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

Abstract
A field trial was undertaken at Riverton in 2019 to investigate combinations of wheat sowing time, seed rate and herbicide treatments to control brome grass. The average seedbank of brome grass at the site was 1863 ± 303 seeds/m^2. Brome grass at this site was effectively controlled (>80%) by delaying sowing by 2 weeks, with treatment effects from herbicide and wheat seed rate treatment only being significant in the early sown plots, where brome grass density was high. These results clearly indicate that brome grass population present at this site has very low seed dormancy and germinates readily after the season opening rains and can be effectively controlled with a knockdown herbicide. Wheat grain yield results reflected the level of brome grass control with herbicide and wheat seed rate treatments improving yields significantly as brome suppression improved. These treatments did not have a significant effect on yield when sowing was delayed because brome was effectively controlled by the knockdown herbicides. In the early sown crop when brome grass was controlled effectively with Intercept®, the 2 week delay in sowing caused a 9% reduction in wheat yield.

Introduction

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. This is one of reasons why farmers who have adopted early seeding have reported excellent results in crop yield and weed suppression. 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 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 Riverton was undertaken to investigate factorial combinations of sowing time, seed rate and herbicides on the management of brome grass in wheat.

Methods

This field trial investigated combinations of the following management tactics.

1. **Sowing time (2)**: early May 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) Trifluralin® 2 L/ha + Avadex Xtra® 2 L/ha IBS
(ii) Sakura® 118 g/ha + Avadex Xtra® 2L/ha IBS
(iii) Trifluralin® 2 L/ha + Avadex Xtra® 2 L/ha IBS fb Intercept® 750 mL/ha post

Variety: Razor 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, wheat grain yield.

Trial Management

Table 1. Key management operations undertaken.

Operation	Details
Location	Riverton, SA
Seedbank soil cores	26 April, 2019
Plot size	1.83 m x 10 m
Seeding date	TOS 1: 16 May, 2019 TOS 2: 31 May, 2019
Fertiliser	At sowing – DAP + zinc + impact (18:20:0:2) @ 100 kg/ha, Urea (46:0:0) @ 100kg/ha mid tiller and Z31 (separately for TOS)
Variety	Razor Cl plus wheat
Seeding rate	100 seeds/m^2 150 seeds/m^2 200 seeds/m^2
Herbicides	Pre-emergents: 15 May and 30 May, 2019 (applied just before seeding) Post emergent: tillering stage Trifluralin (480 g/L trifluralin) 2 L/ha + Avadex Xtra (500 g/L triallate) 2 L/ha IBS Sakura (850 g/kg pyroxasulfone) 118 g/ha + Avadex Xtra (500 g/L triallate) 2L/ha IBS Trifluralin (480 g/L trifluralin) 2 L/ha + Avadex Xtra (500 g/L triallate) 2 L/ha IBS fb Intercept (imazamox 33g/L + imazapyr 15g/L) 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 2019, annual rainfall received at Riverton was 39% below the long-term average and the growing season rainfall was 33% below the long-term average. The rainfall received in May and June was greater than the long-term average with all other months being well below the long-term average (Table 2).

Table 2. Rainfall received at Riverton in 2019 and the long-term average for the site.

	Rainfall (mm)	
Month	**2019**	**Long-term rainfall**
Jan	1.4	22.0
Feb	9.0	20.8
Mar	8.8	22.7
Apr	4.4	39.8
May	71.6	57.7
Jun	69.4	63.6
Jul	42.2	63.9
Aug	42.8	66.9
Sep	27.8	58.8
Oct	8.6	47.0
Nov	20.4	34.3
Dec	13.8	27.3
Annual total	320.2	524.8
GSR total	266.8	397.7

Results and Discussion

Wheat plant density

There was a significant interaction between sowing time and wheat seed rate (Figure 1). Three distinct wheat plant densities were achieved by seed rate treatments. Similar wheat establishment was achieved for each seed rate for both TOS, only the high seed rate was significantly higher (9%) in TOS 2.

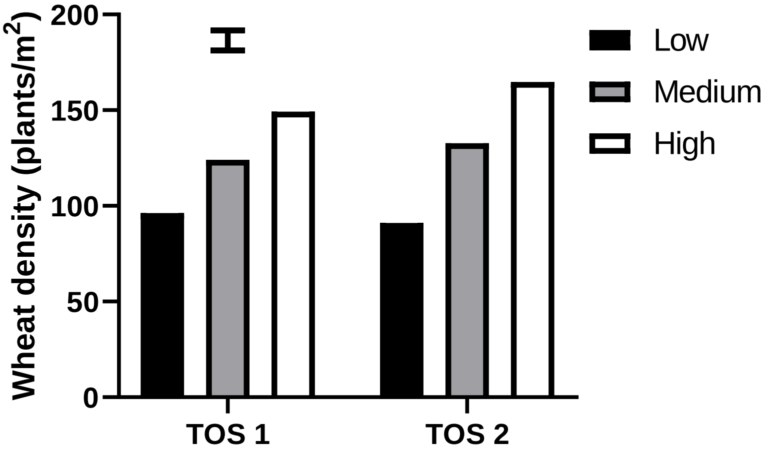

Figure 1. The effect of seed rate on wheat plant density in time of sowing 1 (TOS 1) and time of sowing 2 (TOS 2). The vertical bar represents the LSD (P=0.05).

Brome grass plant density and seedbank

The average seedbank of brome grass at the site was 1863 ± 303 seeds/m^2. Brome grass plant density was significantly influenced by the time of sowing (P<0.001), herbicide treatment (P<0.001) and the interaction between the time of sowing and herbicide (P=0.013; Figure 2). Sowing time had a large influence on brome density, with 2 week delay in sowing reducing in-crop brome grass density from 458 to 81 brome plants/m^2 (82% reduction). A similar response was observed in the Sakura + Avadex treatment where brome plant density was reduced from 256 to 20 brome plants/m^2, a 92% reduction from the short delay in sowing. However, the most effective treatment of Treflan + Avadex fb Intercept treatment did not benefit from delayed sowing with 36 and 38 brome plants/m^2 in TOS 1 and TOS 2, respectively. This large reduction in brome grass density from the short delay in sowing wheat indicates presence of low seed dormancy in brome population at this site, which germinates rapidly after the season opening rainfall events. These early germinating brome plants can be easily controlled by the knockdown herbicide application. When sowing early, highly effective herbicide treatments such as Treflan + Avadex fb intercept would be needed to achieve effective brome control.

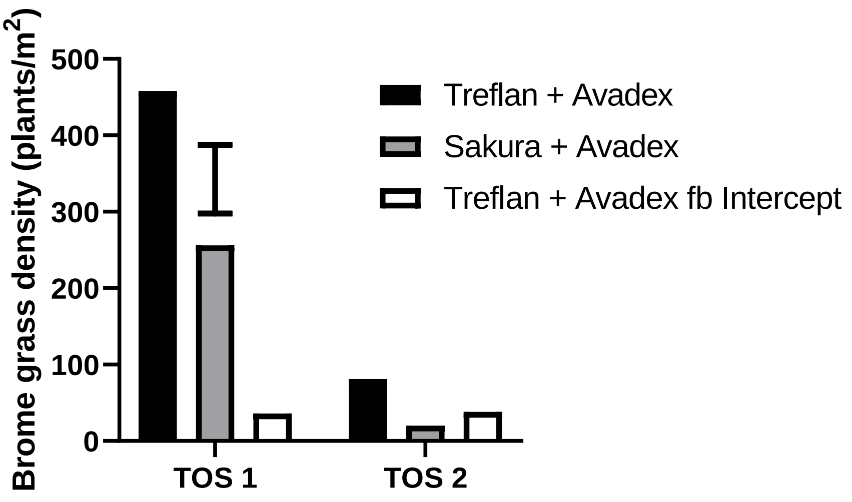

Figure 2. The interaction between the time of sowing and herbicide treatments (P=0.001) on brome grass plant density. The vertical bar represents the LSD (P=0.05).

The recruitment index (RI) of brome grass (the ratio between brome grass seedbank and plant density) was also significantly affected by the interaction between the time of sowing and herbicide treatments (P=0.013). RI was significantly reduced in Treflan + Avadex and the Sakura + Avadex herbicide treatments when crop sowing was delayed. Delayed sowing had no effect on Treflan + Avadex fb Intercept herbicide treatment (Figure 3), which was extremely effective in both times of sowing. RI at the site ranged from 0.011 (i.e. 1.1% recruitment) up to 0.290 (29% recruitment) in the TOS, herbicide and wheat seed rate treatments applied.

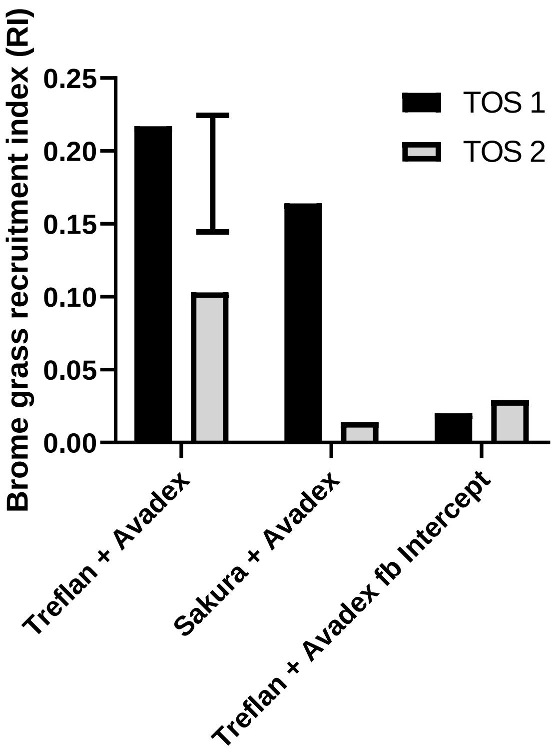

Figure 3. The interaction between the time of sowing and herbicide treatments (P=0.001) on brome grass RI. The vertical bar represents the LSD (P=0.05).

Brome grass panicle density and seed production

Brome panicle density was significantly influenced by the time of sowing (P=0.039), herbicide treatment (P<0.001), interaction between the TOS and wheat seed rate (P=0.05), as well as the interaction between the TOS and herbicide treatment (P<0.001). When averaged across the wheat seed rate and herbicide treatments, the two week delay in seeding at Riverton reduced brome panicles from 244 to 42 brome panicles/m^2 (83% reduction). Wheat seed rate also had a significant effect on brome panicle density in TOS 1 with medium and high seed rates reducing brome panicles by 24% and 47% respectively compared to the low seed rate (Figure 4). These results clearly highlight the benefit of higher crop density for weed suppression.

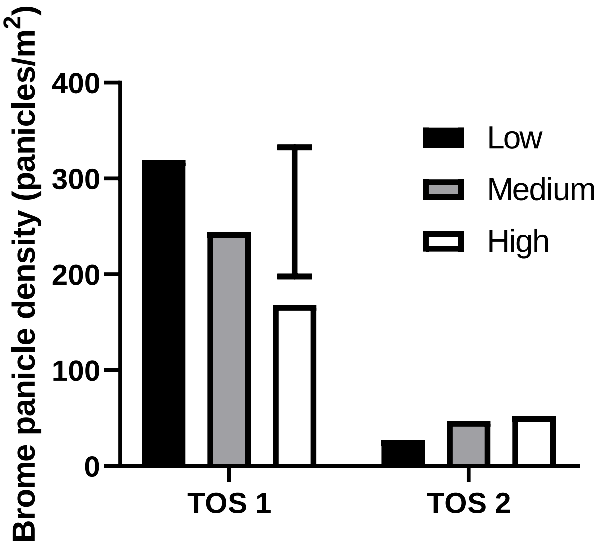

Figure 4. The effect of interaction between the time of sowing and wheat seed rate treatments (P=0.005) on brome grass panicle density. The vertical bar represents the LSD (P=0.05).

Consistent with the results for brome plant density, the interaction between TOS and herbicide treatment reduced brome panicle density by 76% for Treflan + Avadex and 93% for Sakura + Avadex treatments when sowing was delayed by 2 weeks. However, there was no such reduction in Treflan + Avadex fb Intercept, which provided effective brome grass control in both times of sowing (Figure 5).

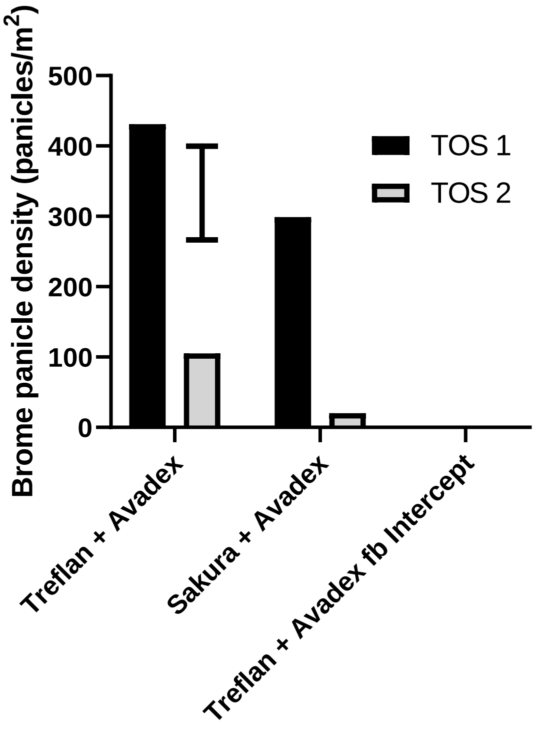

Figure 5. The effect of interaction between the time of sowing and herbicide treatments (P<0.001) on brome grass panicle density. The vertical bar represents the LSD (P=0.05).

Consistent with the trends observed for brome panicle density, brome grass seed production was also significantly influenced by the time of sowing (P=0.05), herbicide treatments (P<0.001) and the interaction between the TOS and the herbicide treatments (P<0.001). Brome grass seed production was reduced by 86% when wheat sowing was delayed by two weeks. For the Treflan + Avadex treatment, brome grass produced 20712 brome seeds/m^2 in TOS 1, which was reduced to 4483 brome /m^2 in TOS 2 (78% reduction). A similar response was observed for Sakura + Avadex treatment where brome seed production was reduced by delayed sowing from 16576 (TOS 1) to 884 (TOS 2) seeds/m^2 (95% reduction). Consistent with the results for brome panicle density, the Treflan + Avadex fb Intercept treatment was extremely effective in both times of sowing and did not benefit from delayed sowing with a brome grass seed production of 7 and 0 brome grass seeds/m^2 for TOS 1 and TOS 2 respectively (Figure 6). When weaker herbicide options are utilised, delayed sowing would be recommended at this site to achieve effective brome control through the use of knockdown herbicides.

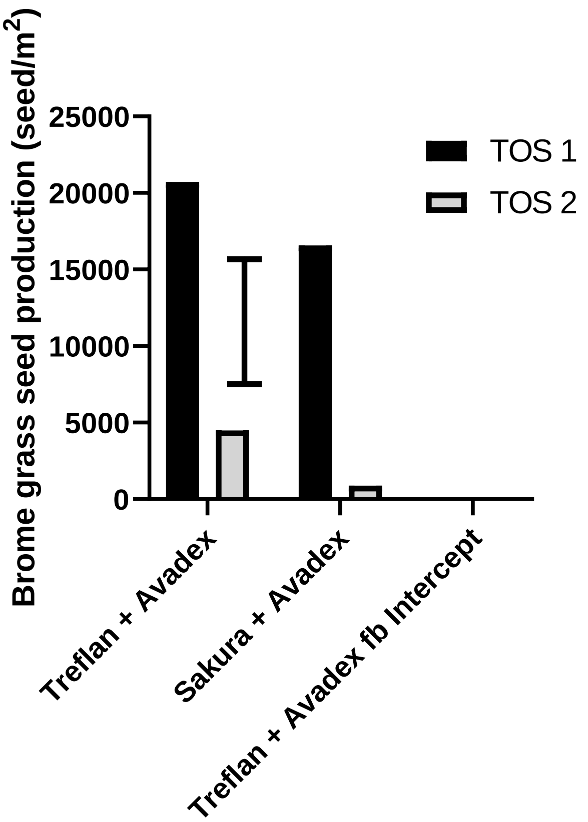

Figure 6. The effect of interaction between the time of sowing and herbicide treatments ($P<0.001$) on brome grass seed production. The vertical bar represents the LSD ($P=0.05$).

Wheat grain yield

Wheat grain yield at Riverton ranged from 1.426 t/ha to 4.468 t/ha with a site mean yield of 3.551 t/ha. Wheat grain yield was significantly influenced by wheat seed rate ($P=0.014$), with the highest seed rate yielding 14% higher than the lowest seed rate (Figure 7). Higher crop seed rate was also shown to reduce brome grass panicle density (Figure 4).

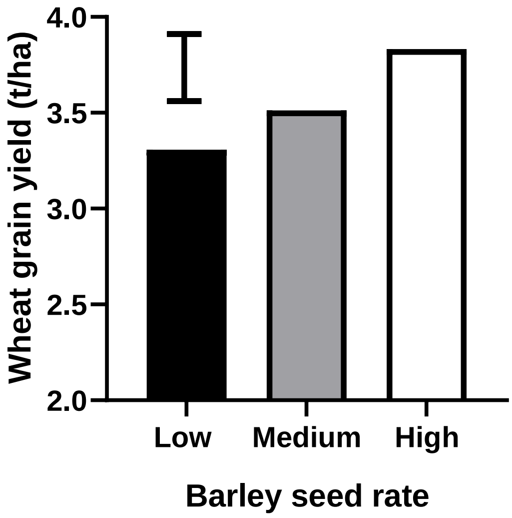

Figure 7. The effect of wheat seed rate treatments (P=0.014) on wheat grain yield. The vertical bar represents the LSD (P=0.05).

Herbicide treatment had a significant effect on wheat grain yield (P<0.001). The interaction between TOS and herbicide treatment also had a significant effect on wheat grain yield (P<0.001). In TOS 1, when Intercept (POST) was applied after Treflan +Avadex IBS (2.391 t/ha), wheat grain yield increased by 45% to 4.319 t/ha (Figure 8). The comparison of the same treatments in TOS 2 showed only 15% increase in wheat grain yield from 3.418 t/ha to 3.929 t/ha. The large difference in brome plant density in Treflan +Avadex IBS between TOS 1 and TOS 2 (Figure 2) is the most likely reason for these yield responses. Unlike TOS 1, TOS 2 did not have any significant difference in wheat yield between herbicide treatments as brome grass was effectively controlled by the knockdown herbicide due to the low seed dormancy in this brome grass population. As brome grass was almost completely controlled in Treflan + Avadex fb Intercept (Figure 6), comparison of TOS 1 and TOS 2 for this treatment provides an indication of the yield penalty from delayed sowing. The wheat yield for this herbicide treatment was 4.319 t/ha for TOS 1 as compared to 3.929 t/ha for TOS 2, which equates to 9% yield penalty (Figure 8) or 130 kg/ha/week.

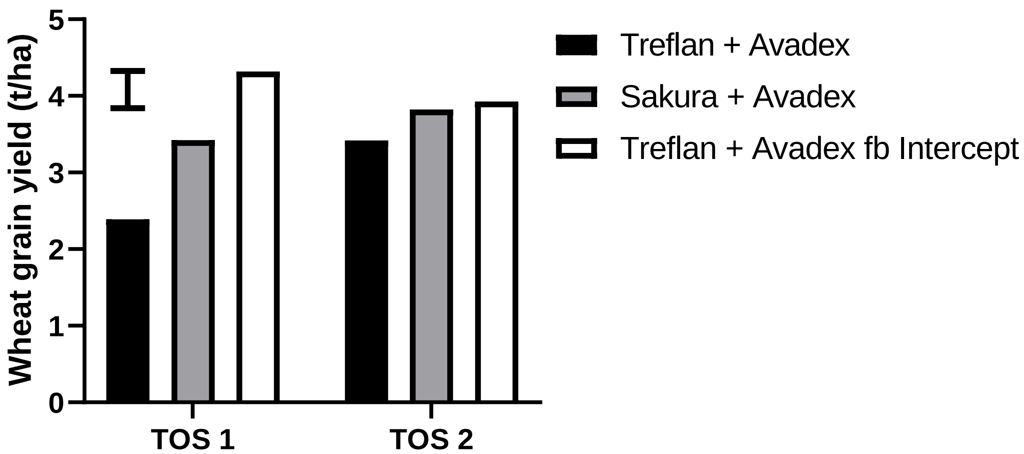

Figure 8. The effect of interaction between the time of sowing and herbicide treatments (P<0.001) on wheat grain yield. The vertical bar represents the LSD (P=0.05).

Wheat grain size (1000 grain weight) was significantly influenced by the herbicide treatments with Treflan + Avadex fb Intercept treatment (37.5 g/1000 grains) was significantly larger than Sakura + Avadex (35.6 g/1000 grains) and Treflan + Avadex (34.8 g/1000 grains). Therefore, treatments that provided the highest brome grass control and wheat yield also had the greatest wheat grain mass.

Wheat grain contamination with brome grass seed

Brome seed contamination in the wheat grain sample was significantly influenced by sowing time (P<0.001), herbicide treatment (P<0.001), the interaction between TOS and wheat seed rate (P=0.008), and also the interaction between TOS and herbicide treatment (P<0.001). The interaction between TOS and wheat seed rate on brome contamination (Figure 9) was consistent with brome panicle production (Figure 4). Here significant improvements were achieved when increasing wheat seed rate in TOS 1 where brome weed pressure was high. There was no significant effect of wheat seed rate in brome contamination in TOS 2 where brome weed pressure was low. The interaction between TOS and herbicide on brome seed contamination in wheat grain sample (Figure 10), was consistent with the results for brome grass control (Figure 6).

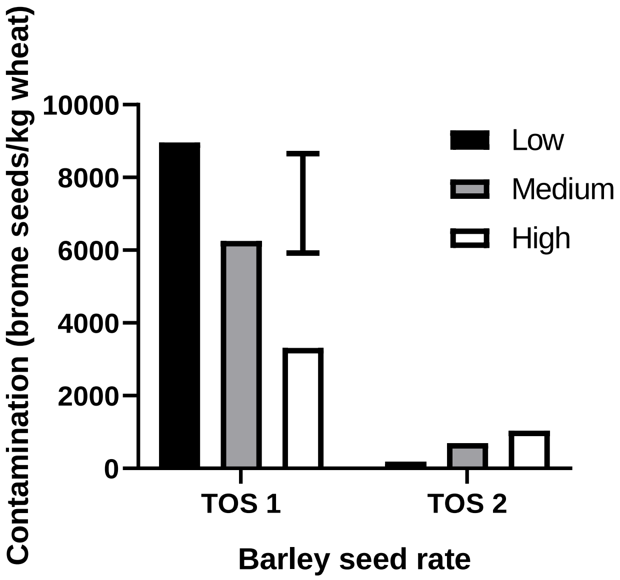

Figure 9. The effect of interaction between the time of sowing and wheat seed rate treatments (P<0.001) on brome grass seed contamination in wheat grain sample. The vertical bar represents the LSD (P=0.05).

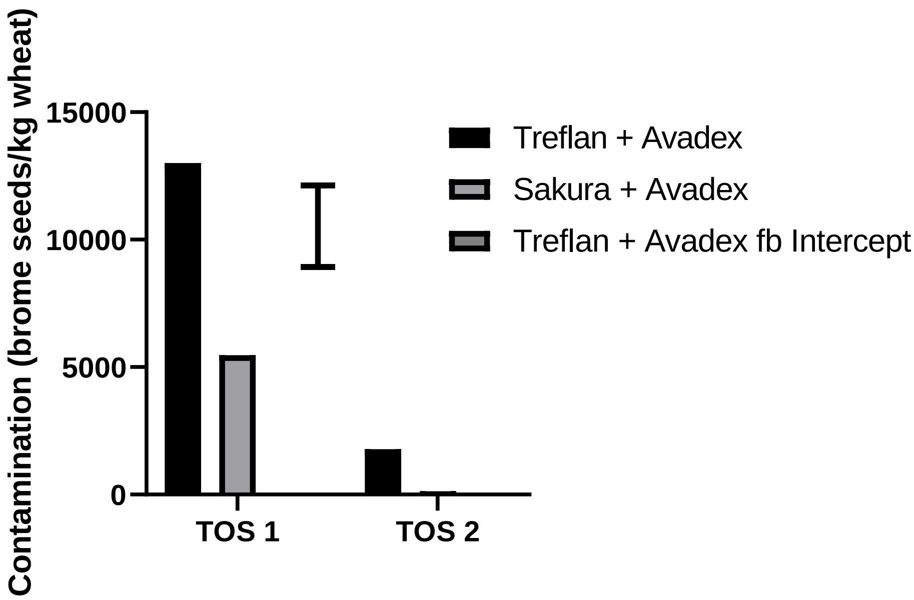

Figure 10. The effect of interaction between the time of sowing and herbicide treatments (P<0.001) on brome grass seed contamination in wheat grain sample. The vertical bar represents the LSD (P=0.05).