Effect of sowing time x seed rate x herbicides on brome grass management in barley (Watchman, SA)

Abstract

A field trial was undertaken at Watchman in 2020 to investigate combinations of barley sowing time, seed rate and herbicide treatments to control brome grass. The average seedbank of brome grass at the site was 2140 ± 178 seeds/m^2. Delaying sowing by three weeks did not impact on barley establishment (P=0.368) and brome grass plant density (P=0.417). However, delayed sowing of barley did have a significant effect on brome panicle density (P=0.019) and it had an interaction with herbicide treatment on brome seed production (P=0.049). This lack of an effect of delayed sowing on brome plant density, compared to other brome sites indicates presence of high seed dormancy in Watchman population. Barley seed rate did not have a significant effect on brome panicle production (P=0.854), or brome seed production (P=0.392). However it did have a small, but significant impact on barley yield with a 6% increase in grain yield when barley seed rate was increased from 100 to 200 seeds/m^2 (P=0.049). Increase in barley seed rate also significantly reduced barley grain contamination with brome grass seeds by 38% (P=0.049). Herbicide treatments had a significant effect on brome plant density (P<0.001), brome panicle density (P<0.001), brome seed production (P<0.001), brome grain contamination (P<0.001), and barley grain yield (P=0.023). Where IMI herbicide treatments were applied in this trial, brome grass control was improved greatly, which resulted in an increase in barley grain yield. These IMI herbicides were effective in providing high levels of brome grass control and should be considered a very useful tool in the management of brome grass. While herbicide resistance to these herbicides is common in annual ryegrass, IMI resistance in brome grass is far less common. However, over reliance on IMI herbicides should be avoided in order to preserve their activity for the future.

Introduction

Delayed sowing can provide opportunities to deplete weed seedbank before seeding the crop but weeds that establish in late sown crops can be more competitive on per plant basis. Therefore, it is important to investigate sowing time in combination with other practices across different rainfall zones. The review of Widderick et al. (2015) also recommended research on sowing time in many crops. Delayed sowing can also reduce crop yield so the gains made in weed control may be completely nullified by the yield penalty.

There has been some research already on the effect of crop seed rate on weed suppression but none of these studies have investigated the benefits of higher crop density in factorial combinations with sowing time and herbicide treatments. Crop seed rate is an easy tactic for the growers to adopt provided they are convinced of its benefits to weed management and profitability. Furthermore, growers in the low rainfall areas tend to be reluctant to increase their seed rate due to concerns about the negative impact of high seed rate on grain screenings.

This field trial at Watchman was undertaken to investigate factorial combinations of sowing time, seed rate and herbicides on the management of brome grass in barley.

Methods

This field trial investigated combinations of sowing time, seed rate and herbicide treatment on brome grass control in barley. Refer to Table 1 for details of treatments applied.

Variety: Spartacus CL Plus

Trial design: split plot design

Replicates: 3

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

Trial Management

Table 1. Key management operations undertaken.

Operation	Details
Location	Watchman, SA
Seedbank soil cores	April, 2019
Plot size	1.83 m x 10 m
Seeding date	TOS 1: 12 May, 2020 TOS 2: 3 June, 2020
Fertiliser	At sowing – DAP + zinc + impact (18:20:0:2) @ 100 kg/ha, Urea (46:0:0) @ 100kg/ha late tillering (separately for TOS)
Variety	Spartacus Cl plus barley
Seeding rate	100 seeds/m^2 150 seeds/m^2 200 seeds/m^2
Herbicides	Pre-emergent spray: 11 May and 3 June, 2020 (applied just before seeding) Post emergent: 15 July TOS 1, 3 August TOS 2, brome Z12-22 and barley Z22-24. (i) Trifluralin 2 L/ha + Avadex Xtra 2 L/ha IBS (ii) Trifluralin 2 L/ha + Avadex Xtra 2 L/ha IBS fb Intercept 750 mL/ha post (iii) Sentry + Trifluralin 2 L/ha + Avadex Xtra 2 L/ha IBS fb Intercept 750 mL/ha post

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

In 2020, annual rainfall received at Watchman (Balaklava data) was 15% below the long-term average and the growing season rainfall was 9% below the long-term average. The rainfall received in April and October was greater than the long-term average other months were well below the long-term average, particularly May to August (Table 2).

Table 2. Rainfall received at Balaklava in 2020 and the long-term average for the site.

	Rainfall (mm)	
Month	**2020**	**Long-term rainfall**
Jan	9.0	18.1
Feb	24.6	19.0
Mar	2.6	17.5
Apr	91.8	32.8
May	17.1	41.2
Jun	18.2	45.1
Jul	9.8	41.6
Aug	28.4	42.5
Sep	43.6	39.9
Oct	44.4	34.0
Nov	11.8	23.9
Dec	20.6	20.7
Annual total	321.9	378.8
GSR total	253.3	277.1

Results and Discussion

Barley plant density

As expected barley seed rate had a significant influence on barley density (P<0.001, Table 3). Three distinct plant densities were achieved, with seedling establishment ranging from 77 to 85%. Time of sowing did not influence barley establishment at this site (P=0.368). Herbicide treatments did not affect barley establishment (P=0.514), suggesting similar crop safety across pre-emergent herbicide treatments.

Table 3. Effect of barley seed rate on plant density (P<0.001); means followed a different letter indicate significant (P=0.05) differences. Seedling establishment (%) is shown in parenthesis.

Barley Seed Rate (seeds/m^2)	**Crop density Barley plants/m^2**
100	84.9 ***a*** *(85%)*
150	125.1 ***b*** *(83%)*
200	153.6 ***c*** *(77%)*

Brome grass plant density and seedbank

The average seedbank of brome grass at the site was 2140 ± 178 seeds/m^2. Brome grass plant density not significantly influenced by sowing time (P=0.417), or barley seed rate (P=0.109). However, it was significantly influenced by herbicide treatment (P<0.001; Figure 1). The addition of Intercept POST or Sentry IBS fb Intercept POST significantly reduced brome plant density from when Trifluralin + Avadex Xtra was used alone. There was no significant difference between treatments that included either Intercept or Sentry fb Intercept, suggesting good level of brome grass whenever an effective IMI herbicide is applied.

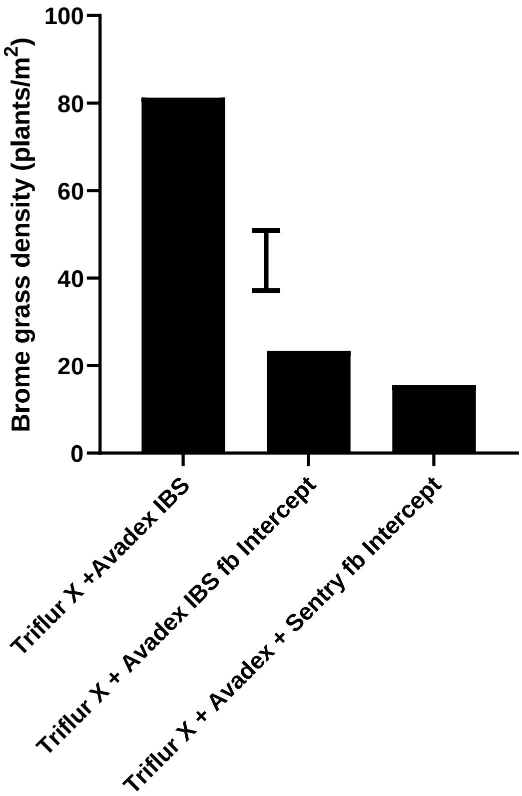

Figure 1. Herbicide effect on brome plant density (P<0.001); vertical bar represents the LSD (P=0.05).

Brome grass panicle density and seed production

Brome panicle density was significantly influenced by the time of sowing (P=0.019), and herbicide treatment (P<0.001). Seed rate, however did not significantly affect brome panicle denity (P=0.392) or brome seed production (P=0.854). When averaged across the barley seed rate and herbicide treatments, the three week delay in seeding at Watchman reduced brome panicles from 22.9 to 17.3 brome panicles/m^2, a 24% reduction in brome panicles. This is quite a modest reduction in brome panicle density compared to other brome sites in previous research that experienced >80% reduction with the same delay in sowing. These results suggest that this Watchman population of brome is likely to have high seed dormancy status. IMI herbicides had a large impact on brome panicle density, almost completely controlling brome grass with 99.7-100% less brome panicles compared to the Trifluralin + Avadex Xtra IBS alone (Table 4).

Table 4. Effect of herbicide treatments on brome panicle density (P<0.001). Means followed by a different letter indicate significant differences (P=0.05).

Herbicide treatment	**Brome panicle density (panicles/m²)**
Trifluralin + Avadex Xtra IBS	60.2 ***b***
Trifluralin + Avadex Xtra IBS fb Intercept POST	0.2 ***a***
Trifluralin + Avadex Xtra + Sentry IBS fb Intercept POST	0 ***a***

Similar to the trends observed for brome panicle density, brome grass seed production was close to significantly influenced by the time of sowing (P=0.056), herbicide treatments (P<0.001) and the interaction between the TOS and the herbicide treatments (P=0.042). A delay in sowing of three weeks resulted in a 36% reduction brome grass seed production in Trifluralin + Avadex Xtra IBS treatment. However, no such time of sowing influence occurred in other herbicide treatments that included IMI herbicides; these treatments achieved very high brome control for both TOS 1 and TOS 2 (Table 5). Use of IMI herbicides (Intercept or Sentry fb Intercept) provided very high levels of brome grass control and should be considered a very useful tool in the management of brome grass. While herbicide resistance to these herbicides are common in annual ryegrass, the occurance of IMI resistance in brome grass is far less common. However, considerations need to be taken to preserve this highly effective brome grass control tool for the future.

Table 5. The effect of the interaction between time of sowing and herbicide treatment on brome grass seed production (P=0.042). Means followed by a different letter indicate significant differences (P=0.05).

Herbicide treatment	**TOS 1** ***(Brome seeds/m²)***	**TOS 2** ***(Brome seeds/m²)***
Trifluralin + Avadex Xtra IBS	6031 ***c***	3867 ***b***
Trifluralin + Avadex Xtra IBS fb Intercept POST	2 ***a***	0 ***a***
Trifluralin + Avadex Xtra + Sentry IBS fb Intercept POST	0 ***a***	0 ***a***

Barley grain yield

Barley grain yield at Watchman ranged from 3.598 t/ha to 4.425 t/ha and with a site mean across all treatments of 4.045 t/ha. Time of sowing did not significantly impact on barley grain yield (P=0.179). Barley grain yield was significantly influenced by barley seed rate (P=0.011), with the low seed rate yielding 5% and 6% lower than the medium and high seed rates respectively. There was no significant difference between the medium and high barley seed rate barley grain yields. Herbicide treatments had a significant effect on barley grain yield (P=0.023; Table 6). Similar to the results for brome grass seed production, Trifluralin + Avadex Xtra IBS yielded significantly lower than the herbicide treatments that included IMI herbicides. These higher yielding plots also provided the highest brome grass control.

Table 6. Effect of herbicide treatment on barley grain yield (P=0.023). Means followed by a different letter represent significant differences (P=0.05).

Herbicide treatment	Barley grain yield (t / ha)
Trifluralin + Avadex Xtra IBS	3.922 ***b***
Trifluralin + Avadex Xtra IBS fb Intercept POST	4.140 ***a***
Trifluralin + Avadex Xtra + Sentry IBS fb Intercept POST	4.073 ***a***

Barley grain size (1000 grain weight) was significantly influence by time of sowing (P=0.011). Where, TOS 2 (43.53 g/1000 grains) was 14% higher than TOS 1 (38.23 g/1000 grains). These differences could be due to barley in TOS 2 being able to make better use of above average rainfall received at the site in September and October (Table 2).

Brome seed contamination in the barley grain sample was significantly influenced by barley seed rate (P=0.049), and herbicide treatment (P<0.001). Brome seed contamination reduced as barley seed rate increased, where the high seed rate had significantly lower (38%) brome seed contamination than the lowest seed rate (Table 7). Herbicide treatment also significantly influenced brome grain contamination, where treatments that included IMI herbicides had significantly less brome grain contamination than Trifluralin + Avadex Xtra IBS (P<0.001, Table 8).

Table 7. Effect of barley seed rate on brome grain contamination (P=0.049). Means followed by a different letter represent significant differences (P=0.05).

Barley seed rate (seeds / m^2)	Brome grain contamination (brome seeds/kg barley)
100	393 ***b***
150	320 ***ab***
200	245 ***a***

Table 8. Effect of herbicide treatment on brome grain contamination (P<0.001). Means followed by a different letter represent significant differences (P=0.05).

Herbicide treatment	Brome grain contamination (brome seeds/kg barley)
Trifluralin + Avadex Xtra IBS	937 ***b***
Trifluralin + Avadex Xtra IBS fb Intercept POST	15 ***a***
Trifluralin + Avadex Xtra + Sentry IBS fb Intercept POST	5 ***a***