Integrated weed management for ryegrass control

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Take home messages

- **a combination of chemical and non-chemical weed control strategies can extend the life of herbicides and improve the sustainability of intensive cropping systems**
- **windrow burning, crop topping and chaff carts are options which can reduce the ryegrass seed bank without any yield penalty**
- **cutting a cereal crop for hay for one year can significantly decrease ryegrass levels in the following crop. Hay cutting in 2009 decreased ryegrass heads in the 2010 crop by 92%.**

Background

As farmers, we are unfortunately becoming accustomed to dealing with resistant weed populations. Recent surveys have indicated that greater than 70% of ryegrass populations tested in the Mallee and Wimmera have resistance to group B herbicides. Resistance to group A herbicides is lower, but in the Wimmera there is relatively high levels of resistance to group B herbicides Hoegrass®, Achieve® and Axial® (50-60% populations resistant). Ryegrass resistance to TriflurX® is increasing: from 2005 to 2010 resistance increased by 6% in the Mallee and 33% in the Wimmera (refer to 'Changes in herbicide resistance in western Victoria; 2005-2010' in this publication page 151).

There are also increasing reports of herbicide resistance in brome grass, wild oats and radish. Most of those populations have developed resistance to in-crop selective herbicides, especially Group A. This has placed greater reliance on pre-emergent herbicides (TriflurX) and non-selective herbicides (Roundup®).

While rotations allow use of many alternative herbicides and management practices, the option of a break crop is not always possible. Often farmers are forced to keep the risks low by growing cereals on cereals, especially in years with no stored soil moisture. However, when continuously cropping cereals, farmers have few herbicide or management options for weed control. As a result, they are faced with increasing weed seed banks and rising levels of herbicide resistance. This trial was set up specifically to discover how to employ integrated weed management (IWM) and drive down seed banks in continuous cereal systems.

This paper will present the findings from a three-year field trial undertaken in the southern Mallee investigating weed seed set control strategies for ryegrass. The trial is part of the GRDC funded 'Improving Integrated Weed Management in Conservation Farming Systems' (UA 00113).

Aim

To determine the effectiveness of weed seed set control strategies in driving down the seedbank without reducing yields in cereal-intensive cropping systems.

Method

A medium term (three year) replicated trial investigating control options for decreasing the weed seedbank was undertaken at Jil Jil, 32km north of Birchip, on a clay loam soil. Three replicated plots with four treatments were established in a Yitpi wheat crop in October 2009.

Location:	Jil Jil	
Replicates:	3	
Sowing date:	17 May	
Crop type:	Correll wheat	
Sowing rate:	80kg/ha	
Fertiliser:	17 May	55kg/ha MAP
4 July		40kg/ha Urea
Herbicides (all plots):	18 March	2L/ha Roundup PowerMax®, 100ml/haGoal®
17 May		1.5L/ha TriflurX, 2L/ha Roundup PowerMax, 100ml/ha Goal
Fungicides:	30 August	150ml/ha Prosaro® + BS1000 (0.25% v/v)
Seeding equipment:	knife points, press wheels on 30cm row spacing	

Treatments were:

- chaff-cart: chaff was collected at harvest using a bulker bag behind the header. Straw was gathered and spread over the plot, simulating a commercial operation.
- crop-topping: wheat was sprayed at hard dough stage (GS87) with Roundup PowerMax at 2L/ha (28 October 2009 ryegrass soft dough to flowering, 17 November 2010 ryegrass milky dough and 15 November 2011 ryegrass soft dough to ripe). The trial was harvested as normal.
- hay-cut: wheat was sprayed at flowering with Roundup PowerMax at 2L/ha. The wheat was cut for hay four days after application and then removed from the plot to simulate baling.
- narrow windrow-burn: chaff and straw were concentrated into narrow windrows (60-80cm wide) at harvest using rubber flaps behind the header. Windrows were burnt the following autumn.

To determine the effectiveness of treatments, which began at harvest 2009, the following assessments were taken each year:

- ryegrass, brome grass and wild oat head counts at crop milky dough stage
- ryegrass soil seedbank was measured by collecting 12 soil cores (0-5cm) from each plot. Placed in trays, the soil was kept moist and was regularly disturbed to stimulate further germination. The number of ryegrass plants which germinated over the following four months was measured.
- grain yield was measured and grain quality analysed. Biomass production was measured for the hay cutting treatment.

Results

Rainfall

Annual rainfall at the site was variable for the three years of the trial (Table 1).

Table 1. Annual rainfall at the trial site.

Year	Annual rainfall (mm)
2009	329
2010	581
2011	473

Ryegrass panicle counts

From 2009 to 2011, all weed control treatments significantly reduced the number of ryegrass heads in crop relative to the control (P<0.001, LSD 48.2, CV 20.7%) (Figure 1).

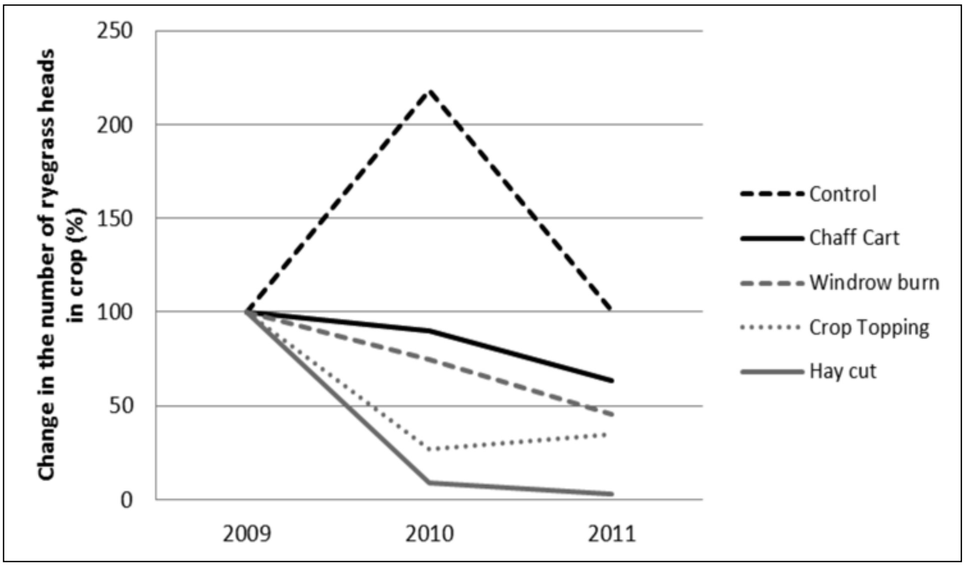

Figure 1. Cumulative change in the number of ryegrass heads in crop as a percentage change from 100% in of the treatment in 2009.

Hay cutting significantly reduced ryegrass levels in crop compared with all other treatments (P<0.001). Hay cutting reduced ryegrass head numbers from 234heads/m^2 in 2009, 20heads/m^2 in 2010 to 7heads/m^2 in 2011. Although it took longer to reduce ryegrass levels, by 2011, crop topping reduced numbers from 283 to 99heads/m^2, windrow burning from 168 to 76heads/m^2 and chaff cart from 200 to 127heads/m^2 (P<0.001). By contrast, ryegrass levels in the control spiked from 89heads/m^2 in 2009 to 204heads/m^2 in 2010. Wild oat and brome grass head numbers were maintained at a low level across treatments and control plots.

Weed seed bank

From 2009 to 2011 ryegrass emergence increased for all treatments except hay cutting (Figure 2).

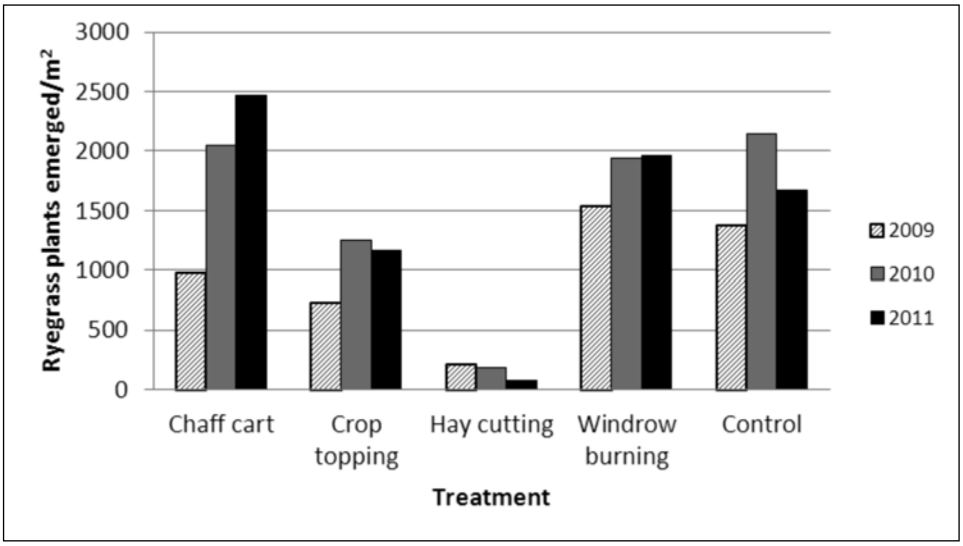

Figure 2. Ryegrass seeds which germinated from the soil seedbank from 2009 to 2011 (Not Significant)

Grain Yield

After three years of weed control, grain yield was not affected by any treatment (Table 2). Chaff cart, crop topping, windrow burning and the control essentially yielded the same in 2009 and 2011. However, in 2010 these treatments yielded higher than the control by at least 0.4t/ha.

Table 2. Crop and hay yield of four weed control treatments starting at 2009 harvest

Treatment	Crop yield (t/ha)		
	2009	2010	2011
Chaff cart	0.8	2.2[b]	3.1
Crop topping	0.9	2.2[b]	2.1
Windrow burn	0.8	2.4[b]	3.1
Control0.8	1.8[a]	2.4	
Sig Difference **LSD (P=<0.05)** **CV %**	**NS**	**P<0.05** **0.4** **17.3**	**NS**
Hay	1.2	2.1	3.3

Net Income

Net income on a yearly and cumulative basis (2009-2011) was calculated, based on annual prices for wheat, hay, herbicides and hay baling costs (Table 3).

Table 3. Annual gross margins and cumulative gross margins, 2009-2011, and ryegrass panicle counts and seed emergence in 2011

Treatment	Gross margin ($/ha)*				Ryegrass heads in crop (heads/m^2)	Ryegrass seed emergence (plants/m^2)
	2009	2010	2011	2009-2011	2011	2011
Chaff cart	156	683	498	1337	127	2467
Crop topping	132	667	482	1280	99	1162
Windrow burn	156	683	498	1337	76	1963
Hay	147	301	502	950	7	72
Control	156	527	498	1180	94	1667
Sig. Diff. **LSD (P<0.05)** **CV %**	**P<0.001** **7** **2.5**	**P<0.001** **41** **3.8**	**P=0.019** **11** **1.2**	**P<0.001** **43** **1.9**	**P<0.001** **48** **20.7%**	**NS**

** Wheel tracking loss for crop topping of 5% yield was accounted for prior to net income calculations. Wheat (APW1) prices for 2011 184.25/t, 2010 297/t, 2009 $195/t; hay prices $200/t 2009-2011; chemical and spraying for crop topping and hay 16t/ha; hay cutting and raking $37/t, baling $25/t, stacking and carting $8.20/t. Where there was no significant difference between treatment yields, net income was calculated using the mean yield of non-significantly different treatments. Where the treatment yields were different, the yield of each treatment was averaged across replicates and used in the gross margin.*

Interpretation

Reducing ryegrass levels in a cropping system requires strategies that drive down the soil seedbank, avoid development of herbicide resistance and preferably do not have a yield penalty. Management decisions are also important for their impact on the current season's and, more importantly, future profitability.

Hay cutting

Hay cutting was the best strategy for rapidly reducing ryegrass numbers in crop and in the seedbank. After one year (2009), cutting hay reduced ryegrass numbers in the seed bank by 78% compared with the control. In the same year, hay cutting reduced ryegrass heads in crop by 92%. This reflects the large percentage of ryegrass heads removed during hay cutting and also the reduced seed viability due to herbicide application. In the same year, the number of ryegrass heads in the control increased 117%, reflecting the increase in annual rainfall from 329mm in 2009 to 581mm in 2010.

Whilst cutting crops for hay is the least profitable practice, it is by far the most effective at reducing ryegrass levels. The likely reduction in profitability from one year's hay cutting needs to be balanced against the need to significantly reduce the seedbank and to increase the potential profitability in following years when consecutive cereal crops can be planted.

Windrow burn

Reductions in ryegrass seed set for windrow burning was variable. In crop, ryegrass head numbers were reduced by 55% over three years, while emergence increased in 2010 and plateaued in 2011. For all treatments, head counts were reflective of the season whereas seed emergence was conducted under optimum conditions and reflected the full potential of the seedbank in that year. Previous studies have established that windrow burning of harvest residues can effectively destroy ryegrass seed. However, success is reliant on achieving adequate temperatures during burning: ultimately, the hotter the burn the better (Walsh & Newman 2007).

Despite this, there are some downsides to windrow burning including: low-yielding crops produce insufficient biomass to achieve a hot burn; the risk of burning the whole paddock and increasing errosion potential; summer rain reducing burning temperatures; redistribution of nutrients such as potassium into the windrow area and the loss of nutrients in the smoke, including nitrogen and sulfur (Walsh & Newman 2007).

Windrow burning had a higher cumulative gross margin relative to crop topping and hay cutting, reflecting the lower input costs for windrowing.

Chaff Cart

Using a chaff cart was the least effective treatment for reducing ryegrass levels. Over three years, head counts were reduced by 36%, but in the same period emergence increased 147%. This increase in emergence may be due to a late harvest in 2009, which resulted in considerable preharvest seed shedding and ryegrass heads breaking off at harvest and not entering the header. Accordingly, late harvests will dramatically reduce the efficacy of using a chaff cart. Previous research has shown that when used effectively, chaff carts can collect up to 75 to 85% of ryegrass seeds entering the header (Walsh & Powles 2007). Using a chaff cart had a cumulative gross margin of $1337/ha which was relatively higher than crop topping and hay cutting.

Crop topping

One year of crop topping reduced ryegrass head numbers in crop by 66%. In the same period, seed bank emergence increased 172%. Following the second year of crop topping, head numbers and seed bank emergence plateaued, indicating a level of seed bank control. Previous research has shown that late season application of non-selective herbicides can reduce viable seed production. However, this is reliant on the weed seeds being immature at crop maturity (Walsh & Powles 2007). Over the three years of the trial, ryegrass growth stages at crop topping varied from flowering/soft dough in 2009 to late dough/ripe in 2011, demonstrating the seasonal challenges of crop topping. The crop topping cumulative gross margin of $1280/ha was lower than chaff cart and windrow burning.

Where possible, crop topping has been adopted by farmers, particularly now that Roundup PowerMax is registered in wheat from late dough stage (28% moisture) onwards. However, as demonstrated in this trial, crop topping is highly dependent on timing and certainly will not achieve 100% control. Crop topping is also likely to increase the risk of developing glyphosate resistance; alternative herbicides such as Gramoxone® should be used as knockdowns the following season.

Commercial practice: what this means for the farmer

- windrow burning, crop topping and chaff carts are options that can reduce ryegrass seed set without a yield penalty
- selecting an option that suits the overall cropping program and can be implemented correctly is essential to ensure seed set is effectively reduced
- hay cutting can rapidly reduce ryegrass numbers, but results in lower returns in the short term. In situations where ryegrass levels are high (above 50-60plants/m^2) and herbicide application isn't an option, hay cutting can rapidly reduce ryegrass numbers.
- by combining chemical and non-chemical strategies, the life of herbicides can be extended and intensive cropping systems can be continued.

References

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Acknowledgments

This project was funded by the Grains Research and Development Corporation.