Effect of combinations of sowing time, seed rate and herbicides on brome grass management in barley (Kinnabulla, VIC)

Abstract

A field trial was undertaken at Kinnabulla (VIC) in 2019 to investigate combinations of sowing time, seed rate and herbicide treatments to control brome grass in barley. Spartacus CL barley was used in this trial to enable the use of Intervix® for post-emergence control of brome grass. In 2019, the trial site received 181 mm rainfall during the growing season (April-October), which was 23% lower than the long-term average for the site. However in December 2018, the site received a heavy downpour of 199 mm, which created good growing conditions for barley crop grown in 2019. In this trial, barley seeding rate did not have a significant effect on either yield (P=0.213), brome panicles/m^2 at maturity (P=0.889) or brome seed set/m^2 (P=0.409). This lack of effect of crop seed rate on the number of brome panicles and seed set could be related to the high plant available water during the crop and weed life-cycle or due to Spartacus being a less competitive barley cultivar due to its erect architecture. Time of sowing had a significant effect on brome panicles/m^2 at maturity and brome seed set/m^2. TOS 2 had a lower brome panicle density at maturity than TOS 1 across all herbicide strategies, which was most likely due to low pre-sowing weed kill in TOS 1 as brome grass had not yet germinated. However, brome population that had germinated after the opening rains was killed by glyphosate application prior to seeding barley in TOS 2. As the numbers of panicles were lower in TOS 2, brome seed set was also reduced in TOS2 relative to TOS 1. Herbicide strategy had a significant effect on barley grain yield. As the herbicides reduced the impact of brome on barley, its yield increased from 3.24 t/ha in the knockdown treatment (NIL), to 3.72 t/ha in the pre-emergent herbicides only and to 3.96 t/ha when the pre-emergent herbicides were followed by post-emergent Intervix. Somewhat surprisingly, TOS 2 produced higher yields than TOS 1 across all the treatments, with the greatest difference being 0.46 t/ha in the Nil herbicide treatments. However, the yield difference between the two times of sowing decreased when more effective herbicides were used (0.08t/ha difference between TOS 1 and 2 in pre-emergent only and 0.04t/ha difference when pre-emergent herbicides followed by Intervix). Higher barley grain yield in the later sown crop is most likely due to a significantly greater weed density in barley in TOS 1 than in TOS 2, as large numbers of early germinating brome plants were controlled with glyphosate knockdown in TOS 2. TOS 1 also experienced a mild frost during flowering, resulting in patchy frost damage. Furthermore, May 23 (TOS 2) sowing date still falls within the optimum sowing window for Spartacus, which is an early maturity variety, and TOS 1 on April 29 was earlier than optimum for this variety.

Introduction

Brome grass (*Bromus diandrus*) is becoming an increasing problem across the medium to low rainfall regions across the Mallee and Wimmera. As cereal cropping intensity, and no-till farming systems have increased, so too has the prevalence of brome, due to a lack of control methods in non-Clearfield cereals and the burial needed for germination, which delays germination until after seeding of the crops. Brome is highly competitive with crops and well adapted to low rainfall environments due to an extensive root system. Furthermore, it has been shown to significantly reduce yields at low densities, and at high densities (100 plant/m^2) reduce wheat yields by as much as 30-50 percent (Kleemann 2011 GRDC Factsheet).

To better understand which cultural and chemical controls could be used to be used to reduce the impact of brome grass in cereal crops in the Mallee, this trial was conducted. The aim of this experiment was to determine the effect of sowing time, barley density and herbicides on brome grass control.

Methods

This field trial investigated combinations of the following management tactics.

1. **Sowing time (2)**: late April and late May
2. **Seed rate (3)**: 1x (200 seeds/m^2), 0.75x (150 seeds/m^2), 0.5x (100 seeds/m^2)
3. **Herbicides (3)**:
   (i) Nil (knockdown treatment only)
   (ii) Treflan 2 L (480 g/L) + Avadex 2 L/ha (500 g/L) Incorporated by sowing (IBS)
   (iii) Treflan 2 L (480 g/L) + Avadex 2 L/ha (500 g/L) Incorporated by sowing (IBS)

Variety: Spartacus CL barley

Trial design: split plot design
Replicates: 3

Measurements: pre-sowing weed seedbank, crop density, weed density, brome panicle density, brome grass seed production, barley grain yield.

Trial Management

Table 1. Key management operations undertaken.

Operation	**Details**
Location	Kinnabulla, VIC
Seedbank soil cores	22 March, 2019
Plot size	2 m x 10 m
Seeding date	TOS 1: 29 April, 2019 TOS 2: 23 May, 2019
Fertiliser	At sowing – DAP+Zn+Impact (18:20:0:2) @ 75 kg/ha, Post application of Urea 7 August
Variety	Spartacus CL barley
Seeding rate	100 seeds/m^2 150 seeds/m^2 200 seeds/m^2
Herbicides	29 April and 23 May, 2019 (applied just before seeding) 1. Control (knockdown only) 2. Triflur Xtra (480 g/L trifluralin) @ 1.5L/ha + Avadex (500 g/L triallate) @ 2L/ha + RoundUp PowerMax (540 g/L glyphosate) @ 2L/ha IBS 3. Triflur Xtra (480 g/L trifluralin) @ 1.5L/ha + Avadex (500 g/L triallate) @ 2L/ha + RoundUp PowerMax (540 g/L glyphosate) @ 2L/ha IBS Fb Intervix (33 g/L imazamox + 15 g/L imazapyr) @ 0.6L/ha (TOS1: GS30, TOS2: GS21)

All data collected during the growing season was analysed using the Analysis of Variance function in GenStat version 19.0.

In 2019, Kinnabulla received 181 mm rainfall during the growing season (April-October), which was 83% of the annual rainfall in that year. The annual rainfall in 2019 was much (39%) lower than the long-term average at the site. Most of the rainfall in 2019 fell during the GSR, which was 23% lower than the long-term average. However, December of 2018 received 199 mm rainfall and it's quite likely some of it would have been conserved in the soil and used by the barley crop grown in 2019.

Table 2. Rainfall received at Kinnabulla (VIC) in 2019.

	Rainfall (mm)	
Month	**2019**	**Long-term average**
Jan	0.0	21.1
Feb	13.0	23.2
Mar	0.0	21.0
Apr	3.0	24.1
May	51.2	34.9
Jun	41.0	35.3
Jul	34.2	34.3
Aug	28.0	35.8
Sep	23.4	35.2
Oct	0.0	35.1
Nov	22.8	26.6
Dec	0.0	25.3
Annual total	216.6	351.9
GSR total	180.8	234.7

Results and Discussion

Barley plant density

This trial did not reach the targeted sowing densities, with all treatments except for TOS 2 targeted seeding rate 100 plants/m^2 having lower than targeted plant establishment. Time of sowing, seeding rate and herbicide treatment all had a significant effect on plant establishment (Table 3). TOS 2 had greater plant establishment than TOS 1, and the use of pre-emergent chemistries Treflan and Avadex decreased plant establishment slightly compared to the nil treatment (knockdown only).

Despite the differences in plant establishment, targeted seeding rate did not have a significant relationship with either yield (P=0.213), brome panicles/m^2 at maturity (P=0.889) or brome seed set/m^2 (P=0.409). Increase in crop density did not reduce the number of brome panicles and seed set, which could partly related to the high plant available water during the crop and weed life-cycle or due to Spartacus CL being a less competitive barley cultivar (Walters 2017) due to its erect architecture.

Table 3. Average barley establishment (plants/m^2) across treatments, displayed with Fisher's Protected LSD (5%). (TOS p<0.001, Seeding rate P<0.001, Herbicide p<0.001, LSD=18.6, CV=8.7%)

		Barley establishment (plants/m^2)		
		Herbicide Treatment		
Seed Rate	**Time of Sowing**	**Nil**	**Treflan + Avadex**	**Treflan + Avadex Fb Intervix**
100	**TOS1**	86.4^{ab}	76.1^{a}	84.4^{ab}
	TOS2	110.6^{c}	106.7^{c}	100.3^{bc}
150	**TOS 1**	135.8^{e}	115.6^{cd}	110^{c}
	TOS2	143.1^{ef}	131.7^{de}	144.2^{ef}
200	**TOS1**	160^{fg}	146.1^{ef}	147.8^{ef}
	TOS2	182.2^{h}	172.2^{gh}	170.3^{gh}

Brome grass panicles and seed set

The trial site at Kinnabulla had an average brome grass seedbank of 489 ± 63 seeds/m^2, which is a moderate level. Time of sowing had a significant relationship with brome panicles/m^2 at maturity and brome seed set/m^2 (Table 4). TOS 2 had lower brome panicle density at maturity than TOS 1 across all herbicide strategies (Table 4). This was most likely due to the brome that germinated on the opening break being still present in TOS 1, but in TOS 2, the brome population that had already germinated was killed by glyphosate application prior to seeding barley. As the numbers of panicles were lower in TOS 2, brome seed set was also reduced in TOS2 (Table 4).

Barley grain yield

Herbicide strategy had a significant relationship with barley grain yield (Table 4). As expected, the combination of Treflan and Avadex pre-emergent and Intervix post-emergent had the lowest weed density, followed by pre-emergent only strategy, with the knockdown herbicide treatment having the highest weed density. This demonstrates the importance of herbicides as a tool to manage brome populations. The effect of these herbicides on the brome population indicates that resistance is not an issue in this paddock. As the herbicides reduced the impact of the brome on the barley crop, yield increased, with nil yielding an average on 3.24 t/ha, pre-emergent herbicides only yielding 3.72 t/ha and the pre-emergent herbicides followed by post-emergent Intervix yielding 3.96 t/ha (Table 4).

TOS 2 yielded higher than TOS 1 across all treatments, with the greatest difference being 0.46t/ha in the Nil herbicide treatments. However, the yield difference between the two times of sowing decreased as the herbicides became more effective (with a 0.08t/ha difference between TOS 1 and 2 in pre-emergent only and 0.04t/ha difference when pre-emergent herbicides followed by Intervix) (Table 4). This result is unexpected, as earlier sown crops generally yield higher than later sown crops. This result is most likely due to a significantly greater weed density in barley in TOS 1 than in TOS 2, as the early germinating brome was controlled with glyphosate knockdown in TOS 2. TOS 1 also experienced a frost during flowering, resulting in small amounts of patchy frost damage. Furthermore, May 23 (TOS 2) sowing date still falls within the optimum sowing window for Spartacus, an early maturity variety, while the April 29 is earlier than ideal (2020 Victorian Crop Sowing Guide).

Commercial implications

This trial has shown that brome grass control can be improved by sowing later but within the optimum sowing window without any yield penalty. A lack of yield penalty seen in 2019 may also be related to a full soil moisture profile at the site due to 199 mm rainfall in December 2018. Without this subsoil moisture, with the 178.3mm GSR and dry spring, it would be expected that the TOS 1 would have yielded higher than TOS 2 (barring major frost damage).

While Intervix is a strong control option for brome in cereal crops, the constant use of Intervix and other Clearfield chemistries will increase the risk of brome grass becoming resistant. It is important to rotate chemicals with different modes of action, and to consider other methods of controlling brome, such as time of sowing, harvest weed seed control and crop competition. While the use of Intervix on Clearfield cereal crops to control brome is currently an effective option, eventually this mode of action will become less effective than seen in this trial.

On-farm profitability

The highest yielding treatments were also the most profitable, due to small differences between SP1 and FEED 1 barley price in 2019 ($5 per tonne). Overall, the return minus the cost of spraying for the treatments ranged between $745-978/ha, driven by yields ranging between 2.92-4.11t/ha (Table 5). In 2019, using the combination of the post-emergent and pre-emergent herbicides provided an additional financial return for the grower. The pre and post emergent herbicide strategy provided the highest incomes after spray costs, followed by pre- emergent only, followed by the nil (knockdown only) herbicide treatments.

Table 4. Average brome density at maturity (panicles/m^2), yield (t/ha) and brome seed set/m^2 for time of sowing and herbicide treatments. Statistical tests on brome seed and brome density conducted on square-root transformed data.

Time of Sowing	Herbicide Strategy	Brome panicles/m^2	Yield (t/ha)	Brome seed set (seeds/m^2)
TOS 1	**Nil**	147.4	3.01	3950
	Treflan + Avadex	73.2	3.69	1947
	Treflan + Avadex + Intervix	10.8	3.94	142
TOS 2	**Nil**	102.0	3.47	2939
	Treflan + Avadex	31.0	3.79	982
	Treflan + Avadex + Intervix	1.4	3.97	41
	Sig. Diff			
	TOS	0.048	0.024	0.042
	Seeding Rate	NS	NS	NS
	Herbicide	<0.001	<0.001	<0.001
	LSD (P=0.05)			
	TOS	32.06	0.17	985
	Seeding Rate	39.27	0.20	873
	Herbicide	39.27	0.20	873
	Herbicide*TOS	55.53	0.29	1512.
	CV %	38.2	8.2	39.4

Table 5. Income remaining after treatment costs per ha ($) for each treatment, displayed with Fisher's Protected LSD (5%). Estimated using SP1=$248/t delivered to Birchip GrainFlow (GrainFlow website 20/11/19); Treflan $5.24/L (SARDI Gross Margins Guide); Avadex $8.86/L; RoundUp PowerMax $6.30/L; Intervix $30/L; Contract Spraying costs=$10/ha, with the pre-emergent only strategy requiring one pass, and the pre- emergent followed by post-emergent strategy requiring two passes.

		Adjusted income ($/ha)		
		Herbicide		
Time of Sowing	**Seed Rate**	Nil	Treflan + Avadex	Treflan + Avadex Fb Intervix
TOS 1	**100**	$722[a]	$803[abc]	$898[cd]
	150	$747[ab]	$916[cd]	$848[abcd]
	200	$768[ab]	$870[bcd]	$945[d]
TOS 2	**100**	$846[abcd]	$851[bcd]	$903[cd]
	150	$843[abcd]	$859[bcd]	$870[bcd]
	200	$868[bcd]	$917[cd]	$936[d]
		Sig. diff.		
		TOS	NS	
		Seeding Rate	NS	
		Herbicides	0.001	
		LSD (P=0.05)		
		TOS	44.8	
		Seeding Rate	54.9	
		Herbicides	54.9	
		TOS *Seeding Rate*Herbicides	129.2	
		CV%	9.1	