Strategies for managing annual ryegrass in HRZ's and for using pre-emergent herbicides

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Take home message

- Resistance to the Group 1 and Group 2 post-emergent herbicides in annual ryegrass is widespread and 23% of samples of annual ryegrass from NSW are resistant to glyphosate
- Resistance to pre-emergent herbicides is at low frequencies, allowing their use to effectively control annual ryegrass
- Control of annual ryegrass in higher rainfall zones needs to include double breaks, mixtures and sequences of pre-emergent herbicides, and stacking of tactics within each crop
- Less soluble and more persistent pre-emergent herbicide performs better in higher rainfall zones

Resistance to herbicides in annual ryegrass in NSW

A survey of resistant weeds was conducted across the grain growing regions of Australia in 2020/2021. From this survey 1,353 annual ryegrass samples collected were tested for resistance to the common post-emergent and pre-emergent herbicides. For the Group 1 herbicide Axial® (pinoxaden + cloquintocet-mexyl) resistance was common across all states with 73% of samples collected in NSW resistant (Table 1). However, resistance to the Group 1 herbicide clethodim was lower than Axial® with only 17% of samples collected in NSW resistant. Resistance to the Group 2 herbicides was common across Australia with 86% of samples collected in NSW resistant to Hussar® OD (iodosulfuron-methyl-sodium + mefenpyr-diethyl) and 67% resistant to Intervix® (imazamox + imazapyr). Perhaps the most alarming result was the increase in resistance to glyphosate (Group 9). This was identified in 16% of samples nationally, and 23% of samples collected in NSW. No resistance to paraquat (Group 22) was detected in the survey.

Table 1. Extent of resistance in annual ryegrass to various post-emergent herbicides from random samples collected in 2020/2021 across Australia. Resistance is defined as 20% survival or greater.

State (samples tested)	Resistant samples (%) (resistant ≥20% survival in pot trial)					
	Axial®[1] 300 mL ha^{-1}	Clethodim[2] 500 mL ha^{-1}	Hussar® OD 100 mL ha^{-1}	Intervix® 750 mL ha^{-1}	Glyphosate[3] 1.5 L ha^{-1}	Paraquat[4] 1.2 L ha^{-1}
National (1,354)	71	23	91	79	16	0
NSW (317)	73	17	86	67	23	0
Victoria (183)	73	10	95	86	22	0
Tasmania (21)	86	52	71	57	0	0
SA (279)	66	14	85	68	14	0
WA (554)	71	35	98	92	12	0

[1] Axial 100 EC (100 g/L pinoxaden + 25 g/L cloquintocet-mexyl)
[2] clethodim 240 g/L
[3] glyphosate 450 g/L
[4] paraquat 330 g/L

In contrast to the post-emergent herbicides, there was much less resistance to the pre-emergent herbicides identified (Table 2). There were low levels of resistance to trifluralin (Group 3) and Boxer Gold® (prosulfocarb + s-metolachlor, Group 15), with no resistance identified to Sakura® (pyroxasulfone, Group 15), Rustler® (propyzamide, Group 3), Luximax® (cinmethylin, Group 30) nor Overwatch® (bixlozone, Group 13).

The pre-emergent herbicides are still likely to be effective for annual ryegrass control, where post-emergent herbicides are increasingly likely to fail. However, just because the survey failed to identify resistance to some herbicides does not mean resistance is not present.

Table 2. Extent of resistance in annual ryegrass to various pre-emergent herbicides from random samples collected in 2020/2021 across Australia. Resistance is defined as 20% survival or greater.

State (Samples tested)	Resistant samples (%) (resistant ≥20% survival in pot trial)					
	Trifluralin[1] 1.5 L ha^{-1}	Boxer Gold® 2.5 L ha^{-1}	Sakura® 850 118 g ha^{-1}	Rustler® 1 L ha^{-1}	Luximax® 0.5 L ha^{-1}	Overwatch® 1.25 L ha^{-1}
National (1,354)	12	2	0	0	0	0
NSW (317)	0	1	0	0	0	0
Victoria (183)	21	9	0	0	0	0
Tasmania (21)	0	0	0	0	0	0
SA (279)	38	1	0	0	0	0
WA (554)	4	2	0	0	0	0

[1] trifluralin 480 g/L

Controlling annual ryegrass in the high rainfall zone

In the high rainfall zone (HRZ), annual ryegrass can be challenging to control due to the extended emergence of plants through the season. Resistance to post-emergent herbicides also removes the most effective control tactic in these regions. Any surviving plants can also set a lot of seed, leading to rapid increases in population size.

Trials in the HRZ of South Australia and Victoria have identified a number of principles for managing annual ryegrass in high yield grain production regions, as follows.

Double breaks

Take the opportunity in the rotation to have two crops in a row where high levels of annual ryegrass control can be achieved. Some examples of double breaks include: a pulse crop followed by canola, canola followed by oaten hay, or oaten hay followed by a pulse crop. Well implemented double breaks are able to reduce annual ryegrass numbers to low levels.

Mixtures and sequences of pre-emergent herbicides

The extended emergence of annual ryegrass and the lack of effective post-emergent herbicides due to resistance means annual ryegrass can escape pre-emergent herbicide control, particularly when growing cereals. Using mixtures or sequences of pre-emergent herbicides that extend the period of control of annual ryegrass can help to reduce the number of annual ryegrass plants setting seed.

Stacking tactics

Stacking tactics within a season keeps annual ryegrass numbers lower. A long-term trial at Lake Bolac from 2012 to 2020 showed that the high cost strategy (2 to 4 annual ryegrass control tactics per crop with mixtures or sequences of pre-emergent herbicides) for annual ryegrass control is able to restrict the increase in annual ryegrass numbers (Figure 1). The high cost strategy was able to maintain annual ryegrass populations at a lower level and thereby reduce the impact on crop yield. This meant the high cost strategy provided a cumulative $1,613 per ha gross margin advantage, compared to the low cost strategy (1 to 3 annual ryegrass control tactics per crop), over the 9 years of the trial. This trial also illustrated the value of the double break at reducing annual ryegrass numbers.

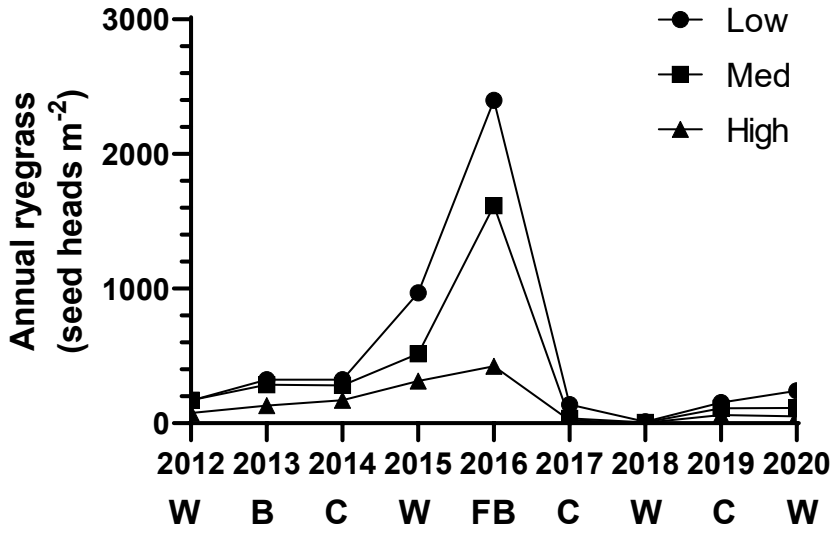

Figure 1. The mean effect of control strategy (low cost, medium cost, high cost) on annual ryegrass seed heads m^{-2} in a nine-year trial at Lake Bolac. "W" is wheat, "B" is barley, "C" is canola, "FB" is faba beans. There are significant differences in annual ryegrass seed head numbers between strategies in all years except 2017.

Harvest weed seed control (HWSC)

HWSC is less effective in the HRZ due to the time of harvest relative to ryegrass maturity – more annual ryegrass seed is shed prior to harvest. Despite this, HWSC is still a useful practice to reduce overall numbers of annual ryegrass. In high yielding crops, it is more practical to make HWSC

functional than perfect. For example, cutting low only through the patches of weeds can speed up harvest, while still reducing annual ryegrass seed numbers.

Pre-emergent herbicide strategies in the high rainfall zone

The use of pre-emergent herbicides in the HRZ comes with a number of considerations. Firstly, the extended emergence of annual ryegrass in this region means that products with short persistence are not sufficiently effective. Secondly, high rainfall can increase the risk of crop damage from pre-emergent herbicides.

Table 3 provides information on solubility and soil binding characteristics of pre-emergent herbicides available for annual ryegrass. In the HRZ, the best choices are the less water soluble products, which will be less mobile in the soil. The products with higher water solubility have higher risk of crop damage and may also be lost (and ineffective) due to too much rain. Usually, there is sufficient rainfall to allow the less water-soluble products to work. There are also more opportunities to use early post-emergent applications of pre-emergent herbicides and these can be used in a strategic way to increase the amount of annual ryegrass controlled and also the length of time of control.

Table 3. Behaviour of some pre-emergent herbicides used for grass weed control.

Pre-emergent herbicide	Trade name	Solubility (mg L^{-1})		K_{OC} (mL g^{-1})	
Carbetamide	Ultro®	3270	Very high	88.6	Medium
S-Metolachlor	Dual Gold®, Boxer Gold®*	480	High	226	Medium
Metazachlor	Tenet®	450	High	45	Low
Cinmethylin	Luximax®	63	Medium	300	Medium
Bixlozone	Overwatch®	42	Medium	400	Medium
Prosulfocarb	Arcade®, Boxer Gold®*	13	Low	2000	High
Propyzamide	Edge®	9	Low	840	High
Tri-allate	Avadex® Xtra	4.1	Low	3000	High
Pyroxasulfone	Sakura®, Mateno® Complete*	3.5	Low	223	Medium
Aclonifen	Mateno® Complete*	1.4	Low	7126	High
Trifluralin	TriflurX®	0.2	Very low	15,800	Very high

*Boxer Gold contains both prosulfocarb and S-metolachlor, Mateno Complete contains aclonifen, pyroxasulfone and diflufenican

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