Demonstrating integrated weed management strategies to control barley grass in low rainfall zone farming systems

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Summary Barley grass (*Hordeum glaucum*) continues to be the major grass weed in cereal cropping regions on the upper Eyre Peninsula (EP). A three-year field trial was undertaken to investigate barley grass management strategies. The traditional management of pasture systems resulted in an increase in barley grass set and its infestation next year. In contrast, the use of a desiccated late hay freeze in the pasture phase reduced barley grass seed set by 75%. Use of simazine and clethodim in triazine tolerant canola reduced barley grass seed set. Imidazolinone herbicide worked well in the year of application (2019) but barley grass was able to infest the sown pasture system in the following season.

Despite achieving effective control in one season barley grass has the ability to germinate from the weed seed bank the following season and still set high weed seed numbers. Therefore barley grass management and lowering weed seed set needs to be a focus in all seasons in low rainfall farming systems.

Keywords Barley grass, weed management, low rainfall farming systems.

INTRODUCTION

Barley grasses (*Hordeum glaucum* and *H. leporinum*) possesses several biological traits that make it difficult to manage in the low rainfall zone, so it is becoming a more prevalent weed species in field crops in southern and western cropping regions. A survey by Llewellyn, *et al.* (2016) showed that barley grass is now in the top 10 weeds of Australian cropping in terms of area infested, crop yield loss and revenue loss.

The biological traits that make barley grass difficult to manage in low rainfall zones include the early onset of seed production, which reduces effectiveness of crop-topping or spray-topping in pastures; shedding seeds well before crop harvest which reduces the ability of harvest weed seed control effectiveness compared to weeds such as ryegrass which have a much higher seed retention; increased seed dormancy due to a cold vernalisation requirement (Fleet *et al*., 2012) which reduces weed control from pre-seeding knockdown herbicides due to delayed emergence; and increasing herbicide resistance, especially to Group 1 herbicides commonly used to control grass weeds in pasture phase and legume crops.

Barley grass management is more challenging in the low rainfall zone because the growing seasons tend to be more variable in terms of rainfall, which can affect the performance of the pre-emergent herbicides. Furthermore, many growers in these areas tend to have lower budgets for management tactics, and break crops are generally perceived as a higher risk rotation strategy than cereals. Therefore, wheat and barley tend to be the dominant crops in the low rainfall zone. This research was undertaken at the SARDI Minnipa Agricultural Centre (MAC) as part of a coordinated GRDC research project with farming systems groups across the southern and western cropping regions to demonstrate tactics that can be reliably used to improve the management of barley grass.

MATERIALS AND METHODS

In 2019 low rainfall growers and weeds researchers met to discuss the issue of barley grass in low rainfall upper Eyre Peninsula farming systems. A three-year broad acre management plan was developed to be implemented with five different strategies to test and compare barley grass management in a replicated broad acre farm trial on the SARDI Minnipa Agricultural Centre from 2019 to 2021 (Table 1). The strategies implemented were System 1 (S1) - District Practice, S2 - Strategic control, S3 - Continuous Cereals, S4 - Two Year Break and S5 - Cultural Control system. The Minnipa Agricultural Centre has an average annual seasonal rainfall of 324 mm, with an average growing season rainfall of 241 mm.

The five management strategies were tested over the three years of rotation with the focus on barley grass weed management and weed seed set. The trial was composed of three replicated broad acre strips of three seeder widths of 27 metres wide of each treatment in MAC paddock S3. Crop establishment, dry matter, barley grass numbers pre-sowing, in crop and at barley grass seed set, grain yield and quality were assessed during the growing seasons. Stubbles and pastures were grazed by sheep over the summer period. The barley grass population present at the trial site has been confirmed to be resistant to group

1 herbicides. For this reason, the use of group 1 herbicides were reduced as management strategies in the broadacre demonstration.

RESULTS

2019

In 2019 the barley grass plant numbers in June/August ranged from 0 to 130 plants/m^2. However, treatments with between 3 to 8 plants/m^2 (District Practice and Cultural Control) still produced over 300 seeds/m^2. In contrast the use of imidazolinone in Scope CL barley in System 2 (S2 - Strategic control) had no barley grass weed seed set in 2019. Compass barley in the District Practice (S1) and Cultural Control systems (S5) had very similar barley grass seed set. Compass barley crop-topped before cutting for hay (S3) reduced barley grass seed set in 2019. The Two Year Break (S4) with self-regenerating pasture in 2019 had higher barley grass plant numbers during the season, but late paraquat application in early September in the pasture phase lowered weed seed set.

System	2019	2020	2021
1. District practice	17 May: Compass barley sown @ 68 kg/ha Glyphosate 1.2 L/ha + Trifluralin 1.5 L/ha	Self-regenerating medic pasture Clethodim 330 mL/ha POST	2 June: Scepter wheat sown @ 75 kg/ha Glyphosate 1.2 L/ha + Trifluralin 1.5 L/ha
2. Strategic control	17 May: Scope CL barley sown @ 68 kg/ha Glyphosate 1.2 L/ha + Trifluralin 1.5 L/ha 16 July: POST Intervix 700 mL/ha	26 April: Sultan medic 3 June: POST Clethodim 330 mL/ha	2 June: Scepter wheat sown @ 75 kg/ha Glyphosate 1.2 L/ha + Trifluralin 1.5 L/ha
3. Continuous cereals	17 May: Compass barley sown @ 95kg/ha Glyphosate 1.2 L/ha + Trifluralin 1.5 L/ha 3 Sep: hay freeze with Weedmaster DST @ 1.8 L/ha	12 May: Scepter wheat sown @ 70 kg/ha PRE Trifluralin 1.5 L/ha	10 June: Spartacus CL barley sown @ 70 kg/ha 6 August: POST Intervix 700 mL/ha
4. Two year break	Self-regenerating grass free pasture 17 May: Propyzamide 1 L/ha 2 July: Targa Bolt 190 mL/ha + Clethodim 250 mL/ha 3 Sep: spray-topping with Paraquat 1.2 L/ha	26 April: Trident TT canola sown @ 1.8 kg/ha Glyphosate 1.5 L/ha + Hammer 50 mL/ha + Trifluralin 0.8 L/ha + Simazine 0.8 L/ha 3 June: Clethodim 330 mL/ha 11 June: Atrazine 800 g/ha	2 June: Scepter wheat sown @ 75 kg/ha Glyphosate 1.2 L/ha + Trifluralin 1.5 L/ha
5. Cultural control	17 May: Compass barley double seeded @ 120 kg/ha 17 May: Glyphosate @ 1.2 L/ha	Self-regenerating grass-free pasture 3 June: Clethodim @ 330 mL/ha 6 Sep: hay freeze with Paraquat @ 1.2 L/ha	2 June: Scepter wheat double sown 2 June: Glyphosate 1.2 L/ha + Trifluralin 1.5 L/ha

Table 1. The five different management strategies, crops, pastures and herbicide treatments for each season (2019-2021) at Minnipa Agricultural Centre, paddock S3.

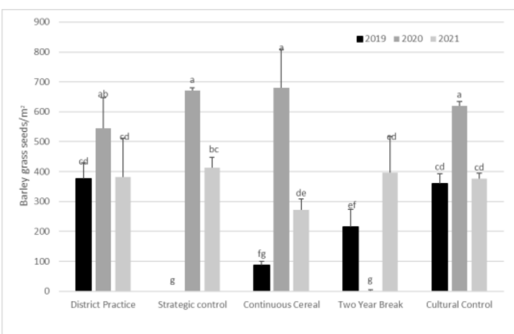

Figure 1. Barley grass weed seed set in five different management strategies over three years (2019-2021) at Minnipa Agricultural Centre, paddock S3. Treatments with different letters are significantly different at P=0.05 (LSD =138). Error bars represent standard deviation of the treatment. Refer to Table 1 for information regarding the management strategies investigated.

2020

With a late break to the season in 2020 most of the barley grass germinated in mid-July to August thereby avoiding the early weed control with pre-sowing herbicide applications. All crops established well but below average rainfall in May, June and July resulted in very slow crop growth until August and September. The 2020 herbicide applications to the break crop systems of the canola and medic crops reduced barley grass plant numbers, with the triazine tolerant canola system (S4) giving the best late barley grass weed management.

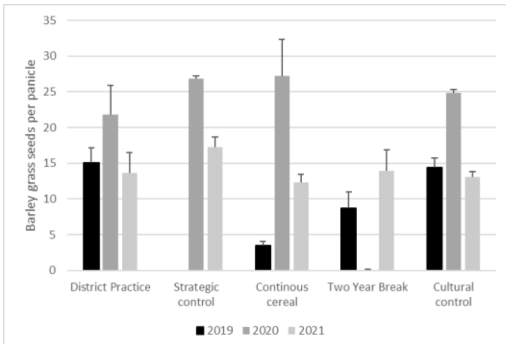

Figure 2. Barley grass seeds per panicle for weed seed set in five different management strategies over three years (2019-2021) at Minnipa Agricultural Centre, paddock S3. Treatments with different letters are significantly different at P=0.05 (LSD =4.6). Error bars represent standard deviation of the treatment. Refer to Table 1 for information regarding the management strategies investigated.

Despite excellent weed control in 2019 by the imidazolinone herbicide in S2, barley grass plants and seeds set in 2020 were as high as the other three systems (Figure 1). It is highly likely barley grass was able to establish in this system from the residual seedbank.

2021

Some barley grass plants started to germinate by early July in 2021, but like previous years, most barley grass germinated in mid-July to August, which was reflected in the higher late barley grass numbers in September. The Continuous Cereal system sown with Spartacus CL barley had high early barley grass numbers, but imidazolinone applied in early August reduced the barley grass density and lowered the seed set (Figure 1). All other management strategies which were sown to Scepter wheat had a similar barley grass seed set of greater than 370 seeds/m^2. There were no differences in grain yield between weed management strategies in 2021.

The barley grass seed set per panicle weed seed set per panicle varied between seasons with 2020 having greater number of weed seeds being set and returned to the weed seed bank than the other seasons (Figure 2).

DISCUSSION

During the three years of this trial, management tactics found to be effective on barley grass included imidazolinone herbicides, the use of triazine tolerant (TT) canola with simazine and a late hay freeze in pasture with paraquat. Even though imidazolinone worked well in the year of application (2019), barley grass was able to establish in the following year from the seedbank and its population increased in the sown pasture system in the following season.

While the imidazolinone herbicide system is working well in low rainfall farming systems, it must be strategically used to maximise the effectiveness and long-term use of this system. Growers need to be aware of the risk of herbicide resistance and also imidazolinone herbicide residues and plant back periods, especially in low rainfall seasons.

This field trial failed to identify a management strategy capable of eliminating barley grass in a single year. Therefore, barley grass management and lowering weed seed set needs to be a focus of growers in all seasons in low rainfall farming systems.

With confirmed resistance to 'fop' herbicides in barley grass populations at the Minnipa Agricultural Centre, switching to clethodim could be effective in the short term. Generally, a higher rate of clethodim (500 mL ha^{-1}) appears to be effective on most populations. Recent work has shown butroxydim was highly effective against most of 'fop' and clethodim resistant populations of barley grass (Gill *et.al.*, 2021). However, resistance to the higher rate is likely to evolve with sustained use over the next few years.

With group 1 herbicide resistance becoming more common and widespread within the upper EP low rainfall zone there needs to be less reliance on their use in the pasture phase and alternative weed control strategies implemented across the rotation are required. If barley grass herbicide resistance is suspected, the barley grass population needs to be tested to know which herbicides can be used effectively.

To ensure group 1 resistance is kept in check, growers should ensure any suspected resistant plants are dealt with in pasture systems by following up with a knockdown herbicide as early as possible to prevent seed set. Growers should always have follow up options to control any survivors and to preserve group 1 herbicides for as long as possible.

The loss of group 1 herbicides within the pasture break system has the potential to change farming systems. Currently farmers on the upper Eyre Peninsula rely on self-regenerating medic-based systems with a profitable livestock enterprise, with grass control applied to prevent weed seed set in spring. Inability to control barley grass with group 1 herbicides will result in medic pasture having to be sprayed out using glyphosate in spring. This will reduce the feed base and livestock carrying capacity, delayed crop sowing times in the cropping phase to gain early weed control or more cropping dominant systems with other break crops (canola, vetch, lentils) and alternative herbicide groups which will increase risk and could impact on profitability.

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