Developments in herbicide resistance and new products

Chris Preston[1,2], Peter Boutsalis[2] and Angela Wakelin[2]

[1]CRC for Australian Weed Management and

[2]School of Agriculture, Food & Wine, University of Adelaide, PMB1 Glen Osmond SA 5064.

Take home messages

- *High levels of herbicide resistance are present in annual ryegrass in South Australia and Victoria.*
- *Trifluralin resistance is high in South Australia, but lower elsewhere.*
- *There is no cross resistance to the new pre-emergent herbicides Boxer Gold and Bay 191.*
- *Mataven resistance in wild oats appears related to use of fenoxaprop and clodinafop.*
- *Fencelines and other uncropped areas around the farm are at risk of glyphosate resistance.*
- *Using robust rates of paraquat will reduce the risk of selecting paraquat-resistant annual ryegrass.*

Surveys of herbicide resistant annual ryegrass

Recent surveys of cropping regions in South Australia, Victoria and WA have indicated that most farms have annual ryegrass with resistance to Groups A or B (Table 1). The worst examples of resistance are occurring in continuously cropped areas where Group A and B herbicides have been intensively used for many years. Resistance to Dims is increasing, including resistance to Select. Resistance to trifluralin is high in South Australia, but lower in other areas.

Cross resistance within Group A herbicides

Axial (active ingredient pinoxaden) a 'den' herbicide was introduced in 2006. While Axial has different chemistry to the fops and dims, its resistance profile in annual ryegrass is similar to Sertin and Achieve (Table 2). This means Axial is unlikely to control Dim resistant annual ryegrass.

Mataven resistance in wild oats

There is a lot of Group A resistance in wild oats as well as annual ryegrass. As yet, much of the resistance in wild oats is 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. The current thinking is that selection of wild oats with Wildcat or Topik has tended to select for Mataven resistance. 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 3). In contrast, Mataven was not detected at all in Fop resistant wild oat populations collected in 1990-1992.

Table 1. Resistance in Victoria, South Australia and Western Australia fields.

	Victoria (2005) Mallee/ Wimmera	Victoria (2006) North central and north eastern	South Australia (2003) Mid-north and YP	Western Australia (2003) Entire cropping zone
Sampled paddocks	125	118	187	503
HERBICIDE	% of paddocks with resistance			
Trifluralin	4.5	1.5	49	0.2
Hoegrass	35	40	77	37
Glean	57	43	75	68
Hoegrass + Glean	21	31	60	31
Achieve/ Sertin*	28	NT	45	13*
Axial	29	36	36	NT
Select	12.5	11	NT	0.

Table 2. Frequency of annual ryegrass populations resistant to various Group A herbicides. From a collection of 108 populations tested by Plant Science Consulting.

Herbicide	Fops	Achieve	Select	Axial
Populations resistant (%)	78	47	11	31

Table 3: 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).*

Group D resistance in annual ryegrass.

There has been a significant increase in the amount of trifluralin being used to control annual ryegrass in Australia. Much of this is being used in no-till cropping systems and where there is existing resistance to the Group A and/or Group B herbicides. This increased use of trifluralin is inevitably applying additional selection pressure for trifluralin resistance in annual ryegrass.

A recent survey has identified an emerging problem with trifluralin resistance in annual ryegrass in South Australia (Table 4). Almost 50% of all populations had some level of resistance to trifluralin. At present, South Australia seems to be the worst affected state. There is some trifluralin resistance apparent in Victoria, but little yet in New South Wales or Western Australia. The challenge for the future will be to manage populations that are resistant to all the selective herbicides in wheat.

Table 4. Frequency of resistance to trifluralin by region in a random sample of annual ryegrass populations from South Australia collected in 2003 and Victoria collected in 2005 & 2006.

Region	Moderate resistance (% of samples)	High resistance (% of samples)
SA - Lower North	44	8
SA - Mid North	19	6
SA - Yorke Peninsula	84	22
Vic - Wimmera	2	0
Vic - Mallee	10	1
Vic - North East	1.5	0

High resistance is defined all samples that with survival greater than 21% at 400 g ai ha-1 trifluralin. Moderate resistance is defined as all samples with survival greater than 21% survival at 200 g ai ha-1 but less than 21% survival at 400 g a.i. ha-1.

New pre-emergence herbicides

Since 2005 the efficacy of trifluralin has been compared to alternative pre-emergence herbicides including a new herbicides including, KIH-485 discovered by Kumiai Chemical Industry Co., Ltd (now Bayer BAY-191) and Boxer Gold (Prosulfocarb + S-Metolachlor) to be marketed in 2008 by Syngenta. A number of field trials have been conducted in South Australia showing these herbicides are effective at controlling annual ryegrass on sites where trifluralin resistance is present. A pot study has shown that both new herbicides control trifluralin resistant ryegrass (Figure 1).

Glyphosate Resistance

There are now 73 populations of annual ryegrass from around Australia with known resistance to glyphosate (Table 5). Many of these are from winter fallow systems in northern NSW; however, an increasing number are from fencelines and other uncropped parts of the farm. Glyphosate resistance occurs when annual ryegrass populations are treated intensively with glyphosate, where no other herbicides applied and where there is little or no tillage.

The good news is that despite early forecasts, the number of resistant populations from no-till cropping systems is still low. The glyphosate resistant populations seem not to perform well under crop competition. However, in areas with little competition, like fencelines, resistance does occur. Once resistance is present on the fenceline, it can be dragged into the cropped area with harvest and seeding equipment creating a problem throughout the paddock.

Resistance to 2,4-D in Indian hedge mustard

2,4-D resistance in Indian hedge mustard has been confirmed in South Australia. Plants from this population survived 5.6 kg a.e. ha-1 of 2,4-D dimethylamine, whereas two susceptible populations were completely controlled with 250 g a.e. ha-1. This population is resistant to Group B herbicides and to other Group I herbicides (Table 6). This is a worrying development as Group I herbicides are often used to control Group B resistant broadleaf weeds. There is a second population with suspected resistance nearby.

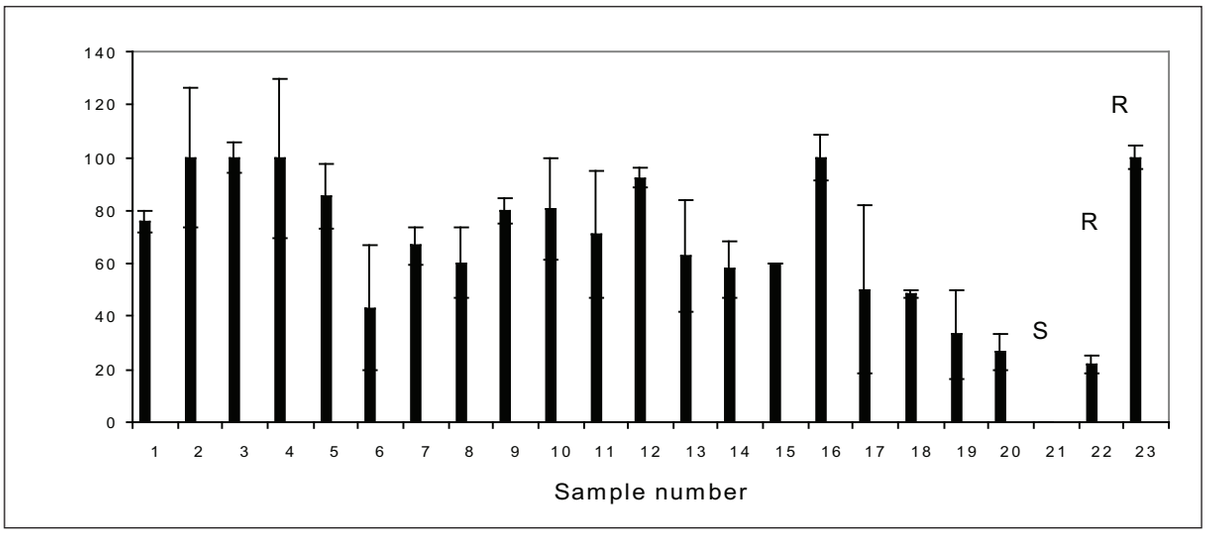

Figure 1: Effect of Trifluralin (■), BAY-191 (□) and Boxer Gold (☒) on 20 trifluralin-resistant ryegrass populations, 6 weeks after treatment. A standard susceptible (S) and two previously confirmed trifluralin-resistant biotypes (R1 & R2) were used. No survival was detected with BAY-191 or Boxer Gold.

Table 5. Occurrence of glyphosate resistant annual ryegrass in Australia

Situation		Number of sites	States
Broadacre cropping	Chemical fallow	24	NSW
	No-till winter grains	10	NSW, Vic, SA, WA
Horticulture	Tree crops	3	NSW
	Vine crops	14	SA, WA
Other	Driveway	1	NSW
	Fenceline	11	NSW, SA, Vic
	Firebreak	2	SA, NSW
	Irrigation channel	6	NSW
	Airstrip	1	SA
	Railway	1	WA

From Preston, C. (2007) Australian Glyphosate Resistance Register. National Glyphosate Sustainability Working Group.Online. Available from www.weeds.crc.org.au/glyphosate

Table 6. Estimated LD50s (g a.i. ha-1) and resistant ratios for populations from Roseworthy (S), Port Broughton (R) and Tumby Bay (R to Group B herbicides only) treated with various herbicides.

Herbicide	S	R LD_{50} (g ha^{-1})	R/S	Tumby Bay LD_{50} (g ha^{-1})	R/S
2,4-D	81	2009	25	91	1.1
MCPA	72	1510	21	75	1.0
Chlorsulfuron	0.18	90	545	>1000	>5000
Metsulfuron-methyl	0.18	5.69	32	7.35	42
Imazethapyr	9.5	37	4	>1000	>100
Metosulam	0.45	192	425	232	513
Florasulam	0.31	7.04	23	31.6	103

Resistance to paraquat in annual ryegrass

There are many paraquat-resistant populations of barleygrass in Australia, but so far no paraquat-resistant annual ryegrass. Paraquat resistant annual ryegrass has occurred in vineyards in South Africa. One of the reasons for the lack of paraquat resistant annual ryegrass in Australia is that paraquat rates have been sufficiently high in Australia to control individuals containing only one copy of the resistance allele (Figure 2). Our research indicates that robust rates of paraquat for the conditions should be used to ensure that paraquat resistance stays rare in Australia. Using rates of less than 200 g ha-1 consistently will encourage the evolution of paraquat resistant annual ryegrass.

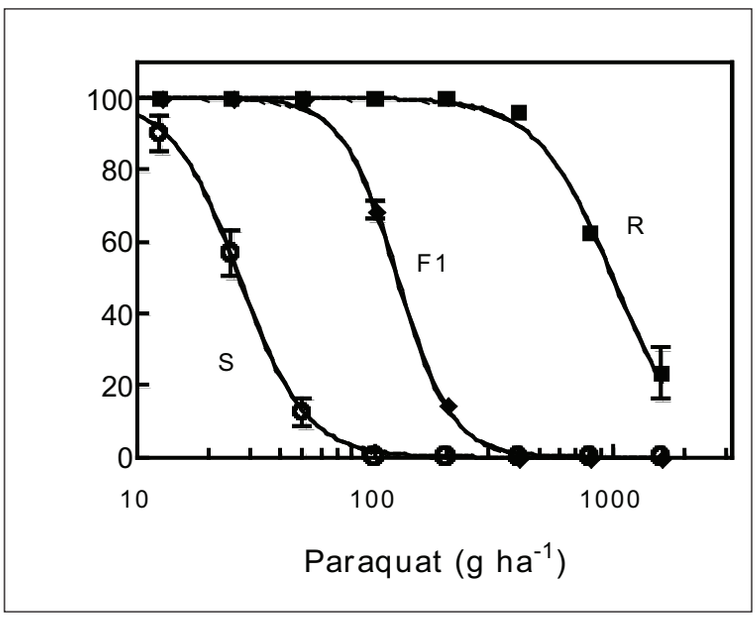

Figure 2: Response of paraquat resistant and susceptible populations of annual ryegrass and their cross to paraquat.

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