Pre-emergent herbicides lose the battle to control annual ryegrass in the high rainfall zone

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KEY MESSAGES

- Continuous cropping is not an effective way to manage herbicide resistant annual ryegrass over the long term in the high rainfall zone.
- The increase in weed numbers over time can be slowed by adopting an intensive and high cost herbicide strategy, but not enough to reduce soil weed seed bank.
- Increasing annual ryegrass density by 100 seed heads per square meter was associated with a 150 kg/ha decrease in grain yield.

INTRODUCTION

This ongoing trial aims to assess the effectiveness and applicability of cultural control practices in combination with pre-emergent herbicides for the management of herbicide resistant annual ryegrass in the high rainfall zone of Victoria. The trial, at Southern Farming Systems' Lake Bolac research site, is experimenting with a range of cultural control practices in combination with pre- and post-emergent herbicides.

The full report for the first three years of the trial, "Integrated weed management: pre-sowing tactics are not sufficient for controlling herbicide resistant annual ryegrass in the high rainfall zone", can be found in the 2014 SFS Trial Results Book (p66-70).

METHOD

The trial combines four different cultural weed control options with three different herbicide treatments from 2012 to 2015. Treatments applied are detailed in table 1.

The three stubble cultural control treatments (retain, incorporate and burn) were carried out prior to sowing in 2012 and 2013. Mouldboard ploughing was seen as a one-off intervention prior to sowing in 2012 and was followed by retained stubble in 2013. After harvest 2013 all treatments were harvested short and the stubble windrowed before the entire site, including windrows, was burnt prior to sowing canola in 2014. In 2015 wheat was sown directly into standing canola stubble across the entire site.

Overlaid on the four seedbed management treatments were three different chemical control treatments that were carried out each year. The three herbicide strategies were designed to range from a lower cost standard district practice (A) to a mid-cost (B) to the best available, highest cost strategy (C). The aim was to use whatever existing and experimental chemistry was available for pre- and post-emergent ryegrass control in each crop. Due to Group A and B herbicide resistance in annual ryegrass at this site, the chemical options in the wheat and barley crops were limited to those that could be applied prior to seeding and crop emergence.

Table 1. The four different cultural control methods and three different chemical control regimes being trialled in combination at Lake Bolac to control herbicide resistant annual ryegrass.

Cultural control treatments:	
Mouldboard ploughing	
Stubble burning	
Stubble incorporation with light cultivation	
Retained stubble with direct sowing	
Chemical control treatments:	
2012 (wheat)	A. (low cost): Trifluralin 2L/ha + Dual Gold 250ml/ha IBS
	B. (mid cost): Boxer Gold 2.5L/ha IBS
	C. (high cost): Sakura 118g/ha + Avadex Xtra 1L/ha IBS
2013 (barley)	A. (low cost): Trifluralin 2L/ha + Dual Gold 250ml/ha IBS
	B. (mid cost): Boxer Gold 2.5L/ha IBS
	C. (high cost): Boxer Gold 2.5 L/ha IBS, Boxer Gold 1.5L/ha @ GS11 ryegrass
2014 (RT canola)	A. (low cost): Trifluralin 3L/ha IBS, Atrazine 900 2.2kg/ha + Select 0.5 L/ha @ 4 leaf canola
	B. (mid cost): Trifluralin 3L/ha IBS, Roundup Ready 0.9 kg/ha @ cotyledon, Roundup Ready 0.9kg/ha + Atrazine 900 1.1 kg/ha @ 6 leaf canola
	C. (high cost): Trifluralin 3L/ha IBS, Roundup Ready 0.9 kg/ha @ cotyledon, Roundup Ready 0.9kg/ha + Atrazine 900 1.1 kg/ha @ 6 leaf canola, Weedmaster DST 3.5 L/ha @ crop top
2015 (Wheat)	A. (low cost): Trifluralin 3L/ha + Avadex Xtra 1L/ha + Dual Gold 0.25L/ha IBS
	B. (mid cost): Sakura 118g/ha IBS
	C. (high cost): Sakura 118g/ha + Avadex Xtra 2L/ha IBS, Boxer Gold 2.5L/ha GS 11

RESULTS RECAP: THE FIRST THREE YEARS OF THE TRIAL

In the first three years of the trial, the cost of herbicide strategy was strongly correlated with weed numbers and crop yield. Higher cost herbicide strategies were associated with better annual ryegrass control and higher yields, whereas low cost herbicide strategies were associated with worse control and lower yields.

Wheat in 2012

- Cultural control practices had no significant impact on annual ryegrass establishment
- Mouldboard plough treatment significantly reduced weed seed heads
- The more expensive chemical option C, Sakura and Avadex, significantly reduced weed seed heads
- There was no significant impact on yield due to any control or chemical control treatments

Barley in 2013

- Mouldboard plough treatment significantly reduced annual ryegrass establishment
- Boxer Gold IBS and at GS11 significantly reduced weed establishment
- There was no significant impact on yield due to any control or chemical control treatments

Canola in 2014

- Chemical control strategy C significantly reduced annual ryegrass establishment and seed heads
- There was no impact of cultural control strategy on weed numbers
- There was no significant impact on yield due to any control or chemical control treatments

Results in year four: wheat in 2015

In 2015 pre-emergent treatments, including a knockdown, were applied on the 17th April. Revenue wheat was then direct drilled into canola stubble following application of each herbicide strategy. Crop establishment and annual ryegrass numbers were assessed on the 14th of May. Seed head numbers on annual ryegrass were collected on the 17th December. Strategy C post emergent Boxer Gold was applied on the 26th of May with the annual ryegrass at GS11. Annual ryegrass numbers were reassessed on the 28th of July. On 31st of December all plots were harvested at 15 cm height and strategy C trash was treated with a weed seed destruction mill (PIM) to reduce weed seed survival.

There were significantly higher annual ryegrass numbers in the incorporation treatment in May and July counts of weed emergence but this did not lead to significant differences in weed seed heads at maturity. The lowest numbers of ryegrass at establishment and crop maturity occurred where the most expensive herbicide strategy had been employed for four years in row, followed by intermediate weed populations under strategy B and the highest weed numbers under the low-cost option A.

There was a significant increase in yield in relation to the cost level of the herbicide strategy (table 2). High cost strategy C was more than double the price of the two other chemical control options but resulted in a 0.4-0.8 t/ha yield bonus and a $23-93/ha increase in gross margin.

Table 2. Treatment costs and results of the three chemical control strategies being trialled in combination at Lake Bolac to control herbicide resistant annual ryegrass.

Chemical control strategy	Herbicide	Rate/ha	Cost ($/ha)	Yield (t/ha)	Seed heads (spikes/m2)	Gross margin ($/ha)
A (low cost)	Trifluralin	3L	21.81	2.26	969	415
	Avadex Xtra	1L	10.80			
	Dual Gold	0.25L	3.61			
Total cost of A ($)			**36.22**			
B (mid cost)	Sakura	118g	43.13	2.64	596	485
Total cost of B ($)			**43.13**			
C (high cost)	Sakura	118g	43.13	3.04	313	508
	Avadex Xtra	2L	21.6			
	Boxer Gold	2.5L	36.26			
Total cost of C ($)			**100.99**			

There was also a significant increase in the plough treatment for yield in comparison to the other cultural control treatments (table 3).

CONCLUSIONS

Overall, the population of annual ryegrass increased between 2012 and 2015, even for the most intensive strategies (figure 1). This indicates that continuous cropping – and a reliance on the cultural and chemical treatments we have used here – is not an effective way to manage herbicide resistant annual ryegrass populations in this environment.

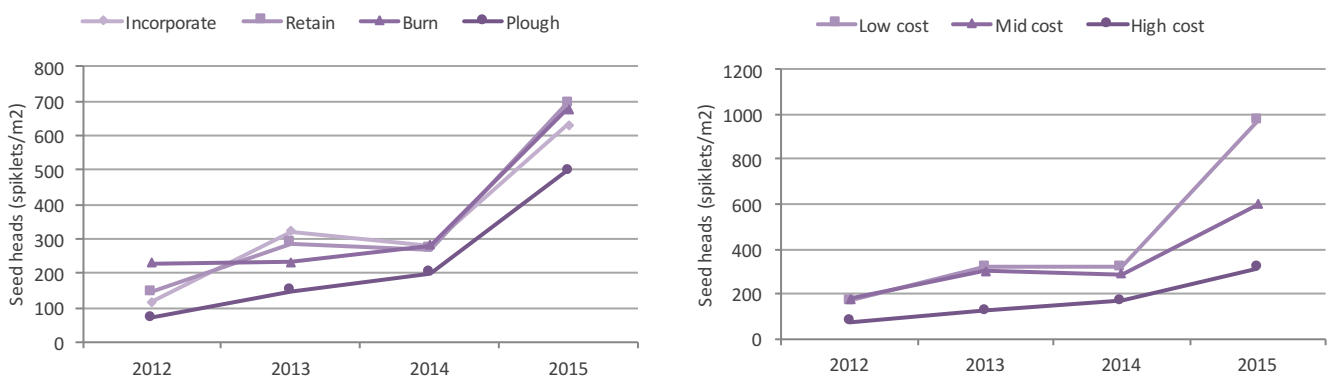

Figure 1 - a (left) and b (right). Annual ryegrass seed heads under the four different cultural control treatments (a) and three different herbicide treatments (b) from 2012 to 2015.

The lack of effective seed set control options in these crops in a high rainfall environment means that populations will continue to increase as late-in-crop weeds escape earlier attempts at control. Rotations that have the option of seed set control every year, such as those that utilise pasture or fodder phases, are essential to reduce annual ryegrass seed banks.

An intensive and high cost herbicide strategy can slow the increase in annual ryegrass numbers over time, but no strategy was successful at consistently reducing weed populations. Mouldboard ploughing can be effective at reducing the annual ryegrass seed bank but at this site it failed to eliminate the annual ryegrass and where lax management followed the plough, weed numbers rapidly increased.

From 2012 to 2015, higher annual ryegrass populations were consistently associated with decreased grain yield. For every 100 seed heads per square metre there was a reduction in grain yield of 110 kg/ha for wheat and canola and 180 kg/ha for barley. Higher cost herbicide strategies were associated with better annual ryegrass control, higher yields and higher gross margins.

The harvest weed seed mill used on high cost strategy in 2015 will be watched closely to gauge its impact on annual ryegrass numbers in 2016. However even in the high cost strategy the weed numbers have increased to the highest levels since the commencement of the trial (figure 1) It will now require drastic action with cultural and chemical control measures over several years to reduce weed seed banks to acceptable levels. This will be our challenge in season 2016.

ACKNOWLEDGEMENTS

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Table 3. Annual ryegrass population and crop yield in 2012-2015. Means followed by the same letter do not differ significantly at p=0.05. DAS = days after sowing.

Cultural treatment	Herbicide treatment	2012 – Wheat (Beaufort)		2013 – Barley (Westminster)		2014 – Canola (Hyola 525 RT)		2014 – Canola (Hyola 525 RT)		2015 – Wheat (Revenue)	
		Seed heads (spikes/m2)	Yield (t/ha)	Seed heads (spikes/m2)	Yield (t/ha)	Seed heads (spikes/m2)	Yield (t/ha)	Seed heads (spikes/m2)	Yield (t/ha)	Seed heads (spikes/m2)	Yield (t/ha)
Retain	*	146 b	7.8	286	7.64	271	1.72	271	1.72	694	2.63 b
Plough	*	69 c	8.09	149	8.19	200	1.89	200	1.89	499	2.87 a
Incorporate	*	116 bc	8.1	323	8.14	279	1.84	279	1.84	632	2.54 b
Burn	*	229 a	7.82	232	7.83	280	1.89	280	1.89	678	2.54 b
†	A (low cost)	169 a	7.8	316 a	7.77	320 a	1.76	320 a	1.76	969 a	2.26 c
†	B (mid cost)	175 a	7.96	302 a	7.88	287 a	1.83	287 a	1.83	596 b	2.64 b
†	C (high cost)	76 b	8.09	124 b	8.2	165 b	1.92	165 b	1.92	313 c	3.04 a
Retain	A (low cost)	215	7.61	377	7.42	360	1.54	360	1.54	2.2	1105
	B (mid cost)	166	7.62	386	7.19	301	1.76	301	1.76	2.57	690
	C (high cost)	56	8.15	95	8.32	152	1.87	152	1.87	3.1	289
Plough	A (low cost)	107	8.1	221	8.28	279	1.81	279	1.81	3.18	833
	B (mid cost)	65	7.98	160	7.98	189	1.97	189	1.97	2.97	452
	C (high cost)	36	8.18	65	8.33	131	1.9	131	1.9	3.18	214
Incorporate	A (low cost)	125	8.13	398	8.1	336	1.76	336	1.76	2.12	933
	B (mid cost)	113	8.09	351	8.13	307	1.82	307	1.82	2.53	490
	C (high cost)	112	8.09	221	8.2	194	1.94	194	1.94	2.97	413
Burn	A (low cost)	231	7.37	269	7.3	305	1.92	305	1.92	2.18	946
	B (mid cost)	356	8.15	311	8.22	351	1.77	351	1.77	2.54	754
	C (high cost)	101	7.94	117	7.98	184	1.97	184	1.97	2.91	335

** averaged across herbicide treatments*

† averaged across cultural treatments