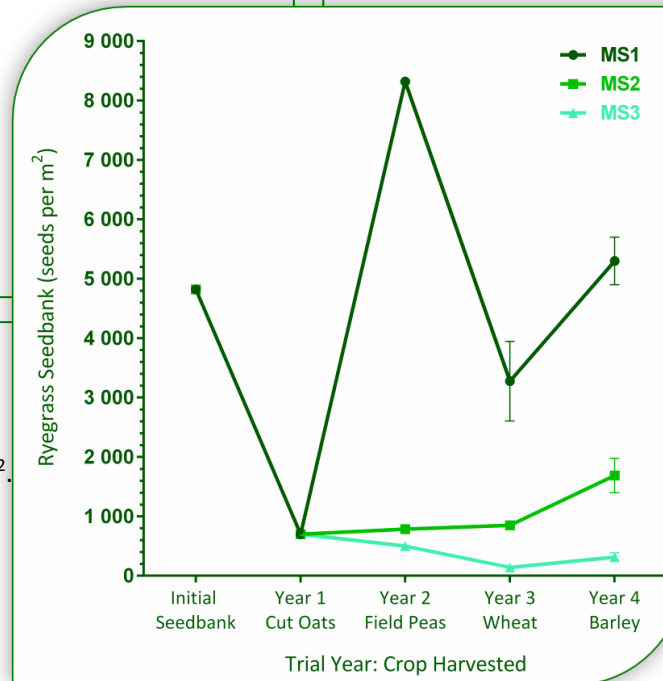
- Complete control of ryegrass achieved.
- Extremely effective in reducing soil seedbank: 86% fewer ryegrass seeds m^{-2} .
- No viable seed set because hay was cut when ryegrass was flowering & subsequent regrowth was controlled.
- It is important to prevent ryegrass regrowth via heavy grazing or non-selective herbicides (glyphosate, paraquat).
- Early-cut oaten hay is an effective strategy for achieving a large reduction in herbicide-resistant ryegrass.

Year 3: Wheat

- All strategies prevented build-up in ryegrass seedbanks.
- MS3 reduced seedbanks in the 3rd year to <140 seeds m^{-2} .
- MS1 significantly reduced seedbanks that had escalated after poor control in the field pea rotation.
- Crop-topping (glyphosate) wheat was relatively ineffective in preventing ryegrass seed set.
- Pre-emergence herbicides gave good residual control.
- Prosulfocarb + S-metolachlor (*Boxer Gold*®) and pyroxasulfone (*Sakura*®) have excellent activity on ryegrass, including trifluralin-resistant populations.
- Management strategies that integrated effective pre-emergence herbicides with a competitive crop proved to be a valuable combination against ryegrass.

Year 2: Field Pea

- Clethodim + crop-topping (MS3) was highly effective: seed set prevented & seed viability reduced.
- Continued control of seedbank achieved with MS2.
- Trifluralin alone (MS1) was ineffective; seedbank levels increased dramatically, by 11 fold!
- Trifluralin-resistance meant ryegrass populations rebounded when trifluralin was relied upon (MS1).
- Field peas are poor weed competitors and together with poor weed control by trifluralin under MS1, ryegrass quickly reinfested from residual seedbanks.



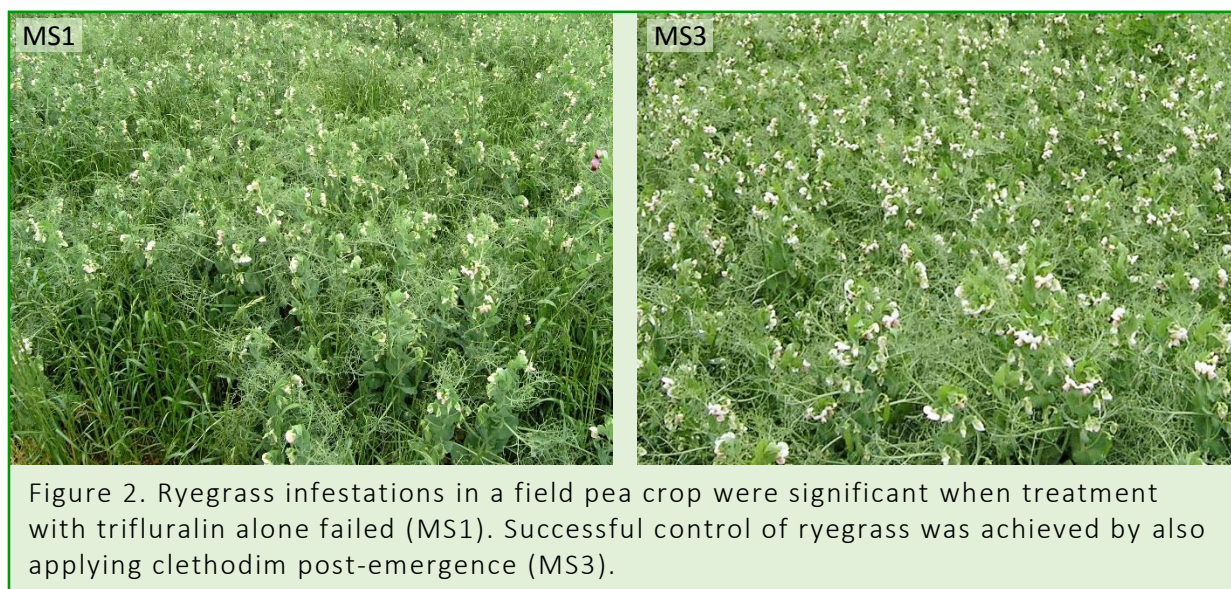
Year 4: Barley

- Ryegrass rapidly built-up infestations from low levels.
- Barley has a strong ability to compete with weeds but was unable to prevent a rebound in ryegrass density when control with trifluralin failed.
- Prosulfocarb + S-metolachlor (*Boxer Gold*®) is an effective alternative to control trifluralin-resistant ryegrass in barley.
- Substantial increase in ryegrass seedbanks; poor control achieved with trifluralin (all MS).
- Trifluralin-resistance in the population caused this phase to be ineffective for reducing seedbanks.

Figure 1: Ryegrass seedbanks changed each year depending on the crop grown & the associated weed management strategy (MS1-3). After 4 years it was depleted by 59-71% under MS2 and 92-95% under MS3. In contrast, when ryegrass control was poor in field peas (MS1) a legacy effect was evident that resulted in the seedbank increasing by more than 500 seeds m^{-2} . Seedbanks assessed after crop harvest. MS1-3 are detailed in Table 1.

Influence of Management Strategies

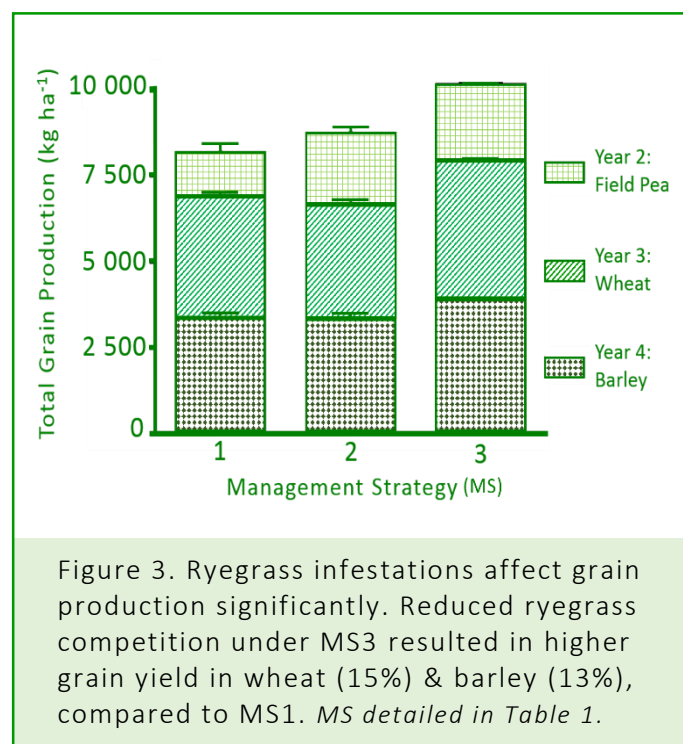
The different effects that alternative management strategies can have on weed control was especially clear in Year 2, when field pea was grown (Figure 2). Field peas are poor weed competitors and with inadequate weed control from trifluralin, under MS1, ryegrass quickly reinfested from residual seedbanks. In contrast, with the addition of post-emergence application of clethodim under MS3, ryegrass remained under control.



Grain Production Increased

Annual ryegrass infestation had a significant effect on grain production and economic returns from the three management strategies (MS) (Figure 3). Additional investment in weed management in field peas and wheat substantially improved overall profitability of the cropping system.

- Over the 3-year cropping sequence, more effective management of ryegrass populations in MS3 and MS2 resulted in a 25% and 7% increase in grain production, relative to the less effective MS1.
- Higher grain yields occurred under MS3 every year by containing ryegrass to < 35 plants m⁻².
- Effective management provided an additional economic return of AUD \$498 ha⁻¹ (MS3) and \$155 ha⁻¹ (MS2), when compared to MS1.
- Early intervention under MS3 reduced ryegrass infestations, which increased grain yields by 15% in wheat and 13% in barley, compared to MS1.



Summary

- ♣ Prevention of seed-set not only returned ryegrass seedbanks to more manageable levels, but also significantly improved grain production and profitability.
- ♣ Effective management to reduce seed set can rapidly deplete seedbanks of large ryegrass infestations.
- ♣ Although ryegrass has relatively low levels (10-20%) of seedbank persistence between years, each plant can produce large quantities of seed. This means that ryegrass is able to rapidly replenish its seedbank if control in successive years is not maintained.
- ♣ Effective management of ryegrass in a cropping rotation can consistently maintain populations at very low levels.

Cautions & Considerations

Crop-topping can be a compromise between crop damage and weed control. If undertaken at the ideal stage of weed development greater than 90% reduction of seed set can be achieved.

However....

Be Aware: Even slightly earlier than optimal timing of crop-topping with glyphosate in field peas and wheat can result in significant penalties in grain yield and quality.

Be Aware: The optimal timing of crop-topping for targeting annual ryegrass is when it is flowering, which can occur before the optimal timing for crop safety of some pulses.

To avoid excessive yield loss in this study, crop topping with glyphosate was delayed until 70% of field pea pods had turned yellow and seed moisture content was < 30%.

Field peas are generally better suited to crop-topping than lentils or chickpeas, with earlier-maturing varieties less affected than those maturing later. Paraquat is often a better option than glyphosate for crop-topping field peas because it can be effective against ryegrass at later stages of seed head development than glyphosate.

Growers should always adhere to label recommendations.

In wheat, only glyphosate is registered for crop-topping as a harvest-aid, but must be applied when the grain is at 28% moisture content. Consequently, earlier maturing wheat varieties such as Axe, which was used in this study, are far better suited to crop-topping than a later-maturing variety.

Use clethodim wisely: Resistance to clethodim (Select®) is on the increase in South Australia with growers reporting variable control of annual ryegrass with clethodim. This is a major concern given the herbicide's importance for providing effective control of ryegrass in break crops, such as pulses and canola.



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Funding: This factsheet is based on research funded by GRDC, project code UA00113.

Contributors: Samuel Kleemann, Fleur Dolman, Gurjeet Gill and Christopher Preston (UofA).

Resources:

- Kleemann SGL, Preston C, Gill GS (2016) Influence of Management on Long-Term Seedbank Dynamics of Rigid Ryegrass (*Lolium rigidum*) in Cropping Systems of Southern Australia. *Weed Science*. 64:303-311.
- Factsheet (UofA): [Maximise clethodim performance: Impact of frost](http://agwine.adelaide.edu.au/research/farming-systems/weed-science/factsheets/Clethodim_&_Frost.pdf) (http://agwine.adelaide.edu.au/research/farming-systems/weed-science/factsheets/Clethodim_&_Frost.pdf)
- Boutsalis P, Gill GS, Preston C (2012) Incidence of Herbicide Resistance in Rigid Ryegrass (*Lolium rigidum*) across Southeastern Australia. *Weed Technology*. 26:391-398