Brome grass behaviour and management in the Victorian Mallee

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Take home messages

- *Brome grass is becoming more prevalent in the Victorian Mallee with adoption of no-till farming and intensification of cereal cropping systems where few effective herbicides are available for control.*
- *The ecology of brome grass has changed, making it more problematic to control in crops.*
- *Aim for two consecutive years of control to deplete the seedbank of this troublesome weed.*

Background

Brome grass has been infesting crops for many years. However, its status as a troublesome weed in cereal crops of the Victorian Mallee has risen dramatically in recent years. This well-adapted weed has increased in prevalence with the growing adoption of no-till farming and with intensification of cereal-based cropping systems (i.e. wheat on wheat) where few effective herbicides are available for control. In crops and pastures, this highly competitive weed can markedly reduce productivity, with seeds contaminating grain samples and causing injury to livestock. Brome grass competing early in wheat at a density of 100 plants/m^2 can reduce yield by as much as 30-50%.

The two main species of brome grass commonly found infesting crops of the Mallee are *Bromus diandrus* and *Bromus rigidus* with accepted common names of great and rigid brome. Both species have similar appearance in early vegetative stage of growth (i.e. hairy leaves and stems), but they can clearly be distinguished at the reproductive stage upon examination of the panicle or inflorescence, with *B. diandrus* possessing a looser or nodding panicle in contrast with the erect or rigid panicle of *B. rigidus*.

The dominance of *B. rigidus* in crops of southern Australia has been shown to be related to its slow dormancy release which allows for greater persistence with late germinations evading control and invariably infesting crops. By contrast, *B. diandrus* shows a rapid release from dormancy, which ensures high germinability of the species upon opening rains and subsequent control with knockdown herbicides. However, growers in the Victorian Mallee are reporting an increase in both brome grass species, with *B. diandrus* being found as frequently in crop as *B. rigidus*, which has generally been thought of as the more troublesome of the two.

Consequently, studies have been undertaken at Waite Campus to examine the mechanisms responsible (e.g. dormancy status) for the proliferation and persistence of brome grass spp. *B. diandrus* in the Victorian Mallee. Potential management strategies are also discussed.

Aim

To investigate the germination behaviour and seed dormancy of brome grass (*Bromus diandrus*) populations from the Victorian Mallee and provide information on control.

Method

Brome panicle samples were collected from within crops located at Manangatang (Man) and Swan Hill (SH) in the spring of 2009. Examination of the callus scar (detachment point on underside of seed) confirmed that both populations of brome grass were *B. diandrus*. Seed of the populations was stored at 25°C in the dry and then used to assess the rates of dormancy loss after germinating in petri dishes in continuous dark at 20/12°C in germination cabinets from January to July (2010). A similar approach was also used to examine the effect of chilling (cold requirement) as a means of releasing seed from dormancy with the seed of SH population exposed to different durations of 5°C before returning to germinate at 20/12°C in continuous darkness. A population of *B rigidus* collected from the Yorke Peninsula of South Australia known for its high level of seed dormancy was included for comparative purposes.

Results

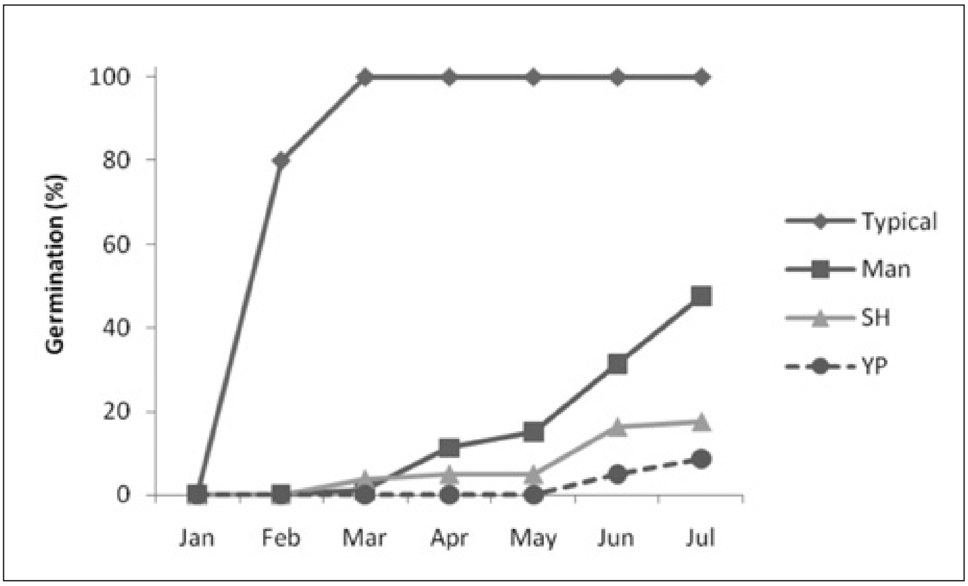

Figure 1. Percentage seed germination (%) of Manangatang (Man) & Swan Hill (SH) populations of B. diandrus from January to July. Note germination was undertaken in controlled temperature cabinets at 20/12°C in continuous darkness. Population YP (B rigidus from Yorke Peninsula of South Australia) was used as a recalcitrant check (i.e. exhibits high level of seed dormancy).

Both Manangatang and Swan Hill populations showed high levels of seed dormancy, with maximum germination of <50% by July (Figure 1). This is in contrast to earlier research from WA and SA where populations of *B. diandrus* showed little or no seed dormancy with near complete germination (100%) by as early as February (i.e. typical population in Figure 1). Furthermore, given that germinability of Victorian populations increased significantly with both gibberelic acid and chilling (Figure 2) it appears that seed dormancy is under strong hormonal control (i.e. control at embryo level). In the field this means that the dormant brome grass requires not only moisture, but a period of colder temperatures to germinate.

Therefore larger germinations of brome would not be expected until cooler moist conditions in late autumn-early winter which encourage a break in dormancy. High dormancy and chilling requirement in brome grass would enable these populations of *B. diandrus* to avoid knockdown herbicides and germinate in-crop where control options are far more limited.

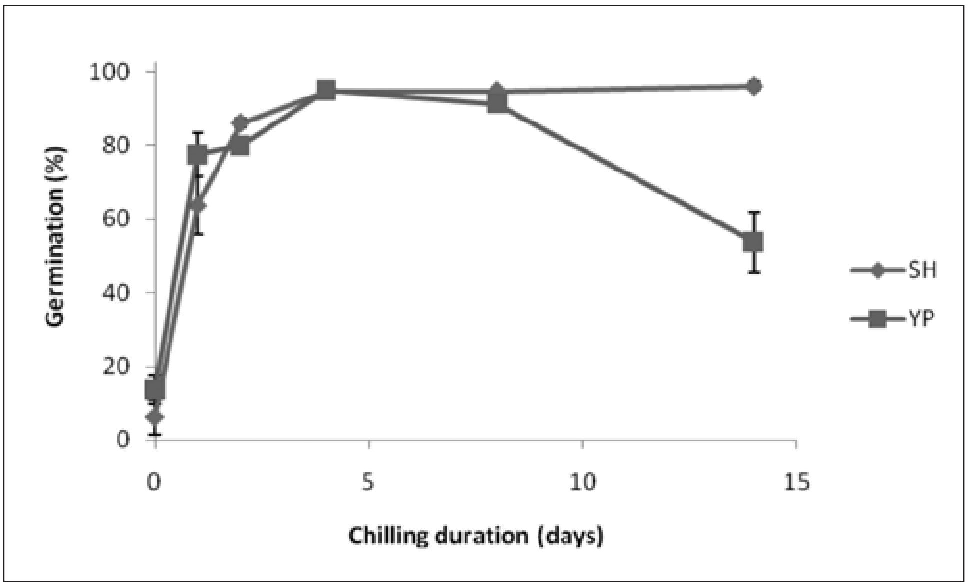

Figure 2. Effect of chilling duration (i.e. exposure to 5°C) on seed germination of Swan Hill (SH) and Yorke Peninsula (YP) populations of brome grass. Note responsiveness of both populations with complete germination (100%) following <5 days of chilling.

Given the protracted germination of these *B. diandrus* populations, seedbank carryover from one season to the next would be expected to be greater than the 5 – 10% previously recorded for less persistent populations from SA and WA. For example, seedbank carryover has been shown for *B. rigidus* to be as high as 30%, with seeds remaining viable on the soil surface for up to three years. Such high levels of persistence of seed of both brome grass species means that, if control is to be effective, it must be undertaken over successive years in order to deplete the weed seedbank.

Interpretation

An integral component of the brome grass integrated weed management (IWM) plan should be a robust crop rotation ensuring at least two consecutive years of management to deplete the seedbank. For example, a break crop such as a pulse or canola where triazines or glyphosate (i.e. Roundup Ready) and Group A herbicides (i.e. Targa, Verdict) can be used, followed by Clearfield wheat and use of Midas herbicide is an effective combination against brome. Canola can be substituted for pasture in lower rainfall environments where pasture-topping with paraquat or glyphosate can be used to limit seed set. Be mindful that overuse of certain herbicides (i.e. Targa and Verdict) can and will lead to development of herbicide resistance in brome. Many populations from the Victorian Mallee already show confirmed resistance to Group A herbicides (pers comm. P. Boutsalis). Alternate herbicide and cultural tactics for controlling brome should be implemented as part of an IWM plan which will help prevent herbicide resistance development. A few examples are shown in Table 1.

Table 1. Effectiveness of different management tactics and techniques for brome grass control (Source: Bowcher, Gill and Moore, 2005)

Tactic	Likely % control (range)	Comments on use
Burning residues	70 (60-80)	Sufficient crop residues are needed
Autumn tickle	50 (20-60)	Depends on seasonal break. Seed burial through shallow cultivation enhances seed depletion through germination, especially in *B. diandrus* with its shorter dormancy and faster germination
Delayed sowing	70 (30-90)	Depends on seasonal break
Knockdown (non-selective herbicide)	80 (30-99)	If possible delay spraying until full emergence and youngest plants have 2 leaves
Pre-emergent herbicide	80 (40-90)	Follow label recommendations, especially on incorporation requirements of some herbicides. Use triazines and trifluralin mainly in pulses
Post-emergent (selective)	90 (75-99)	Apply when weeds have 2-6 leaves and are actively growing
Pasture spray-topping	75 (50-90)	Timing is critical. Respray or graze survivors
Silage and hay	60 (40-80)	Hay freezing works well. Silage is better than hay. Graze or spray regrowth
Grazing	50 (20-80)	Graze infested areas heavily and continuously in winter and spring
Residue collection at harvest	40 (10-75)	Works best on early harvested crops before weeds drop their seeds

Acknowledgments

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Weed management of herbicide resistant ryegrass in no-till systems

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Take home messages

- *Herbicide resistance is common in ryegrass in most cropping regions in southern Australia.*
- *New pre-emergent herbicides can effectively control multiple-resistant ryegrass.*
- *New pre-emergent herbicides work well under knife-point and disc systems.*
- *Trifluralin damage of wheat can be expected in zero-till disc systems.*
- *Glyphosate resistance occurs where there is intensive use of glyphosate and few or no other weed control tactics.*
- *Alternatives to glyphosate are available to control glyphosate-resistant ryegrass on fence lines.*

Background

Random surveys of weed populations across southern Australia have identified considerable levels of herbicide resistance in ryegrass. There are variations across regions. Trifluralin resistance is high in parts of South Australia, compared with Victoria, NSW and WA. These regional differences reflect differences in cropping practices and hence in herbicide use patterns, with SA having a longer history of no till and a greater reliance on trifluralin compared with Victoria. Of particular concern is the increase in populations with resistance to multiple herbicides with different modes of action.

Aim

Over the past five years, we have been investigating alternative pre-emergent herbicides in ryegrass. The compounds of interest include prosulfocarb (in Boxer Gold), pyroxasulfone (Sakura), dimethenamid-P (NUL 1493/ Outlook) and triallate (Avadex). All can be effective at controlling resistant ryegrass in no-till knife point systems either alone or in mixtures. We also investigated the effect of pre-emergence herbicides in certain disc systems.

Table 1. Percentage of paddocks with herbicide resistant ryegrass in cropping regions of southern Australia.

Region	Year	Trifluralin	Hoegrass	Glean	Achieve	Axial	Select
		Populations resistant (%)					
SA- Mid North	1998	9	38	22	nt	nt	19
SA- Mid North	2003	49	76	75	51	40	36
SA- Mid North	2008	40	76	73	64	59	40
SA- Mallee	2007	19	6	67	2	2	2
SA- South East	2007	39	60	69	50	53	41
Vic- Western	2005	5	35	57	28	30	12
Vic- Northern	2006	2	40	43	nt	34	11
Vic- Southern	2009	0	73	81	84	68	23
SA- Kang. Isl.	2009	0	46	67	55	50	9
SA- Eyre Pen	2009	5	30	78	29	30	11

Method

Trials were sown in 2008 with different field plot seeders because they were conducted by different consulting groups. Plots were 2m wide x 10m long. Spraying was conducted by field plot sprayers delivering between 70 – 100L/ha output. Incorporation was obtained by the sowing system. All treatments received 100kg/ha of DAP fertiliser and were sown on 25cm spacing. Normal sowing speeds were used for disc (12km/h) and knife-point tine systems (8 – 9 km/h). Each trial was conducted in paddocks that had been in no-till for at least five years.

Results

a) Performance of pre-emergent herbicides on trifluralin resistant ryegrass in knife-point tillage systems

One of the problems with pre-emergent herbicides is the requirement for moisture to activate the herbicide product. The performance of Boxer Gold and Sakura has been generally excellent on resistant ryegrass under a variety of environmental conditions (Figures 1 and 2). Control with Avadex/trifluralin mixtures appears to be more susceptible to dry environmental conditions. Under very high rainfall conditions, crop damage can occur if the herbicides are washed down to the crop roots. Dragging treated stubble into the crop row can also cause crop toxicity problems with herbicides that rely on separation from the seed for selectivity (data not shown). This is less of an issue with Sakura in wheat. Numerous university pot trials (data not shown) suggest that Sakura is extremely safe in wheat. It seems to be more of a problem with Boxer Gold, trifluralin and Avadex.

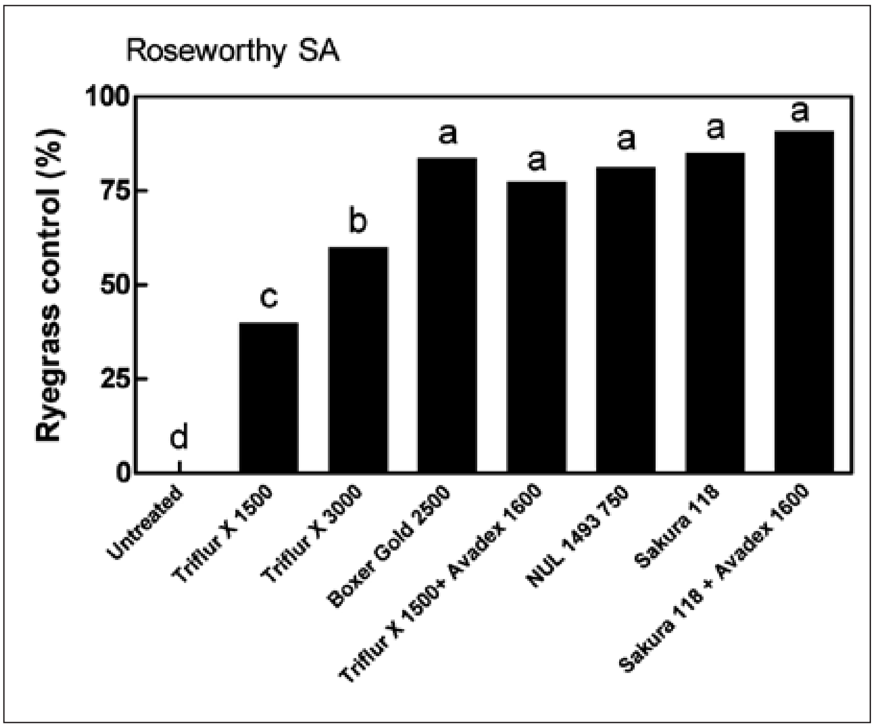

Figure 1: Performance of pre-emergence herbicides on trifluralin-resistant ryegrass at Roseworthy, SA (high rainfall site) in no-till wheat sown using knife points and press wheels. Rates are in ml or g/ha of product. Columns with the same letter are not significantly different at the 5% level.

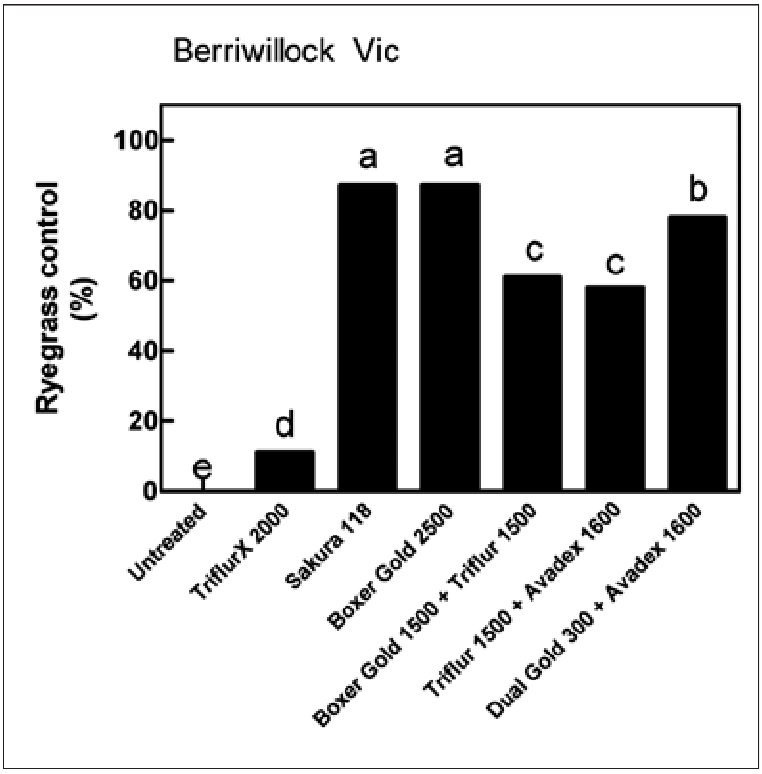

Figure 2. Performance of pre-emergent herbicides on trifluralin-resistant ryegrass at Berriwillock, Vic (low rainfall site) in no-till wheat sown using knife points and press wheels. A previous resistance pot test had detected 70% resistance. Rates are in ml or g/ha of product. Columns with the same letter are not significantly different at the 5% level. Efficacy of pre-emergent herbicides under knife-points vs disc systems

(b) Ryegrass control under knife-point versus disc tillage systems

Recent field studies have consistently shown the ability of new pre-emergence herbicides Boxer Gold and Sakura to provide effective ryegrass control (≥81%) under both knife-point and single disc systems (Figure 3). Interestingly, ryegrass control with trifluralin and its mixture with Avadex-Xtra were not compromised with the low soil disturbance Austil disc (72 to 81%) by comparison with the knife-point system (83 to 87%). It is likely that a combination of seed placement close to the soil surface and ideal conditions for herbicide activity (adequate rainfall) were responsible for the activity of trifluralin in the disc system. Soil incorporation is a requirement and a label recommendation for trifluralin because of its high vapour pressure and sensitivity to photo-decomposition (light).

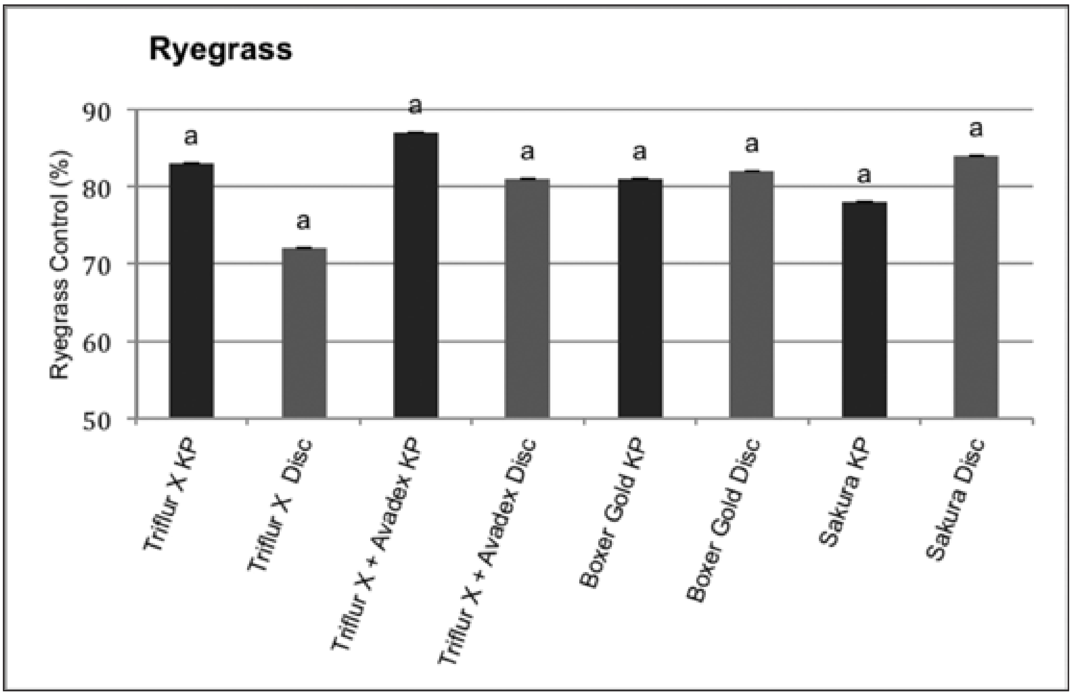

Figure 3. Effect of seeding system (KP = knife point (narrow point), Disc = low disturbance disc (Austil) and pre-emergence herbicides on ryegrass control (%) at Roseworthy in 2008. The ryegrass at this site is trifluralin-susceptible. Columns with the same letter are not significantly different at the 5% level. Untreated mean annual ryegrass density = 251 plants/m^2.

(c) Crop selectivity

Excellent crop safety with pre-emergence herbicides was shown under narrow-points (Figure 3). By contrast, crop establishment was reduced with Triflur-X (54% of the untreated control) and the Triflur-X + Avadex Xtra (62%) mixture under the low soil disturbance Austil disc system. Herbicide damage with the Austil system occured as a result of a combination, of shallow seeding depth and limited displacement of herbicide from the seed furrow (Figure 4). In combination this can result in seedlings germinating in close proximity to the concentrated herbicide band, retarding establishment. Importantly, new pre-emergence herbicides Boxer Gold and Sakura were safe on the emerging wheat crop, regardless of seeding system. However, it is noteworthy that soil conditions at and following herbicide application were dry and less conducive to herbicide mobility and consequent crop damage.

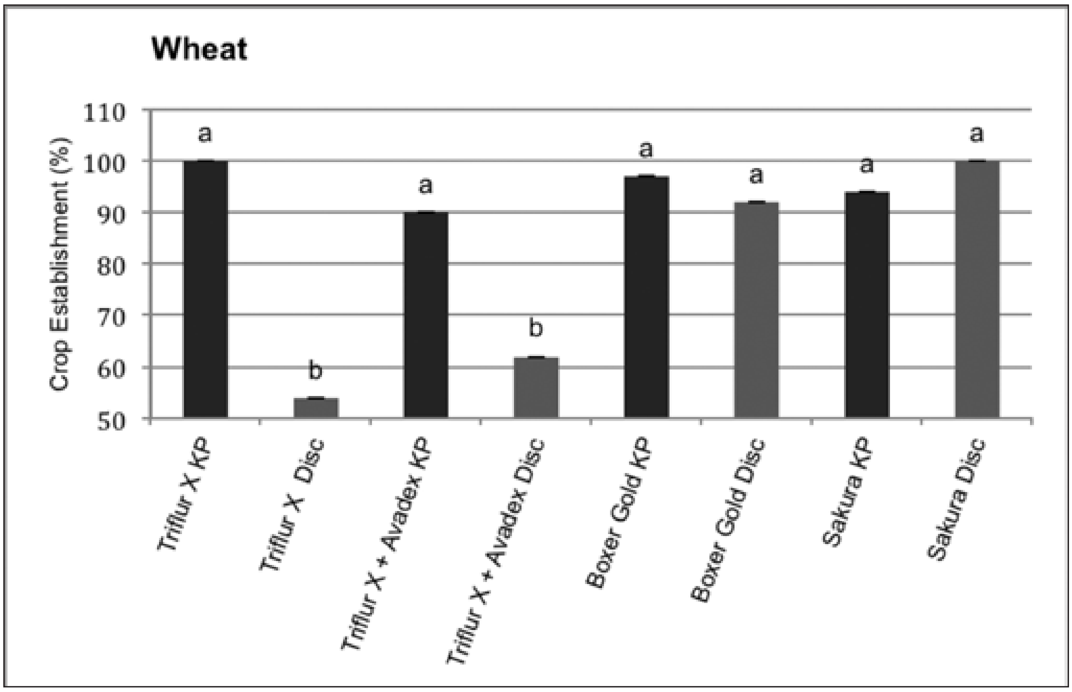

Figure 4. Effect of seeding system (KP = knife point (narrow point), Disc = low disturbance disc (Austil) and pre-emergence herbicides on wheat establishment (%) at Roseworthy in 2008. Columns with the same letter are not significantly different at the 5% level. Untreated mean wheat density = 170 plants/m^2.

Glyphosate resistance in ryegrass

There are now over 100 confirmed sites with glyphosate resistant ryegrass in Australia. These come from four states and a variety of situations (Table 2). An increasing number of sites in SA and Victoria are from fence lines and other uncropped parts of the farm. Recently, several populations from within paddocks have also been confirmed. Glyphosate resistant ryegrass occurs when populations are treated intensively with glyphosate, where no other herbicides are 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.

Table 2: Situations containing glyphosate resistant ryegrass.

Situation		Number of sites	States
Broadacre cropping	Chemical fallow	28	NSW
	No-till winter grains	19	Vic, SA, WA
Horticulture	Tree crops	4	NSW
	Vine crops	15	SA, WA
Other	Driveway	1	NSW
	Fence line/Firebreak	25	NSW, SA, Vic, WA
	Irrigation channel	8	NSW
	Airstrip	1	SA
	Railway	1	WA
	Roadside	1	SA

From Preston, C. (2009) Australian Glyphosate Resistance Register. Australian Glyphosate Sustainability Working Group. (www.glyphosateresistance.org.au)

Management of glyphosate resistant ryegrass on crop margins, especially fence-lines and fire-breaks is necessary in order to stop resistance moving into the cropped area. A trial was conducted to look at the ability of glyphosate mixtures and alternative herbicides to control a glyphosate-resistant population of ryegrass on a fence line (Figure 5). Glyphosate, even at high rates provided little control of the resistant ryegrass. Mixtures with diuron were effective, as was Alliance and two applications of Spray.Seed 14 days apart.

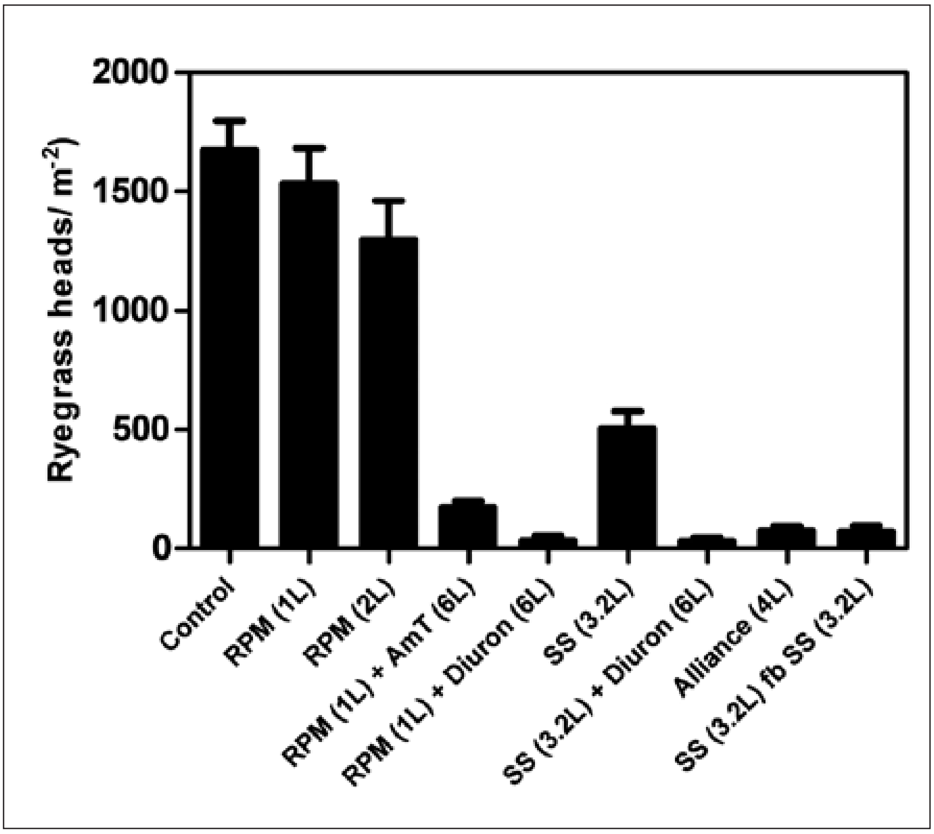

Figure 5: The efficacy of different mixes and rates of herbicides on glyphosate resistant ryegrass in a fenceline at Clare, SA. (RPM = Roundup PowerMax, SS = Spray.Seed, AmT = Amitrole T, fb = followed by after 14 days).

Interpretation

The fence-line trial has shown that alternative herbicides to glyphosate exist to effectively control ryegrass along fence-lines and firebreaks. Farmers should implement such strategies where glyphosate is not controlling ryegrass. In addition, alternative herbicides should be implemented to prevent glyphosate resistance being selected.

Acknowledgments

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