Invited article

Changes in herbicide resistance in western Victoria, 2005 – 2010

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Take home messages

- **resistance to Group B herbicides is common across western Victoria**
- **resistance to trifluralin is increasing**
- **new pre-emergent herbicides should become a fundamental part of an integrated weed management strategy to aid in control of multiple-resistant ryegrass**

Background

Random surveys of weed populations across southern Australia have identified significant levels of herbicide resistance in ryegrass, with variations across regions. Previous weed surveys showed that trifluralin resistance was higher in parts of South Australia, compared with Victoria, NSW and WA. These regional differences reflect changes in cropping practices and hence in herbicide use patterns. SA has a longer history of no-till and a greater reliance on trifluralin compared with Victoria. Repeating random surveys in the same geographical regions over time reveals changes in the levels of herbicide resistance. Of particular concern is the increase in populations with resistance to multiple herbicides with different modes of action, including trifluralin.

Aim

To determine the level of herbicide resistance to selective in-crop herbicides in annual ryegrass across western Victoria using random weed surveys.

Method

The first survey in western Victoria was conducted in 2005 (Figure 1). In 2010, a repeat survey over the same geographical region was conducted (Figure 2). This information has enabled the changes in herbicide resistance over the past 5 years to be identified. By monitoring changes, growers can understand which products are under threat of resistance and make changes before resistance appears on their property.

Seed was randomly collected from paddocks in intensively cropped areas of western Victoria (see Figure 1). Paddocks were sampled just prior to crop harvest once ryegrass seed had matured. Harvested paddocks were still surveyed because intact ryegrass stalks remained on the soil surface. Paddocks were selected by travelling for a pre-determined distance (five km) on minor roads. At each stop, a single paddock was surveyed. This comprised walking in an inverted W pattern across approximately 0.5ha to 1ha. Surveying started 10m in from the edge of the crop. Whenever ryegrass plants were encountered, the mature spikes were removed. When a large patch of plants was encountered, only up to 20 spikes were removed from the patch. Sampling was discontinued once about 100 spikes had been collected or after 30 minutes, whichever occurred first.

Testing for resistance to trifluralin was conducted by placing seeds on the surface of soil in pots and applying trifluralin directly to the seed and soil. The seed and soil were then covered with soil to a depth of 5mm. Trifluralin was applied with a laboratory moving boom sprayer equipped with T-jet fan nozzles at a speed of $1ms^{-1}$. Output from the sprayer was calibrated at $109L\ ha^{-1}$ at a pressure of 250kPa. Each

pot experiment for the 2005 and 2010 surveys were conducted in the same manner as previous years; outdoors during the normal growing season (July – August). Using this testing procedure, volatilisation losses were minimised by the immediate and even incorporation of trifluralin. Under these conditions, trifluralin activity is greater than in the field and this needed to be taken into account when interpreting the results. Trifluralin was applied at 0 and 1L ha^{-1}. The pots were watered immediately after covering with soil and emergence of seedlings measured four weeks after spraying. Seedlings were considered emerged if they had reached the 2-leaf stage at this time. In each test, three known trifluralin-susceptible and two known trifluralin-resistant populations were included. One of the resistant populations (SLR31) had moderate resistance to trifluralin; the other (L99) had higher resistance as confirmed in a previous test. Samples were classed as resistant if emergence following trifluralin application was at least 20% of the emergence in the absence of trifluralin.

Resistance to post-emergent herbicides was tested by applying a range of herbicides at the 2-leaf seedling stage which had been germinated in pots during the winter period. Assessment was made four weeks after treatment with survival recorded. Samples where ≥ 20% survival was recorded were scored as resistant.

Results

Resistance to Hoegrass®, Achieve® and Axial® (cereal selective)

Resistance to these three herbicides was significantly higher in the more intensively cropped Wimmera than in the Mallee. In the Wimmera in 2005 and 2010 the level of resistance to Hoegrass, Achieve and Axial ranged between 50 and 60% (Table 1). In contrast, in the Mallee, the level of resistance to the three Group A herbicides was much lower. In 2005 3-12% of the samples exhibited resistance to Hoegrass, Achieve and Axial, and in the 2010 survey only 10-13% exhibited resistance. Similar resistance levels between Hoegrass, Achieve & Axial indicates that the majority of resistant plants contain Group A target-site resistance (plants that survive Axial have been documented in laboratory studies to posses Group A target-site resistance). However, a large proportion of the target-site resistant plants were not cross-resistant to Select. An interesting observation was that even though Axial was not registered until after 2005, 29% of the ryegrass in the survey was resistant to this herbicide. This indicates how serious cross-resistance within a chemical group can be.

Resistance to Select®

The resistance levels detected to Select (clethodim) were lower than to the other Group A herbicides tested. In both years, no resistance was detected in the Mallee. In the Wimmera in 2005, 26% of the ryegrass samples exhibited resistance whereas only 9% exhibited resistance in 2010. The main reason for this difference was the higher rate used in the 2010 survey (350ml/ha vs 250ml/ha in 2005) to reflect the increased rates used currently. Increasing rates of clethodim are commonly being used to control ryegrass that is not controlled at lower rates. This strategy will be short-lived if plants that survive higher rates of clethodim are allowed to set seed, as a majority of this seed will be resistant to higher rates.

Resistance to Group B herbicides

Glean® was chosen to represent the Group B sulfonylurea herbicide class. Resistance to Glean increased from 57% in 2005 to 73% in 2010. The level of resistance was similar between regions. This indicates that use of Glean (and other sulfonylureas) is similar in both regions. The effective nature and low cost of sulfonylureas has led to their widespread and frequent use. For this reason, resistance to this class of herbicides is high across southern Australia. They are still commonly used as they control other weed species although this practice continues to impose strong selection for resistance in all sensitive species.

Intervix® was tested in the 2010 survey, but not in the 2005 survey. For this reason it is not presented in the table. The resistance detected to Intervix was 18% across the entire survey, with 18% resistance detected in the Wimmera and 19% in the Mallee. The large discrepancy between sulfonylurea and IMI resistance (73% vs 18%) indicates that in approximately 50% of samples, the sulfonylurea resistance did not exhibit cross-resistance to IMI herbicides. From a herbicide efficacy perspective, the low IMI resistance suggests that these herbicides remain a viable option in some circumstances.

Trifluralin resistance

In the 2005 survey, 5% of ryegrass samples collected across western Victoria was confirmed as resistant to trifluralin (Table 1). By contrast, after five years, the level of resistance had increased to 25% percent, with the greatest increase occurring in the Wimmera: 2% in 2005 to 35% in 2010. A major factor for the significant increase in resistance to trifluralin in the Wimmera is increased reliance on trifluralin to combat Group A and B resistance, as was detected in the 2005 survey.

Table 1. Percentage of paddocks with herbicide resistant ryegrass in cropping regions in western Victoria in 2005 and 2010. Populations were classed as resistant if greater or equal to 20% of plants in a pot test survived the herbicide

** tested with 350 ml/ha Select in 2010*

Region	Triflur X	Hoegrass	Glean	Achieve	Axial	Select
	(1L/ha)	(1.5L/ha)	(30g/ha)	(380g/ha)	(300ml/ha)	(250ml/ha)
2005	**Populations resistant (%)**					
Total area	5	35	57	28	30	12
Wimmera	2	60	60	55	55	26
Mallee	7	12	54	3	7	0
2010	**Populations resistant (%)**					
Total area	25	40	73	35	33	5*
Wimmera	35	60	74	57	54	9*
Mallee	13	13	72	11	10	0*

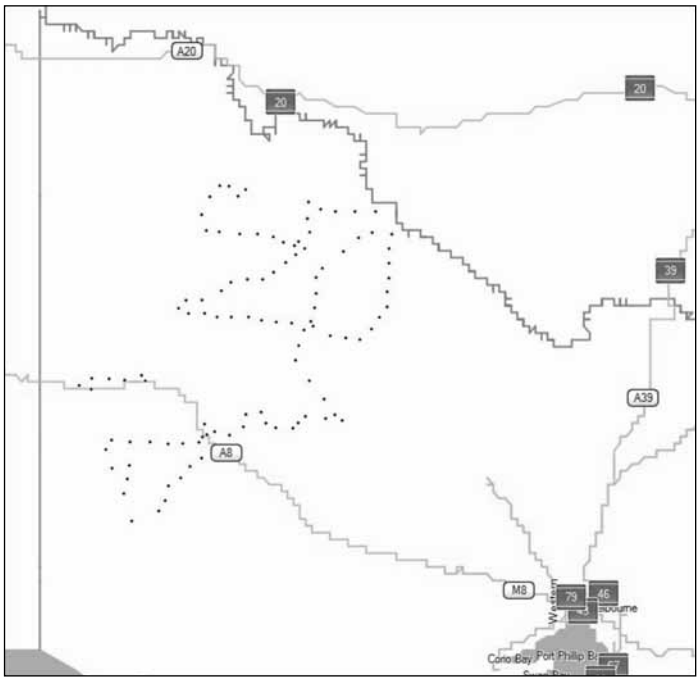

Figure 1. Survey locations in the 2005 survey. Each point represents a surveyed paddock

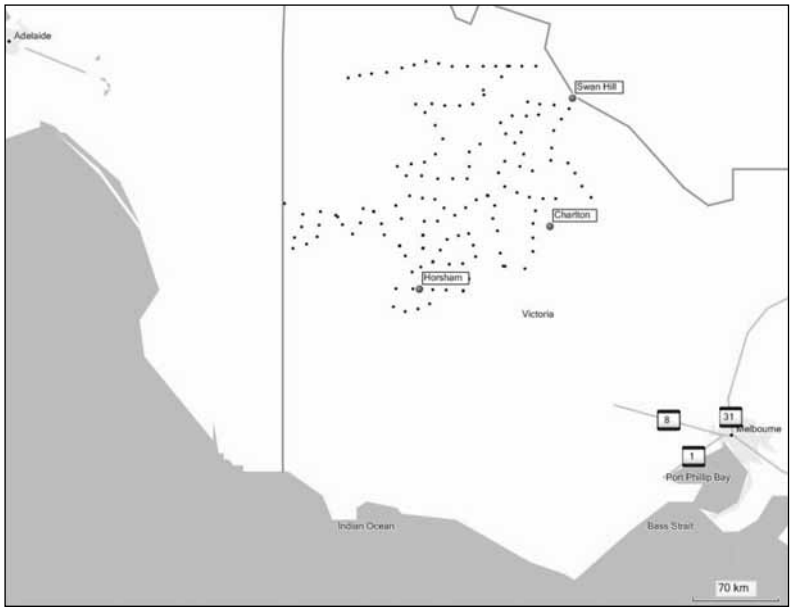

Figure 2. Survey locations in the 2010 survey. Each point represents a surveyed paddock

Interpretation

Ryegrass resistance to Group A and B herbicides in western Victoria has not significantly changed between 2005 and 2010, with the exception of resistance to Glean; which increased from 57% to 73% in the five year period. The growing reliance on trifluralin for annual ryegrass control has resulted in a large increase in resistance to this herbicide. In order to manage trifluralin resistance, it is recommended that farmers incorporate some of the newer pre-emergent mode of action herbicides, such as Boxer Gold® and Sakura®, into their rotations. These herbicides should become a crucial part of their integrated weed management tactics to combat multiple-resistant ryegrass.

Commercial Practice: what this means for the farmer

- resistance to Group A, B and D herbicides has been confirmed in western Victoria, with resistance to Group B and D herbicides increasing between 2005 and 2010
- use of herbicide resistance testing to establish the baseline resistance status of each paddock is important to maximise weed control
- combatting herbicide resistance may involve changing planned cropping rotations to tackle resistance with effective weed control measures.

Acknowledgments

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