Frequency of glyphosate resistance in herbicide resistant annual ryegrass populations

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Summary There has been several reports of glyphosate resistance in ryegrass in southern Australia. Widespread resistance in annual ryegrass in winter cropping systems has yet to occur. Several populations of ryegrass resistant to the group A (acetyl CoA carboxylase inhibitors) and B (acetolactate synthase inhibitors) herbicides were treated with glyphosate and low levels of resistance are reported. The mean level of resistance in 20 populations was 3% when treated with 1.5 L ha^{-1} of 540 g a.i. L^{-1} of glyphosate product. Eighty percent of affected farmers reported annual usage of glyphosate.

Keywords Herbicide resistance, annual ryegrass, glyphosate.

INTRODUCTION

Several populations of ryegrass submitted to the Resistech testing service in 2001 were observed to have detectable levels of resistance to glyphosate in preliminary screenings. Resistech Testing Service tests samples of weeds submitted as seed samples for resistance to herbicides. The material is usually resistant to other herbicides and does not represent a random sample from across SA. In fact it represents a selection of troublesome ryegrass populations in which resistance to other herbicides has already become evident.

MATERIALS AND METHODS

Forty populations from the original 89 were selected based on a preliminary screening and seeds were sown in pots containing 1:1 mixture of sand and recycled potting soil. Plants were grown outside in southern Australian winter conditions and watered by rainfall and supplementary watering as required. Two to three leaf plants were treated with a 1:1 mix of Bonus® and Credit®, at 0.75, 1.5 and 3 L of 540 g a.i. L^{-1} glyphosate equivalent per hectare. Herbicides were applied in 120 L ha^{-1} of water with a hand sprayer pressurised by propane. Three replicates were treated at each herbicide rate.

All survivors were resprayed 6 weeks after the first treatment. Retreatment rates were 0.75 L ha^{-1} on the lowest initial rate and 1 L ha^{-1} of 540 g a.i. L^{-1} glyphosate equivalent on the two higher rates, surviving plants were counted and results expressed as a percentage of the number of plants initially treated.

RESULTS

The survival percentages of each population are shown in Table 1.

The selected populations were treated and 50% of these had a low level of survivors at or above the recommended field application rate of glyphosate product (1.5 L ha^{-1}). The mean percentage of survivors from 20 populations containing survivors was 3.0% and 2.3% from 1.5 L and 3.0 L ha^{-1} glyphosate product respectively. More than 75% of the populations treated had survivors to 0.75 L ha^{-1} of glyphosate.

Table 1. Mean survival (%) of test populations following treatment with two rates of glyphosate.

	Plant survival %			
	810 g a.i. ha^{-1} glyphosate		1620 g a.i. ha^{-1} glyphosate	
Pops.	Mean survival %	SE of mean	Mean survival %	SE of mean
1	2.67	0.27	0.00	0.00
2	3.33	0.72	0.00	0.00
3	4.33	0.54	0.00	0.00
4	3.00	0.47	1.67	0.54
5	2.00	0.47	1.00	0.47
6	1.33	0.27	1.67	0.98
7	0.67	0.27	0.33	0.27
8	0.67	0.27	1.33	0.72
9	5.67	0.72	4.67	0.98
10	5.33	2.60	5.33	0.72
11	2.67	0.72	2.33	0.54
12	8.33	1.44	5.00	0.47
13	3.67	0.72	0.00	0.00
14	2.33	0.72	2.00	0.47
15	1.67	0.98	2.33	0.27
16	2.00	0.47	1.67	0.54
17	6.00	0.47	4.33	1.44
18	1.67	0.72	2.00	0.47
19	1.33	0.72	1.00	0.47
20	1.33	0.54	0.00	0.00
Mean	3.00		1.83	

DISCUSSION

Populations displaying resistance were mainly from the mid-north region of South Australia with the Yorke Peninsula and South East also represented. The distribution of resistant populations is probably a reflection of the history of product usage and intensity of crop production systems.

The populations surviving glyphosate all had some resistance to the 'fop' herbicides (Group A). More than 50% had high levels of resistance (greater than 30% survival to the fops) but only 10% had resistance to the 'dims' (Group A). Two populations had high levels of resistance to the dims. Most populations had resistance to the group B herbicides usually at low to moderate levels, (10–30% survival).

The paddock histories, where available, indicate use of glyphosate over a long period. Farmers were surveyed as to glyphosate use and all the respondents reported at least 10 applications of glyphosate on the suspect paddocks. Eighty percent of the populations had at least 15 years application history, the rest between 10 and 15 years. In all cases glyphosate application rates have risen from about 0.75 L to 1.5 L ha^{-1} in recent years. Most of the paddocks were under continuous glyphosate use, at least once per year.

There appears to be a serious potential for glyphosate resistance in annual ryegrass populations as all these populations were drawn from annual dry land cropping areas in SA, and in this respect is a serious development. The extent of glyphosate resistance encountered in this survey is high and should serve as a warning to farmers with a high reliance on glyphosate that resistance may be more widespread than previously thought. It should also serve as a warning to farmers, agronomists and consultants that there is a potential for the rapid development of widespread glyphosate resistance if pre-seeding ryegrass control or ryegrass seed set suppression is completely dependent upon glyphosate. The level of glyphosate resistance encountered in the populations that had survivors indicates a real potential to rapidly increase under further use in the absence of alternative methods to kill any survivors from previously applied glyphosate.

All of the populations that had survivors already exhibited resistance to some other herbicide which indicates that resistance to glyphosate is becoming apparent or being selected for in the absence of other effective herbicides. As other herbicides have failed or continue to fail there may be an increased selection for glyphosate resistance as glyphosate survivors will not be killed by post-emergent products. The level of glyphosate resistance may increase rapidly if other effective herbicides or management procedures are not implemented.

Probably the most simple management tool is to make sure post-emergent herbicides are used to maximum effectiveness, if possible. Other methods would include a follow-up treatment with paraquat prior to sowing or use of some cultivation prior to sowing. It is worthwhile to make sure that water quality or mixtures of other herbicides are not reducing glyphosate efficacy. The use of paraquat for crop topping or spray topping will relieve the selection pressure on glyphosate resistance. Other non-chemical methods of ryegrass control should be seriously considered.

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