FACTSHEET

Alternative Herbicides for Management of Group A Herbicide-Resistant Barley Grass in Field Pea

Barley grass is a problematic annual weed species in Australia, typically growing in areas with less than 425 mm of rainfall. It is commonly found in crop fields and pastures, on roadside verges and in livestock enclosures.

Although valued for animal feed in pastures early in the season, upon maturity the long barbed awns of barley grass seeds irritate livestock and entangle in wool, reducing productivity and product quality. Barley grass can also serve as a host for pathogenic fungi and nematodes in cereal-growing areas.

Barley grass plants (A) and seed head (B). Mature seeds cause problems for animals (C).

Group A Herbicide Resistance

Weed management practices used in cropping systems of South Australia have increased seed dormancy in barley grass populations. This evolving characteristic has enabled barley grass to escape typical pre-sowing control and establish after crops have been planted. Consequently, local growers have relied heavily on post-emergence herbicides, particularly those from mode of action Group A, leading to resistant populations.

Group A herbicides inhibit acetyl co-enzyme A carboxylase (ACCase), which is essential for fat synthesis, and include herbicides from the chemical classes of 'Fops, Dims and Dens'.

The combination of group A herbicide-resistance plus high seed dormancy makes barley grass increasingly difficult for Australian farmers to control. At present, growers are relying heavily on imidazolinone herbicides (Group B) in Clearfield® cereals, post-emergence. This practice needs to be used with caution because resistance to these group B herbicides can develop rapidly compared to other herbicide groups.

In southern Australia, grain legume crops are widely grown in rotations with cereals, but they tend to be less competitive with weeds. Control of Group A herbicide-resistant barley grass in field peas can be particularly difficult, so field trials were conducted to identify alternative herbicides for effective management in this situation. The findings and associated management advice are outlined in this factsheet.

Prevalence of Group A herbicide resistant barley grass in South Australia

The location (●) of SA fields where barley grass was collected for herbicide resistance screening. *Adapted from Shergill et al 2015*

Screening of barley grass populations randomly collected in a field survey of the Upper North and Eyre Peninsula regions of SA, revealed that the greatest incidence of Group A herbicide-resistance was to quizalofop (e.g. Targa®).

Of the 90 populations tested, 15% had Group A resistance. The majority (54%) were collected from wheat fields, which dominate these cropping systems. Resistance was also detected in populations collected within pasture (23%), pea (15%) and barley (8%) crops.

Considerable variation in quizalofop resistance was identified between regions. Of the fields surveyed, the greatest frequency of resistance was in the Upper North region (39%) but it was lower on the Eyre Peninsula (6%).

Managing Group A herbicide resistant barley grass

- Effective control of group A herbicide-resistant barley grass was provided by pre-emergence application of pyroxasulfone (Group K) and an experimental herbicide (Group D).
    - Weed competition and seed production successfully reduced
    - Crop yields increased
    - Excellent crop safety
- Post-emergence treatment with Imazamox (Group B) was effective.
- These products should be considered as part of a resistance-management program; they provide an alternative mechanism of action and are highly effective on barley grass.
- Highest crop yields occurred when weeds were effectively controlled.
- Current common management practices are selecting for greater seed dormancy in Group A resistant barley grass. Such populations are difficult to manage with pre-emergence herbicides.
- Integrating non-chemical weed management strategies for long term weed management is necessary.

Field trials - Identifying alternative herbicides

Two trials were established in South Australian fields that were infested with barley grass confirmed to be resistant to Group A herbicides. The effectiveness of various herbicide treatments (Table 1), with a focus on products used pre-emergence, were evaluated in field peas (cv Kaspa) seeded at a depth of 5 cm with a no-till drill. The crop was sown at a seed rate of 90 kg ha^{-1} in rows about 24 cm apart. Crop safety and yield impacts were also assessed (Page 4: Table 2).

Table 1. Herbicide treatments tested for effectiveness in controlling Group A resistant barley grass. Each treatment was applied to soil pre-emergence except for Imazamox, which was applied 6-7 weeks post-emergence (POST). Plant density was measured 12 weeks after planting.

Treatments	Mode of Action	Rate	Weed Control 2012	Weed Control 2014	Seed Production 2012	Seed Production 2014
	Group	*g ai ha^{-1}*	*–% of untreated–*		*–seeds per m^2–*	
Nil (untreated control)	–	–	–	–	31,515	14,972
Pyroxasulfone (Sakura®)	K	100	**87**	**86**	**522**	**415**
Prosulfocarb + S-metolachlor (Boxer® Gold)	J + K	2000 + 300	48	52	16,785	5,610
Dimethenamid-P (Outlook®)	K	720	49	61	4,618	3,503
Trifluralin (Trilogy®)	D	960	52	51	20,802	8,346
Trifluralin + Triallate (Trilogy® + Avadex Xtra®)	D + J	960 + 1000	63	60	19,213	5,539
Trifluralin + Diuron (Trilogy® + Diuron 900DF)	D + C	960 + 900	86	63	14,206	8,045
Experimental herbicide	D	750	**99**	**99**	**258**	**69**
Imazamox (Raptor®) POST	B	32	**99**	**84**	**6**	**1,710**

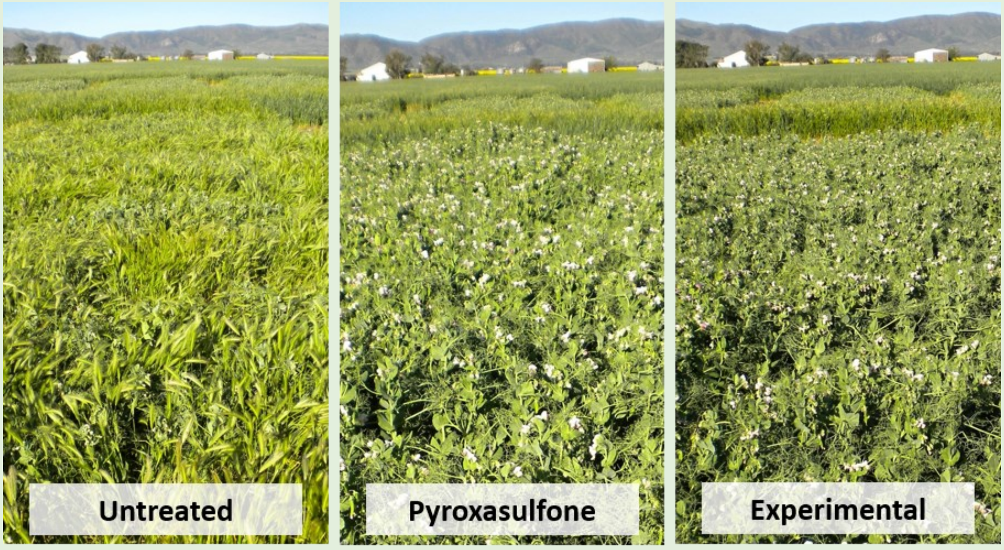
Herbicides that controlled Group A resistant barley grass (Table 1)

Pyroxasulfone (Group K) and an experimental herbicide (Group D) applied pre-emergence, and imazamox applied post-emergence, can provide effective control and reduce weed seed-set of field populations of Group A herbicide resistant barley grass.

Although all herbicide treatments reduced barely grass plant density and seed production, they did so to significantly different extents. During both growing seasons, good soil moisture conditions due to excellent post-seeding rainfall favoured the activity of pre-emergence herbicides on barley grass. Control may be less in drier seasons.

Most effective: Pyroxasulfone (Sakura®) and The Experimental Herbicide

Pre-emergence application of pyroxasulfone (Group K) and the experimental herbicide (Group D) provided high levels of barley grass control, reducing weed density by 99% and 86%, compared to the untreated. They also greatly reduced barley seed production with fewer than 525 seeds m^{-2} produced (Table 1).



Severe barley grass infestation in an untreated field pea crop, compared to excellent control by pyroxasulfone and an experimental herbicide applied pre-emergence.

Crop yields increased significantly in treatments with high barley grass control, up to 2.8 times compared to the untreated, and no crop damage was evident (Table 2).

Both of these herbicides have residual soil activity, which provided effective control of later emerging seedlings in barley grass populations.

Effective but survivors produce many seeds: Imazamox (Raptor®) post-emergence

Effective barley grass control by Imazamox applied post-emergence.

The effectiveness of imazamox (Group B) varied between seasons, with greater control of barley grass infestations in 2012 (Table 1). Although reasonably effective in 2014, survivors produced a lot of seed (1,700 m^{-2}). This means imazamox is a riskier option because it takes only a few survivors to repopulate the seed bank.

Failure to consistently reduce herbicide-resistant weed seed production can rapidly cause large build-ups in weed infestations, which will continue to cause problems in future cropping seasons.

Field pea treated with imazamox produced similar yields to the most effective pre-emergence herbicide treatments (Table 2).

Pre-emergent herbicides providing inadequate control:

Prosulfocarb plus S-metolachlor (Boxer Gold®), dimethenamid-P (Outlook®), and trifluralin (Trilogy®) alone or in combination with triallate (Avadex Xtra®) or diuron were relatively ineffective in reducing barley grass seed production (Table 1). However, they all provided increased grain and forage yields relative to the untreated, due to reduction in early competition from weeds. Weed survivors produced lots of seed, highlighting the uncompetitive nature of field pea.

Barley grass treated with dimethenamid-P was severely stunted and most eventually died even though only a modest reduction in plant density was evident when evaluated shortly after crop-emergence. Despite this, dimethenamid-P was ineffective for reducing the production of barley grass seed (Table 1).

The addition of diuron to trifluralin improved weed control relative to trifluralin alone, in 2012 only (Table 1). The lower activity of diuron in 2014 might be due to leaching of the herbicide by 67 mm of rainfall that fell over four consecutive days after herbicide application, compared to no rainfall within this period in 2012.

Poor control of barley grass by trifluralin and prosulfocarb + S-metolachlor.

Field pea yields are influenced by extent of weed control achieved

During both trial years, the highest yields were recorded in plots treated with the experimental herbicide, pyroxasulfone, dimethenamid-P or imazamox (Table 2). This field study confirmed that barley grass is highly competitive against field pea and unless effective control tactics are used there are large yield penalties due to weed competition (Table 2). Poor control of barley grass in field pea, which is less competitive than cereals, will undoubtedly intensify future weed infestations that are likely to cause production problems in subsequent crops.

Table 2. All herbicide treatments increased field pea grain and forage yields by reducing weed competition for growing resources such as water and nutrients. Grain yield was measured in 2012, whilst forage yield was measured in 2014 because of a severe frost event affecting grain production.

Treatments	Mode of Action	Grain Yield 2012	Gain in grain yield	Forage Yield 2014	Gain in forage yield
	Group	*t per ha*	*% increase of untreated*	*t per ha*	*% increase of untreated*
Untreated	–	**0.8**	–	**2.1**	–
Pyroxasulfone (Sakura®)	K	**2.3**	188	**3.2**	52
Prosulfocarb + S-metolachlor (Boxer® Gold)	J + K	1.4	75	2.6	24
Dimethenamid-P (Outlook®)	K	2.1	163	3.3	57
Trifluralin (Trilogy®)	D	1.2	50	3	43
Trifluralin + Triallate (Trilogy® + Avadex Xtra®)	D + J	1.3	63	3	43
Trifluralin + Diuron (Trilogy® + Diuron 900DF)	D + C	1.6	100	2.8	33
Experimental herbicide	D	**2.3**	188	**3.8**	81
Imazamox (Raptor®) POST	B	2.1	163	3.2	52

Disclaimer: The registered names for herbicide chemistries stated in this factsheet are those that were used in our field trials. There are other registered herbicides containing the same chemistries and could therefore be substituted. Please observe label recommendations when designing your weed management strategy.

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Resources:

Shergill LS, Fleet B, Preston C, Gill GS (2016) Management of ACCase-inhibiting herbicide-resistant smooth barley (*Hordeum glaucum*) in field pea with alternative herbicides. Weed Technology. 30(2):441-447

Shergill LS, Fleet B, Preston C, Gill GS (2015) Incidence of herbicide resistance, seedling emergence, and seed persistence of smooth barley (*Hordeum glaucum*) in South Australia. Weed Technology 29:782-792.