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

Abstract

Barley plant density was significantly influenced by the time of sowing (P=0.025) and crop seed rate (P=0.002). Averaged across the seed rates and herbicide treatments, the first time of sowing (TOS 1) had barley density of 125 plants/m^2 compared to 82 plants/m^2 in TOS 2, which was related to dry soil conditions after sowing in TOS 2. Brome grass plant density was significantly affected by the time of sowing (P=0.018) and the herbicide treatments (P<0.001). The 4-week delay in sowing between TOS 1 and TOS 2, allowed greater emergence of brome grass seedlings before the sowing of the TOS 2. Consequently, barley sown at TOS 2 had 48% lower brome grass infestation (107.9 plants/m^2) than in TOS 1 (207 plants/m^2). As expected, herbicide treatments had a significant (P<0.001) effect on brome grass density. When averaged across the sowing time and seed rates, the treatment of Treflan + Avadex was only moderately effective and reduced brome grass density by 36% (173 plants/m^2) relative to the untreated control (271 plants/m^2). In contrast, the same pre-emergent treatment (Treflan + Avadex) followed by Intervix reduced brome grass density by 90% (28 plants/m^2). When averaged across seed rates and herbicide treatments, the time of sowing barley had a significant effect on its grain yield (P=0.011). TOS 1 produced 940 kg/ha greater barley grain yield than TOS 2. The post-emergence application of Intervix to the crop treated with Treflan + Avadex further increased barley grain yield by 872 kg/ha. These results are consistent with the trends in brome grass density and panicle production. The untreated control plots produced 40% lower grain yield than the Intervix treatment, which completely controlled brome grass. These results highlight the strong competitive ability of brome grass in cereals.

Introduction

Even though most of the Australian research on cultural weed management has been done with wheat, previous studies usually investigated single tactics and not their combinations. Change in sowing time can have multiple effects on crop-weed competition. Delayed sowing can provide opportunities to kill greater proportion of weed seedbank before seeding the crop but weeds that establish in late sown crops can be more competitive on per plant basis.

Crop density is an important non-chemical weed management tactic especially in wheat. Barley growers are usually reluctant to increase crop seed rates due to concerns about foliar diseases. Furthermore, barley is generally considered a more weed competitive crop than wheat so there may be no benefit of increasing the seed rate. However, crop seed rate is an easy tactic for the growers to change during their seeding program provided they are convinced of its benefits to weed management.

This trial aims to investigate the impact of integration of sowing time and seed rate of barley with pre-emergent herbicides on brome grass density and seed production as well as on barley grain yield.

Methods

Trial site: Marrabel, SA

This field trial investigated the effectiveness of non-chemical tactics (sowing time and seed rate) with herbicides for brome grass control in barley (refer to Table 1 for details). Management factors investigated were:

1. **Sowing time (2)**: early May and early June
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) Control (pre-sowing glyphosate treatment only);
(ii) Treflan 2 L/ha (480 g/L) + Avadex 2 L/ha (500 g/L) IBS
(iii) Treflan 2 L/ha (480 g/L) + Avadex 2 L/ha (500 g/L) IBS
Intervix 350-750 mL/ha (use rate within this range depending on weed density); GS12-14 of brome and GS13-31 of barley

Barley variety: Spartacus CL

Trial design: split-split plot design

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

Trial Management

Table 1. Key management operations undertaken.

Operation	**Details**
Sowing date	TOS 1: 24 May, 2018 TOS 2: 19 June, 2018
Fertiliser at sowing	Diammonium phosphate @ 100 kg/ha
In-crop fertiliser application	Urea @ 100 kg/ha at GS30
General broadleaf weed control	Affinity Force 100mL/ha + MCPA amine (750g/L) 330mL/ha
Pre-emergent herbicide treatments	Within 12 hours of crop sowing
Post-emergent Intervix	TOS 1: 1 Aug, 2018 – crop at GS 22-23, brome GS 22-24 TOS 2: 28 Aug, 2018 – crop at GS 22, brome GS 14-22

All data collected during the growing season was analysed using the Analysis of Variance function in GenStat version 15.0.

Results and Discussion

Barley plant density

Barley crop density was significantly influenced by the time of sowing (P=0.025) and crop seed rate (P=0.002). Averaged across the seed rates and herbicide treatments, TOS 1 had barley density of 125 plants/m^2 compared to 82 plants/m^2 in TOS 2. It is quite likely that cold and dry soil conditions experienced by barley seed in the late sown crop (19 June) reduced crop emergence. In TOS 1, crop density achieved was similar to the target density in the low seed rate but the gap between the two increased with seed rate (Figure 1). However in TOS 2, the gap between the achieved and target density ranged from 34% in the low seed rate, 45% in the medium to 52% in the high seed rate. Such large failure of barley seeds to establish is likely to be related to the extremely dry start to the growing season in 2018.

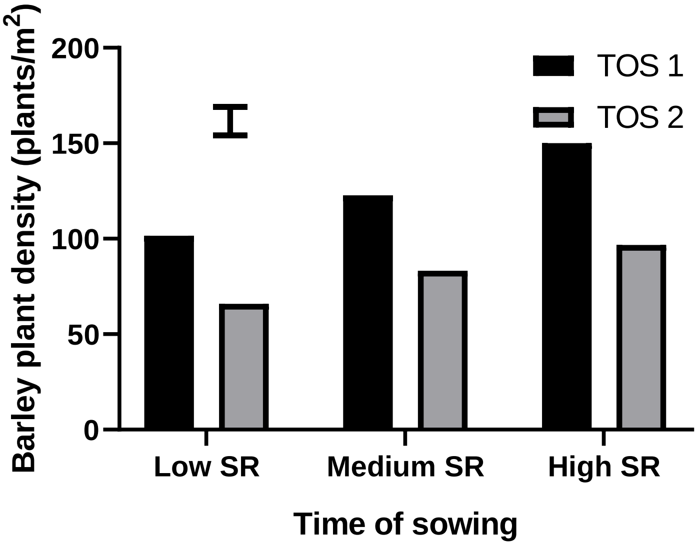

Figure 1. The effect of barley seed rate on barley plant density at the two times of sowing. The vertical bar represents LSD (P=0.05).

Brome grass seedbank, plant density and recruitment

Brome grass seedbank at the Marrabel trial site 1737 ± 110 seeds/m^2. The three replicates had a fairly uniform and similar seedbank of brome ranging from 1665 seeds/m^2 to 1841 seeds/m^2. Therefore, the experimental site had a moderate but uniform infestation of brome grass, which was ideal for the trial.

Brome grass plant density was significantly affected by the time of sowing (P=0.018) and the herbicide treatments (P<0.001). As there was almost 4 week interval between TOS 1 and TOS 2, this allowed greater emergence of brome grass seedlings before the sowing of the TOS 2. Consequently, barley sown at TOS 2 had 48% lower brome grass infestation (107.9 plants/m^2) than in TOS 1 (207 plants/m^2; Figure 2). However, brome grass is a highly competitive weed which is likely to cause significant yield losses when present at such high densities.

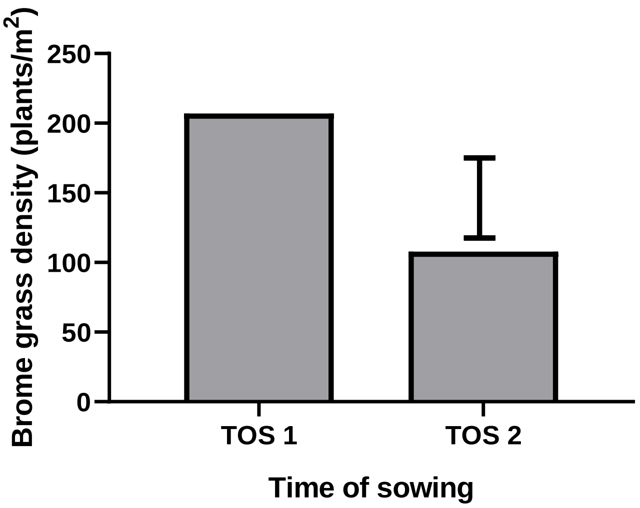

Figure 2. The effect of delayed sowing on brome grass plant density in barley. The vertical bar represents LSD (P=0.05).

As expected, herbicide treatments had a significant (P<0.001) effect on brome grass density. When averaged across the sowing time and seed rates, the treatment of Treflan + Avadex was only moderately effective and reduced brome grass density by 36% (173 plants/m^2) relative to the untreated control (271 plants/m^2). In contrast, the same pre-emergent treatment (Treflan + Avadex) followed by Intervix reduced brome grass density by 90% (28 plants/m^2).

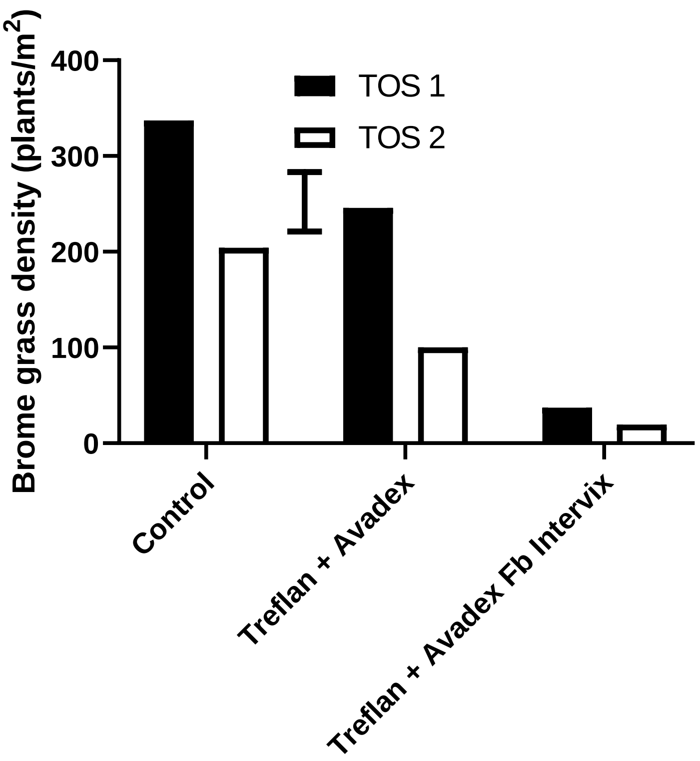

Figure 3. The effect of time of sowing on brome grass control by the herbicide treatments. The vertical bar represents LSD (P=0.05).

There was a significant interaction between the time of sowing x herbicide treatments (P=0.026). This interaction appears to be mainly associated with improved activity of Treflan + Avadex in TOS 2 compared to TOS 1 (Figure 3). In TOS 2, the week before crop sowing received 32.4 mm and would have created moist seedbed and suitable conditions for the activity of trifluralin and triallate. In contrast, the total rainfall for the week before and week after sowing for TOS 1 was only 8.8 mm.

Brome grass recruitment from the seedbank was significantly affected only by the herbicide treatment. This result would be expected based on high herbicide efficacy presented in Figure 3. The recruitment from the seedbank in the untreated control was 22% in barley TOS 1 and 23% in TOS 2. Dry conditions during 2018 may have reduced pre-sowing losses from the seedbank. Consequently, establishment of brome grass plants from the seedbank was very similar. It would be interesting to explore this relationship in a season with greater rainfall.

Brome grass panicle density

Even though delayed sowing caused a large reduction in brome grass plant density (P<0.001) present in barley (Figure 2), there was no difference in brome grass panicle density between the two times of crop sowing. Surprisingly, TOS 1 had a slightly lower panicle density (87 panicles/m^2) than TOS 2 (99 panicles/m^2). These results highlight 2 main points: (a) barley crop sown early was superior in its competitive ability and was able to suppress the higher brome grass density present; and (b) dry seasonal conditions experienced resulted in large mortality in brome grass in TOS 1. In TOS 1 brome plant density of 207 plants/m^2 only produced 87 panicles/m^2, which means there was >50% plant mortality. In contrast, 108 plants/m^2 present in TOS 2 produced 99 panicles/m^2 which means 92% survival of brome grass plants in TOS 2.

There was a highly significant effect of the herbicide treatment ($P<0.001$) and sowing time x herbicide ($P<0.001$) on brome grass panicle production (Figure 4). In the untreated control, greater competitive ability of barley when sown early resulted in a significantly lower brome panicles than the crop sown on June 19 (TOS 2). However, consistent with brome plant density data, Treflan + Avadex treatment showed greater efficacy in TOS 2 than in TOS 1, which is likely to be related to higher rainfall before sowing in TOS 2. However, the use of Intervix following the pre-emergent treatment with Treflan + Avadex was able to completely prevent brome grass panicle production in both sowing times. Therefore, the best time of sowing at this site was entirely determined by barley grain yield. However, TOS 1 would place greater selection pressure for resistance on Intervix.

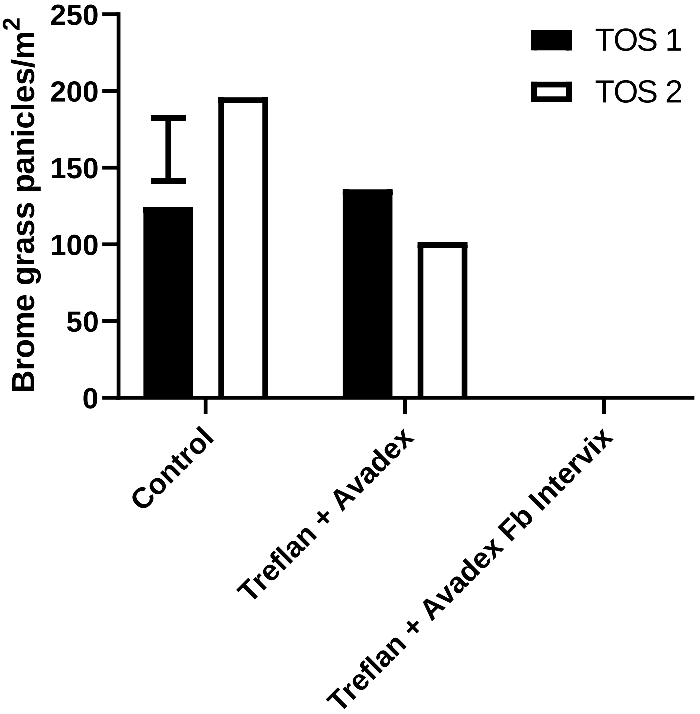

Figure 4. The effect of the interaction between time of sowing and herbicide treatments on brome grass panicle density. The vertical bar represents LSD ($P=0.05$).

Brome grass seed production

Brome grass seed production was significantly affected by the herbicide treatment ($P<0.001$) and the interaction between sowing time and herbicide treatment ($P=0.007$). The interaction between these two management factors was almost entirely due to significantly lower brome grass seed production in the untreated control in TOS 1 than in TOS 2 (Figure 5). This result appears to be associated with the lower panicle density in the control plots in TOS 1 than TOS 2. It appears barley is more competitive with brome grass under early sowing than sown later in much colder conditions in mid-June. Imidazolinone herbicide Intervix was extremely effective and completely prevented brome grass seed production in this trial. The cheaper herbicide option of Treflan + Avadex was weak against brome grass which was reflected in 6258 seeds/m^2 in TOS 1 and 5667 seeds/m^2 in TOS 2.

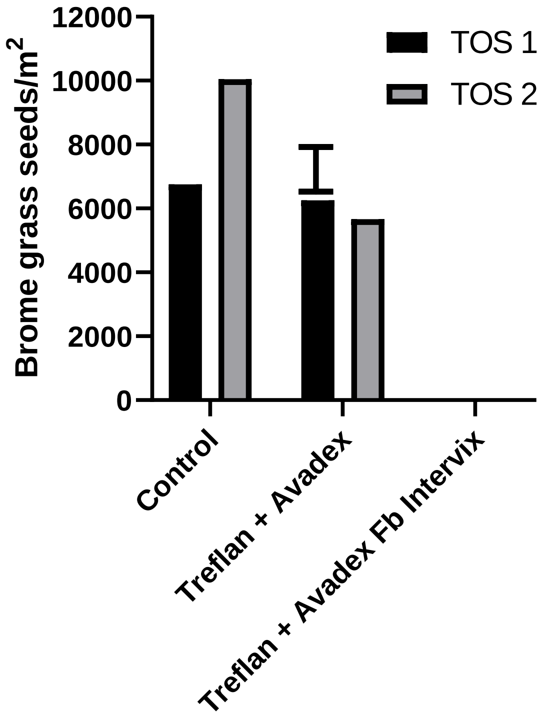

Figure 5. The effect of the interaction between time of sowing and herbicide treatments on brome grass seed production. The vertical bar represents LSD (P=0.05).

Barley grain yield

When averaged across seed rates and herbicide treatments, the time of sowing barley had a significant effect on its grain yield (P=0.011). TOS 1 produced 940 kg/ha greater barley grain yield than TOS 2 (Figure 6). There was also a significant interaction between barley seed rate and the time of sowing (P=0.022). This interaction is a reflection of the absence of any response to crop seed rate in TOS 1 but grain yield increased significantly in TOS 2 when seed rate increased from low to medium (Figure 7). Barley sown in May would have been growing in a warmer soil whereas TOS 2 experienced lower establishment and cooler conditions during early growth. Herbicide treatment also had a significant effect on crop yield (Figure 8), which was reflected in a significant increase in grain yield by the herbicide treatments compared to the untreated control. The post-emergence application of Intervix to the crop treated with Treflan + Avadex further increased barley grain yield by 872 kg/ha. These results are consistent with the trends in brome grass density and panicle production (Figure 3 and 4). The untreated control plots produced 40% lower grain yield than the Intervix treatment, which completely controlled brome grass. These results also highlight the strong competitive ability of brome grass in cereals.

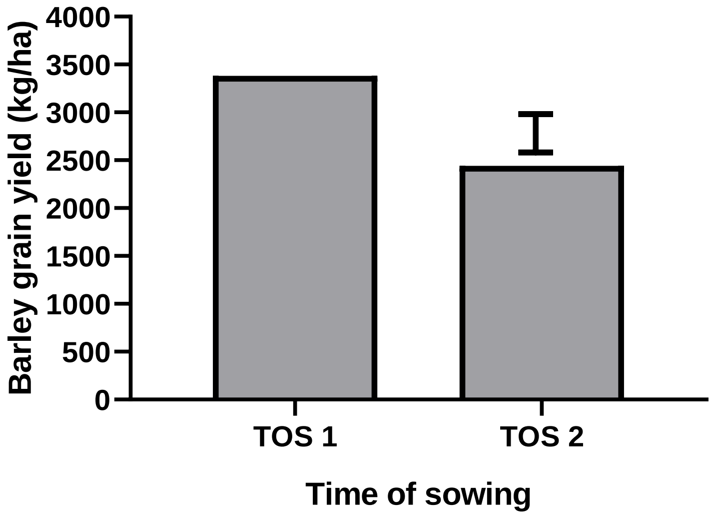

Figure 6. The effect of time of sowing barley on its grain yield. The vertical bar represents LSD (P=0.05).

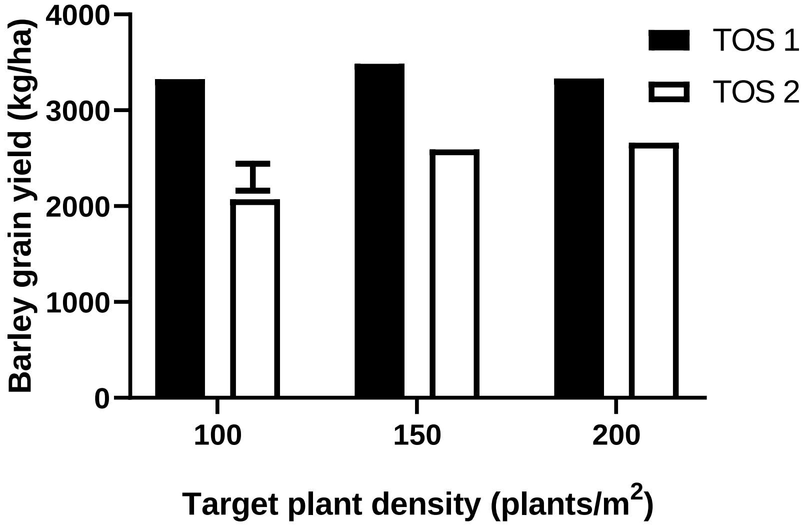

Figure 7. The effect of interaction between the time of sowing and target barley density. The vertical bar represents the LSD (P=0.05).

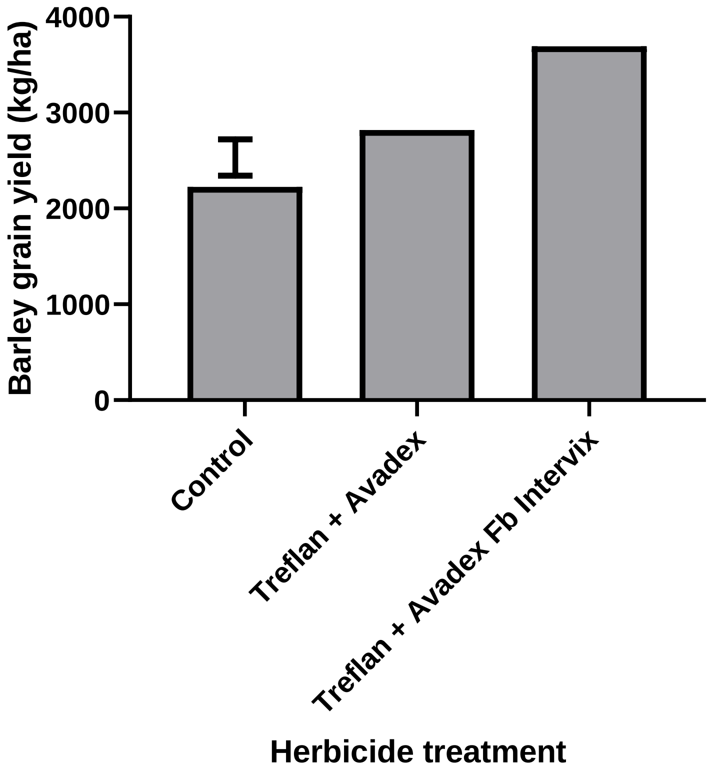

Figure 8. The effect of herbicide treatments averaged across the two sowing dates and three herbicide treatments on barley grain yield. The vertical bar represents the LSD (P=0.05).