Testing control of annual ryegrass in the HRZ using faba beans, pre-emergent herbicides and desiccation

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KEY MESSAGES

- Annual ryegrass (ARG) establishment and seed head numbers increased significantly under the faba bean herbicide strategies used in 2016
- There were no significant differences between herbicide strategies in 2016, with the legacy of past years' management strategies not creating any difference in yields this year
- Over the five years of the trial, RT Canola in 2014 was been the best option to maintain ARG seed head numbers
- ARG seed head numbers increased by 35% in 2016 following the high cost weed strategy (strategy C) in combination with HWS prototype mill
- ARG seed head numbers increased by 148% (low cost, strategy A) and 171% (mid cost, strategy B) in 2016
- Effects of pre-harvest desiccations in 2016 will not be evidenced until emergence in 2017

INTRODUCTION

Herbicide resistant annual ryegrass (ARG) is an increasing concern for growers in the high rainfall zone of Victoria. This ongoing trial aims to assess cultural control practices in combination with pre-emergent herbicides for the management resistant ARG at the Lake Bolac research site. The trial has been continuous since 2012, comparing different pre- and post- emergent herbicide treatments. In the first two years of the trial (2012 and 2013), a range of cultural control practices were also tested (table 1). In 2015 a prototype integrated weed mill (PIM) was used as an addition to high cost strategy C. In 2016, there was no difference between the low and mid cost treatments (strategies A and B), Only one different product, of similar cost, was used in the high cost treatment (strategy C), Differences seen were the result of previous years' treatments.

The full report for the first four years of the trial, 'Pre-emergent herbicides lose the battle to control resistant ARG in the HRZ', can be found in the 2015 SFS Trial Results Book (p94-97).

METHOD

The trial combines four different cultural weed control options, in 2012 and 2013, with three different herbicide treatments from 2012 to 2016. Treatments applied are detailed in table 1 below.

Table 1. The four cultural control methods and three chemical control regimes being trialled in combination at Lake Bolac to control herbicide resistant ARG. Herbicide strategies: A: low cost; B: mid cost; C: high cost. IBS = incorporated by sowing, GS11=Zadoks growth stage 11.

Cultural control treatments applied pre-sowing:	
Mouldboard ploughing – 2012 only	
Stubble burning – 2012 & 2013 (all treatments burnt in 2014 & 2016. Retained 2015)	
Stubble incorporation with light cultivation – 2012 & 2013 (burnt 2014 & 2016. Retained 2015)	
Retained stubble with direct sowing – 2012, 2013 & 2015 (burnt 2014 & 2016)	
Chemical control treatments:	
2012 Wheat	A. (low cost): Trifluralin 2 L/ha + Dual Gold 250 ml/ha IBS
	B. (mid cost): Boxer Gold 2.5 L/ha IBS
	C. (high cost): Sakura 118 g/ha + Avadex Xtra 1 L/ha IBS
2013 Barley	A. (low cost): Trifluralin 2 L/ha + Dual Gold 250 ml/ha IBS
	B. (mid cost): Boxer Gold 2.5 L/ha IBS
	C. (high cost): Boxer Gold 2.5 L/ha IBS, Boxer Gold 1.5 L/ha @ GS11 ryegrass
2014 RT canola	A. (low cost): Trifluralin 3 L/ha IBS, Atrazine 900 2.2 kg/ha, Select 0.5 L/ha @ 4 leaf canola
	B. (mid cost): Trifluralin 3 L/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 3 L/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 3 L/ha, Avadex Xtra 1 L/ha, Dual Gold 0.25 L/ha IBS
	B. (mid cost): Sakura 118 g/ha IBS
	C. (high cost): Sakura 118 g/ha, Avadex Xtra 2 L/ha IBS, Boxer Gold 2.5 L/ha GS 11
2016 Faba beans	A. (low cost): Terbyne Extreme 1 kg/ha, Boxer Gold 2.5 L/ha IBS. Clethodim 0.5L/ha, Factor 0.18kg/ha, Uptake 1 L/ha @ GS13. Gramoxone 0.8 L/ha, BS1000 60 ml/ha @ desiccation
	B. (mid cost): Terbyne Extreme 1kg/ha, Boxer Gold 2.5 L/ha IBS. Clethodim 0.5L/ha, Factor 0.18kg/ha, Uptake 1 L/ha @ GS13. Gramoxone 0.8 L/ha, BS1000 60 ml/ha @ desiccation
	C. (high cost): Terbyne Extreme 1 kg/ha, Propyzamide 1.11 L/ha IBS. Paraquat* 250 1.2 L/ha PSPE, Clethodim 0.5 L/ha, Factor 0.18kg/ha, Uptake 1 L/ha @ GS13. Gramoxone 0.8 L/ha, BS1000 60 ml/ha @ desiccation

*Paraquat not applied in 2016 as beans emerged before it could be done.

The three stubble cultural control treatments (retain, incorporate and burn) were carried out prior to sowing in 2012 and 2013. Mouldboard ploughing was a one-off intervention prior to sowing in 2012 and was followed by retained stubble in 2013. In 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. A prototype integrated harvest weed seed mill (PIM) was used on herbicide treatment C plots at harvest in 2015. This was to test if it could further reduce efficacy of any ARG seeds remaining at harvest.

In 2016, all treatments had wheat stubble burnt. Zahra faba beans were sown deep on the 11th April 2016 using an Equaliser seeder bar after pre-emergent treatments were applied.

Results recap: the first four years of the trial

In the first four 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 ARG 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 ARG 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

Wheat in 2015

- Mouldboard plough treatment significantly reduced ARG 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

Barley in 2013

- Mouldboard plough treatment significantly reduced ARG 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 ARG 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

Wheat in 2015

- ARG numbers increased in 2015. High cost strategy C had the lowest ARG numbers at establishment and lowest seed head numbers at maturity
- Weed emergence counts were significantly higher in the incorporation treatment in May and July, but this did not lead to significant differences in weed seed heads at maturity
- There was a significant increase in yield in relation to the cost level of the herbicide strategy
- There was a 0.4-0.8 t/ha yield bonus and a $23-93/ha increase in gross margin for the high cost herbicide strategy.

Trial results 2016 – Zahra faba beans

Given the low levels of control of the previous crop and herbicide strategies we opted for faba beans with a full suite of herbicide options in 2016 (see table 2). Faba beans and other pulse crops allow use of a wider range of pre-emergent, in crop and pre-harvest herbicide options and practices. Desiccation pre-harvest can seriously reduce ARG seed set and the effect of this treatment will be evidenced in 2017 ARG emergence.

- There was no significant yield differences in any treatments for 2016
- Strategy B and C had significantly less ARG at establishment and post emergence counts than A
- Strategy C had significantly less ARG tillers and seed heads than A and B

Table 2. Treatment costs and results of the three chemical control strategies being trialled in combination at Lake Bolac to control herbicide resistant ARG in a Zahra bean crop. Faba bean price used $250/t.

Chemical control strategy	Herbicide	Rate/ha	Cost ($/ha)*	Yield (t/ha)	Seed heads (spikes/m2)	*Gross margin ($/ha)
A (low cost)	Terbyne Extreme IBS	1kg	18	3.74	2399	848.98
	Boxer Gold IBS	2.5L	32.5			
	Clethodim	0.5L	7			
	Factor	180g	11.52			
	Uptake	1l	9			
	Gramoxone	0.8l	4			
	BS1000	2l	4			
Total cost of A ($)			86.02			
B (mid cost)	Terbyne Extreme IBS	1kg	18	3.86	1616	878.98
	Boxer Gold IBS	2.5L	32.5			
	Clethodim	0.5L	7			
	Factor	180g	11.52			
	Uptake	1l	9			
	Gramoxone	0.8l	4			
	BS1000	60ml	4			
Total cost of C ($)			86.02			
C (high cost)	Terbyne Extreme IBS	1kg	18	3.8	423	869.48
	Propyzamide 500	1.11l	27			
	Paraquat#	6.48				
	Clethodim	0.5L	7			
	Factor	180g	11.52			
	Uptake	1l	9			
	Gramoxone	0.8l	4			
	BS1000	60ml	4			
Total cost of C ($)			80.52			

*Pre-sowing 2016 prices. No machinery costs included.

#Paraquat not applied in 2016 as beans emerged before it could be done.

CONCLUSIONS

Overall, the population of ARG increased between 2012 and 2016, even for the most intensive strategies (figure 1 and 2). This indicates that continuous cropping, and a reliance on the cultural and chemical treatments we have used here, is not an effective way to decrease herbicide resistant ARG populations in this environment. Notably the rate of population increase was in line with the treatments (figure 2). This trend continued in 2016 when there was little difference between pre- and post- sowing ARG management, suggesting low starting populations are a buffer to ARG blow outs. Weed population dynamics in 2017 will help clarify the extent of this buffer and at what point the legacy of previous 'best practice management' is diluted.

The success of the desiccation treatments on all plots cannot be determined until ARG emergence in 2017 but we expect a good level of seed set control from this practice.

The lack of effective seed set control options in some 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, like Faba beans, and canola, or pasture and fodder phases, are essential to reduce ARG seed banks.

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

From 2012 to 2015, higher ARG populations were consistently associated with decreased grain yield (table 3). 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 ARG control, higher yields and higher gross margins in 2012-2015. There was no significant yield advantage for the intensive cost strategy in 2016. This was despite significantly less ARG emergence, tiller and seed head numbers in the high cost herbicide strategy C. The favourable growing season in 2016 may have reduced the negative yield impacts of the high ARG numbers that was seen in other drier seasons.

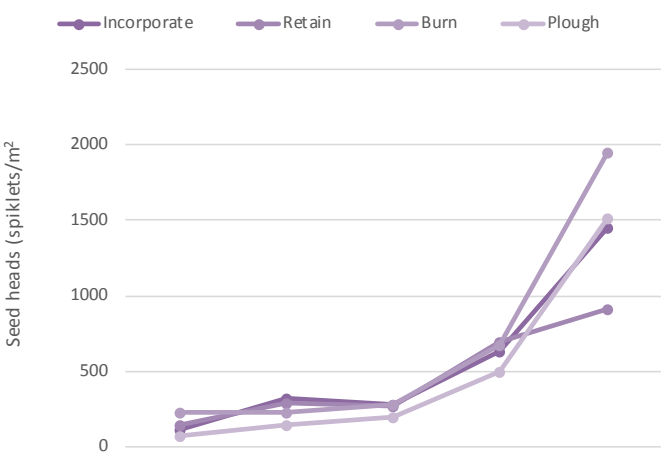

Figure 1. ARG seed heads under the four different cultural control treatments.

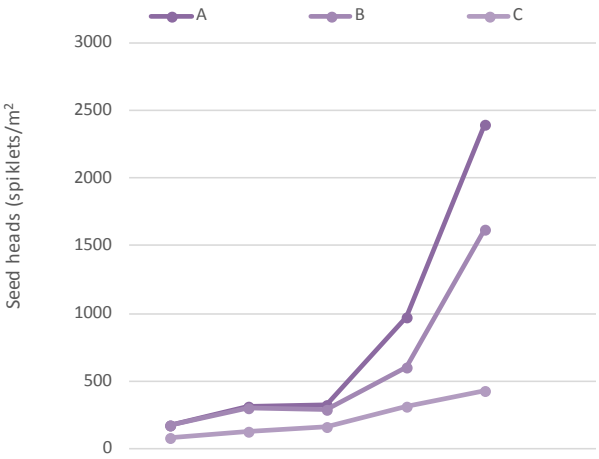

Figure 2. ARG seed heads under the three different herbicide treatments.

Table 3. ARG population and crop yield in 2012-2016. 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)		2015 – Wheat (Revenue)		2016 – Faba beans (Zahra)	
		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	694	2.63 b	909	3.76
Plough	*	69 c	8.09	149	8.19	200	1.89	499	2.87 a	1519	4.01
Incorporate	*	116 bc	8.1	323	8.14	279	1.84	632	2.54 b	1545	3.82
Burn	*	229 a	7.82	232	7.83	280	1.89	678	2.54 b	1946	3.62
†	A (low cost)	169 a	7.8	316 a	7.77	320 a	1.76	969 a	2.26 c	2399 a	3.74
†	B (mid cost)	175 a	7.96	302 a	7.88	287 a	1.83	596 b	2.64 b	1616 a	3.85
†	C (high cost)	76 b	8.09	124 b	8.2	165 b	1.92	313 c	3.04 a	423 b	3.8
Retain	A (low cost)	215	7.61	377	7.42	360	1.54	1105	2.2	1398	3.7
	B (mid cost)	166	7.62	386	7.19	301	1.76	690	2.57	1088	3.8
	C (high cost)	56	8.15	95	8.32	152	1.87	289	3.1	241	3.77
Plough	A (low cost)	107	8.1	221	8.28	279	1.81	833	3.18	2657	4.01
	B (mid cost)	65	7.98	160	7.98	189	1.97	452	2.97	1625	4.05
	C (high cost)	36	8.18	65	8.33	131	1.9	214	3.18	274	3.96
Incorporate	A (low cost)	125	8.13	398	8.1	336	1.76	933	2.12	2825	3.75
	B (mid cost)	113	8.09	351	8.13	307	1.82	490	2.53	1205	3.91
	C (high cost)	112	8.09	221	8.2	194	1.94	413	2.97	604	3.8
Burn	A (low cost)	231	7.37	269	7.3	305	1.92	946	2.18	2717	3.51
	B (mid cost)	356	8.15	311	8.22	351	1.77	754	2.54	2546	3.66
	C (high cost)	101	7.94	117	7.98	184	1.97	335	2.91	572	3.68

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