Optimising control of annual ryegrass

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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 (group 9)
- There is more resistance in wild oats to the Group 1 herbicide Topik® compared to Axial®. Resistance testing can help decision making with Group 1 herbicides
- Resistance to pre-emergent herbicides in annual ryegrass remains at low frequencies, enabling their use in annual ryegrass control programs
- Continuous cropping is selecting for increased dormancy in annual ryegrass populations. Crop competition coupled with effective pre-emergent herbicide strategies can be used to reduce the impact of late emerging annual ryegrass

Resistance to herbicides in annual ryegrass in NSW

In 2020/2021 a survey of resistant weeds was conducted across the grain growing regions of Australia. This survey collected more than 1300 annual ryegrass samples that were then tested for resistance to common post-emergent and pre-emergent herbicides. In annual ryegrass, resistance to the Group 1 herbicide Axial® (pinoxaden + cloquintocet-mexyl) was high across all states and 73% of samples collected in NSW were resistant to this herbicide (Table 1). The frequency of resistance present to the Group 1 herbicide clethodim was lower, with only 17% of samples collected in NSW resistant. Likewise, resistance to the Group 2 herbicides was high with 86% of samples collected in NSW resistant to Hussar® (iodosulfuron-methyl-sodium + mefenpyr-diethyl) and 67% resistant to Intervix® (imazamox + imazapyr). Resistance to glyphosate (Group 9) is increasing in annual ryegrass and 23% of samples collected in NSW were resistant to this herbicide. 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 100 300 mL ha^{-1}	Clethodim (240g/L) 500 mL ha^{-1}	Hussar OD 100 mL ha^{-1}	Intervix 750 mL ha^{-1}	Glyphosate (540g/L) 1.5 L ha^{-1}	Paraquat (250g/L) 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

In contrast to the post-emergent herbicides, resistance to the pre-emergent herbicides was less frequent (Table 2). Resistance was identified to trifluralin (Group 3) and Boxer Gold® (prosulfocarb + s-metolachlor; Group 15), but not to Sakura® (pyroxasulfone; Group 15), Rustler® (propyzamide; Group 3), Luximax® (cinmethylin; Group 30) or Overwatch® (bixlozone; Group 13). Therefore, 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 1.5 L ha^{-1}	Boxer Gold 2.5 L ha^{-1}	Sakura 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

Resistance to herbicides in wild oats in NSW

The same survey collected just under 600 wild oat samples that were tested for resistance to the Group 1 herbicides Topik® (clodinafop-propargyl + cloquintocet-mexyl) and Axial. About 40% of the samples tested were from NSW. Resistance to Topik was identified in 27% of samples from NSW (Table 3). Resistance to Axial was less common in wild oats and present in only 16% of samples from NSW. NSW had a higher frequency of resistance in wild oats compared to other states.

While often resistance results in cross resistance to other herbicides in the same mode of action, there are cases where one or more herbicides from that mode of action may still be effective against the resistant population. This can provide a useful short-term option for management of resistant populations. As these patterns of resistance are unpredictable, it is important to conduct resistance testing to ensure susceptibility of the population.

Table 3. Extent of resistance in wild oats to the Group 1 herbicides Topik and Axial from random samples collected in 2020/2021 across Australia. Resistance is defined as 20% survival or greater. Some wild oat samples collected had insufficient germination to test with Axial.

State	Topik 65 mL ha^{-1}		Axial 100 200 mL ha^{-1}	
	Samples tested	Resistance (%)	Samples tested	Resistance (%)
National	582	16	295	8
Queensland	61	20	40	8
NSW	232	27	125	16
Victoria	72	15	54	0
Tasmania	4	0	0	-
SA	63	6	10	0
WA	150	4	84	0

Changes in annual ryegrass emergence patterns

The adaptability of annual ryegrass is a major reason it is the most important weed of grain cropping in Australia. In addition to evolution of resistance to herbicides, annual ryegrass can also evolve other traits that allow it to avoid control tactics. One of these traits is increased seed dormancy. There is evidence that populations of annual ryegrass have changed their emergence pattern where more of the population emerges later in the season. This allows some of the population to avoid control by knockdown and pre-emergent herbicides.

We have established that there is heritable variation for dormancy within annual ryegrass populations. In these studies, the early emerging and late emerging proportions of populations were separated and crossed among themselves. The progeny of these two sub-populations had different emergence patterns (Figure 1). There is about a 3-week difference in emergence between the two sub-populations.

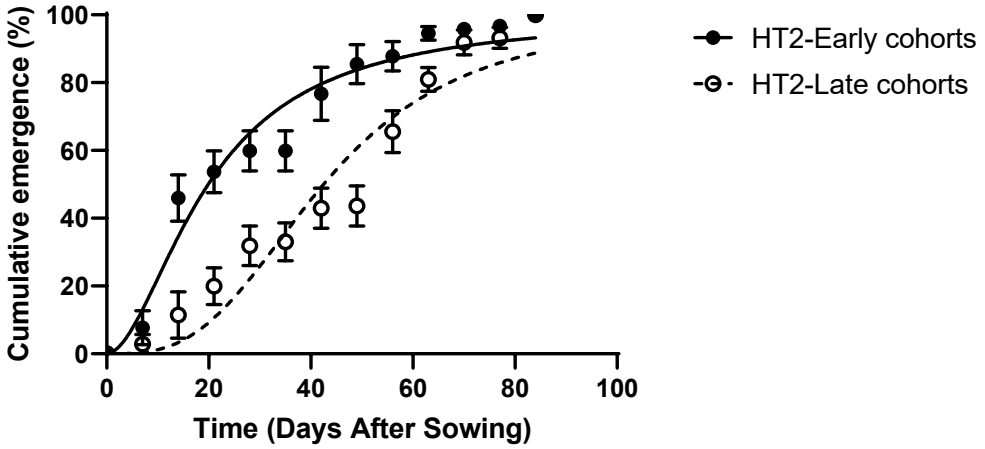

Figure 1. Cumulative emergence of seeds of early and late cohorts selected from an annual ryegrass population.

This pattern of delayed emergence has previously been identified in brome grass and barley grass populations in southern Australia. It is likely that more dormant populations of other grass weeds, such as wild oats, could also be selected in continuous cropping fields.

Delayed emergence will make annual ryegrass more difficult to control, particularly as reliance on knockdown and pre-emergent herbicides for control of annual ryegrass control is high. Management strategies will need to adapt. Previously we have shown that the combination of crop competition with effective pre-emergent herbicides is one tactic that can limit the impact of late emerging annual ryegrass. The use of pre-emergent herbicide mixtures and sequences to provide longer control of emerging annual ryegrass is another tactic that can be used to help combat later emergence. Stopping seed set of surviving annual ryegrass plants through crop-topping and harvest weed seed control is also valuable to combat increased seed dormancy of populations.

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