HERBICIDE RESISTANCE IN WEEDS AND ITS MANAGEMENT

Chris Preston, Peter Boutsalis, Jenna Malone and Fleur Dolman
School of Agriculture, Food & Wine, University of Adelaide, PMB1 Glen Osmond SA 5064

Key words
Herbicide resistance, wild oats, barnyard grass, liverseed grass, annual ryegrass

GRDC code
UA00088, UA00098, UA00104

Take home message
- Resistance to Groups A, B and Z occurs in wild oats.
- Group Z (Mataven®) resistance can be selected by use of Group A herbicides.
- Glyphosate resistance has been discovered in barnyard grass and liverseed grass as well as in annual ryegrass.
- If glyphosate is the only weed management tool used, glyphosate resistance will occur.

Herbicide resistance in wild oats

There are two species of wild oats that occur in crops in Australia: *Avena fatua* and *Avena sterilis ssp. ludoviciana*. While the two species have different biological behaviour, they both evolve resistance to herbicides. Group A resistance has evolved in both species. *Avena sterilis ssp. ludoviciana* has also evolved resistance to Group B herbicides and to the Group Z herbicide flamprop-methyl (Mataven).

There is a lot of Group A resistance in wild oats with much of the resistance to the Fop chemistry only, so Dims and Dens will still work. However, the last few years have seen an increase in reports of wild oats with resistance to Achieve® and Mataven. A survey of Fop resistant wild oat populations collected in 2005-2006 found 42% with resistance to Mataven, despite many populations not having previous exposure to Mataven (Table 1). In contrast, Mataven was not detected at all in Fop resistant wild oat populations collected in 1990-1992. The current thinking is that selection of wild oats with Wildcat® or Topik® has tended to select for Mataven resistance. This is an example of non-target site cross resistance. This work suggests that growers with Group A resistant wild oats who have used a lot of Wildcat or Topik in the past may find Mataven will not control these wild oats.

Table 1: Survival (%) of selected Fop-resistant wild oat populations to Wildcat, Topik, Axial®, Atlantis® and Mataven.

	Wildcat 300 ml/ha	Topik 75 ml/ha	Axial 200 ml/ha	Atlantis 330 ml/ha	Mataven 2.5 L/ha
Resistant samples (%)	83	63	21*	4*	42

*Survivors to Axial and Atlantis were classed as possessing weak resistance (survivors exhibited heavy herbicide damage but recovered by the production of new tillers).

Why and how of testing for herbicide resistance

When considering getting tests done for herbicide resistance it is important to first be clear about why the test is being conducted. What information is required to aid decision making? On occasions, this may simply be conformation that the weeds are resistant to the herbicide used and the failure was not the result of other factors. More often, it is valuable to have information about herbicides that will still work on the population. This decision will dictate which herbicides are used in the test.

Sampling is also an essential factor in testing for resistance. A common way of sampling for pests is a random sample across the site. However, this is usually not appropriate for herbicide resistance testing. Sampling randomly across the paddock will result in an average percentage of resistance for that paddock. Resistance is most often clumped and restricted to part of the paddock. Also, management of resistance tends to be applied across the paddock, despite resistance only being in one patch. Most often the important information is whether the suspect patch is resistant. Therefore, the strategy for sampling is to collect from the centre of the suspect patch.

There are a few things to watch out for. Testing for resistance in one patch provides little information about what is happening in other patches in the paddock. This can lead to a negative test result, but a herbicide failure elsewhere in the paddock. Interpreting resistance test results is an art. A developing resistance or low level resistance result is usually the most difficult answer to deal with. Information from paddock histories, the size and location of the patch can help in decision making, as can knowledge about the behaviour of that herbicide. Also cross resistance patterns within Groups can vary. Susceptibility to one member of a Group does not guarantee that the population is susceptible to all members of that Group.

Glyphosate resistant weeds in Australia

There are now 92 confirmed sites with glyphosate resistant weeds in Australia. These come from 4 states and a variety of situations (Table 1). A number of populations are from winter fallow systems in northern NSW; however, others are from fencelines and other uncropped parts of the farm. Glyphosate resistant annual ryegrass occurs when populations are treated intensively with glyphosate, where no other herbicides applied and where there is little or no tillage. Relying solely on glyphosate for weed control is the greatest risk factor for glyphosate resistant weeds.

Three populations of awnless barnyard grass and two populations of liverseed grass have been confirmed resistant to glyphosate in summer cropping/ fallow situations in northern NSW. Resistance in these summer grass weeds has major implications for the management of summer fallows and weed control in summer crops. It also demonstrates that weeds other than annual ryegrass can evolve resistance to glyphosate.

Table 2. Occurrence of glyphosate resistant weeds in Australia

Situation		Number of sites	States
Broadacre cropping	Chemical fallow	30	NSW
	No-till winter grains	13	NSW, Vic, SA, WA
Horticulture	Tree crops	4	NSW
	Vine crops	14	SA, WA
Other	Driveway	1	NSW
	Fenceline	20	NSW, SA, Vic, WA
	Firebreak	2	NSW, SA
	Irrigation channel	6	NSW
	Airstrip	1	SA
	Railway	1	WA

From Preston, C. (2008) Australian Glyphosate Resistance Register. National Glyphosate Sustainability Working Group.Online. Available from www.weeds.crc.org.au/ glyphosate

To date, glyphosate resistance has not occurred widely in no-till cropping systems, despite the large amount of glyphosate used in this system. Studies have indicated that glyphosate resistant annual ryegrass populations do not perform well under crop competition. However, resistance can appear in areas with little competition like fence lines and be dragged into the cropped area with harvest and seeding equipment creating a problem in the paddock. In addition, small numbers of glyphosate resistant ryegrass are likely present in paddocks that could become apparent with lack of competition.

Glyphosate resistance mechanisms

So far at least two mechanisms of resistance to glyphosate have been discovered. These are a target site mutation and reduced herbicide translocation. The target site resistance mechanism is a single amino acid mutation within EPSPS (the enzyme glyphosate binds to) and typically results in 2 to 5-fold resistance to glyphosate (Figure 1). The reduced translocation mechanism results in glyphosate accumulating in the tips of leaves rather than being well translocated around the plant. This mechanism provides 5 to 12-fold resistance to glyphosate. Both mechanisms provided modest levels of resistance meaning some control can be gained of resistant populations with glyphosate or glyphosate mixtures. However, populations can accumulate both mechanisms of resistance and are much more resistant to glyphosate. In annual ryegrass the reduced translocation mechanism is much more common than the target site mechanism.

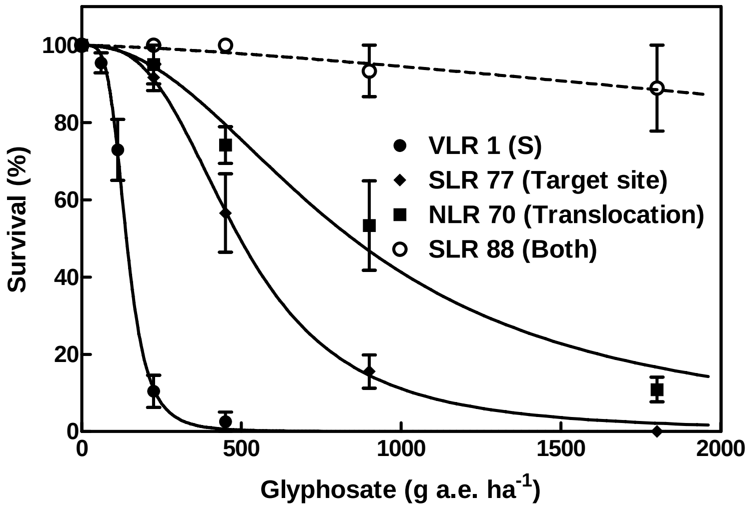

Figure 1. Dose response to glyphosate of populations of annual ryegrass with different mechanisms of resistance.

The resistance mechanisms in barnyard grass and liverseed grass are less well studied. In one population of glyphosate resistant barnyard grass the reduced translocation mechanism is not present. This population contains a mutation within the target site.

Contact details

Dr. Christopher Preston
University of Adelaide
PMB 1 Glen Osmond SA 5064
Ph: 08 8303 7237
Email: christopher.preston@adelaide.edu.au

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