Effect of sowing time x seed rate x herbicides on ryegrass management in barley

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Location
McEvoy Road, paddock N20
Rainfall
Av. Annual: 282 mm
Av. GSR: 202 mm
2019 Total: 235 mm
2019 GSR: 216 mm
Paddock history
2019: Self-regenerating medic pasture, barley in trial
2018: Mace wheat
2017: Self-regenerating medic pasture
2016: Mace wheat
Yield limiting factors
Annual Ryegrass

Key messages

- **There were large weed control benefits of delayed sowing of barley at Minnipa. However, when a highly effective pre-emergent herbicide was applied the benefit of delayed sowing was negligible.**
- **In barley a three week delay in sowing time did not significantly reduce grain yield as it did in the previous year in wheat. Lower yield penalty in barley from delayed sowing may be related to its earlier maturity and more competitive nature compared to wheat.**

Why do the trial?

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 a 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 Minnipa was undertaken to investigate factorial combinations of sowing time, seed rate and herbicides on the management of annual ryegrass in barley.

How was it done?

This field trial investigated combinations of the management tactics in Table 1.

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 Minnipa was 17% below the long-term average but the growing season rainfall was 7% above the long-term average. The rainfall received in May, June and September was greater than the long-term average with all other months being well below the long-term average (Table 2).

What happened?

Barley plant density

There was a significant interaction between sowing time and wheat seed rate (Figure 1). As a general trend seedling establishment efficiency reduced as seed rate increased. Only in the high seeding rate, barley establishment differed significantly between TOS 1 and TOS 2.

Annual ryegrass plant density and seedbank

The average seedbank of annual ryegrass (ARG) at the site was 4168 ± 411 seeds/m^2. ARG plant density was significantly influenced by the time of sowing (P=0.002), herbicide treatment (P<0.001) and the interaction between the time of sowing and herbicide (P=0.001).

There was a large impact of the 3 week delay in seeding barley on ARG plant density (Figure 2). This was particularly evident in the untreated control in which ARG density decreased from 676 plants/m^2 in TOS 1 to 379 plants/m^2 in TOS 2 (44% reduction).

Table 1. Key management operations undertaken at Minnipa trial site in 2019.

Operation	Details
Location	Minnipa, SA
Seedbank soil cores	11 April
Plot size	1.5 m x 10 m
Seeding date	TOS 1: 4 May TOS 2: 24 May
Fertiliser	At sowing – DAP (18:20:0:0) @ 60 kg/ha
Variety	Compass barley
Seeding rate	100 seeds/m^2 150 seeds/m^2 200 seeds/m^2
Herbicides	4 May and 24 May (applied just before seeding) Boxer Gold 2.5 L/ha IBS Trifluralin 1.5 L/ha IBS Control (knockdown treatment only)
Trial design	split plot design with three replicates
Measurements	pre-sowing weed seedbank, crop density, weed density, ARG spike density, ARG seed production, wheat grain yield

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

Month	Rainfall (mm)	
	2019	Long-term rainfall
Jan	4.0	11.2
Feb	1.2	13.2
Mar	0.2	18.9
Apr	11.0	15.5
May	57.2	28.2
Jun	56.4	37.1
Jul	15.6	35.0
Aug	19.2	38.7
Sep	53.6	27.5
Oct	3.4	19.9
Nov	7.0	16.9
Dec	6.4	18.9
Annual total	235.2	282.3
GSR total	216.4	201.9

This large response of ARG density to delayed sowing is most likely related to rainfall events in May, which would have caused weed emergence (Figure 2). The reduction in ARG plant density due to delayed seeding was also apparent in the herbicide treatments (Figure 2) with both herbicide treatments providing greater efficacy in TOS 2. However in the most effective herbicide treatment (Boxer Gold), high level of ARG control was also achieved in TOS 1, making any benefits from delayed sowing redundant.

Annual ryegrass spike density and seed production

ARG spike density was significantly influenced by the time of sowing (P=0.019), herbicide treatment (P<0.001) as well as the interaction between the TOS and herbicide treatment (P=0.006). However, there was no effect of barley seed rate on ARG spike density (P=0.237). When averaged across the seed rates and herbicide treatments, the three week delay in seeding at Minnipa reduced ARG spike density from 194 spikes/m^2 to 123 spikes/m^2 (37% reduction). Herbicide treatments were also more effective in TOS 2, with Boxer Gold treatment resulting in the production of only 27 ARG spikes/m^2 (Figure 3). These results clearly highlight the ability of Boxer Gold to manage moderate levels of ARG seedbank under adequate soil moisture conditions, reducing ARG seed production (spikes/m^2) by 83% and 87% for TOS 1 and TOS 2, respectively.

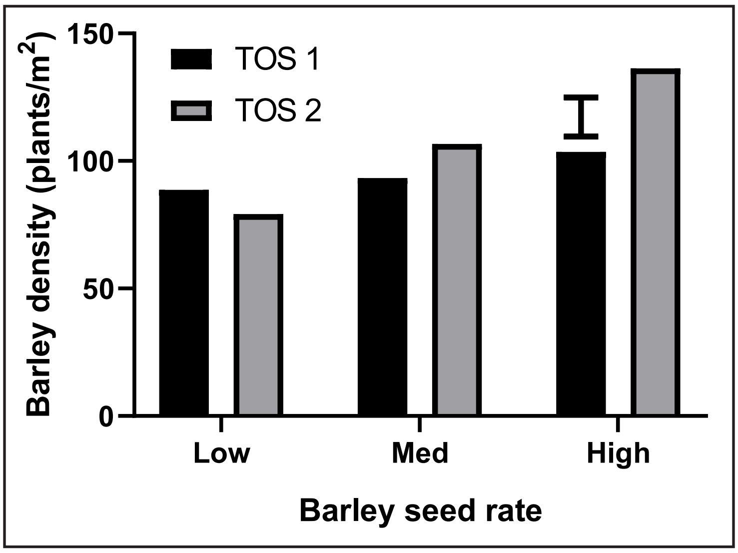

Figure 1. The effect of seed rate on barley plant density in time of sowing 1 (TOS 1) and time of sowing 2 (TOS 2). The vertical bar represents the LSD (P=0.05).

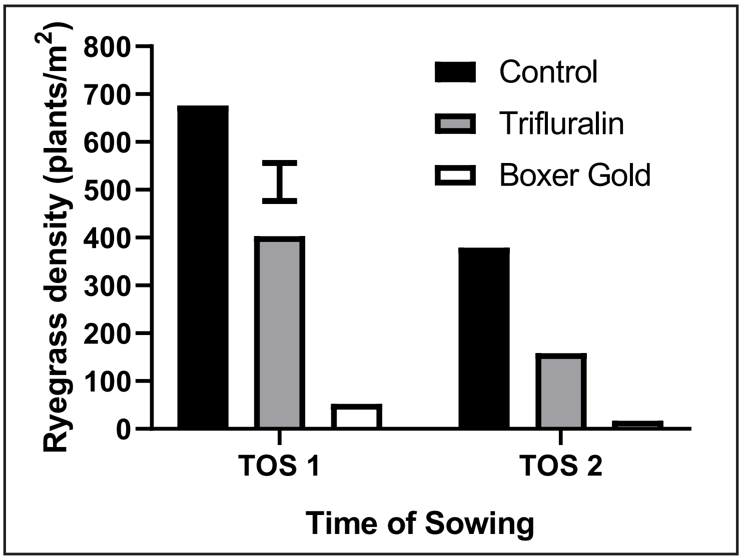

Figure 2. The interaction between the time of sowing and herbicide treatments (P=0.001). The vertical bar represents the LSD (P=0.05).

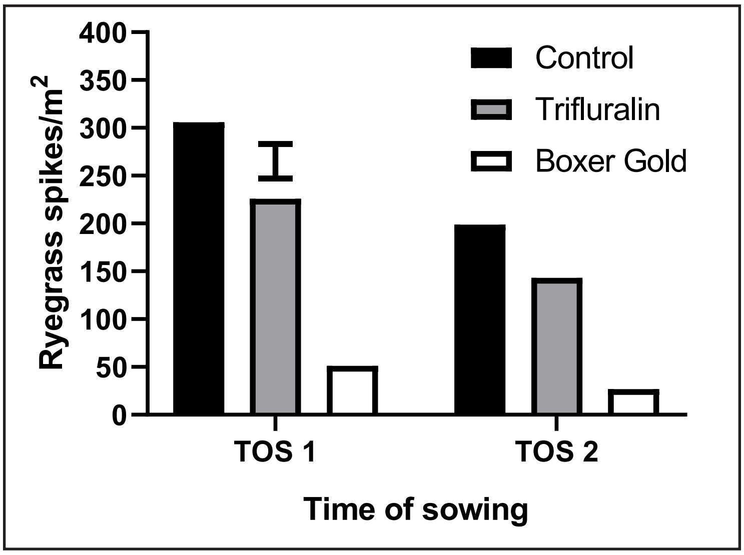

Figure 3. The effect of interaction between the time of sowing and herbicide treatments (P=0.006) on ARG spike density. The vertical bar represents the LSD (P=0.05).

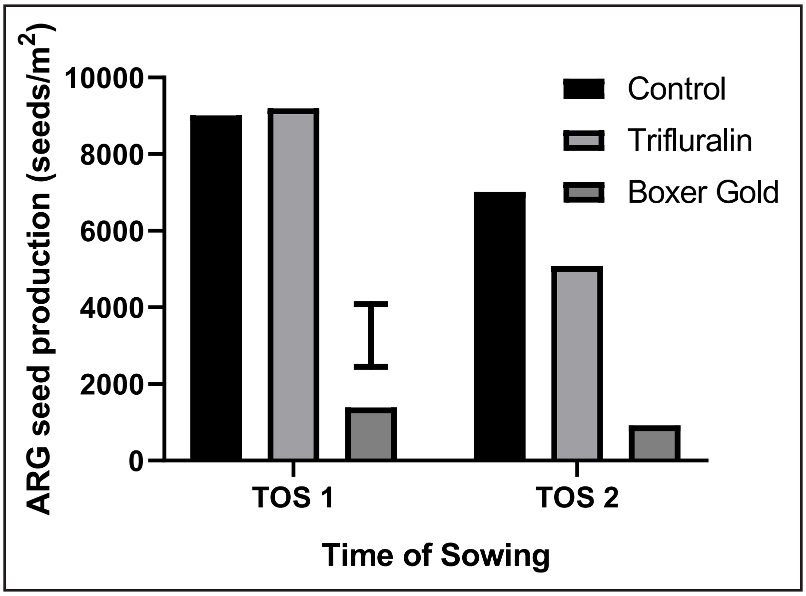

Figure 4. The effect of interaction between the time of sowing and herbicide treatments (P=0.021) on ARG seed production. The vertical bar represents the LSD (P=0.05).

Barley grain yield

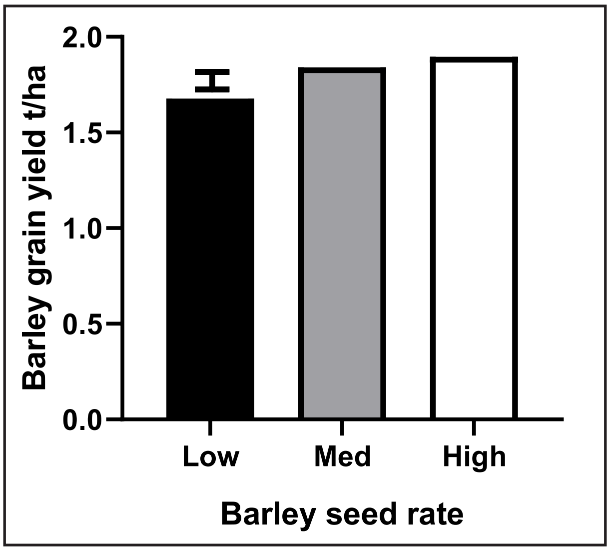

Figure 5. The effect of barley seed rate treatments (P<0.001) on barley grain yield. The vertical bar represents the LSD (P=0.05).

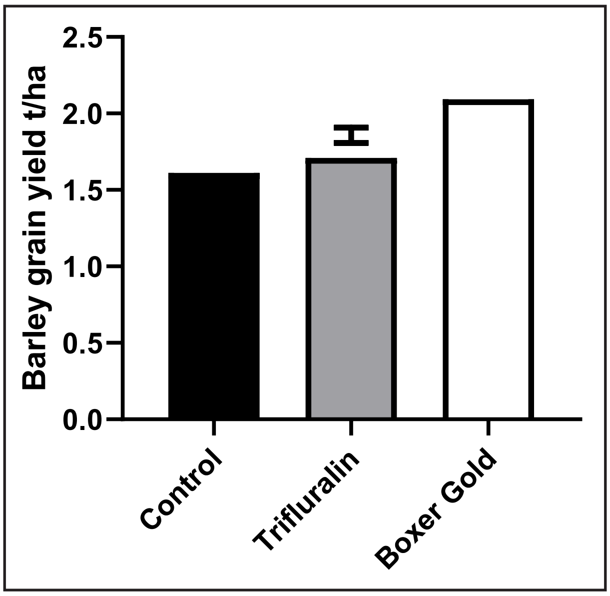

Figure 6. The effect of herbicide treatments (P<0.001) on barley grain yield. The vertical bar represents the LSD (P=0.05).

Barley grain yield at Minnipa was not significantly influenced by the time of sowing (P=0.644). However, crop seed rate (P<0.001), and herbicide treatment (P<0.001) had a significant effect on grain yield. Averaged across all treatments barley produced a grain yield of 1.81 t/ha (site mean yield). Barley yield increased as seed rate increased from low (1.68 t/ha), to medium (1.84 t/ha) and high (1.90 t/ha) (Figure 5). Even though the increase in barley yield as seed rate increased from low to high was only 13%, it was statistically significant. This increase in barley grain yield with increased seed rate was identical to the trend seen in wheat in 2018. Increased seed rate had no influence on percentage of barley screenings, however percentage of barley screenings reduced with increased control of annual ryegrass with herbicides.

Herbicide treatment had a significant effect on barley grain yield with Trifluralin (1.71 t/ha) increasing grain yield by 6% and Boxer Gold (2.09 t/ha) by 30% compared to the control (1.61 t/ha) (Figure 6). These yield gains equate to approximately a 2:1 return on the cost of trifuralin and a 3.75:1 return on Boxer Gold.

What does this mean?

Consistent with the trends observed for ARG spike density, ARG seed production was also significantly influenced by the time of sowing (P=0.023), herbicide treatments (P<0.001) and the interaction between the TOS and the herbicide treatments (P=0.021). Pre-emergence herbicides performed better in TOS 2 where the density of ARG plants had been reduced by the delay in seeding (Figure 4). The Trifluralin treatment produced 9192 ARG seeds/m^2 for TOS 1 and 5078 ARG seeds/m^2 for TOS 2. However in the most effective herbicide treatment (Boxer Gold), high level of ARG control was also achieved in TOS 1, making any benefits from delayed sowing redundant. While these Boxer Gold treatments all set less seed than the 2019 ARG soil seed bank, a substantial ARG infestation would be expected in 2020. In contrast to ARG plant density and spike density, trifluralin in TOS 1 produced a similar amount of ARG seeds to the untreated control. This means that the plants that survived the trifluralin tillered well and adequately compensated for the reduced plant density.

The three week delay in sowing barley did not significantly reduce its grain yield (P=0.64). This is in complete contrast to a similar wheat trial in 2018 where a 6 week delay in sowing reduced wheat grain yield by 36%. This could partially be explained by the longer sowing delay due to drier May and June in 2018. However, this lack of impact on barley yield from this delay in sowing was most likely related to the greater early vigour of barley and its earlier maturity than wheat. This is also evident by how much an effective herbicide improved grain yield with the most effective herbicide improving wheat yield in 2018 by up to 44% and 30% for barley in 2019 despite much heavier weed pressure.

These results give some confidence in using a short delay in sowing barley to achieve ARG control compared to wheat, however the cost of that delay would be dependent on seasonal conditions and the variety of barley grown. Compass barley grown in this trial is quite weed competitive and well adapted to a shorter growing season. If a long season barley like Planet or less competitive barley like Spartacus was grown the cost from the delay in seeding could be larger.

Acknowledgement

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